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GLENCORE MERAFE VENTURE OPERATIONS: PROPOSED KROONDAL HERITAGE AND GRAVES ASSESSMENT PROJECT, GLENCORE KROONDAL MINE, BOJANALA PLATINUM DISTRICT MUNICIPALITY, NORTH WEST PROVINCE

Archaeological Impact Assessment

Prepared for: **Glencore Merafe Venture Operations**

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ARCHAEOLOGICAL IMPACT ASSESSMENT (AIA) OF DEMARACTED AREAS ON A PORTION OF KROONDAL 304JQ FOR THE PROPOSED KROONDAL HERITAGE AND GRAVES ASSESSMENT AT THE GLENCORE KROONDAL MINE, NORTH WEST PROVINCE

Conducted on behalf of:
Glencore Merafe Venture Operations

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DECLARATION

I, Nelius Le Roux Kruger, declare that –

- I act as the independent specialist;
- I am conducting any work and activity relating to the proposed Kroondal Heritage and Graves Assessment Project in an objective manner, even if this results in views and findings that are not favourable to the client;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have the required expertise in conducting the specialist report and I will comply with legislation, including the relevant Heritage Legislation (National Heritage Resources Act no. 25 of 1999, Human Tissue Act 65 of 1983 as amended, Removal of Graves and Dead Bodies Ordinance no. 7 of 1925, Excavations Ordinance no. 12 of 1980), the Minimum Standards: Archaeological and Palaeontological Components of Impact Assessment (SAHRA, AMAFA and the CRM section of ASAPA), regulations and any guidelines that have relevance to the proposed activity;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signature of specialist
Company: Exigo Sustainability
Date: 25 January 2019

EXECUTIVE SUMMARY

This report details the results of an Archaeological Impact Assessment (AIA) and further GPR (Ground Penetrating Radar) assessments for the proposed Kroondal Heritage and Graves Assessment Project on a portion of Kroondal 304JQ in the Bojanala Platinum District Municipality, Northwest Province. The project investigated the potential presence of previously undetected burials at the site of a storage yard at the Glencore Kroondal Mine east of Rustenburg. The report includes background information on the area's archaeology, its representation in Southern Africa, and the history of the larger area under investigation, survey methodology and results as well as heritage legislation and conservation policies. A copy of the report will be supplied to the South African Heritage Resources Agency (SAHRA), the Burial Grounds and Graves (BGG) Unit of SAHRA and recommendations contained in this document will be reviewed.

Project Title	Kroondal Heritage and Graves Assessment Project
Project Location	S25.713419° E27.320255°
1:50 000 Map Sheet	2527CB
Farm Portion / Parcel	Kroondal 304JQ
Magisterial District / Municipal Area	Bojanala Platinum District Municipality
Province	Northwest Province

The history of the western Northwest Province is reflected in a rich archaeological landscape. The interaction between the climate, geology, topography, and the fauna and flora in the Bankeveld over millions of years has established a milieu in which prehistoric and historic communities thrived. Stone Age habitation occurs in places, mostly in open air locales or in sediments alongside rivers or pans. Bantu-speaking groups moved into this area during the last millennia and these presumably Batswana groups, who practised herding, agriculture, metal working and trading, found a suitable living environment during the Late Iron Age times at around AD 1500-1800. It was here that their chiefdoms flourished. The settlements of these early Batswana chiefdoms are characterised by an impressive and elaborate stone-built tradition. Hundreds of sites were built along the bases of the granite hills. The accounts of early travellers provide important data on the fauna, flora and inhabitants of the Waterberg. The observations of travellers, missionaries and hunters who traversed the region throughout the 18th and the 19th centuries constitute a source of implicit ethnography on the late presence of hunting and gathering groups, the African farmers and in moving colonists. The region is also rich in rock art. European farmers, settling in the area since the middle of the 19th century, divided up the landscape into a number of farms. In recent years an urban element developed, expanding at a rapid rate, largely as a result of mining development in the region.

At the Kroondal Mine, a number of burials on the mine property were not located during an initial Phase I Heritage Impact Assessment (Pistorius, 2010). Known to the mine, these burials were fenced off prior to the construction of a concrete storage yard in the vicinity of the graves. A claim was recently made that additional human burials might be present at the site of the storage yard and a site survey and GPR assessment were conducted to establish if human remains are indeed present at the site of the yard and in its surroundings. During the site survey, the presence of a number if burials within the fenced cemetery could be confirmed and the remains of a Historical Period settlement were located in association with the graves at the site. The GPR

survey detected anomalies which could be attributed to buried human remains but the survey could not conclusively establish the existence of outlaying and previously undetected burials. However, a careful analysis of historical aerial imagery and archive maps indicated that large parts of the Kroondal Mine plant – and particularly areas subject to this assessment – were constructed directly over an area that used to be an informal settlement in the mid 1900's, where houses, livestock enclosures and agricultural fields were clearly visible. This correlates with the presence of homestead remains located during the site survey. It is therefore highly likely that pervious undetected human remains could occur in areas surrounding the fenced graveyard, including the storage yard.

The following general recommendations are made based on these observations at the site.

- The site assessment verified the existence of an informal cemetery directly north of the storage yard and the footpath in the project area. It can be assumed that the burials belong to individuals who resided at the nearby homesteads visible on historical aerial photographs and topographic maps and it is highly likely that previously undetected burials might occur in surrounding areas; even though the GPR survey could not provide conclusive evidence to this effect. As the cemetery probably dates to at least 1955, the burial site as well as any possible graves in its surrounds is protected heritage resources according to the NHRA with a high significance rating. It is primarily recommended that an exclusion zone (demarcated by GPR focus areas) be implemented around the known burials in order to protect any possible previously undetected human burials. It is advisable that the storage yard and core shed be decommissioned and included in this exclusion zone in order to ensure the preservation of the site. The exclusion zone should be fenced off, access control should be applied and a site notice indicating the heritage status of the site should be erected. A further heritage conservation buffer of 100m, as required by SAHRA, should be implemented around the exclusion zone. A site management plan detailing strict site management conservation measures should be implemented. Should these mitigation measures proved unachievable, the relocation of all burials should be conducted. This measure should be undertaken by a qualified archaeologist, and in accordance with relevant legislation and subject to any local and regional provisions and laws and by-laws pertaining to human remains. A full social consultation process should occur in conjunction with the mitigation of cemeteries and burials **(see Addendum 2).** Should any additional graves or human remains be encountered io the project area, these should be reported to the Heritage Specialist and relevant authorities (SAHRA) and development activities should be suspended until the site has been inspected by the Specialist.
- The remains of a settlement area consisting of homestead remains occur in the project area along the rock outcrop north of the storage yard. The settlement remains date to the early Historical Period and the structures are older than 60 years. As the site falls within the recommended exclusion zone (see above), no further action is recommended in terms of heritage mitigation should this zone be effected. However, should the site be impacted in any way, a permit for the destruction of any of the features will be required, subject to terms stipulated in the NHRA
- Considering the localised nature of heritage remains, the general monitoring of the development progress by an ECO is recommended for all stages of the project. Should any subsurface palaeontological, archaeological or historical material, or burials be exposed during construction

activities, all activities should be suspended and the archaeological specialist should be notified immediately

This report details the methodology, limitations and recommendations relevant to these heritage areas, as well as areas of proposed development. It should be noted that recommendations and possible mitigation measures are valid for the duration of the development process, and mitigation measures might have to be implemented on additional features of heritage importance not detected during this Phase 1 assessment (e.g. uncovered during the construction process).

NOTATIONS AND TERMS/TERMINOLOGY

Absolute dating: Absolute dating provides specific dates or range of dates expressed in years.

Archaeological record: The archaeological record minimally includes all the material remains documented by archaeologists. More comprehensive definitions also include the record of culture history and everything written about the past by archaeologists.

Artefact: Entities whose characteristics result or partially result from human activity. The shape and other characteristics of the artefact are not altered by removal of the surroundings in which they are discovered. In the Southern African context examples of artefacts include potsherds, iron objects, stone tools, beads and hut remains.

Assemblage: A group of artefacts recurring together at a particular time and place, and representing the sum of human activities.

Context: An artefact's context usually consists of its immediate *matrix*, its *provenience* and its *association* with other artefacts. When found in *primary context*, the original artefact or structure was undisturbed by natural or human factors until excavation and if in *secondary context,* disturbance or displacement by later ecological action or human activities occurred.

Cultural Heritage Resource: The broad generic term *Cultural Heritage Resources* refers to any physical and spiritual property associated with past and present human use or occupation of the environment, cultural activities and history. The term includes sites, structures, places, natural features and material of palaeontological, archaeological, historical, aesthetic, scientific, architectural, religious, symbolic or traditional importance to specific individuals or groups, traditional systems of cultural practice, belief or social interaction.

Cultural landscape: A cultural landscape refers to a distinctive geographic area with cultural significance.

Cultural Resource Management (CRM): A system of measures for safeguarding the archaeological heritage of a given area, generally applied within the framework of legislation designed to safeguard the past.

Feature: Non-portable artefacts, in other words artefacts that cannot be removed from their surroundings without destroying or altering their original form. Hearths, roads, and storage pits are examples of archaeological features

Impact: A description of the effect of an aspect of the development on a specified component of the biophysical, social or economic environment within a defined time and space.

Lithic: Stone tools or waste from stone tool manufacturing found on archaeological sites.

Matrix: The material in which an artefact is situated (sediments such as sand, ashy soil, mud, water, etcetera). The matrix may be of natural origin or human-made.

Midden: Refuse that accumulates in a concentrated heap.

Microlith: A small stone tool, typically knapped of flint or chert, usually about three centimetres long or less.

Monolith: A geological feature such as a large rock, consisting of a single massive stone or rock, or a single piece of rock placed as, or within, a monument or site.

Phase 1 CRM Assessment: An Impact Assessment which identifies archaeological and heritage sites, assesses their significance and comments on the impact of a given development on the sites. Recommendations for site mitigation or conservation are also made during this phase.

Phase 2 CRM Study: In-depth studies which could include major archaeological excavations, detailed site surveys and mapping / plans of sites, including historical / architectural structures and features. Alternatively, the sampling of sites by collecting material, small test pit excavations or auger sampling is required. Mitigation / Rescue involves planning the protection of significant sites or sampling through excavation or collection (in terms of a permit) at sites that may be lost as a result of a given development.

Phase 3 CRM Measure: A Heritage Site Management Plan (for heritage conservation), is required in rare cases where the site is so important that development will not be allowed and sometimes developers are encouraged to enhance the value of the sites retained on their properties with appropriate interpretive material or displays.

Provenience: Provenience is the three-dimensional (horizontal and vertical) position in which artefacts are found. Fundamental to ascertaining the provenience of an artefact is *association,* the co-occurrence of an artefact with other archaeological remains; and *superposition,* the principle whereby artefacts in lower levels of a matrix were deposited before the artefacts found in the layers above them, and are therefore older.

Random Sampling: A probabilistic sampling strategy whereby randomly selected sample blocks in an area are surveyed. These are fixed by drawing coordinates of the sample blocks from a table of random numbers.

Scoping Assessment: The process of determining the spatial and temporal boundaries (i.e. extent) and key issues to be addressed in an impact assessment. The main purpose is to focus the impact assessment on a manageable number of important questions on which decision making is expected to focus and to ensure that only key issues and reasonable alternatives are examined. The outcome of the scoping process is a Scoping Report that includes issues raised during the scoping process, appropriate responses and, where required, terms of reference for specialist involvement.

Site (Archaeological): A distinct spatial clustering of artefacts, features, structures, and organic and environmental remains, as the residue of human activity. These include surface sites, caves and rock shelters, larger open-air sites, sealed sites (deposits) and river deposits. Common functions of archaeological sites include living or habitation sites, kill sites, ceremonial sites, burial sites, trading, quarry, and art sites,

Stratigraphy: This principle examines and describes the observable layers of sediments and the arrangement of strata in deposits

Systematic Sampling: A probabilistic sampling strategy whereby a grid of sample blocks is set up over the survey area and each of these blocks is equally spaced and searched.

Trigger: A particular characteristic of either the receiving environment or the proposed project which indicates that there is likely to be an *issue* and/or potentially significant *impact* associated with that proposed development that may require specialist input. Legal requirements of existing and future legislation may also trigger the need for specialist involvement.

LIST OF ABBREVIATIONS

Abbreviation	Description
ASAPA	Association for South African Professional Archaeologists
AIA	Archaeological Impact Assessment
BP	Before Present
BCE	Before Common Era
BGG	Burial Grounds and Graves
CRM	Culture Resources Management
EIA	Early Iron Age (also Early Farmer Period)
EIA	Environmental Impact Assessment
EFP	Early Farmer Period (also Early Iron Age)
ESA	Earlier Stone Age
GIS	Geographic Information Systems
GPR	Ground Penetrating Radar
HIA	Heritage Impact Assessment
ICOMOS	International Council on Monuments and Sites
K2/Map	K2/Mapungubwe Period
LFP	Later Farmer Period (also Later Iron Age)
LIA	Later Iron Age (also Later Farmer Period)
LSA	Later Stone Age
MIA	Middle Iron Age (also Early later Farmer Period)
MRA	Mining Right Area
MSA	Middle Stone Age
NHRA	National Heritage Resources Act No.25 of 1999, Section 35
PHRA	Provincial Heritage Resources Authorities
SAFA	Society for Africanist Archaeologists
SAHRA	South African Heritage Resources Association
YCE	Years before Common Era (Present)

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1 BACKGROUND

1.1 Scope and Motivation

Exigo Sustainability was commissioned by Glencore Merafe Venture Operations for an Archaeological Impact Assessment (AIA) study and further GPR (Ground Penetrating Radar) assessments for the proposed Kroondal Heritage and Graves Assessment Project on a portion of Kroondal 304JQ in the Bojanala Platinum District Municipality, Northwest Province. The project investigated the potential presence of previously undetected burials at the site of a storage yard at the Glencore Kroondal Mine east of Rustenburg. The rationale of this AIA was to establish the potential presence of human remains and, if present grade impacts to such resources in order to provide heritage management measures for the site and the resources. Ultimately, the study will act to advise the developer on measures that will align to objectives of development with successful and legally compliant heritage management.

1.2 Project Direction

Exigo Sustainability's expertise ensures that all projects be conducted to the highest international ethical and professional standards. As archaeological specialist for Exigo Sustainability, Mr Neels Kruger acted as field director for the project; responsible for the assimilation of all information, the compilation of the final consolidated AIA report and recommendations in terms of heritage resources on the demarcated project areas. Mr Kruger is an accredited archaeologist and Culture Resources Management (CRM) practitioner with the Association of South African Professional Archaeologists (ASAPA), a member of the Society for Africanist Archaeologists (SAFA) and the Pan African Archaeological Association (PAA) as well as a Master's Degree candidate in archaeology at the University of Pretoria.

1.3 Project Brief and Previous HIA

The author was contracted to undertake a heritage assessment at the Glencore Kroondal Chrome Mine on portions of the farm Kroondal 304JQ in the North-West Province. At present only underground mining remains as the old opencast areas have been closed and rehabilitated.

The Mine undertook a Phase I Heritage Impact Assessment[1] in 2010 but at the time, the study revealed no sensitive heritage receptors. However, it later became apparent that a number of burials existed on the mine property and these were fenced off prior to the construction of a concrete storage yard in the vicinity of the graves. A claim was recently made that human burials might be present at the site of the storage yard and the HIA was commissioned to establish if human remains are present at the site of yard and in its surroundings.

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[1] Pistorius, J.C.C. 2010. A Phase | Heritage Impact Assessment (HIA) study for X Strata Alloy's Kroondal Chrome Mine on the farm Kroondal 304JQ near Rustenburg in the Central Bankeveld of the North-West Province.

Figure 1-1: Aerial map indicating the extent of the proposed Kroondal Heritage and Graves Assessment Project.

1.4 Terms of Reference

Heritage specialist input into the Environmental Impact Assessment (EIA) process is essential to ensure that, through the management of change, developments still conserve our heritage resources. It is also a legal requirement for certain development categories which may have an impact on heritage resources. Thus, EIAs should always include an assessment of heritage resources. The heritage component of the EIA is provided for in the **National Environmental Management Act, (Act 107 of 1998)** and endorsed by section 38 of the **National Heritage Resources Act (NHRA - Act 25 of 1999)**. In addition, the NHRA protects all structures and features older than 60 years, archaeological sites and material and graves as well as burial sites. The objective of this legislation is to ensure that developers implement measures to limit the potentially negative effects that the development could have on heritage resources. Based hereon, this project functioned according to the following **terms of reference for** heritage specialist input**:**

- By means of site surveys as well as non-intrusive methods (GPR), provide a description of the surface and subterranean nature and context of the project area;
- Provide a possible cultural context and provenience for surface and subterranean heritage resources in the project area and in the surrounding landscape, if present, by means of a detailed desktop background study and review of existing heritage information;
- Assess the nature and degree of significance of such resources within the area, if present, and establish possible heritage conservation buffers;
- Assess any current and future developmental impacts heritage resources, of present, and apply these in a standard impact assessment matrix;
- Propose heritage management measures for heritage mitigation, management and permitting for future development activities in the project area, where applicable.
- Drawing on findings from the heritage assessment, guide any development planning in terms of infrastructure layout and potential heritage impacts and recommend further heritage assessment requirements for the project based on the heritage landscape and its estimated sensitivity.
- Liaise and consult with the relevant Heritage Resources authorities (SAHRA, SAHRA BGG) with regards to the site investigation, recommendations pertaining to possible management and mitigation measures as well as the final decision (ROD) for the project heritage landscape.

1.5 CRM: Legislation, Conservation and Heritage Management

The broad generic term *Cultural Heritage Resources* refers to any physical and spiritual property associated with past and present human use or occupation of the environment, cultural activities and history. The term includes sites, structures, places, natural features and material of palaeontological, archaeological, historical, aesthetic, scientific, architectural, religious, symbolic or traditional importance to specific individuals or groups, traditional systems of cultural practice, belief or social interaction.

1.5.1 Legislation regarding archaeology and heritage sites

The South African Heritage Resources Agency (SAHRA) and its provincial offices aim to conserve and control the management, research, alteration and destruction of cultural resources of South Africa. It is therefore vitally important to adhere to heritage resource legislation at all times.

a. National Heritage Resources Act No 25 of 1999, section 35

According to the National Heritage Resources Act No 25 of 1999 (section 35) the following features are protected as cultural heritage resources:

a. Archaeological artifacts, structures and sites older than 100 years
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography
c. Objects of decorative and visual arts
d. Military objects, structures and sites older than 75 years
e. Historical objects, structures and sites older than 60 years
f. Proclaimed heritage sites
g. Grave yards and graves older than 60 years
h. Meteorites and fossils
i. Objects, structures and sites of scientific or technological value.

In addition, the national estate includes the following:

a. Places, buildings, structures and equipment of cultural significance
b. Places to which oral traditions are attached or which are associated with living heritage
c. Historical settlements and townscapes
d. Landscapes and features of cultural significance
e. Geological sites of scientific or cultural importance
f. Archaeological and paleontological importance
g. Graves and burial grounds
h. Sites of significance relating to the history of slavery
i. Movable objects (e.g. archaeological, paleontological, meteorites, geological specimens, military, ethnographic, books etc.)

With regards to activities and work on archaeological and heritage sites this Act states that:

"No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit by the relevant provincial heritage resources authority." (34. [1] 1999:58)

and

"No person may, without a permit issued by the responsible heritage resources authority-

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites. (35. [4] 1999:58)."

and

"No person may, without a permit issued by SAHRA or a provincial heritage resources agency-

(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;

(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority;

(c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) and excavation equipment, or any equipment which assists in the detection or recovery of metals (36. [3] 1999:60)."

b. Human Tissue Act of 1983 and Ordinance on the Removal of Graves and Dead Bodies of 1925

Graves and burial grounds are commonly divided into the following subsets:

a. ancestral graves
b. royal graves and graves of traditional leaders
c. graves of victims of conflict
d. graves designated by the Minister
e. historical graves and cemeteries
f. human remains

Graves 60 years or older are heritage resources and fall under the jurisdiction of both the National Heritage Resources Act and the Human Tissues Act of 1983. However, graves younger than 60 years are specifically protected by the Human Tissues Act (Act 65 of 1983) and Ordinance on Excavations (Ordinance no. 12 of 1980) as well as any local and regional provisions, laws and by-laws. Such burial places also fall under the jurisdiction of the National Department of Health and the Provincial Health Departments.

c. National Heritage Resources Act No 25 of 1999, section 35

This act (Act 107 of 1998) states that a survey and evaluation of cultural resources must be done in areas where development projects, that will change the face of the environment, will be undertaken. The impact of the development on these resources should be determined and proposals for the mitigation thereof are made. Environmental management should also take the cultural and social needs of people into account. Any disturbance of landscapes and sites that constitute the nation's cultural heritage should be avoided as far as possible and where this is not possible the disturbance should be minimized and remedied.

1.5.2 Background to HIA and AIA Studies

South Africa's unique and non-renewable archaeological and palaeontological heritage sites are 'generally' protected in terms of the National Heritage Resources Act (Act No 25 of 1999, section 35) and may not be disturbed at all without a permit from the relevant heritage resources authority. Heritage sites are frequently

threatened by development projects and both the environmental and heritage legislation require impact assessments (HIAs & AIAs) that identify all heritage resources in areas to be developed. Particularly, these assessments are required to make recommendations for protection or mitigation of the impact of the sites. HIAs and AIAs should be done by qualified professionals with adequate knowledge to (a) identify all heritage resources including archaeological and palaeontological sites that might occur in areas of developed and (b) make recommendations for protection or mitigation of the impact on the sites.

A detailed guideline of statutory terms and requirements is supplied in Addendum 1.

2 REGIONAL CONTEXT

2.1 Area Location

The proposed Kroondal Heritage and Graves Assessment Project occurs at the Glencore Kroondal Mine on Kroondal 304JQ in the Bojanala Platinum District Municipality, Northwest Province. Glencore Kroondal Chrome Mine is located approximately 10km east of Rustenburg and 2km east of the Kroondal Township on portions of the farm Kroondal 304JQ in the North-West Province, generally at **S25.713419° E27.320255°.**

The area is situated approximately 10km east of Rustenburg.

The study areas appear on 1:50000 map sheet 2527CB (see Figure 2-1).

2.2 Area Description: Receiving Environment

The Bankeveld is a narrow strip of land between the northern part of South Africa and the centrally situated Highveld. This area is roughly demarcated by Krugersdorp in the south, the Pienaars River to the north, Bronkhorstspruit in the east and the Pilanesberg to the west. This region can be divided into three parallel ecozones, running from east to west, namely the grassveld of the southern Highveld and the northern Bushveld, with the Magaliesberg valley forming a central ecozone. The central ecozone of the Bankeveld is covered by older gabbro penetrated by younger volcanic magma which formed a series of pyramid-shaped granite hills from the Pilanesberg in the north-west to Wonderboom near Pretoria in the east. These hills, as part of the Magaliesberg valley, represent a unique ecozone characterised by grassveld, savanna veld and near wooded valleys. The region has abundant surface water supplies, because the local Pienaar, the Moretele, the Hex and the Apies Rivers all drain their waters into the Crocodile River.

2.3 Site Description

The project area is situated within the Glencore Kroondal Mine Complex and natural surroundings in the study area have largely been transformed. The storage yard and core shed is bordered to the south by mining roads and stock piles, to the west by parking areas and buildings and a small lawn and heavy vehicle parking bay occurs to the east. The area north of the storage yard contains the fenced cemetery with a rock outcrop and natural vegetation forming the northern periphery of the site. A water tower occurs at the site and a footpath bisects the project area from east to west. As such, the only remaining natural vegetation occurs along the rock outcrop directly north of the storage yard and core shed.

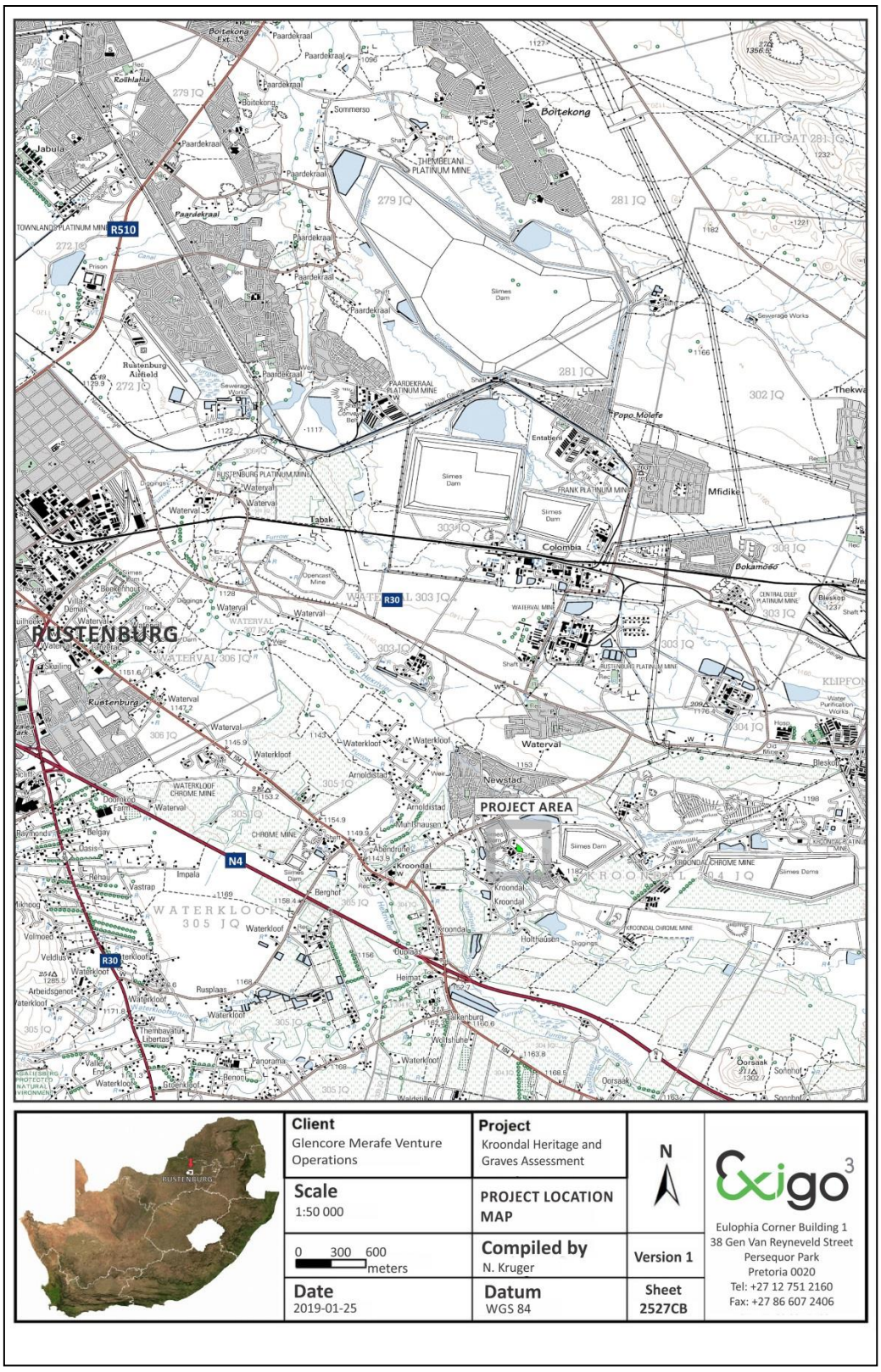

Figure 2-1: 1:50 00 Map representation of the location of the proposed Kroondal Heritage and Graves Assessment Project (sheet 2527CB).

Figure 2-2: Aerial map providing a regional context for the proposed Kroondal Heritage and Graves Assessment Project.

3 METHOD OF ENQUIRY

3.1 Sources of Information

Data from detailed desktop, aerial and field studies and swell as Ground Penetrating Radar (GPR) surveys were employed in order to sample surface areas systematically and to ensure a high probability of heritage site recording.

3.1.1 Desktop Study

The larger landscape of the Bankeveld has been well documented in terms of its archaeology and history. A desktop study was prepared in order to contextualize the proposed project within a larger historical milieu. Numerous academic papers and research articles supplied a historical context for the proposed project and archival sources, aerial photographs, historical maps and local histories were used to create a baseline of the landscape's heritage. In addition, the study drew on available unpublished Heritage Assessment reports to give a comprehensive representation of known sites in the study area. These included:

Hutten, M. 2013c. HIA for the proposed solar park development on the farm Aapieskruil near Koedoeskop, Limpopo Province. Compiled for: Jonk Begin Omgewingsdienste.

Fourie, W. 2012. Wachteenbietjesdraai 350 KQaAnd Kwaggashoek 345 KQ Heritage Impact Report on proposed mining activities of Project Phoenix. PGS Heritage Consultants

Fourie, W. 2014. Proposed Development of the Steenbokpan Extension 3 Township on the Remainder and Portions 1, 2, 3 and 4 of the Farm Grootdoorn 292 LQ, Portions 20, 22 and 25 of the Farm Theunispan 293 LQ and Portion 3 of the Farm Steenbokpan 295 LQ at Steenbokpan, Lephalale Local Municipality, Waterberg District, Limpopo Province. Client: Flexilor Properties (Pty) Ltd . PGS Heritage Consultants.

Pistorius, J.C.C. 1993. 'n Argeologiese impakstudie van die beoogde trajek van roete K16 in die Britsdistrik van Transvaal. (Mede-outeur, F.P. Coetzee). Verslag voorberei vir Liebenberg & Jenkins, Siviele Ingenieurs: Pretoria.

Pistorius, J.C.C. 1993. 'n Argeologiese ondersoek van 'n gedeelte van die plaas Elandsrand (570JQ) in die Britsdistrik van Transvaal. (Mede-outeur F.P. Coetzee). Verslag voorberei vir Wates, Meiring en Barnard, Siviele Ingenieurs: Johannesburg.

Pistorius, J.C.C. 1994. 'n Verslag van argeologiese opgrawings op die plaas Zwartkopjes of Roodekopjes (427JG) in die Britsdistrik van Transvaal. (Medewerkers: P. Nortje, K. Lubbe, W. van der Merwe). Verslag voorberei vir Liebenberg & Jenkins, Siviele Ingenieurs: Pretoria.

Pistorius, J.C.C. 1995. 'n Argeologiese verkenningsopname van 'n gedeelte van die beoogde Adis-Ikaros-Phoebus 400kV transmissielynkorridor tussen Garankuwa en Brits. Verslag voorberei vir die Transmissiegroep van Eskom: Megawattpark.

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Machouse Ontwikkelaars.

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3.1.2 Aerial Survey

Aerial photography is often employed to locate and study archaeological sites, particularly where larger scale area surveys are performed. This method was applied to assist the foot and automotive site surveys where depressions, variation in vegetation, soil marks and landmarks were examined. Specific attention was given to shadow sites (shadows of walls or earthworks which are visible early or late in the day), crop mark sites (crop mark sites are visible because disturbances beneath crops cause variations in their height, vigour and type) and soil marks (e.g. differently coloured or textured soil (soil marks) might indicate ploughed-out burial mounds). Attention was also given to moisture differences, as prolonged dampening of soil as a result of precipitation frequently occurs over walls or embankments. In addition, historical aerial photos obtained during the archival search were scrutinized and features that were regarded as important

in terms of heritage value were identified and if they were located within the boundaries of the project area they were physically visited in an effort to determine whether they still exist and in order to assess their current condition and significance. By superimposing high frequency aerial photographs with images generated with Google Earth as well as historical aerial imagery, potential sensitive areas were subsequently identified and geo-referenced. These areas served as referenced points from where further vehicular and pedestrian surveys were carried out. It is significant to note that historical aerial imagery indicates that large parts of the Kroondal Mine plant – and particularly areas subject to this assessment – were constructed over an area that used to be an informal settlement in the mid 1900's, where houses, livestock enclosures and agricultural fields are visible (see Figure 3-1).

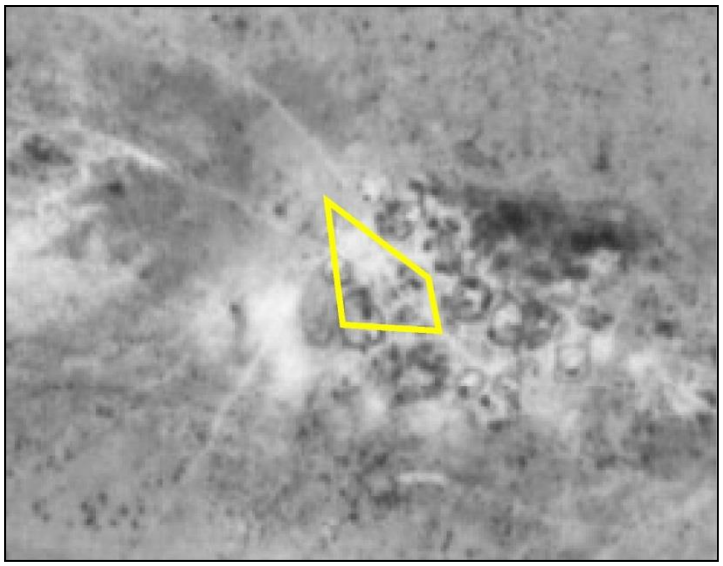

Figure 3-1: An aerial image of Kroondal dating to 1955 indicating the location of the project area (yellow outline) at the site of a number of homesteads during this time.

3.1.3 Mapping of sites

Merging data generated during the desktop study and the aerial survey, the Kroondal project area was plotted on historical and more recent 1:50 000 topographic maps of the Kroondal area. These maps were then superimposed on high definition aerial representations in order to graphically demonstrate the geographical locations and distribution of potentially sensitive landscapes. Similar to indications on historical aerial imagery, historical topographic maps indicate a small settlement where the Kroondal Mine plant – and particularly areas subject to this assessment – can today be found (see Figure 3-2).

3.1.4 Field Survey

Archaeological survey implies the systematic procedure of the identification of archaeological sites. An archaeological survey of the Kroondal mine site was conducted in December 2018. The process encompassed a systematic field survey in accordance with standard archaeological practice by which heritage resources are observed and documented. In order to sample surface areas systematically and to ensure a high probability of site recording, the project area was systematically surveyed on foot. GPS reference points identified during the aerial survey were also visited and random spot checks were made (see detail in previous section). Using a Garmin Montana GPS objects and structures of archaeological / heritage value were recorded and photographed with a Samsung Digital camera. Real time aerial orientation, by means of a mobile Google Earth application was also employed to investigate possible disturbed areas during the survey.

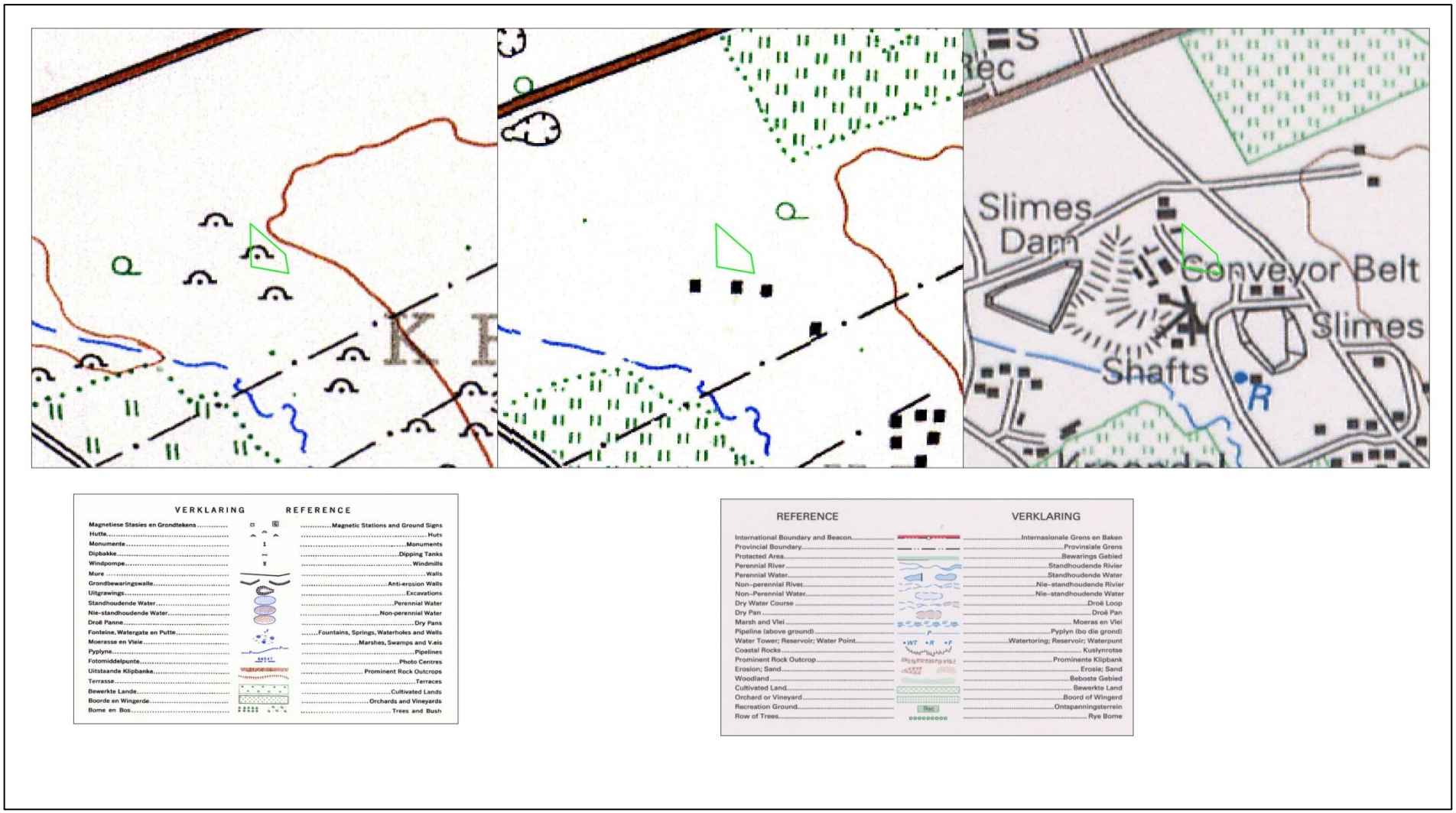

Figure 3-2: Historical topographic maps of Kroondal dating to 1968 (left), 1982 (centre) and 1996 (right) indicating the location of the project area (green outline) at the site of a number of homesteads during early years prior to the establishment of the mine.

3.1.5 GPR Survey

Please refer to Addendum 4 for the full GPR Report[2]

A ground-penetrating radar (GPR) survey was conducted at Glencore's Kroondal Mine Office Complex on 10 December 2018. The purpose of the survey was to detect possible unmarked burial sites (graves) linked to nearby communities. It should be noted that, due primarily to the interference of existing infrastructure on the site, effective GPR surveying was extremely difficult.

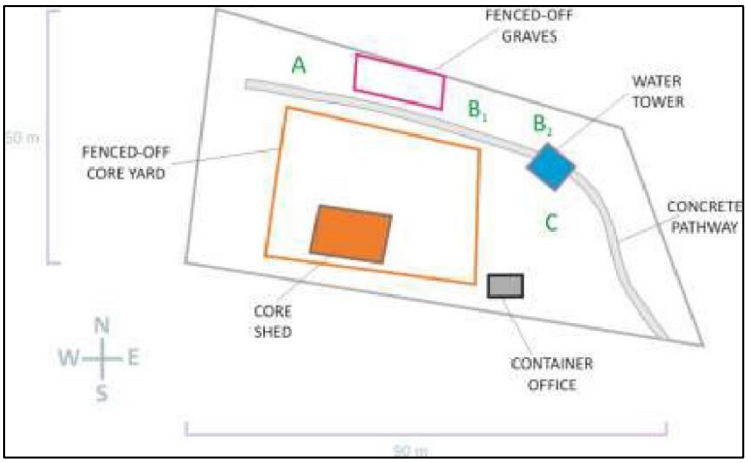

Figure 3-3: Schematic of the Kroondal Mine area of interest during the GPR survey.

A GPR profile was acquired over the existing graves inside the fenced-off area. The intention was to obtain a '*frame of reference*' radar result – or to characterise the possible grave response in this environment. A GPR profile was acquired along the entire length of the pathway shown in Figure 3-3 – from the SE corner of the area of interest to the NW side. The purpose of this profile was to characterise the radar response over the concrete pathway and to determine whether one might be able to achieve GPR penetration through the concrete layer. A series of parallel W-E GPR profiles was acquired in the open area to the west of the fenced-off graves. This area, which is marked 'A' in Figure 3-3, is shown in the photograph in Figure 12. These profiles were spaced approximately 0.5 m apart and were approximately 23 m in length. This effectively resulted in a rectangular survey area of ~ 23 m x 10 m for which a 3D data set was produced. A few profiles were conducted within the core yard where a couple of N-S lines were done over the concrete floor but the reinforcing material in the floor might have an adverse impact on the ability of GPR to penetrate the floor. Except for Area A (described above) and Area C, the only other area where a 3D survey was considered was the area marked 'B1' in Figure 3-3. This is the area to the immediate east of the fenced-off graves just north of the pathway and extending to the east to more or less the location of the water tower. However, due to the bushes and uneven terrain to the northern side, only five parallel profiles were acquired along this strip of ground. A series of parallel E-W GPR profiles was acquired in the open area to the south of the water tower. This area is marked 'C' in Figure 3-3. These profiles were also spaced approximately 0.5 m apart and were approximately 23 m in length, resulting in a rectangular survey area of ~ 23 m x 12 m for which a 3D data set was produced. A few strategically placed 2D profiles were acquired near the fenced-off graves to revisit some of the potential anomalies that were observed earlier in the survey. Despite several obstructions, including big trees, a test profile was also acquired just west of the western boundary fence of the core yard but could not provide conclusive evidence that there are any unmarked graves on the property. The main issue with the survey was that the site had already been

[2] Van Schoor, M. 2018. GPR survey at Glencore's Kroondal Mine Offices

developed due to production activities and the infrastructure present on surface and in the shallow subsurface compromised the acquisition and interpretation of GPR surveys. A few localised anomalies in the areas surrounding the existing fenced-off burials, which deserve further investigation, were identified; however, it is strongly recommended that more detailed follow-up GPR surveys be done in the areas in question, but that these areas be better prepared for such follow up GPR surveys. The ideal preparation would involve removing as much of the interfering surface obstacles and infrastructure as is realistically possible and also levelling the ground surface so that GPR profiling can be done more efficiently and also with an improved positioning accuracy

3.2 Limitations

3.2.1 Access

The study area is accessed directly via internal mine service roads. Strict access control is applied to the project area but no restrictions were encountered during the site visit in terms of access as the author of this report was accompanied by mining officials at all times.

3.2.2 Visibility

The surrounding vegetation in the study area landscape is mostly comprised out of mixed grasslands and scattered trees with dense indicator species occurring throughout. However, the project area has largely been transformed by mining developments. Visibility proved to be a constraint in the more densely vegetated northern periphery of the project area along the rock outcrop (see Figures 3-3 to 3-11). In single cases during the survey sub-surface inspection was possible. Where applied, this revealed no archaeological deposits.

Figure 3-4: View of the fenced storage yard in the project area.

Figure 3-5: The footpath bisecting the project area with the storage yard visible to the right.

Figure 3-6: View of general surroundings along the rock outcrop north of the storage yard.

Figure 3-7: View of general surroundings along a settlement area near the northern periphery of the perfect area.

Figure 3-8: A fence indicating the northern periphery of the project area.

Figure 3-9: View of the project area, looking south towards the storage yard and the cemetery in the foreground.

Figure 3-10: View of the project area, looking west towards the storage yard across a small lawn.

Figure 3-11: View of natural vegetation in the project area along the rock outcrop to the north.

3.2.3 Limitations and Constraints

The site survey for the Kroondal Heritage and Graves Assessment Project AIA primarily focused around areas tentatively identified as sensitive and of high heritage probability (i.e. those noted during the aerial survey) as well as areas of high human settlement catchment. The following constraints were encountered during the site surveys.

- **Visibility** proved to be a constraint where denser surface cover obscured surface occurrences north of the storage yard.
- The main issue with the **GPR survey** was that the site had already been developed due to production activities and the infrastructure present on surface and in the shallow subsurface compromised the acquisition and interpretation of GPR surveys.

It should be noted that, even though it might be assumed that survey findings are representative of the heritage landscape of the project area for the Transnet Boshoek Railway Loop Project, it should be stated that the possibility exists that individual sites could be missed due to the localised nature of some heritage remains as well as the possible presence of sub-surface archaeology. Therefore, maintaining due cognisance of the integrity and accuracy of the archaeological survey, it should be stated that the heritage resources identified during the study do not necessarily represent all the heritage resources present in the project area. The subterranean nature of some archaeological sites, dense vegetation cover and visibility constraints sometimes distort heritage representations and any additional heritage resources located during consequent development phases must be reported to the Heritage Resources Authority or an archaeological specialist.

3.3 Impact Assessment

For consistency among specialists, impact assessment ratings by Exigo Specialist are generally done using the Plomp[3] impact assessment matrix scale supplied by Exigo. According to this matrix scale, each heritage receptor in the study area is given an impact assessment. A cumulative assessment for the proposed project is also included.

[3] Plomp, H.,2004

4 ARCHAEO-HISTORICAL CONTEXT

4.1 The archaeology of Southern Africa

Archaeology in Southern Africa is typically divided into two main fields of study, the **Stone Age** and the **Iron Age** or **Farmer Period**. The following table provides a concise outline of the chronological sequence of periods, events, cultural groups and material expressions in Southern African pre-history and history.

Table 1 Chronological Periods across Southern Africa

Period	Epoch	Associated cultural groups	Typical Material Expressions
Early Stone Age 2.5m – 250 000 YCE	Pleistocene	Early Hominins: *Australopithecines* *Homo habilis* *Homo erectus*	Typically large stone tools such as hand axes, choppers and cleavers.
Middle Stone Age 250 000 – 25 000 YCE	Pleistocene	First *Homo sapiens* species	Typically smaller stone tools such as scrapers, blades and points.
Late Stone Age 20 000 BC – present	Pleistocene / Holocene	*Homo sapiens sapiens* including San people	Typically small to minute stone tools such as arrow heads, points and bladelets.
Early Iron Age / Early Farmer Period 300 – 900 AD	Holocene	First Bantu-speaking groups	Typically distinct ceramics, bead ware, iron objects, grinding stones.
Middle Iron Age (Mapungubwe / K2) / early Later Farmer Period 900 – 1350 AD	Holocene	Bantu-speaking groups, ancestors of present-day groups	Typically distinct ceramics, bead ware and iron / gold / copper objects, trade goods and grinding stones.
Late Iron Age / Later Farmer Period 1400 AD -1850 AD	Holocene	Various Bantu-speaking groups including Venda, Thonga, Sotho-Tswana and Zulu	Distinct ceramics, grinding stones, iron objects, trade objects, remains of iron smelting activities including iron smelting furnace, iron slag and residue as well as iron ore.
Historical / Colonial Period ±1850 AD – present	Holocene	Various Bantu-speaking groups as well as European farmers, settlers and explorers	Remains of historical structures e.g. homesteads, missionary schools etc. as well as, glass, porcelain, metal and ceramics.

4.2 The Bankeveld: Specific Themes.

The history of the western Northwest Province is reflected in a rich archaeological landscape. The interaction between the climate, geology, topography, and the fauna and flora in the Bankeveld over millions of years has established a milieu in which prehistoric and historic communities thrived. Stone Age habitation occurs in places, mostly in open air locales or in sediments alongside rivers or pans. Bantu-speaking groups moved into this area during the last millennia and these presumably Batswana groups, who practised herding, agriculture, metal working and trading, found a suitable living environment during the Late Iron Age times at around AD 1500-1800. It was here that their chiefdoms flourished. The settlements of these early Batswana chiefdoms are characterised by an impressive and elaborate stone-built tradition. Hundreds of sites were built along the bases of the granite hills. The accounts of early travellers provide important data on the fauna, flora and inhabitants of the Waterberg. The observations of travellers, missionaries and hunters who traversed the region throughout the 18th and the 19th centuries constitute a source of implicit ethnography on the late presence of hunting and gathering groups, the African farmers and inmoving colonists (Baines 1872, 1877; Smith 1836; Schlömann 1896; Wallis [Baines]

1946; Burke [Mauch's journals] 1969). The region is also rich in rock art (Eastwood and Eastwood 2006) European farmers, settling in the area since the middle of the 19th century, divided up the landscape into a number of farms. In recent years an urban element developed, expanding at a rapid rate, largely as a result of mining development in the region.

4.2.1 Early History and the Stone Ages

According to archaeological research, the earliest ancestors of modern humans emerged some two to three million years ago. The remains of Australopithecine and *Homo habilis* have been found in dolomite caves and underground dwellings in the Bankeveld at places such as Sterkfontein and Swartkrans near Krugersdorp. Homo habilis, one of the Early Stone Age hominids, is associated with Oldowan artefacts, which include crude implements manufactured from large pebbles. The Acheulian industrial complex replaced the Oldowan industrial complex during the Early Stone Age. This phase of human existence was widely distributed across South Africa and is associated with *Homo erectus*, who manufactured hand axes and cleavers from as early as one and a half million years ago. Oldowan and Acheulian artefacts were also found four to five decades ago in some of the older gravels (ancient river beds and terraces) of the Vaal River and the Klip River in Vereeniging. The earliest ancestors of modern man may therefore have roamed the Vaal valley at the same time that their contemporaries occupied some of the dolomite caves near Krugersdorp. Middle Stone Age sites dating from as early as two hundred thousand years ago have been found all over South Africa. Middle Stone Age hunter-gatherer bands also lived and hunted in the Orange and Vaal River valleys. These people, who probably looked like modern humans, occupied campsites near water but also used caves as dwellings. They manufactured a wide range of stone tools, including blades and point s that may have had long wooden sticks as hafts and were used as spears. The Late Stone Age commenced twenty thousand years ago or somewhat earlier. The various types of Later Stone Age industries scattered across the country are associated with the historical San and Khoi-Khoi people. The San were renowned as formidable hunter-gatherers, while the Khoi-Khoi herded cattle and small stock during the last two thousand years. Late Stone Age people manufactured tools that were small but highly effective, such as arrow heads and knives.

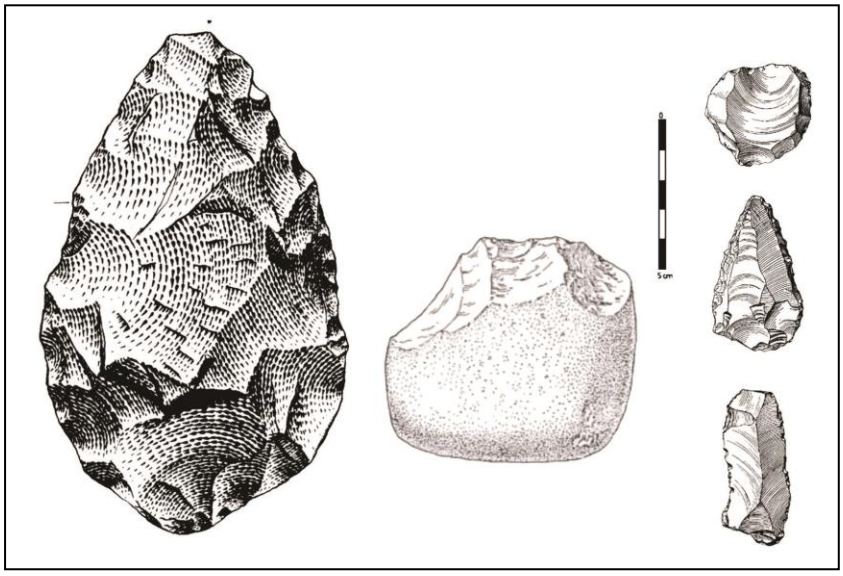

Figure 4-1: Typical ESA handaxe (left) and cleaver (center). To the right is a MSA scraper (right, top), point (right, middle) and blade (right, bottom).

The cultural historical landscape of the Waterberg area spans million years with evidence of hominin occupation, Stone Age traditions, Iron Age farmers and historical events. Makapansgat, a deep limestone

cave near Mokopane has yielded remains of *Australopithecus africanus* that dates to more than 3 million years BP and also *Homo erectus*, dating to approximately 1 million years BP. However, Earlier Stone Age (ESA) material is scarce on the Waterberg plateau. The Middle Stone Age (MSA) is abundantly represented in the Waterberg area and archaeological excavations at sites such as the Olieboomspoort Shelter in the north-western part of the Waterberg have yielded rich MSA deposits which display a large degree of specialisation and skill in stone working (Van der Ryst 1996). These groups occupied open camps which were situated in the proximity of water sources such as pans, lakes or rivers. There is a noticeable gap in the Waterberg between MSA assemblages and material form the Later Stone Age (LSA), suggesting that the Waterberg may not have seen dense human occupation for a long period of time. However, Later Stone Age groups, including the San hunter gatherers and Khoi herders frequented the area in the last few millennia, and numerous LSA sites have been discovered and excavated. Similarly, LSA evidence such as stone implements, ceramics and a wealth of rock paintings and markings are scattered over the plateau. Stone Age material generally occurs along drainage lines and exposed surfaces in the landscape. Stone Age communities well adapted to such climates and ecological niches proliferated into skilled hunter and gatherer bands and probably established themselves over large areas of the Central Bankeveld. Stone Age sites occur in rock shelters and in cave sites in the Magaliesberg.

4.2.2 Iron Age / Farmer Period

The beginnings of the Iron Age (Farmer Period) in Southern Africa are associated with the arrival of a new Bantu speaking population group at around the third century AD. These newcomers introduced a new way of life into areas that were occupied by Later Stone Age hunter-gatherers and Khoekhoe herders. Distinctive features of the Iron Age are a settled village life, food production (agriculture and animal husbandry), metallurgy (the mining, smelting and working of iron, copper and gold) and the manufacture of pottery. Iron Age people moved into Southern Africa by c. AD 200, entering the area either by moving down the coastal plains, or by using a more central route. From the coast they followed the various rivers inland. Being cultivators, they preferred rich alluvial soils. The Iron Age can be divided into three phases. The Early Iron Age includes the majority of the first millennium A.D. and is characterised by traditions such as Happy Rest and Silver Leaves. The Middle Iron Age spans the 10th to the 13th Centuries A.D. and includes such well known cultures as those at K2 and Mapungubwe. The Late Iron Age is taken to stretch from the 14th Century up to the colonial period and includes traditions such as Icon and Letaba.

Early Sotho-Tswana History

Within a larger archaeological context, Iron Age settlement representations in the form of stone walling in the Waterberg can undoubtedly be traced back to ancestral Sotho-Tswana occupation and developments from the sixteenth century AD onwards. Diagnostic pottery assemblages are commonly used in the South African Iron Age to infer group identities and to trace movements across the landscape. Similarly, the migration of the Sotho-Tswana speakers in South Africa in the 16th century marked a new ceramic style, known as Moloko. The Moloko Tradition can be divided into two phases: an early phase (e.g. Icon) in which sites were usually located at the foot of hills and contained little or no stone walling; and a later phase characterised by extensive stone wall complexes which were often erected on hills. In the Waterberg area, this later phase manifested in the Madikwe ceramic facies with pottery typically displaying stab and fingernail impression decoration motives. At around the 17th century, Madikwe pottery developed into a tradition known as “Buispoort”, sites of which display complex and elaborate stone walling. The stone walls were erected to construct stock byres and to demarcate residential units where pole-and-dagha (clay) huts were placed.

In addition, various Sotho-Tswana groups were found in the interior of the Highveld areas of South Africa

by the end of the 18th century. These units occupied a large area, from present-day Botswana across large sections of the old Transvaal, the Free State Province into the Northern Cape. Based on Sotho-Tswana oral histories various groups acted as cores from which the Sotho-speaking communities sprouted

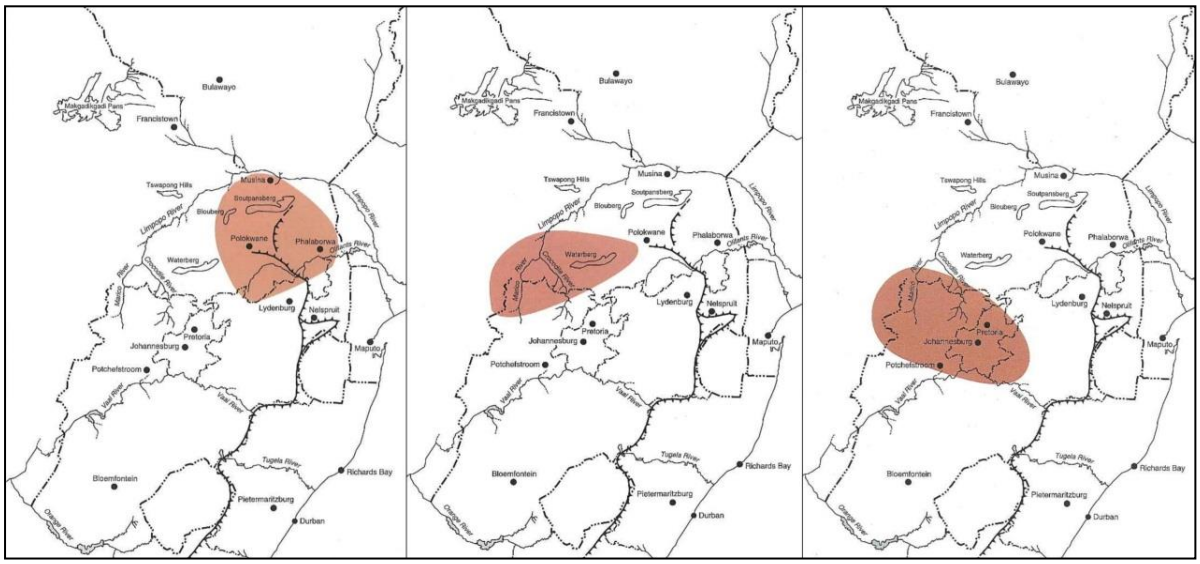

Figure 4-2: Map detailing the distribution of 16th century Mloko (left), 17th century Madikwe (centre) and 18th century Buispoort tradition sites (After Huffman 2007).

Figure 4-3: Ceramic decoration motives typical of 17th century Madikwe (left) and later Buispoort (right) facies (After Huffman 2007).

The study areas fall within a sphere of influence that was occupied by the Bafokeng people who entered the area, according to oral tradition, during the early 17th century. The Bafokeng's royal lineage, however, settled south of Boschhoek at Phokeng. The Bafokeng gradually extended their influence and presence in this area as far north as the Elandsriver, south and west towards to the Magaliesberg and east towards the granite hills that separate Marikana from Rustenburg. Batswana clans such as the Batlokwa, Bakgatla and the Bathlako occupied the Pilanesberg further to the north while the Bakwena Bamodimosasa chiefdoms of Mmatau and Ramanamela occupied the mega stone walled complexes known as Molokwane and Bôitsemagano to the west of the Magaliesberg. Numerous pre-difaqane and difaqane wars took place in the Central Bankeveld during the last quarter of the 18th century and the first three decades of the 19th century. These wars led to the displacement of large numbers of Batswana in the Bankeveld. Refugee sites

occupied by dislocados became a common sight. The Matabele of Mzilikazi caused chaos and havoc in the Bankeveld. The Matabele established several settlement complexes in this region from whence they maintained a grip on the indigenous population. One of these Zulu/Nguni residences (imisi) and military kraals (amakhanda) was discovered during an archaeological survey in 1997 in the newly developed Thlabane-West suburb, north of Rustenburg. The Matabele must have intermarried with the Bafokeng. One of Mzilikzazi's sons, Nkulumane, was buried in Phôkeng. His grave is today wrongly indicated as 'Mzilikazi's grave' in Phôkeng's main street. The Late Iron Age history of the Rustenburg and Boschhoek areas was complex and is not fully recorded in oral traditions or in any other records. This history can therefore only be unravelled by means of the methods and theory associated with archaeological research.

The discontinuous nature of the northern tip of the Magaliesberg near the study area was important for the movement of people such as traders between the Western Bankeveld and the Central Bankeveld. During the first half of the 19th century and decades thereafter, this part of the mountain served as a trail through which wagons passed on their way to Rustenburg and the eastern parts of the Central Bankeveld. Traders such as Schoon and McLuckie (1829), who were the first white people to visit the area north of the Magaliesberg, missionaries such as Robert Moffat (1829), scientists such as Andrew Smith (1835) and the adventurer Cornwallis Harris (1836) trekked through the Magaliesberg (and over the farm Boschhoek) on their way to the eastern part of the Central Bankeveld, where some of them visited Mzilikazi of the Matabele (Ndebele), who occupied at least three villages complexes in the region. The largest and most important towns and villages close to SA Chrome's planned smelter site are the towns of Phôkeng, Rustenburg and Thlabane, located to the south of Boshoek. The towns of Bala and Chuane are located to the north-east of the planned smelter site. The town of Phôkeng came into being when the Bafokeng established themselves, according to oral tradition, at a place called 'Phôka' during the early decades of the 17th century. ('Phôka' is a type of wild grass the people ate during a time of famine). Later Bafokeng rulers reigned between the Magaliesberg in the west and the Thaba ea Maralla range of mountains to the east.

4.2.3 Pastoralism and the last 2000 years

Until 2000 years ago, hunter-gatherer communities traded, exchanged goods, encountered and interacted with other hunter-gatherer communities. From about 2000 years ago the social dynamics of the Southern African landscape started changing with the immigration of two 'other' groups of people, different in physique, political, economic and social systems, beliefs and rituals. One of these groups, the Khoekhoe pastoralists or herders entered Southern Africa with domestic animals, namely fat-tailed sheep and goats, travelling through the south towards the coast. They also introduced thin-walled pottery common in the interior and along the coastal regions of Southern Africa. Their economic systems were directed by the accumulation of wealth in domestic stock numbers and their political make-up was more hierarchical than that of the hunter-gatherers.

4.2.4 Later History

The Historical period in Southern Africa encompass the course of Europe's discovery of South Africa and the spreading of European settlements along the East Coast and subsequently into the interior. In addition, the formation stages of this period are marked by the large scale movements of various Bantu-speaking groups in the interior of South Africa, which profoundly influenced the course of European settlement. Finally, the final retreat of the San and Khoekhoen groups into their present-day living areas also occurred in the Historical period in Southern Africa.

The Waterberg was considered remote and inaccessible by early white migrants from the south and, with the exception of a few hunting and trading expeditions passing through, the area was one of the last

regions in the former Transvaal to be permanently occupied by white farmers. Although the first Voortrekker farmers moved into the Waterberg during the 1850's, the region has been increasingly occupied on a regular basis only since the early part of the twentieth century. The early historical period of the area is dominated by the siege of Makapansgat where in September 1854, Chief Makapane and over 1 500 of his people died of hunger, dehydration and injuries after being besieged in the cave by a Boer commando in retaliation for an attack on a Voortrekker settlement. The majority of farms in the Waterberg area were surveyed in the late 1860's as part of the Transvaal government's strategy to settle white farmers in the Waterberg region. At that time, access to the Waterberg plateau was circuitous and difficult with the shortest route extending via Sandrivierspoort near present-day Vaalwater. After a railway line to Vaalwater was completed in the 1920's, maize became an economically viable crop but by the end of the 1960's, slumps in maize prices resulted in many farmers abandoning crop farming in favour of cattle. Large scale iron ore mining has emerged to become a primary economical enterprise in recent years. Rustenburg is the third oldest town established by Colonials or Voortrekkers in the former Transvaal area during the first half of the 19th century. The town was proclaimed by the governor of the Zuid-Afrikaanse Republiek in September 1851. The Transvaal Volksraad met in the town in 1852 and important decisions relating to the church and state were taken in the town. Rustenburg also served as the seat for the Zuid-Afrikaanse Republiek before Pretoria became the capitol. Farming communities have settled in the landscape at the beginning of the 20th century.

Kroondal, situated on a farm originally known as Kronendal, was one of 22 German Lutheran mission congregations established in the former Natal and Transvaal. Kronendal had been in existence since 1843 and the farm was first surveyed by riding 1 hour in each direction resulting in a farm of approximately 2500 hectare. In 1858 the farm was allocated as a 'pachtplaas' to Lutheran Missionary Pastor Christian Müller. Jan Michiel van Helsdingen registered the farm to his name. Pastor Christian established the church on the farm – then known as – Kronendal. The farm Kronendal was one of 22 German Lutheran mission congregations. The families du Plessis, Riekert and Malan who where relatives of van Helsdingen, occupied the farm until 1877 when they all moved to the Koster region where their descendants can still be found. It was in 1889, when the missionary was suffering financially, that the local Germans bought the Kronendal farm. This is when it became, as we in Rustenburg know it today, to be Kroondal. The farm was divided into residential plots and the typical German zing Kroondal has today, came to be. During 1878 a rift accured in the Ramakoka tribe who lived in Phalane approximately 100 km north of Kroondal and missionary Christian Müller, who was with the Ramakoka tribe, arranged that a portion of the tribe bought Kroonendal for 5000 pounds and settled there. The Ramakoka tribe could not repay the debt or the interest and decided to sell the farm for 5100 pounds and move back to Phalane, as the inter-tribe problem had been settled. Concerned for the local people that were being forced off their land by the Boers, Pastor Ferdinand Zimmerman tried to purchase Kroondal under the name of the missionary as to provide a safe place where the locals could stay. The idea though was not met with political agreement and the lack of funds made it difficult for the attainment of the land.

Georg Wilhelm Otterman was one of the German immigrants that came to Kroondal and began farming with tobacco, wheat and maize. It was in 1889 that Kroondal saw a mill taking shape on Otterman's farm. The mill was relocated to Sandspruit where the Modderspruit's water could offer more power to the wheel. During the Boer War, Georg Otterman and his family were relocated to the concentration camp of Irene. It was during that time that the British took the bearing of the mill and by the time Otterman and his family returned to his farm in 1902, there wasn't anything left. Agriculture continued to be the central theme in Kroondal but many properties were consolidated or leased and today there are only 5 active farmers compared to the 15 active farmers 40 years ago..

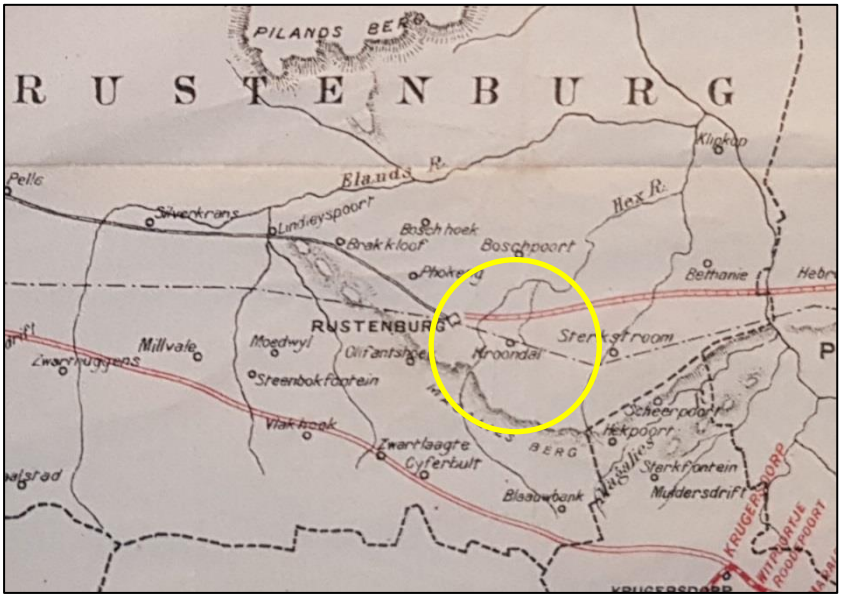

Figure 4-4: Troye's "New Railway and Postal Map" in the Transvaal Colony c. 1899 with Kroondal encircled in yellow.

Figure 4-5: The German Lutheran mission church shortly after its construction in 1896.

5 RESULTS: ARCHAEOLOGICAL AND GPR SURVEYS

The project area occurs within the Glencore Mine plant in largely transformed and disturbed areas but the presence of heritage sites could be confirmed during the surveys.

5.1 The Archaeological Site Survey

5.1.1 Early Historical Period remains

Rustenburg and its surroundings have a long and extensive Colonial Period settlement history. From around the first half of the 19th century, the area was frequented by explorers, missionaries and farmers who all contributed to a recent history of contact and conflict. The remnants of recent occupation, mining and industrialisation are scattered across the landscape and features attributed to the built environment of the early Historical Period occurrences was observed in the project area.

The remains of a number of circular stone wall enclosures were noted along the rock outcrop north of the storage yard **(S25.712955° E27.320194°)**. The enclosures range in size and preservation thereof is generally poor as most of the walls have collapsed. The remains of what seems to be a small square building occur directly west of the outcrop and the storage yard. Here, neatly stacked stones form a linear stone wall to one side and stone foundation structures forms the other faces of the building. No material culture was noted in association with the structures. An analysis of historical aerial photographs and topographic maps suggest that the structures formed part of a number of homesteads which were present in the landscape by at least 1955 (see Figure 5-4) and the structures are thus older than 60 years. The features are poorly preserved bearing limited heritage significance but they are generally protected under the National Heritage Resource Act (NHRA 1999). According to project planning, no further impact will occur in this area but a permit for the destruction of any of the features will be required should impact occur at any stage, subject to terms stipulated in the NHRA.

Figure 5-1: View of a section of stone walling along the rock outcrop.

Figure 5-2: A linear stone wall which forms part of the remains of a square building structure.

Figure 5-3: Irregular stone structures in a Historical Settlement area in the project area.

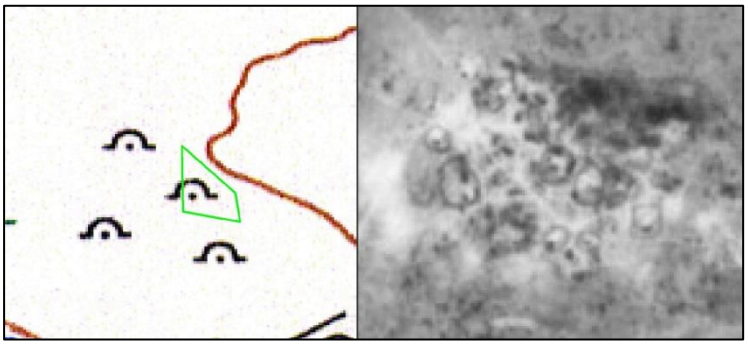

Figure 5-4: Archive map dating to 1968 (left) and a historical aerial image dating to 1955 (right) indicating the presence of the Historical Period homesteads discussed in the text.

5.1.2 Graves

The site assessment verified the existence of an informal cemetery directly north of the storage yard and the footpath in the project area **(S25.713276° E27.320201°)**. The graveyard contains at least 8 graves which are marked by elongated stone cairns and placed in an east-west orientation. One of the graves carries an elongated rock as headstone with irregular hand-carved grave inscriptions of which a date of 1943 is legible. Material culture such as glass bottles were noted on the surface in association with some of the grave. The site is fenced off and the fence is lined with stones similar to those used for the grave dressing. It can be assumed that the burials belong to individuals who resided at the nearby homesteads visible on historical aerial photographs and topographic maps and it is highly likely that previously undetected burials might occur in surrounding areas. As the cemetery probably dates to at least 1955, the burial site as well as any possible graves in its surrounds is protected heritage resources according to the NHRA with a high significance rating.

Figure 5-5: View of the fenced cemetery in the project area.

Figure 5-7: View of stone burial mounds in the cemetery.

Figure 5-8: Detail of hand-carved inscriptions on a headstone in the cemetery.

5.2 The GPR Survey

Please refer to Addendum 4 for the full GPR Report[4]

As noted previously, a ground-penetrating radar (GPR) survey was conducted at the Kroondal Mine Office Complex in order to detect possible unmarked burial sites (graves) linked to nearby communities. The GPR results revealed possible evidence of graves in close proximity to a fenced-off area containing several known graves. However, this finding is not conclusive primarily due to the interference of existing infrastructure on the site which hampered effective GPR surveying. The main issue with the survey was that the site had already been developed due to production activities and the infrastructure present on surface and in the shallow subsurface compromised the acquisition and interpretation of GPR surveys. A few localised anomalies in the areas surrounding the existing fenced-off burials, which deserve further investigation, were identified; however, it would be necessary to conduct more detailed follow-up GPR surveys in the areas in question where these areas are better prepared for such follow up GPR surveys.

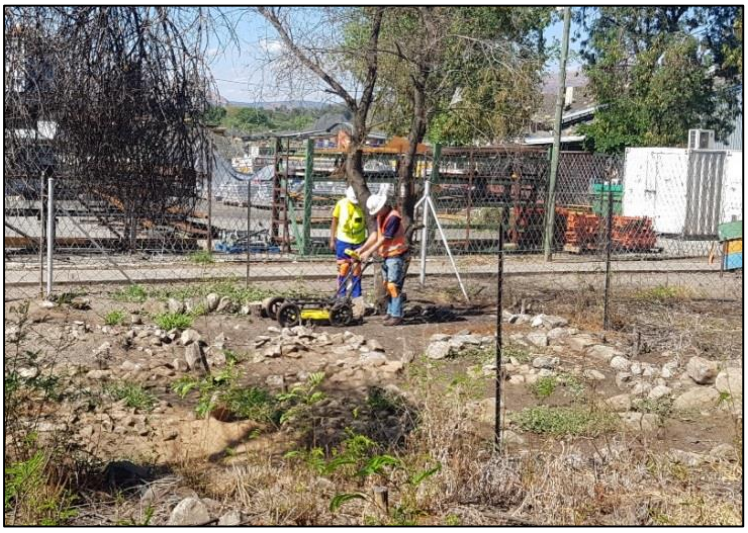

Figure 5-9: Conducting the GPR site survey at the Kroondal Mine cemjetery.

[4] Van Schoor, M. 2018. GPR survey at Glencore's Kroondal Mine Offices

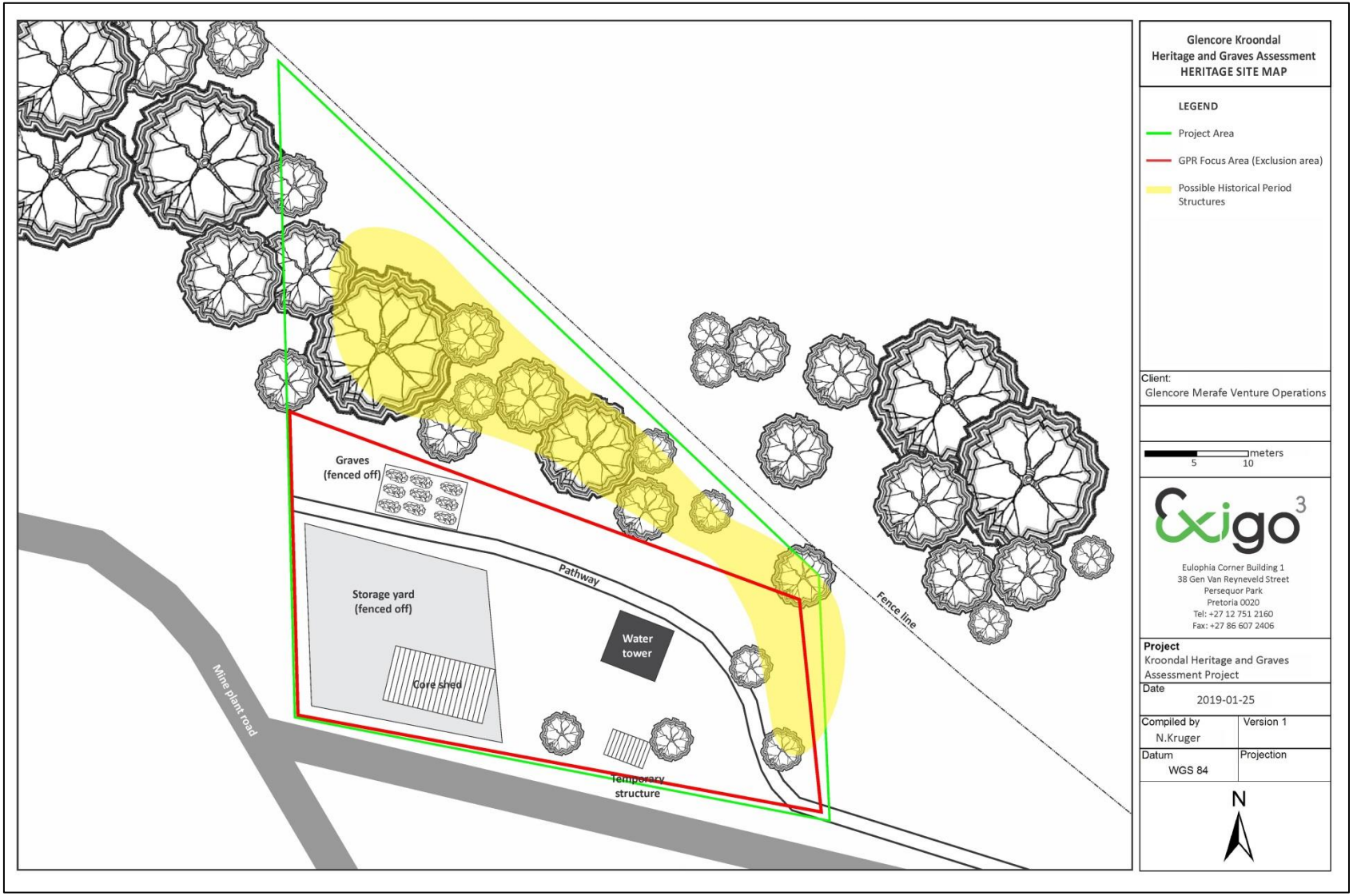

Figure 5-10: Site plan indicating the locations of heritage sites and zones discussed in the text.

6 RESULTS: STATEMENT OF SIGNIFICANCE AND IMPACT RATING

6.1 Potential Impacts and Significance Ratings[5]

The following section provides a background to the identification and assessment of possible impacts and alternatives, as well as a range of risk situations and scenarios commonly associated with heritage resources management. A guideline for the rating of impacts and recommendation of management actions for areas of heritage potential within the study area is supplied in Section 10.2 of Addendum 3.

6.1.1 General assessment of impacts on resources

Generally, the value and significance of archaeological and other heritage sites might be impacted on by any activity that would result immediately or in the future in the destruction, damage, excavation, alteration, removal or collection from its original position, any archaeological material or object (as indicated in the National Heritage Resources Act (No 25 of 1999)). Thus, the destructive impacts that are possible in terms of heritage resources would tend to be direct, once-off events occurring during the initial construction period. However, in the long run, the proximity of operations in any given area could result in secondary indirect impacts. The EIA process therefore specifies impact assessment criteria which can be utilised from the perspective of a heritage specialist study which elucidates the overall extent of impacts.

6.1.2 Direct impact rating

Direct or primary effects on heritage resources occur at the same time and in the same space as the activity, e.g. loss of historical fabric through demolition work. **Indirect effects or secondary effects** on heritage resources occur later in time or at a different place from the causal activity, or as a result of a complex pathway, e.g. restriction of access to a heritage resource resulting in the gradual erosion of its significance, which is dependent on ritual patterns of access (refer to Section 10.3 in the Addendum for an outline of the relationship between the significance of a heritage context, the intensity of development and the significance of heritage impacts to be expected).

As no further development will take place in the project area, no impact on the early Historical Period settlement area or the burial site/s occurring here is foreseen, subject to the careful implementation of required mitigation measures and, provided that no previously undetected heritage remains are encountered at any stage.

6.2 Management actions

Recommendations for relevant heritage resources management actions are vital to the conservation of heritage resources. A general guideline for recommended management actions is included in Section 10.4 of Addendum 3.

OBJECTIVE: prevent unnecessary disturbance and/or destruction of previously undetected heritage receptors.

[5] Based on: W inter, S. & Baumann, N. 2005. *Guideline for involving heritage specialists in EIA processes: Edition 1.*

For the Historical Period burial site/s in the project area, the following recommendations are required:

PROJECT COMPONENT/S	All phases of construction and operation.		
POTENTIAL IMPACT	Damage/disturbance to subsurface burials and surface burial features.		
ACTIVITY RISK/SOURCE	Digging foundations and trenches into sensitive deposits that are not visible at the surface.		
MITIGATION: TARGET/OBJECTIVE	To locate human burials as soon as possible after disturbance so as to maximize the chances of successful rescue/mitigation work.		
MITIGATION: ACTION/CONTROL		**RESPONSIBILITY**	**TIMEFRAME**
Preferred Mitigation Procedure			
Avoidance: An exclusion zone (demarcated by GPR focus areas) should be implemented around the known burials in order to protect any possible previously undetected human burials. It is advisable that the storage yard and core shed be decommissioned and included in this exclusion zone in order to ensure the preservation of the site. The exclusion zone should be fenced off, access control should be applied and a site notice indicating the heritage status of the site should be erected. A further heritage conservation buffer of 100m, as required by SAHRA, should be implemented around the exclusion zone. A site management plan detailing strict site management conservation measures should be implemented.		DEVELOPER QUALIFIED HERITAGE SPECIALIST	Prior to the commencement of construction and earth-moving, monitoring during construction.
Alterative Mitigation Procedure (**if preferred mitigation procedure is not feasible**)			
Grave relocation: Should the recommended preferred mitigation measures proved unachievable, the relocation of all burials should be conducted. This process should include the documentation of the site, full social consultation with affected parties, possible conservation management and protection measures as well as test excavations to locate and identify previously undocumented human burials. This process should occur subject to authorisations, relevant processes and permitting from heritage authorities and all interested and affected parties.		QUALIFIED HERITAGE SPECIALIST	Prior to the commencement of construction and earth-moving.
Fixed Mitigation Procedure (**required**)			
Site Monitoring: Regular examination of trenches and excavations in this area in order to avoid the destruction of previously undetected burials or heritage remains. If burials were to be retained a strict site management and monitoring protocol will be required (planning, construction phases).		ECO	Monitor as frequently as practically possible.
PERFORMANCE INDICATOR	Archaeological sites are discovered and mitigated with the minimum amount of unnecessary disturbance.		
MONITORING	Successful location of sites by person/s monitoring.		

As the early Historical Period settlement area falls within the recommended exclusion zone, no further action is recommended in terms of heritage mitigation. However, should the site be impacted in any way, the following is recommended:

PROJECT COMPONENT/S	All phases of construction and operation.		
POTENTIAL IMPACT	Damage/destruction of sites.		
ACTIVITY RISK/SOURCE	Digging foundations and trenches into sensitive deposits that are not visible at the surface.		
MITIGATION: TARGET/OBJECTIVE	To locate previously undetected heritage remains / graves as soon as possible after disturbance so as to maximize the chances of successful rescue/mitigation work.		
MITIGATION: ACTION/CONTROL		**RESPONSIBILITY**	**TIMEFRAME**
Fixed Mitigation Procedure (**required**)			
Site Monitoring: Regular examination of trenches and excavations. **Destruction Permitting:** The site is older than 60 years and generally protected under the NHRA. Application for a destruction permit should be made with relevant heritage authorities (SAHRA, SAHRA Built Environment) prior to any impact on the site.		ECO HERITAGE PRACTITIONER	Monitor as frequently as practically possible.
PERFORMANCE INDICATOR	Archaeological sites are discovered and mitigated with the minimum amount of unnecessary disturbance.		
MONITORING	Successful location of sites by person/s monitoring.		

Figure 6-1: Aerial map illustrating the extent of the recommended 100m conservation buffer around the exclusion zone discussed in the text.

7 RECOMMENDATIONS

The larger landscape of the Northwest Province and the Bankeveld is rich in pre-historical and historical remnants since the area is highly suitable for pre-colonial habitation. However, the project area occurs within the Glencore Mine plant in largely transformed and disturbed areas but the presence of heritage sites could be confirmed during the surveys. The following general recommendations are made based on general observations at the site.

- The site assessment verified the existence of an informal cemetery directly north of the storage yard and the footpath in the project area. It can be assumed that the burials belong to individuals who resided at the nearby homesteads visible on historical aerial photographs and topographic maps and it is highly likely that previously undetected burials might occur in surrounding areas; even though the GPR survey could not provide conclusive evidence to this effect. As the cemetery probably dates to at least 1955, the burial site as well as any possible graves in its surrounds is protected heritage resources according to the NHRA with a high significance rating. It is primarily recommended that an exclusion zone (demarcated by GPR focus areas) be implemented around the known burials in order to protect any possible previously undetected human burials. It is advisable that the storage yard and core shed be decommissioned and included in this exclusion zone in order to ensure the preservation of the site. The exclusion zone should be fenced off, access control should be applied and a site notice indicating the heritage status of the site should be erected. A further heritage conservation buffer of 100m, as required by SAHRA, should be implemented around the exclusion zone. A site management plan detailing strict site management conservation measures should be implemented. Should these mitigation measures proved unachievable, the relocation of all burials should be conducted. This measure should be undertaken by a qualified archaeologist, and in accordance with relevant legislation and subject to any local and regional provisions and laws and by-laws pertaining to human remains. A full social consultation process should occur in conjunction with the mitigation of cemeteries and burials **(see Addendum 2).** Should any additional graves or human remains be encountered io the project area, these should be reported to the Heritage Specialist and relevant authorities (SAHRA) and development activities should be suspended until the site has been inspected by the Specialist.
- The remains of a settlement area consisting of homestead remains occur in the project area along the rock outcrop north of the storage yard. The settlement remains date to the early Historical Period and the structures are older than 60 years. As the site falls within the recommended exclusion zone (see above), no further action is recommended in terms of heritage mitigation should this zone be effected. However, should the site be impacted in any way, a permit for the destruction of any of the features will be required, subject to terms stipulated in the NHRA
- Considering the localised nature of heritage remains, the general monitoring of the development progress by an ECO is recommended for all stages of the project. Should any subsurface palaeontological, archaeological or historical material, or burials be exposed during construction activities, all activities should be suspended and the archaeological specialist should be notified immediately

It is essential that cognisance be taken of the larger archaeological landscape of the area in order to avoid the destruction of previously undetected heritage sites. It should be stated that the possibility of undetected archaeological remains occurring elsewhere in the project area should not be excluded.

8 GENERAL COMMENTS AND CONDITIONS

This AIA report serves to confirm the extent and significance of the heritage resources of the proposed Kroondal Heritage and Graves Assessment Project area. The larger heritage horizon encompasses rich and diverse archaeological landscapes and cognisance should be taken of heritage resources and archaeological material that might be present in surface and sub-surface deposits. If, at any stage, any possible archaeological material culture discoveries are made, the operations must be stopped and a qualified archaeologist be contacted for an assessment of the find. Such material culture might include:

- Formal Earlier Stone Age stone tools.
- Formal MSA stone tools.
- Formal LSA stone tools.
- Potsherds
- Iron objects.
- Beads made from ostrich eggshell and glass.
- Ash middens and cattle dung deposits and accumulations.
- Faunal remains.
- Human remains/graves.
- Stone walling or any sub-surface structures.
- Historical glass, tin or ceramics.
- Fossils.

If such site were to be encountered or impacted by any proposed developments, recommendations contained in this report, as well as endorsement of mitigation measures as set out by AMAFA, SAHRA, the National Resources Act and the CRM section of ASAPA will be required.

It must be emphasised that the conclusions and recommendations expressed in this archaeological heritage sensitivity investigation are based on the visibility of archaeological sites/features and may not therefore, represent the area's complete archaeological legacy. Many sites/features may be covered by soil and vegetation and might only be located during sub-surface investigations. If subsurface archaeological deposits, artefacts or skeletal material were to be recovered in the area during construction activities, all activities should be suspended and the archaeological specialist should be notified immediately **(*cf*. NHRA (Act No. 25 of 1999)**, Section 36 (6)). It must also be clear that Archaeological Specialist Reports will be assessed by the relevant heritage resources authority (SAHRA).

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10 ADDENDUM 1: HERITAGE LEGISLATION BACKGROUND

10.1 CRM: Legislation, Conservation and Heritage Management

The broad generic term *Cultural Heritage Resources* refers to any physical and spiritual property associated with past and present human use or occupation of the environment, cultural activities and history. The term includes sites, structures, places, natural features and material of palaeontological, archaeological, historical, aesthetic, scientific, architectural, religious, symbolic or traditional importance to specific individuals or groups, traditional systems of cultural practice, belief or social interaction.

10.1.1 Legislation regarding archaeology and heritage sites

The South African Heritage Resources Agency (SAHRA) and their provincial offices aim to conserve and control the management, research, alteration and destruction of cultural resources of South Africa. It is therefore vitally important to adhere to heritage resource legislation at all times.

d. National Heritage Resources Act No 25 of 1999, section 35

According to the National Heritage Resources Act of 1999 a historical site is any identifiable building or part thereof, marker, milestone, gravestone, landmark or tell older than 60 years. This clause is commonly known as the "60-years clause". Buildings are amongst the most enduring features of human occupation, and this definition therefore includes all buildings older than 60 years, modern architecture as well as ruins, fortifications and Iron Age settlements. "Tell" refers to the evidence of human existence which is no longer above ground level, such as building foundations and buried remains of settlements (including artefacts).

The Act identifies heritage objects as:

- objects recovered from the soil or waters of South Africa including archaeological and palaeontological objects, meteorites and rare geological specimens
- visual art objects
- military objects
- numismatic objects
- objects of cultural and historical significance
- objects to which oral traditions are attached and which are associated with living heritage
- objects of scientific or technological interest
- any other prescribed category

With regards to activities and work on archaeological and heritage sites this Act states that:

"No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit by the relevant provincial heritage resources authority." (34. [1] 1999:58)

and

"No person may, without a permit issued by the responsible heritage resources authority-

(d) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(e) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(f) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(g) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites. (35. [4] 1999:58)."

and

"No person may, without a permit issued by SAHRA or a provincial heritage resources agency-

(h) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;

(i) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority;

(j) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) and excavation equipment, or any equipment which assists in the detection or recovery of metals (36. [3] 1999:60)."

e. Human Tissue Act of 1983 and Ordinance on the Removal of Graves and Dead Bodies of 1925

Graves 60 years or older are heritage resources and fall under the jurisdiction of both the National Heritage Resources Act and the Human Tissues Act of 1983. However, graves younger than 60 years are specifically protected by the Human Tissues Act (Act 65 of 1983) and the Ordinance on the Removal of Graves and Dead Bodies (Ordinance 7 of 1925) as well as any local and regional provisions, laws and by-laws. Such burial places also fall under the jurisdiction of the National Department of Health and the Provincial Health Departments. Approval for the exhumation and re-burial must be obtained from the relevant Provincial MEC as well as the relevant Local Authorities.

10.1.2 Background to HIA and AIA Studies

South Africa's unique and non-renewable archaeological and palaeontological heritage sites are 'generally' protected in terms of the National Heritage Resources Act (Act No 25 of 1999, section 35) and may not be disturbed at all without a permit from the relevant heritage resources authority. Heritage sites are frequently threatened by development projects and both the environmental and heritage legislation require impact assessments (HIAs & AIAs) that identify all heritage resources in areas to be developed. Particularly, these assessments are required to make recommendations for protection or mitigation of the impact of the sites. HIAs and AIAs should be done by qualified professionals with adequate knowledge to (a) identify all heritage resources including archaeological and palaeontological sites that might occur in areas of developed and (b) make recommendations for protection or mitigation of the impact on the sites.

The National Heritage Resources Act (Act No. 25 of 1999, section 38) provides guidelines for Cultural Resources Management and prospective developments:

***"38.** (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a*

development categorised as:

(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;

(b) the construction of a bridge or similar structure exceeding 50m in length;

(c) any development or other activity which will change the character of a site:

(i) exceeding 5 000 m^2 in extent; or

(ii) involving three or more existing erven or subdivisions thereof; or

(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;

(d) the re-zoning of a site exceeding 10 000 m^2 in extent; or

(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority,

must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development."

And:

"The responsible heritage resources authority must specify the information to be provided in a report required in terms of subsection (2)(a): Provided that the following must be included:

(k) The identification and mapping of all heritage resources in the area affected;

(l) an assessment of the significance of such resources in terms of the heritage assessment criteria set out in section 6(2) or prescribed under section 7;

(m) an assessment of the impact of the development on such heritage resources;

(n) an evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development;

(o) the results of consultation with communities affected by the proposed development and other interested parties regarding the impact of the development on heritage resources;

(p) if heritage resources will be adversely affected by the proposed development, the consideration of alternatives; and

(q) plans for mitigation of any adverse effects during and after the completion of the proposed development (38. [3] 1999:64)."

Consequently, section 35 of the Act requires Heritage Impact Assessments (HIAs) or Archaeological Impact Assessments (AIAs) to be done for such developments in order for all heritage resources, that is, all places or objects of aesthetics, architectural, historic, scientific, social, spiritual, linguistic or technological value or significance to be protected. Thus any assessment should make provision for the protection of all these heritage components, including archaeology, shipwrecks, battlefields, graves, and

structures older than 60 years, living heritage, historical settlements, landscapes, geological sites, palaeontological sites and objects.Heritage resources management and conservation

10.2 Assessing the Significance of Heritage Resources

Archaeological sites, as previously defined in the National Heritage Resources Act (Act 25 of 1999) are places in the landscape where people have lived in the past – generally more than 60 years ago – and have left traces of their presence behind. In South Africa, archaeological sites include hominid fossil sites, places where people of the Earlier, Middle and Later Stone Age lived in open sites, river gravels, rock shelters and caves, Iron Age sites, graves, and a variety of historical sites and structures in rural areas, towns and cities. Palaeontological sites are those with fossil remains of plants and animals where people were not involved in the accumulation of the deposits. The basic principle of cultural heritage conservation is that archaeological and other heritage sites are valuable, scarce and *non-renewable.* Many such sites are unfortunately lost on a daily basis through development for housing, roads and infrastructure and once archaeological sites are damaged, they cannot be re-created as site integrity and authenticity is permanently lost. Archaeological sites have the potential to contribute to our understanding of the history of the region and of our country and continent. By preserving links with our past, we may not be able to revive lost cultural traditions, but it enables us to appreciate the role they have played in the history of our country.

- Categories of significance

Rating the significance of archaeological sites, and consequently grading the potential impact on the resources is linked to the significance of the site itself. The significance of an archaeological site is based on the amount of deposit, the integrity of the context, the kind of deposit and the potential to help answer present research questions. Historical structures are defined by Section 34 of the National Heritage Resources Act, 1999, while other historical and cultural significant sites, places and features, are generally determined by community preferences. The guidelines as provided by the NHRA (Act No. 25 of 1999) in Section 3, with special reference to subsection 3 are used when determining the cultural significance or other special value of archaeological or historical sites. In addition, ICOMOS (the Australian Committee of the International Council on Monuments and Sites) highlights four cultural attributes, which are valuable to any given culture:

- *Aesthetic value:*

Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria include consideration of the form, scale, colour, texture and material of the fabric, the general atmosphere associated with the place and its uses and also the aesthetic values commonly assessed in the analysis of landscapes and townscape.

- *Historic value:*

Historic value encompasses the history of aesthetics, science and society and therefore to a large extent underlies all of the attributes discussed here. Usually a place has historical value because of some kind of influence by an event, person, phase or activity.

- *Scientific value:*

The scientific or research value of a place will depend upon the importance of the data involved, on its rarity, quality and on the degree to which the place may contribute further substantial information.

- *Social value:*

Social value includes the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a certain group.

It is important for heritage specialist input in the EIA process to take into account the heritage management structure set up by the NHR Act. It makes provision for a 3-tier system of management including the South Africa Heritage Resources Agency (SAHRA) at a national level, Provincial Heritage Resources Authorities (PHRAs) at a provincial and the local authority. The Act makes provision for two types or forms of protection of heritage resources; i.e. formally protected and generally protected sites:

Formally protected sites:

- Grade 1 or national heritage sites, which are managed by SAHRA
- Grade 2 or provincial heritage sites, which are managed by the provincial HRA (MP-PHRA).
- Grade 3 or local heritage sites.

Generally protected sites:

- Human burials older than 60 years.
- Archaeological and palaeontological sites.
- Shipwrecks and associated remains older than 60 years.
- Structures older than 60 years.

With reference to the evaluation of sites, the certainty of prediction is definite, unless stated otherwise and if the significance of the site is rated high, the significance of the impact will also result in a high rating. The same rule applies if the significance rating of the site is low. The significance of archaeological sites is generally
ranked into the following categories.

Significance	Rating Action
No significance: sites that do not require mitigation.	None
Low significance: sites, which may require mitigation.	2a. Recording and documentation (Phase 1) of site; no further action required 2b. Controlled sampling (shovel test pits, augering), mapping and documentation (Phase 2 investigation); permit required for sampling and destruction
Medium significance: sites, which require mitigation.	3. Excavation of representative sample, C14 dating, mapping and documentation (Phase 2 investigation); permit required for sampling and destruction [including 2a & 2b]
High significance: sites, where disturbance should be avoided.	4a. Nomination for listing on Heritage Register (National, Provincial or Local) (Phase 2 & 3 investigation); site management plan; permit required if utilised for education or tourism
High significance: Graves and burial places	4b. Locate demonstrable descendants through social consulting; obtain permits from applicable legislation, ordinances and regional by-laws; exhumation and reinterment [including 2a, 2b & 3]

Furthermore, the significance of archaeological sites was based on six main criteria:

- Site integrity (i.e. primary vs. secondary context),
- Amount of deposit, range of features (e.g., stonewalling, stone tools and enclosures),
- Density of scatter (dispersed scatter),
- Social value,
- Uniqueness, and
- Potential to answer current and future research questions.

11 ADDENDUM 2: GRAVE RELOCATION AND SITE MANAGEMENT: STATUTORY MANDATE

11.1 Archaeology, graves and the law

Note that four categories of graves can be identified. These are:
- Graves younger than 60 years;

- Graves older than 60 years, but younger than 100 years;

- Graves older than 100 years; and

- Graves of victims of conflict or of individuals of royal descent

In terms of Section 36(3) of the National Heritage Resources Act, no person may, without a permit issued by the relevant heritage resources authority:
(a) destroy, damage, alter, exhume or remove from its original position of otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
(b) destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
(c) bring onto or use at a burial ground or grave referred to in paragraph
(a) Or (b) any excavation, or any equipment which assists in the detection or recovery
of metals.

Human remains that are less than 60 years old are subject to provisions of the Human Tissues Act (Act 65 of 1983) and to local regulations. Exhumation of graves must conform to the standards set out in the Ordinance on Excavations (Ordinance no. 12 of 1980) (replacing the old Transvaal Ordinance no. 7 of 1925). Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place.
A registered undertaker can only handle human remains or an institution declared under the Human Tissues Act (Act 65 of 1983 as amended).

Unidentified/unknown graves are also handled as older than 60 until proven otherwise.
Summary of applicable legislation and legal requirements:

- Human Tissue Act (Act 65 of 1983 as amended).
- Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925)
- Ordinance on Excavations (Ordinance no. 12 of 1980)
- Local and regional provisions, laws and by-laws
- National Heritage Resources Act (Act no. 25 of 1999)
- Permit from SAHRA for removal of human remains

11.2 Graves: necessary procedures

When graves are located in an area demarcated for development, the following mitigation options might be considered:

- **Conservation:** The establishment of a 50 meter buffer zone around the burial place which is fenced off and, maintained and conserved. *This option is generally recommended as the relocation of burial places is an extremely complicated, time consuming and sensitive process.*

- **Mitigation and relocation:** In the event where impact on the burial place will occur, mitigation measures may entail full grave relocation. Such a relocation process must be undertaken by suitably qualified individuals with a proven track record. The relocation must also be undertaken in full cognisance of all relevant legislation, including the specific requirements of the National Heritage Resource Act (Act no. 25 of 1999). Furthermore, a concerted effort must also be made to identify all buried individuals and to contact their relatives and descendants. Other legislative measures which may be of relevance include the Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925), the Human Tissues Act (Act no. 65 of 1983, as amended), the Ordinance on Excavations (Ordinance no. 12 of 1980) as well as any local and regional provisions, laws and by-laws that may be in place.

Methodology for grave relocations:

- **Documentation:** Physical documentation of graves and determining context of graves prior to exhumation: Photographic, GPS, Site Map, Historical Background.
- **Public Notices:** In order to locate and notify descendant families, notices (in compliance with the National Heritage Resources Act) must be placed on the site/s, indicating the intent of relocation. These notices, translated into at least 3 languages, have to remain in place for a minimum of 60 days. Additionally, newspaper adverts and notices on local radio stations announcements are required.
- **Social consultation:** If any descendant families were located during initial consultation/public participation phases, a full social consultation action will lodged.
- **Permit application:** Application for a permit from SAHRA can only be obtained after all necessary consent documents from descendant families, landowners and relevant authorities have been secured.
- **Exhumation & relocation**

The exhumation, investigation and reburial of the burial place may commence after SAHRA has issued relevant permits and permissions

12 ADDENDUM 3: CONVENTIONS USED TO ASSESS THE SIGNIFICANCE OF HERITAGE

12.1 Site Significance Matrix

According to the NHRA, Section 2(vi) the **significance** of heritage sites and artefacts is determined by it aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technical value in relation to the uniqueness, condition of preservation and research potential. It must be kept in mind that the various aspects are not mutually exclusive, and that the evaluation of any site is done with reference to any number of these. The following matrix is used for assessing the significance of each identified site/feature.

2. SITE EVALUATION			
2.1 Heritage Value (NHRA, section 2 [3])	High	Medium	Low
It has importance to the community or pattern of South Africa's history or pre-colonial history.			
It possesses unique, uncommon, rare or endangered aspects of South Africa's natural or cultural heritage.			
It has potential to yield information that will contribute to an understanding of South Africa's natural and cultural heritage.			
It is of importance in demonstrating the principle characteristics of a particular class of South Africa's natural or cultural places or objects.			
It has importance in exhibiting particular aesthetic characteristics valued by a particular community or cultural group.			
It has importance in demonstrating a high degree of creative or technical achievement at a particular period.			
It has marked or special association with a particular community or cultural group for social, cultural or spiritual reasons (sense of place).			
It has strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa.			
It has significance through contributing towards the promotion of a local sociocultural identity and can be developed as a tourist destination.			
It has significance relating to the history of slavery in South Africa.			
It has importance to the wider understanding of temporal changes within cultural landscapes, settlement patterns and human occupation.			
2.2 Field Register Rating			
National/Grade 1 [should be registered, retained]			
Provincial/Grade 2 [should be registered, retained]			
Local/Grade 3A [should be registered, mitigation not advised]			
Local/Grade 3B [High significance; mitigation, partly retained]			
Generally Protected A [High/Medium significance, mitigation]			
Generally protected B [Medium significance, to be recorded]			
Generally Protected C [Low significance, no further action]			
2.3 Sphere of Significance	High	Medium	Low
International			
National			
Provincial			
Local			
Specific community			

12.2 Impact Assessment Criteria

The following table provides a guideline for the rating of impacts and recommendation of management actions for sites of heritage potential.

Significance of the heritage resource

This is a statement of the nature and degree of significance of the heritage resource being affected by the activity. From a heritage management perspective it is useful to distinguish between whether the significance is embedded in the physical fabric or in associations with events or persons or in the experience of a place; i.e. its visual and non-visual qualities. This statement is a primary informant to the nature and degree of significance of an impact and thus needs to be thoroughly considered. Consideration needs to be given to the significance of a heritage resource at different scales (i.e. sitespecific, local, regional, national or international) and the relationship between the heritage resource, its setting and its associations.

Nature of the impact

This is an assessment of the nature of the impact of the activity on a heritage resource, with some indication of its positive and/or negative effect/s. It is strongly informed by the statement of resource significance. In other words, the nature of the impact may be historical, aesthetic, social, scientific, linguistic or architectural, intrinsic, associational or contextual (visual or non-visual). In many cases, the nature of the impact will include more than one value.

Extent

Here it should be indicated whether the impact will be experienced:

- On a site scale, i.e. extend only as far as the activity;
- Within the immediate context of a heritage resource;
- On a local scale, e.g. town or suburb
- On a metropolitan or regional scale; or
- On a national/international scale.

Duration

Here it should be indicated whether the lifespan of the impact will be:

- Short term, (needs to be defined in context)
- Medium term, (needs to be defined in context)
- Long term where the impact will persist indefinitely, possibly beyond the operational life of the activity, either because of natural processes or by human intervention; or
- Permanent where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.

Of relevance to the duration of an impact are the following considerations:

- Reversibility of the impact; and
- Renewability of the heritage resource.

Intensity

Here it should be established whether the impact should be indicated as:

- Low, where the impact affects the resource in such a way that its heritage value is not affected;
- Medium, where the affected resource is altered but its heritage value continues to exist albeit in a modified way; and
- High, where heritage value is altered to the extent that it will temporarily or permanently be damaged or destroyed.

Probability

This should describe the likelihood of the impact actually occurring indicated as:

- Improbable, where the possibility of the impact to materialize is very low either because of design or historic experience;
- Probable, where there is a distinct possibility that the impact will occur;
- Highly probable, where it is most likely that the impact will occur; or
- Definite, where the impact will definitely occur regardless of any mitigation measures

Confidence

This should relate to the level of confidence that the specialist has in establishing the nature and degree of impacts. It relates to the level and reliability of information, the nature and degree of consultation with I&AP's and the dynamic of the broader socio-political context.

- High, where the information is comprehensive and accurate, where there has been a high degree of consultation and the socio-political context is relatively stable.

- Medium, where the information is sufficient but is based mainly on secondary sources, where there has been a limited targeted consultation and socio-political context is fluid.
- Low, where the information is poor, a high degree of contestation is evident and there is a state of socio-political flux.

Impact Significance

The significance of impacts can be determined through a synthesis of the aspects produced in terms of the nature and degree of heritage significance and the nature, duration, intensity, extent, probability and confidence of impacts and can be described as:

- Low; where it would have a negligible effect on heritage and on the decision
- Medium, where it would have a moderate effect on heritage and should influence the decision.
- High, where it would have, or there would be a high risk of, a big effect on heritage. Impacts of high significance should have a major influence on the decision;
- Very high, where it would have, or there would be high risk of, an irreversible and possibly irreplaceable negative impact on heritage. Impacts of very high significance should be a central factor in decision-making.

12.3 Direct Impact Assessment Criteria

The following table provides an outline of the relationship between the significance of a heritage context, the intensity of development and the significance of heritage impacts to be expected

	TYPE OF DEVELOPMENT			
HERITAGE CONTEXT	**CATEGORY A**	**CATEGORY B**	**CATEGORY C**	**CATEGORY D**
CONTEXT 1 High heritage Value	Moderate heritage impact expected	High heritage impact expected	Very high heritage impact expected	Very high heritage impact expected
CONTEXT 2 Medium to high heritage value	Minimal heritage impact expected	Moderate heritage impact expected	High heritage impact expected	Very high heritage impact expected
CONTEXT 3 Medium to low heritage value	Little or no heritage impact expected	Minimal heritage impact expected	Moderate heritage impact expected	High heritage impact expected
CONTEXT 4 Low to no heritage value	Little or no heritage impact expected	Little or no heritage impact expected	Minimal heritage value expected	Moderate heritage impact expected

NOTE: A DEFAULT "LITTLE OR NO HERITAGE IMPACT EXPECTED" VALUE APPLIES WHERE A HERITAGE RESOURCE OCCURS OUTSIDE THE IMPACT ZONE OF THE DEVELOPMENT.

HERITAGE CONTEXTS	CATEGORIES OF DEVELOPMENT
Context 1: Of high intrinsic, associational and contextual heritage value within a national, provincial and local context, i.e. formally declared or potential Grade 1, 2 or 3A heritage resources **Context 2:** Of moderate to high intrinsic, associational and contextual value within a local context, i.e. potential Grade 3B heritage resources. **Context 3:** Of medium to low intrinsic, associational or contextual heritage value within a national, provincial and local context, i.e. potential Grade 3C heritage resources **Context 4:** Of little or no intrinsic, associational or contextual heritage value due to disturbed, degraded conditions or extent of irreversible damage.	**Category A: Minimal intensity development** - No rezoning involved; within existing use rights. - No subdivision involved. - Upgrading of existing infrastructure within existing envelopes - Minor internal changes to existing structures - New building footprints limited to less than 1000m2. **Category B: Low-key intensity development** - Spot rezoning with no change to overall zoning of a site. - Linear development less than 100m - Building footprints between 1000m2-2000m2 - Minor changes to external envelop of existing structures (less than 25%) - Minor changes in relation to bulk and height of immediately adjacent structures (less than 25%). **Category C: Moderate intensity development** - Rezoning of a site between 5000m2-10 000m2.

	- Linear development between 100m and 300m. - Building footprints between 2000m2 and 5000m2 - Substantial changes to external envelop of existing structures (more than 50%) - Substantial increase in bulk and height in relation to immediately adjacent buildings (more than 50%) **Category D: High intensity development** - Rezoning of a site in excess of 10 000m2 - Linear development in excess of 300m. - Any development changing the character of a site exceeding 5000m2 or involving the subdivision of a site into three or more erven. - Substantial increase in bulk and height in relation to immediately adjacent buildings (more than 100%)

12.4 Management and Mitigation Actions

The following table provides a guideline of relevant heritage resources management actions is vital to the conservation of heritage resources.

No further action / Monitoring

Where no heritage resources have been documented, heritage resources occur well outside the impact zone of any development or the primary context of the surroundings at a development footprint has been largely destroyed or altered, no further immediate action is required. Site monitoring during development, by an ECO or the heritage specialist are often added to this recommendation in order to ensure that no undetected heritage\ remains are destroyed.

Avoidance

This is appropriate where any type of development occurs within a formally protected or significant or sensitive heritage context and is likely to have a high negative impact. Mitigation is not acceptable or not possible. This measure often includes the change / alteration of development planning and therefore impact zones in order not to impact on resources.

Mitigation

This is appropriate where development occurs in a context of heritage significance and where the impact is such that it can be mitigated to a degree of medium to low significance, e.g. the high to medium impact of a development on an archaeological site could be mitigated through sampling/excavation of the remains. Not all negative impacts can be mitigated.

Compensation

Compensation is generally not an appropriate heritage management action. The main function of management actions should be to conserve the resource for the benefit of future generations. Once lost it cannot be renewed. The circumstances around the potential public or heritage benefits would need to be exceptional to warrant this type of action, especially in the case of where the impact was high.

Rehabilitation

Rehabilitation is considered in heritage management terms as a intervention typically involving the adding of a new heritage layer to enable a new sustainable use. It is not appropriate when the process necessitates the removal of previous historical layers, i.e. restoration of a building or place to the previous state/period. It is an appropriate heritage management action in the following cases:

- The heritage resource is degraded or in the process of degradation and would benefit from rehabilitation.
- Where rehabilitation implies appropriate conservation interventions, i.e. adaptive reuse, repair and maintenance, consolidation and minimal loss of historical fabric.
- Where the rehabilitation process will not result in a negative impact on the intrinsic value of the resource.

Enhancement

Enhancement is appropriate where the overall heritage significance and its public appreciation value are improved. It does not imply creation of a condition that might never have occurred during the evolution of a place, e.g. the tendency to sanitize the past. This management action might result from the removal of previous layers where these layers are culturally of low significance and detract from the significance of the resource. It would be appropriate in a range of heritage contexts and applicable to a range of resources. In the case of formally protected or significant resources, appropriate enhancement action should be encouraged. Care should, however, be taken to ensure that the process does not have a negative impact on the character and context of the resource. It would thus have to be carefully monitored

13 ADDENDUM 4: GPR SURVEY AT GLENCORE'S KROONDAL MINE OFFICES

GPR SURVEY AT GLENCORE'S KROONDAL MINE OFFICES

DECEMBER 2018

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Executive summary

A ground-penetrating radar (GPR) survey was conducted at Glencore's Kroondal Mine Office Complex on 10 December 2018. The purpose of the survey was to detect possible unmarked burial sites (graves) linked to nearby communities. The GPR results revealed possible evidence of such graves in close proximity to a fenced-off area containing several known graves. However, due primarily to the interference of existing infrastructure on the site, effective GPR surveying was extremely difficult. The GPR survey and associated results are described in this report. Recommendations regarding potential follow-up investigations are also included.

1 Background

In December 2018, Exigo Sustainability (Pty) Ltd commissioned CSIR to conduct a ground-penetrating radar (GPR) survey at Glencore's Kroondal Mine Office Complex. The purpose of the survey was to detect possible unmarked burial sites (graves) linked to nearby communities. The possible existence of such burials is reportedly based on assertions from local community members. The fact that a small fenced-off area containing approximately eight known graves exists on the property may be seen as supporting circumstantial evidence for the validity of the above assertions. The Kroondal Mine Office Complex is located just south of the R104 near Kroondal. The area of interest on the property is outlined (white polygon) in the Google Earth image in Figure 1.

Figure 1: Google Earth image of the Kroondal Mine area of interest

A schematic drawing of the area of interest, which measures approximately 90 m x 50 m, is shown in Figure 2. The known graves that exist on the property are located in a small fenced-off area north of the concrete pathway (also see Figure 3).

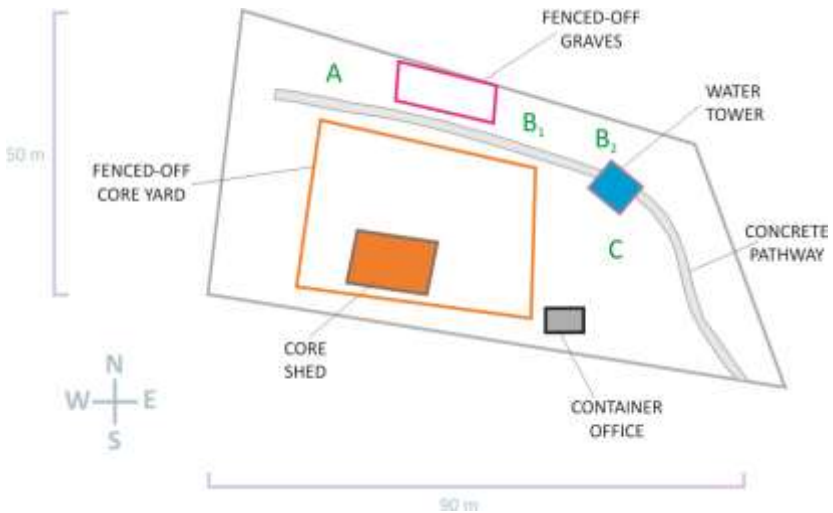


Figure 2: Schematic of the Kroondal Mine area of interest

Figure 3: Concrete pathway (looking west) with fenced of graves on the right/front

The area of interest is generally not suitable for effective GPR surveying due to the abundance of permanent and semi-permanent infrastructure and equipment on the property. These obstacles make it extremely difficult to acquire 3D (grid) data and also limit the options for acquiring conventional 2D GPR profiles[1]. For these reasons, the following survey approach was adopted at the site: A limited number of areas were identified where the 3D approach was attempted; in other words, where small grids of GPR profiles could be acquired. The areas numbered A-C in Figure 1 were subsequently covered with mini-3D surveys. Apart from these mini-3D surveys, several other 2D reconnaissance profiles were acquired at strategically chosen locations. These locations focussed on the area close to the known graves; for example, along and to the sides of the concrete pathway, where it passes the fenced-off graves.

Some reconnaissance profiles were also acquired in less favourable (from a GPR perspective) locations; for example, inside the core yard, along the entire length of the concrete pathway and just outside (to the west) of the core yard. These reconnaissance profiles were done to assess the performance/applicability of GPR in as many different locations within the area of interest. These areas were considered as 'less favourable' due to the anticipated interference from the many metallic objects, including steel/electric fencing, concrete reinforcing bar ('rebar'), high voltage cables and other buried utilities. The close proximity of metallic objects in particular is known to compromise GPR data quality. As an illustrative example of these logistical challenges, Figure 4 shows the many GPR obstacles present inside the core yard area. The client was however informed of these risks to the successful application of GPR at the site.

[1] The term '2D GPR' generally implies the acquisition of data along a single profile, while '3D GPR' refers to the acquisition of a series of closely spaced profiles within a pre-defined polygon. 2D GPR only enables a cross-sectional view of the subsurface below the surveyed line, whereas 3D GPR enables both cross-sectional and depth slices through the sampled volume of the near surface below the survey polygon or grid.

Figure 4: Photos showing the many GPR obstacles inside the core yard area

2 Basic principles of GPR

Ground-penetrating radar (GPR) is a geophysical imaging tool that is widely used in a variety of near-surface geoscience applications. GPR is a shallow exploration tool, but is capable of providing high-resolution details about the first few meters below the ground surface or ahead of a mining face in the case of in-mine geophysics.

A GPR system comprises of a closely spaced transmitter and receiver that can be deployed on some form of trolley or cart system for surface surveys. The antennas can also be manoeuvred by hand in situations where a trolley/cart cannot be used. Various operating frequency options are available; typically in the range 200-1000 MHz. For example, Figure 5a shows a 250 MHz *Rock No*ggin / *Smart Cart* GPR system configuration (typically used for surface-based surveys covering large areas), while Figure 5b shows a 500 MHz system; the 250 MHz cart-based system was used at Kroondal. The different frequency options relate to depth of investigation or range: there is a known trade-off between range and resolution, which can be controlled to some extent by the operating frequency. A higher frequency implies a higher resolution, but at a lower penetration and range. The 500 MHz option is often used in heritage/archaeological/forensic investigations due to it higher reolution capability, but the 250 MHz often offers a better compromise between range and resolution, especially in environments where the bulk ground conductivity is relatively high.

During a GPR survey, a radar pulse is transmitted into the ground, and the receiver records the amplitude of the radar return signal as a function of time (amplitude-time trace). This is done while the antenna is moved along pre-determined survey lines (Figure 6a). A very high sampling rate enables the acquisition of numerous traces separated by cm-scale intervals. The GPR method is sensitive to the dielectric physical property and any sudden changes in this property (for example, a lithological layer boundary or other structural anomaly or bulk property change) will result in a reflection of some of the radar energy. The amplitude of these return signals and the associated two-way travel-times (from transmitter to target and back to receiver) are recorded for a large number of traces as the GPR system moves along a selected survey profile.

Figure 5: The Rock Noggin Smart Cart 250 MHz system (left) and a 500 MHz system (right)

The GPR system can be set up to effectively measure radar *traces* at fixed spatial intervals; typically, a *trace* every few centimetres along the profile. A so-called *trace* is simply a sequence of hundreds of amplitude measurements (separated by a fraction of a nanosecond). Figure 6b shows a typical radar trace.

Radar traces are generally characterised by several reflection events (often overlapping) that rapidly decrease in signal strength over time. This attenuation is a function of the rock properties that are penetrated and, in particular, the higher the bulk electrical conductivity of the subsurface, the more severe the attenuation. The observed reflections include both the wanted reflections (from intended targets) as well as unwanted reflections from other dielectric anomalies and also some spurious reflections and other unwanted background noise. It is these characteristics of raw GPR data that often render the extraction of useful data challenging. All the traces along a GPR profile are usually stacked together on a plot known as a radargram. The example in Figure 7 shows how such a radargram can be used to infer the subsurface structure (in this case tracking an undulating layer boundary at a depth of approximately 1 m). Note how the interference from unwanted reflections and noise sources contaminate the radargram to some extent. The aim of radar data processing is generally to try and amplify/emphasise the desired responses of the targets while suppressing the unwanted signals and background noise.

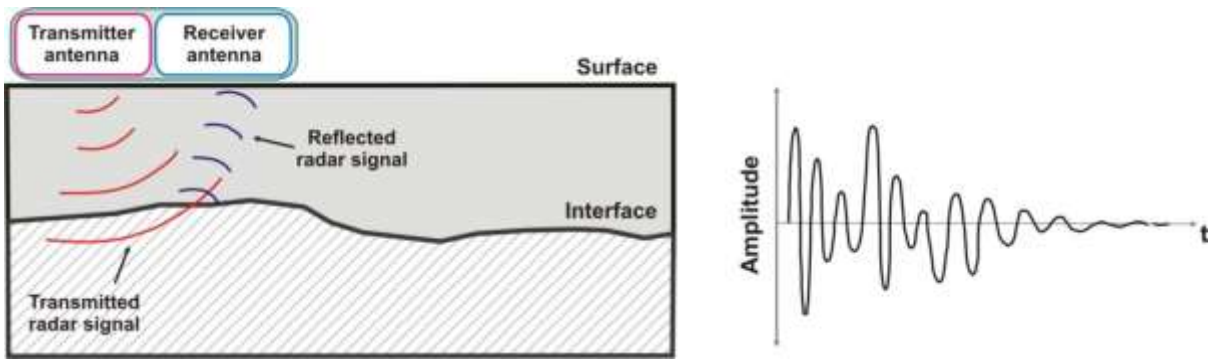


Figure 6: Schematic showing typical GPR survey scenario (left) and singe data trace (right)

The radargram in Figure 7 represents a typical 2D or single profile GPR output. Note that the primary y-axis (time) can be converted to an approximate depth (secondary y-axis) by estimating the bulk velocity of the near surface. In the subsequent data analysis for the Kroondal site, a bulk velocity of 0.09 m/ns was assumed; this is considered a typical velocity for an unsaturated overburden environment.

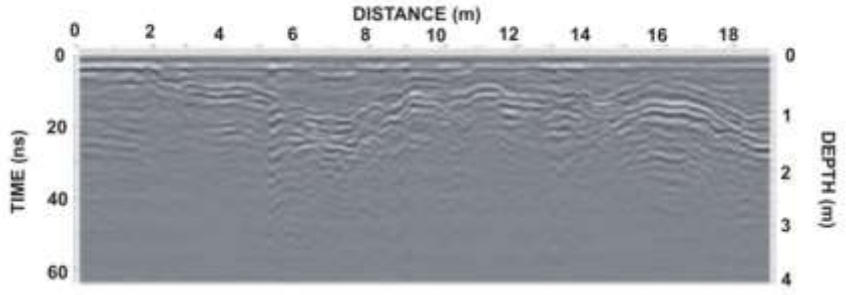


Figure 7: Example of a GPR radargram

3 Survey and results

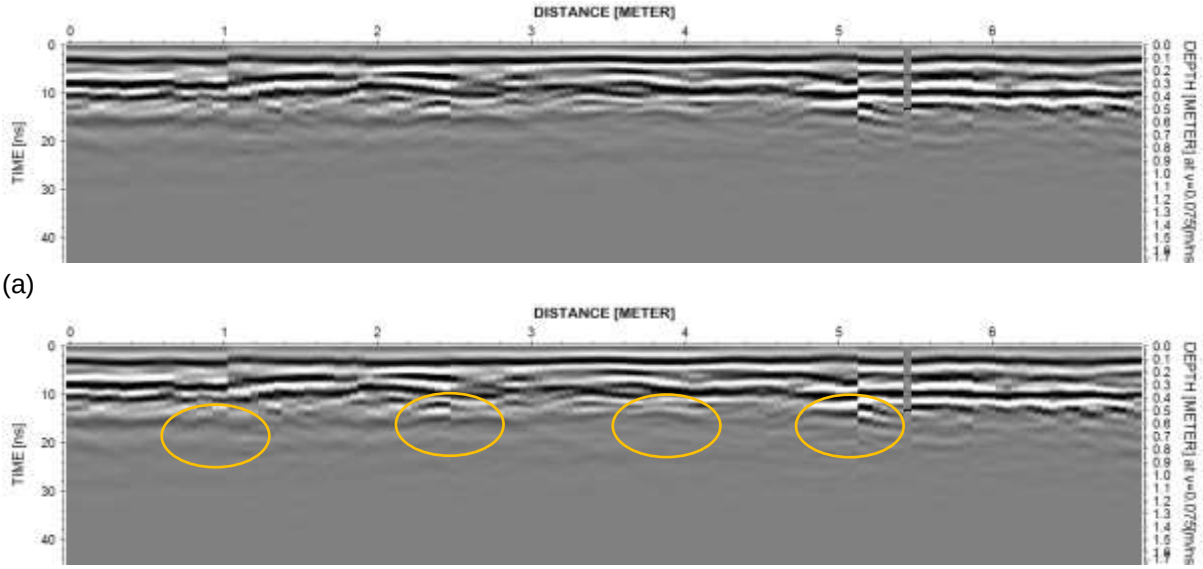
Due to the logistical challenges described earlier, the GPR surveying at the Krrondal site was done in a somewhat fragmented way. Consequently, the results will be presented for each of the following sub-areas or sub-surveys:

1. Reference lines over existing graves
2. Test profile along concrete pathway
3. GPR survey in Area A
4. Test profiles inside the core yard
5. GPR survey in Area B_1
6. GPR survey in Area B_2
7. 3D GPR survey in Area C
8. Selected profiles close to the fenced-off graves
9. Selected profiles west of core yard

3.1 Reference lines over existing graves

A GPR profile was acquired over the existing graves inside the fenced-off area. The intention was to obtain a '*frame of reference*' radar result – or to characterise the possible grave response in this environment. A profile of length ~7 m was done in a W-E direction (Figure 8) and, based on surface evidence (soil mounds, packed rocks etc.), it appeared that the profile transected at least two graves (at ~2 m and ~ 5m). It also seemed possible that the profile start and end positions may have been right on top of possible burials. The processed radargram for this profile is shown in Figure 9.

Figure 8: Photo of the fenced-off graves; the yellow arrow depicts the position of a test GPR profile



The orange ovals indicate possible grave anomalies that are obscured to some extent by other near-surface responses

Figure 9: Processed radargram associated with profile (annotated version at bottom)

Discussion

Unfortunately, the *frame of reference* radargram is not as conclusive as one might have anticipated; for example, compare this result with a past 250 MHz GPR experiment, at a different site, over known burials, shown in Figure 10. Under more ideal conditions, grave responses clearly show up as localised hyperbolic reflection events such as those highlighted in Figure 10.

Such clearly distinguishable anomalies are not evident in the Kroondal radargram in Figure 9, although there are some indications of possible anomalous reflections as indicated in the annotated version of the radargram. However, these potential anomalies are obscured by the multitude of near-surface reflection events. The uneven and rocky surface over which the GPR traversed at the Kroondal site, is thought to contribute to the less than ideal GPR survey conditions and the inconclusive data. It should also be pointed out that the effective

depth of penetration for GPR at the site is not as great as was expected, with little reflections being visible below a depth of approximately 1 m. Limited penetration in GPR is simply a function of ground conductivity. In terms of the Kroondal site, this means that the upper near-surface has a relatively high bulk conductivity, which compromises radar penetration.

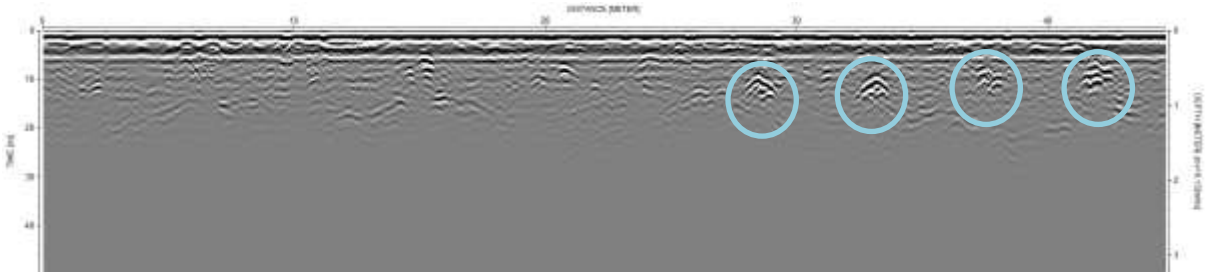


Figure 10: Examples of typical GPR grave responses from a previous study

3.2 Test profile along concrete pathway

A GPR profile was acquired along the entire length of the pathway shown in Figure 2 – from the SE corner of the area of interest to the NW side. The purpose of this profile was to characterise the radar response over the concrete pathway and to determine whether one might be able to achieve GPR penetration through the concrete layer. The result of this profile is shown in Figure 11.

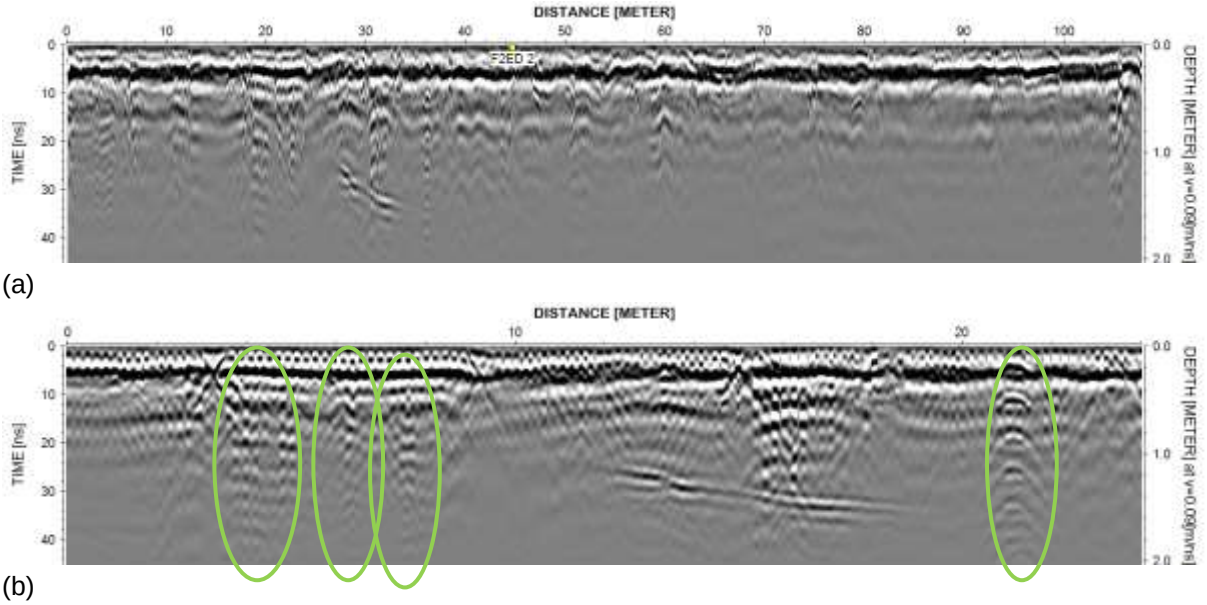


Figure 11: Radargram for test profile along concrete pathway; in the zoomed-in section shown in Figure 10b the response of buried utilities are indicated

Discussion

The concrete layer and associated reinforcing steel mesh clearly manifest on the output radargram. The classic pattern associated with the steel mesh is not that evident in the 100^{+} m radargram (Figure 11a), but becomes more evident in the shorter zoomed-in portion shown in Figure 10b. The response from the mesh clearly reverberates throughout the whole radargram.

The vertical anomalies that appear to persist down to bottom of the radargram and have characteristic repetitive patterns (some are highlighted with green ovals) are typical of buried utilities such as water pipes or metal pipes/cables.

The cause of the sloping reflector that occurs at a depth of ~1.5 m between x = 10 m and x = 20 m is uncertain. Although it could be geological, it is more likely an artefact, in the form of a surface reflection off a vehicle (truck) that was parked alongside the pathway at the time of the survey.

As was the case with the test profile over the known graves, it becomes very difficult to detect any other anomalies below the 'unwanted' near surface responses. This is especially true for analysing 2D profiles in which the spatial extent of small hyperbolic reflection events cannot be assessed as would be the case for 3D surveys where horizontal depth slices can be extracted.

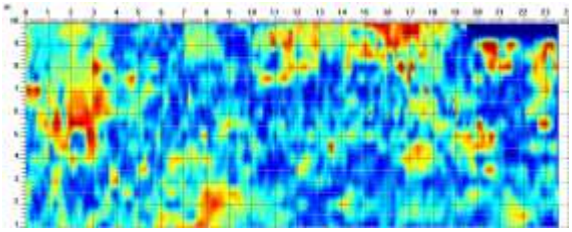
3.3 GPR survey in Area A

A series of parallel W-E GPR profiles was acquired in the open area to the west of the fenced-off graves. This area, which is marked 'A' in Figure 2, is shown in the photograph in Figure 12. These profiles were spaced approximately 0.5 m apart and were approximately 23 m in length. This effectively resulted in a rectangular survey area of ~ 23 m x 10 m for which a 3D data set was produced. From this 3D data set, a sequence of depth slices could then be extracted to assist in identifying possible localised anomalies within the surveyed rectangle. A sequence of selected depth slices is shown in Figure 13.

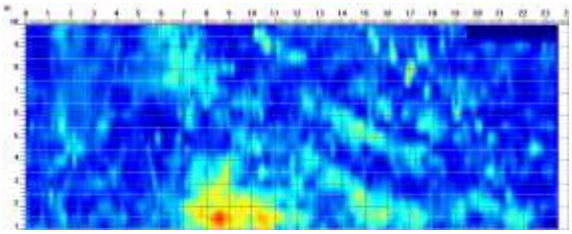
View of 3D survey area A - looking from the west towards the fenced-off graves (behind the dustbin)

Figure 12: Photo of the open area to the west of the fenced-off graves – Area A

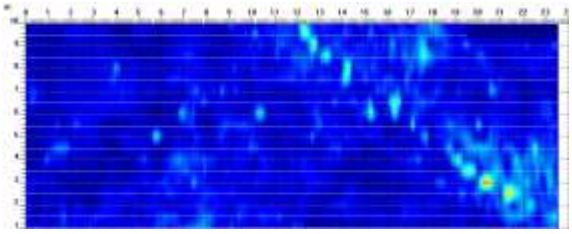
0-0.1 m:



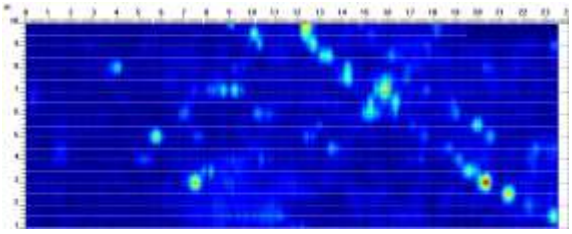
0.2-0.3 m



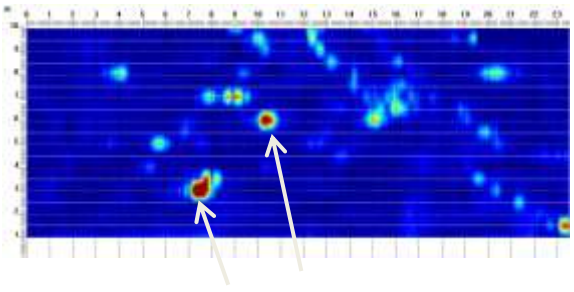
0.4-0.5 m



0.6-0.7 m



1.0-1.1 m



1.3-1.4 m

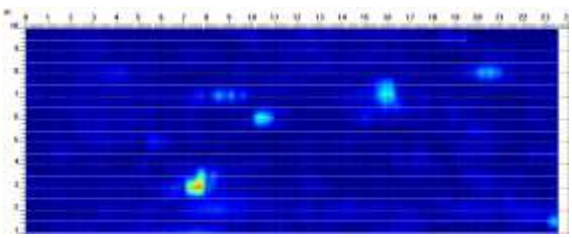


Figure 13: Depth slices extracted from the 3D data set for Area A

Discussion

In the uppermost slice in Figure 13, depicting spatial variations in the radar response associated with the first ~10 cm, a high level of anomalous behaviour is apparent. This is typical for the uppermost depth slice as the non-ideal surface conditions alluded to previously (uneven terrain, vegetation, surface objects etc.) dominate the response. Slices deeper than approximately 20 cm reveal a more uniform character with not many localised anomalies. A noteworthy exception is the pair of linear trending anomalies, which can be seen in the 0.4-0.5 m, 0.6-0.7 m and 1.0-1.1 m slices. One of these linear anomalies extend from the top centre of the depth slices down to the lower right corner; the second one is less evident, but can be seen just north and parallel to the first. These linear anomalies are associated with the surface/buried water pipes that were evident at the site and which were transected by the W-E GPR profiles.

Two other anomalies that deserve further investigation are the localised anomalies indicated with arrows in the 1.0-1.1 m slice. It gradually becomes less prominent and eventually disappears on deeper slices, but can still be seen on the 1.3-1.4 m slice. The cause of these anomalies is not clear, but the possibility of burials cannot be ruled out.

3.4 Test profiles inside the core yard

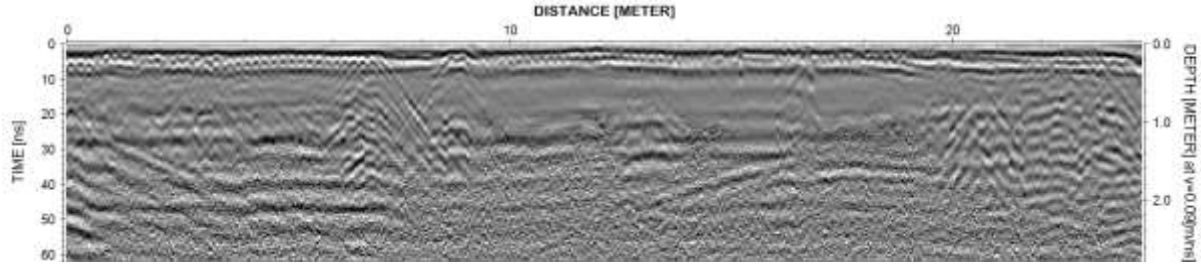
Prior to the survey, the core yard was highlighted as one of the areas where GPR efforts might need to be focussed – presumably because this area lies just south of the existing graves. However, the following concerns around surveying the core yard was raised prior to mobilising for the survey: Much of the core yard area comprises a concrete floor and it was speculated that the reinforcing material in the floor might have an adverse impact on the ability of GPR to penetrate the floor and the ability to obtain useful information from below the concrete layer. An equally problematic issue is the presence and abundance of mostly metallic objects and obstacles that occur within the core yard. The pictures in Figure 14 reveal the extent of this problem. Consequently, only a few profiles were conducted within the core yard. A couple of N-S lines were done over the concrete floor. LINE0 and LINE2 were acquired from north to south and LINE1 and LINE3 from south to north; however, for display purposes, the latter two were flipped along the profile direction so that radargrams LINE0-LINE3, as shown in Figure 15, all have the same (N-S) orientation. A further profile (LINE4) was acquired in a W-E direction to assess the difference between the GPR response over the concrete floor versus the response over a portion of the core yard (to the east, closer to the water tower) that appeared not to have a concrete floor.

(a) (b)

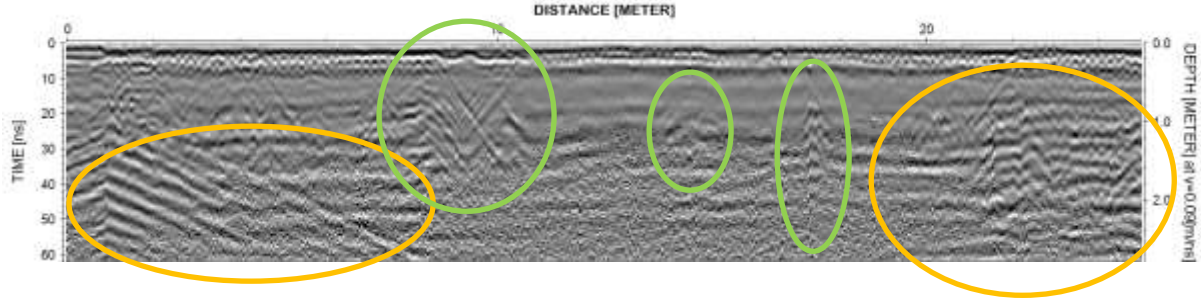
(c)

Figure 14: Photos of the core yard area at Kroondal MIne

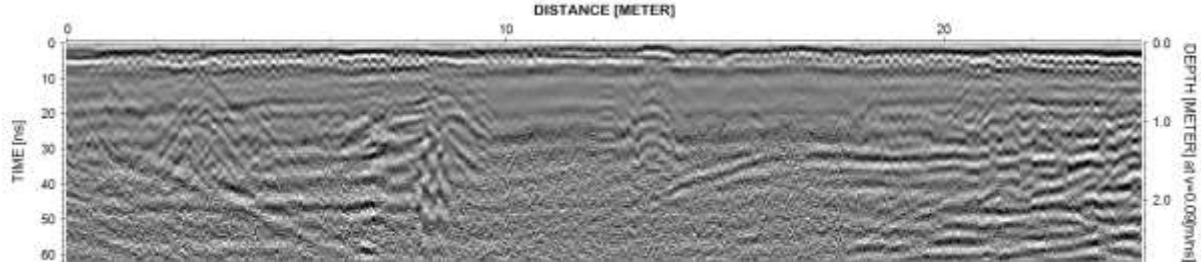
LINE0



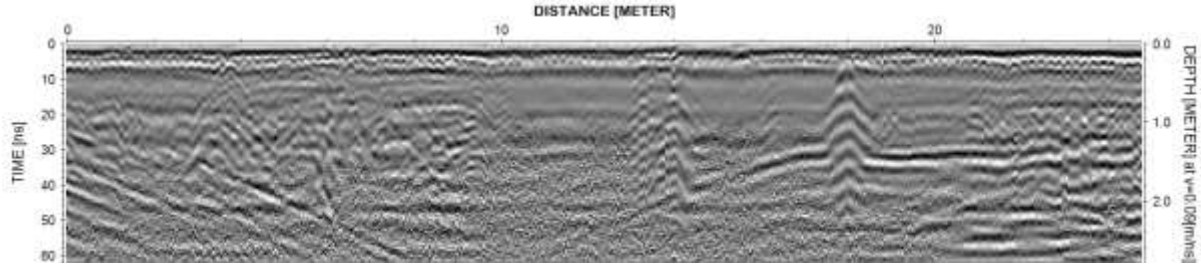
LINE1



LINE2



LINE3



LINE4

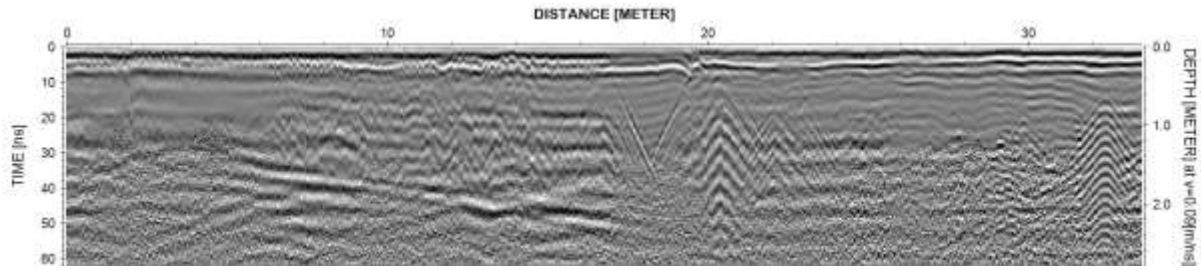


Figure 15: Core yard GPR results

Discussion

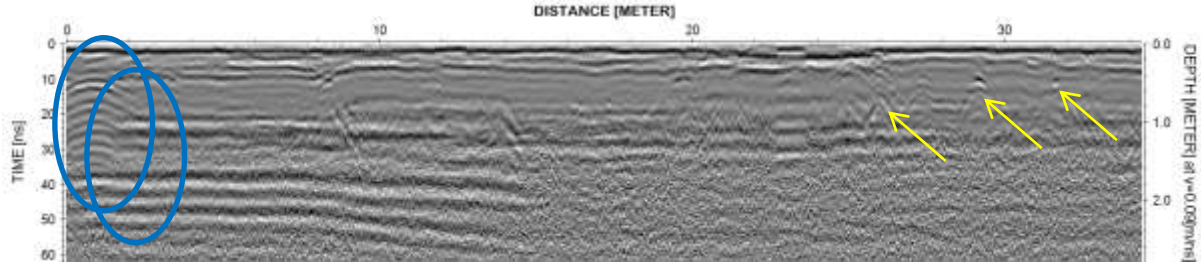
As was the case with the concrete pathway, the concrete floor layer in the core yard and the associated reinforcing steel mesh manifest clearly on most of the output radargrams. The only exception is the last half of LINE4 that traversed a portion of the core yard not covered with concrete. A number of other anomalous reflection events are evident on the core yard radargrams – the most prominent ones are annotated on the LINE2 radargram, but can also be observed in the closely spaced parallel profiles of LINE0, LINE1 and LINE3. The reflection patterns observed near the start of the radargrams (LINE0-LINE3) are associated with the proximity of steel shelving filled with (steel) construction material (see Figure 14a). The anomalies observed towards the end of the profiles (also marked with an orange oval) in LINE2) are attributed to the steel/electric fence and gate / gate motor. The other anomalies, marked with green ovals, are again typical of buried utilities or more prominent steel structures buried within the concrete layer. In this type of non-ideal survey environment with the many artefacts or unwanted reflections it would be extremely difficult to identify the much more subtle / less prominent and localised burial responses, if they did exist under the concrete. To improve the chances of detecting such anomalies one would need to remove most of the surface obstacles, especially the many steel structures, and attempt a detailed 3D survey. However, even if that would be possible, it does not guarantee that grave anomalies would be clearly detectable underneath the reinforced concrete slabs.

The last ~15 m of LINE4 does not have the concrete reinforcing response at early times, but appears to be characterised by interference from the scrap metal, approaching steel fence etc.

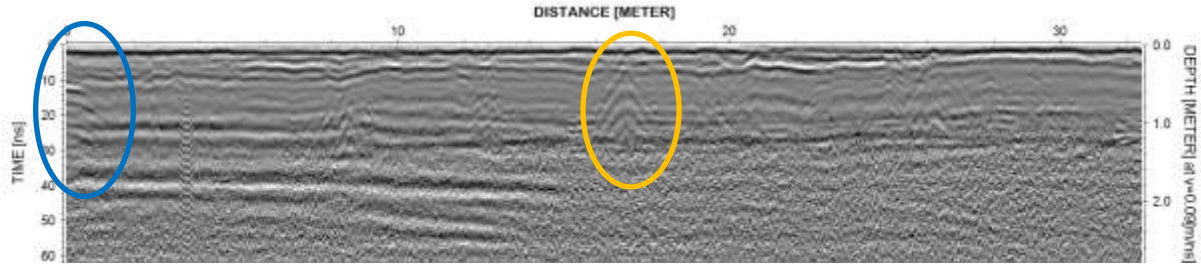
3.5 GPR survey in Area B_1

Except for Area A (described above) and Area C (refer to section 3.7), the only other area where a 3D survey was considered was the area marked 'B_1' in Figure 2 and depicted in Figure 16. This is the area to the immediate east of the fenced-off graves just north of the pathway and extending to the east to more or less the location of the water tower. However, due to the bushes and uneven terrain to the northern side, only five parallel profiles were acquired along this strip of ground. Note that the first three profiles (LINE0-LINE2) started at the SW corner and in front of the fenced-off area – which explains why they are ~10 m longer than LINES 3-5. Note also from the photos in Figure 16, the presence of the surface water pipe, which also impeded data acquisition to some extent. The output radargrams for the five parallel W-E profiles are shown in Figure 17.

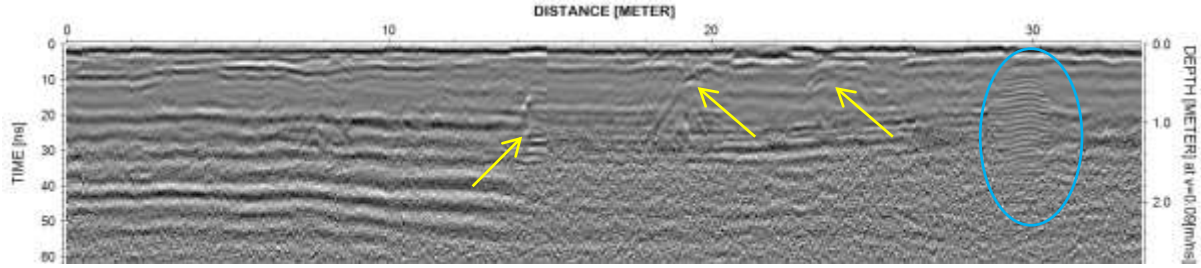
Figure 16: Photos of survey area B



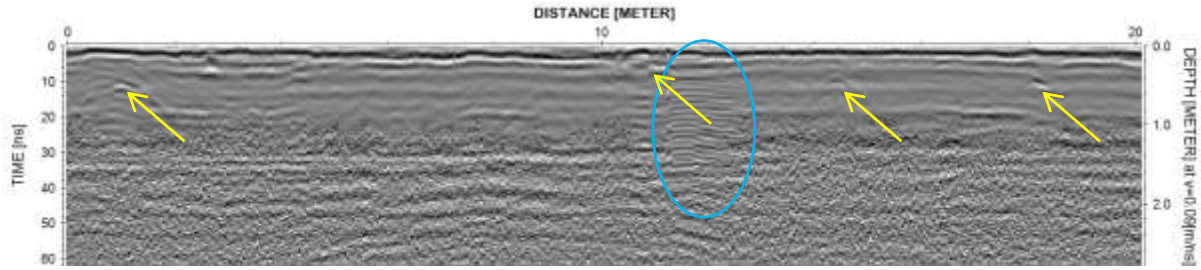
LINE1



LINE2



LINE3



LINE4

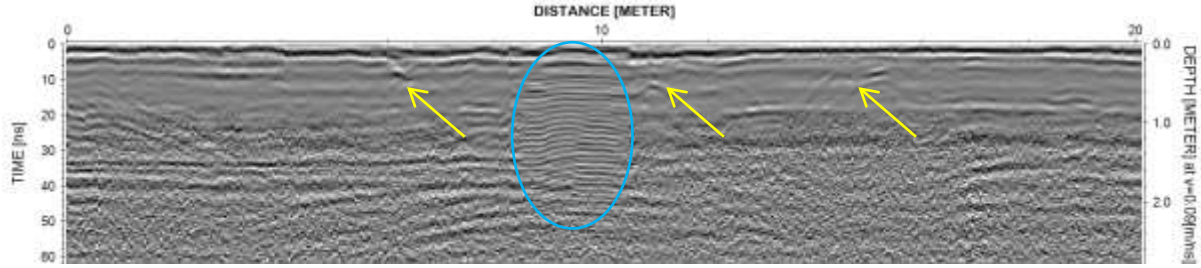


Figure 17: GPR results from Area B

LINE5

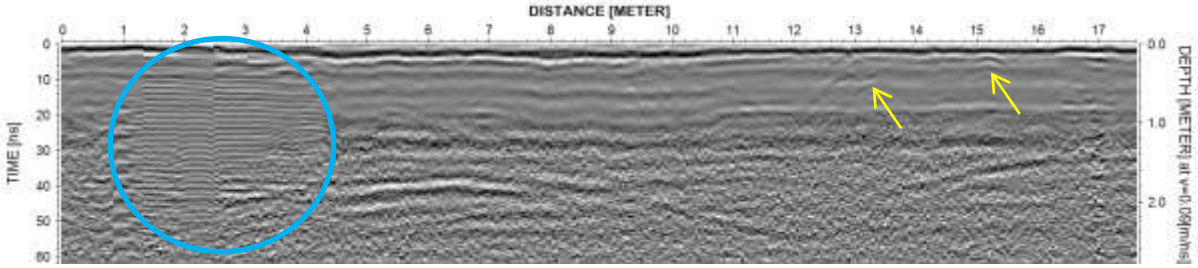


Figure 17 (continued): GPR results from Area B

Discussion

A number of anomalies on the profiles shown in Figure 17 are described below:

- The anomalous zones circled in light blue on LINES 2-5 are associated with the surface water pipe being crossed;
- The response indicated with the navy blue oval at the start of LINE0 (partially evident on LINE1) also appears to be due to a buried utility – possibly another water pipe that comes from the water tower area;
- The anomaly highlighted with an orange oval on LINE1 is probably another buried artefact or utility;
- Several other smaller near-surface anomalies can be seen on the various profiles and these are indicated with yellow arrows. It is extremely difficult to characterise any of these responses as probable grave anomalies without detailed 3D data and associated spatial maps (depth slices). The only effective way to follow up and get better quantitative information regarding these anomalies would be to clear and level the area as much as possible and to then conduct a detailed 3D grid survey. It would also help to have utility maps of the area (if available) to assist in the data analyses and discrimination process.

3.6 GPR survey in Area B_2

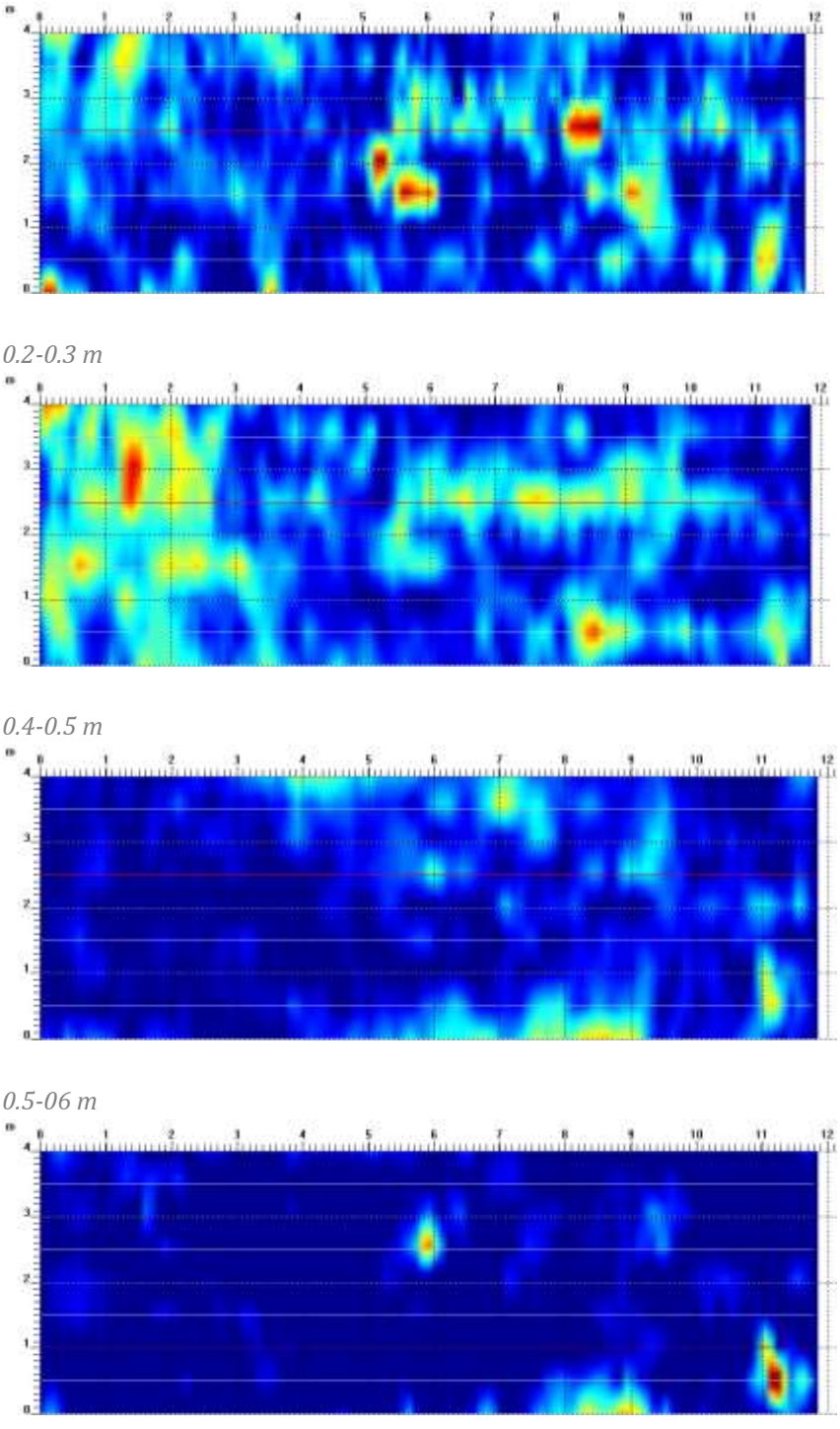
The small rectangle B_2, was covered separately from B_1 and only a limited number of W-E profiles were acquired in this area. The starting point of these few profiles are located approximately 1.5 m east of the end of the profiles acquired in the B_1 area as described above. This 'gap' is due to the large rock that was previously mentioned. The output radargrams, even though there were only seven profiles, were converted into a 3D data set and selected depth slices extracted from the resulting data volume are shown in Figure 18.

Discussion

Apart from the obvious very-near surface anomalies seen in the first few slices, only two other localised anomalies that persist at depth are evident; these are indicated with the white arrows in the last slice in Figure 18. The anomaly in the SE corner of the survey area is associated with thick water pipe that emerges from the ground. A 2D radargram (LINE1) that transects this anomaly is also shown in Figure 19a. The typical water pipe response is clearly seen towards the end of the line.

The cause of the other localised anomaly, which can be seen at ~6 m on LINE5 (Figure 16b) is uncertain. This is one anomaly that probably deserves further investigation during any follow-up surveys.

0-0.1 m



0.2-0.3 m

0.4-0.5 m

0.5-06 m

Figure 18: Selected depth slices for Area B_2

0.4-0.5 m

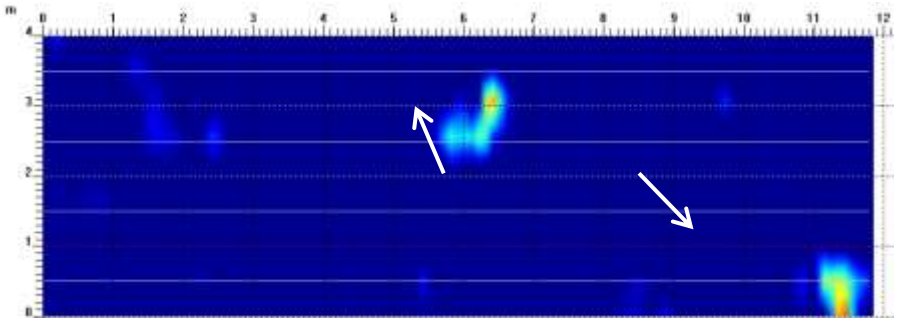
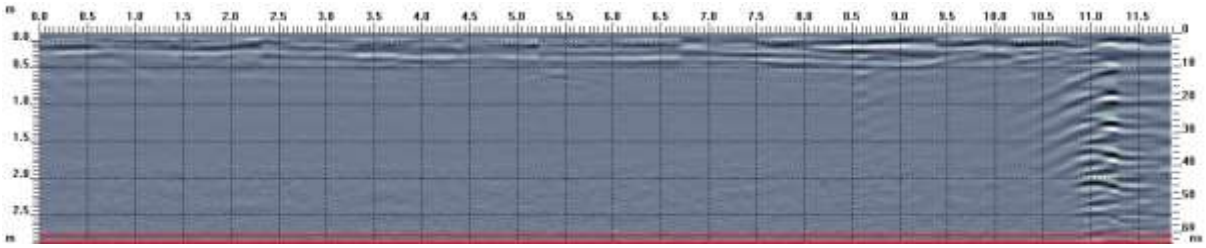


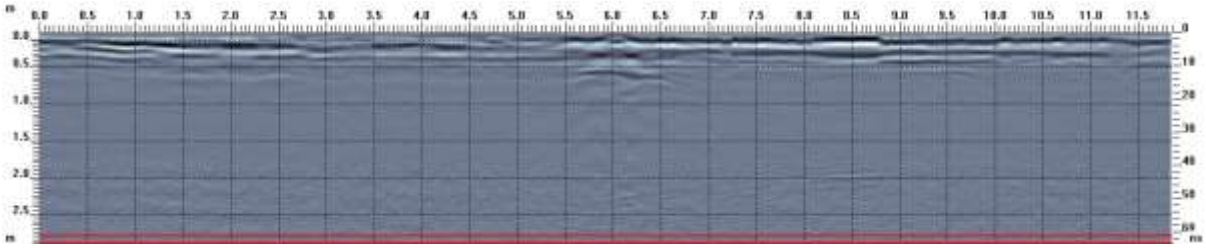
Figure 18 (continued): Selected depth slices for Area B_2

LINE1



(a)

LINE5



(b)

Figure 19: Selected 2D radargrams from Area B_2

3.7 3D GPR survey in Area C

A series of parallel E-W GPR profiles was acquired in the open area to the south of the water tower. This area is marked 'C' in Figure 2. These profiles were also spaced approximately 0.5 m apart and were approximately 23 m in length, resulting in a rectangular survey area of ~ 23 m x 12 m for which a 3D data set was produced. From this 3D data set a sequence of depth slices were then extracted to assist in identifying possible localised anomalies within the surveyed area. A sequence of selected depth slices is shown in Figure 20.

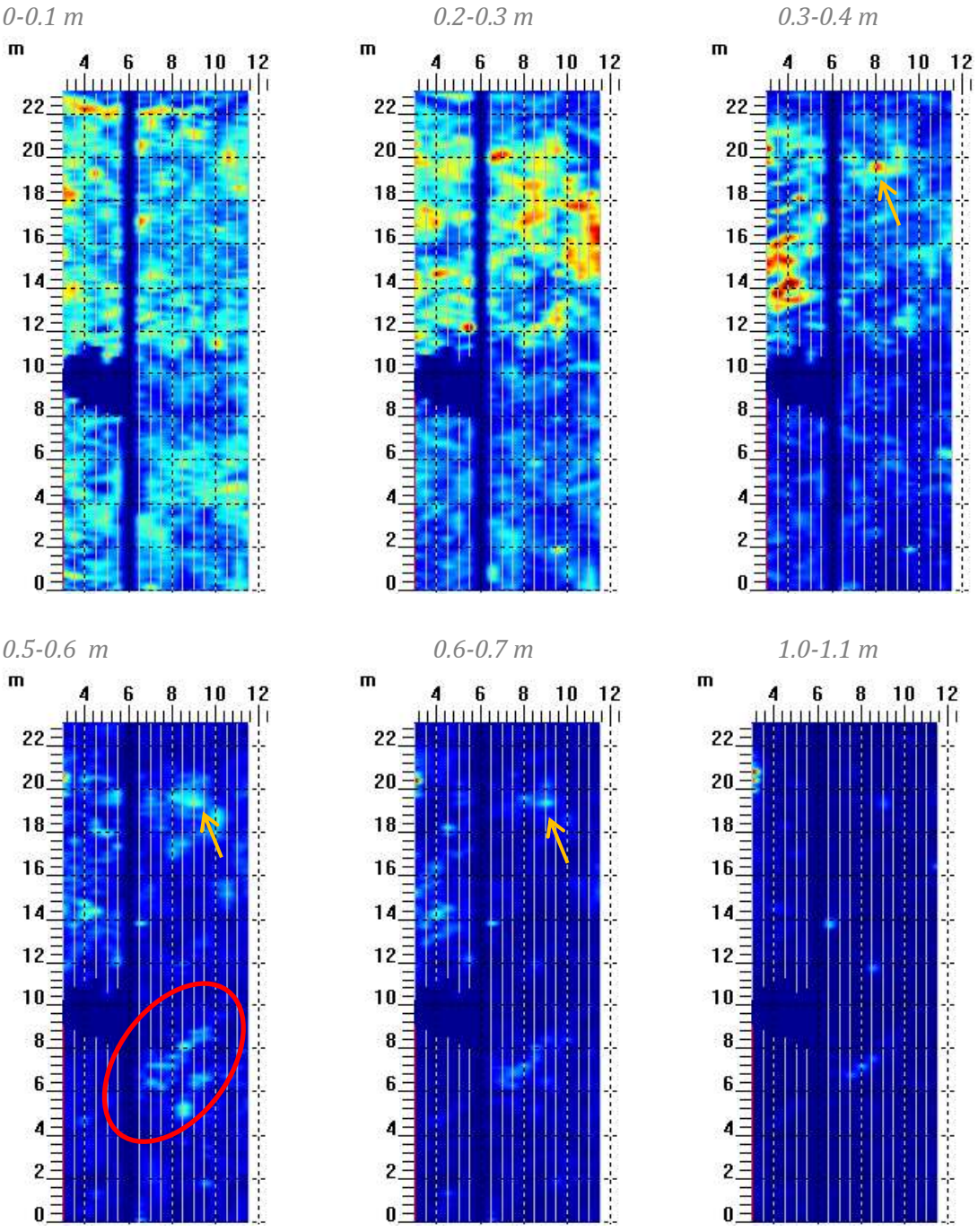


Figure 20: Selected depth slices for Area C

Discussion

The dark area in the depth slices at approximately (x=6, y=10) is associated with the small clump of trees and bush where no data could be acquired. The vertical blue line located at x=6 is also a zone of no data (the associated profile had to be discarded due to positioning errors that was discovered after the fact, during data processing).

As was the case with Area A, the uppermost couple of depth slices show a lot of near-surface variations in reflection intensity. However, these very-near surface effects quickly dissipate beyond the first 20-30 cm below surface.

A linear trending anomaly – albeit not as clear as was the case at Area A – is marked with a red oval on one of the slices. This correlates with the inferred orientation of a buried pipe that extends from the pump located to the northeast, next to the water tower.

The only anomaly that appears to have a localised extent and that can be seen on a number of successive slices is the one at approximately (9, 19), indicated with the orange arrows. However, upon closer inspection – looking at the 2D profile for LINE5 that passes over this anomaly (Figure 21) – it appears that this localised anomaly is most likely associated with a buried artefact or utility rather than a grave.

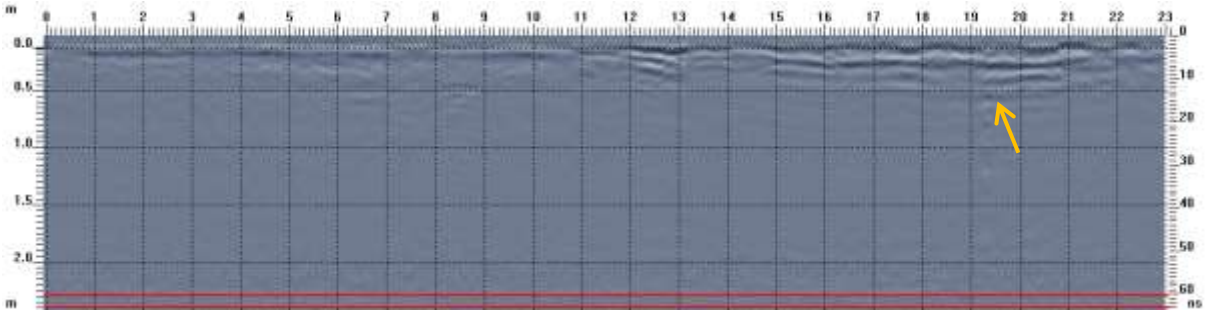


Figure 21: Selected 2D profile (LINE5) extracted from the Area C 3D data set

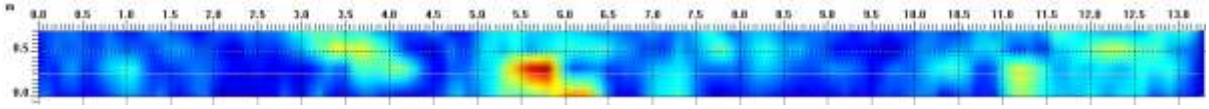
3.8 Selected profiles close to the fenced-off graves

A few strategically placed 2D profiles were acquired near the fenced-off graves to revisit some of the potential anomalies that were observed earlier in the survey. The first four such profiles were done as a mini-3D survey alongside the concrete pathway, starting approximately 10 m west if the fenced area alongside a light pole and extending east to just past the gate of the fenced area. A line spacing of 25 cm was employed. The associated results are shown in Figure 22.

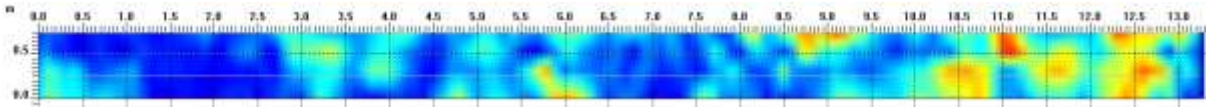
A profile (LINE6) was subsequently acquired parallel to the abovementioned lines, but on the south side of the concrete pathway (Figure 23); the start of this line is offset approximately 1 m east relative to the abovementioned lines and the profile extends to a position in line with the eastern boundary of the fenced-off grave area. LINE7 (Figure 24) is essentially the same as LINE6, except that it is 25 cm closer to the adjacent fence (or 25 cm further away from the concrete pathway).

LINE8 (Figure 35) was done to extend LINE6 to the western side; in other words, a profile starting where LINE6 started, but moving west and parallel to the pathway.

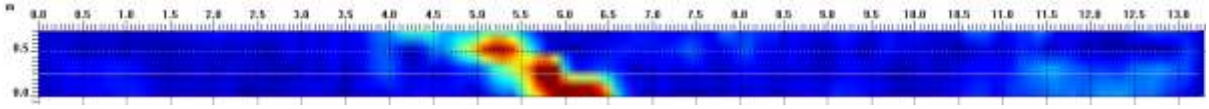
0.2-0.3 m



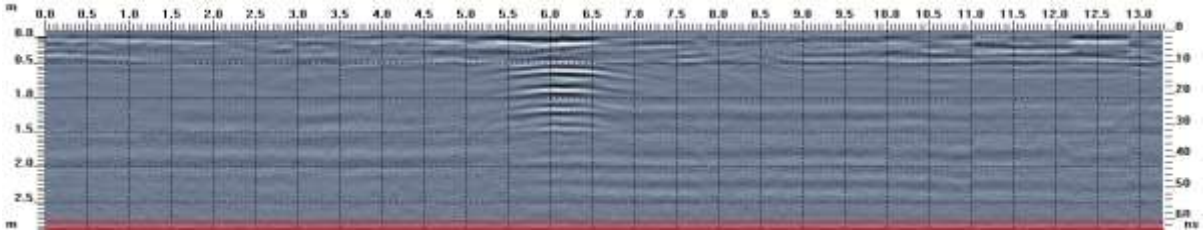
0.4-0.5 m



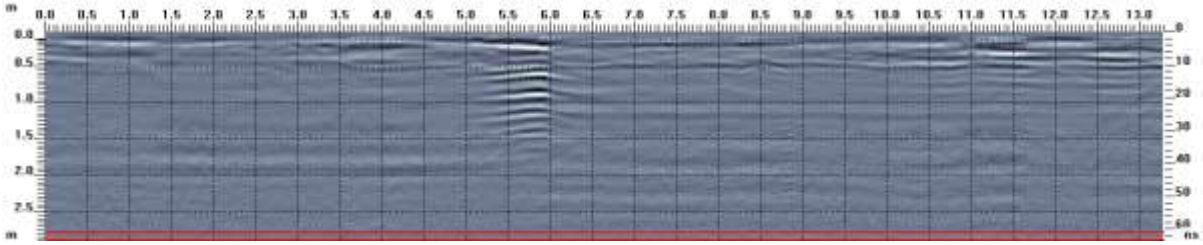
0.6-0.7 m



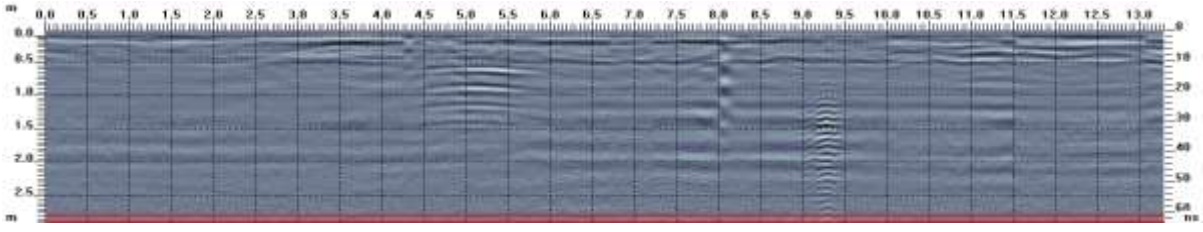
LINE0



LINE1



LINE2



LINE3

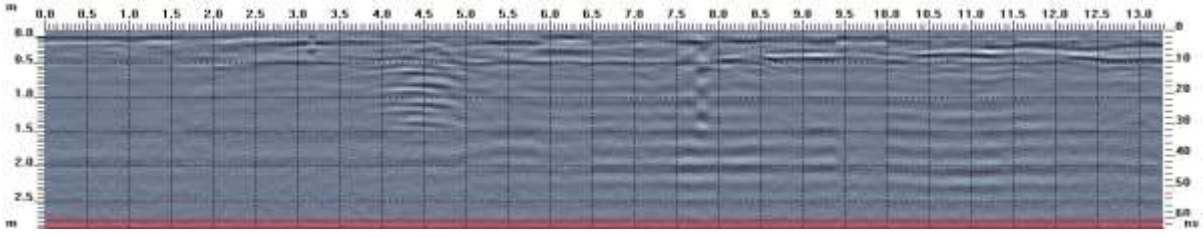


Figure 22: Selected depth slices and 2D profiles (LINES0-3) for the area just SW of fenced-off graves

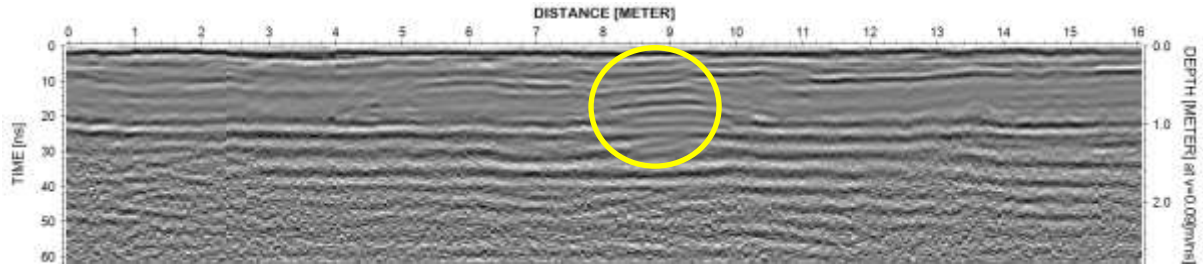


Figure 23: 2D profile (LINE6) for the area just SW of fenced-off graves (parallel to and south of path)

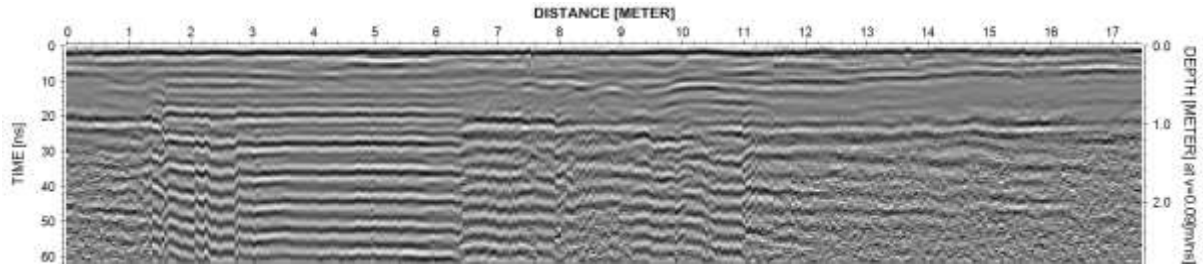


Figure 24: 2D profile (LINE7) for the area just SW of fenced-off graves (parallel to and south of path)

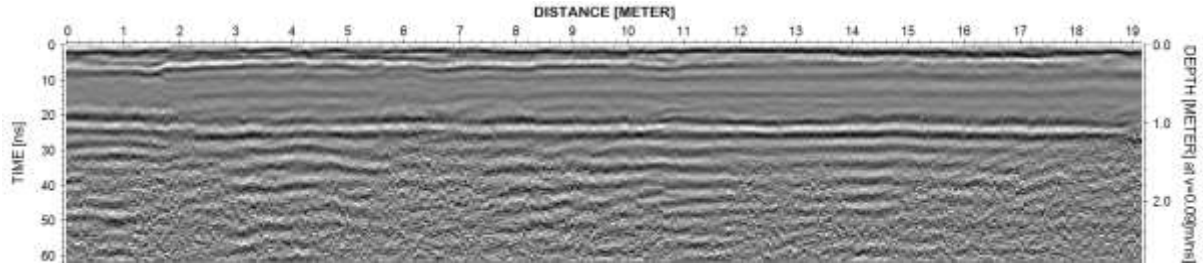


Figure 25: 2D profile (LINE8) for the area just SW of fenced-off graves (parallel to and south of path)

Discussion

In the mini-3D survey depicted in Figure 22, the only prominent anomalies are those associated with what appears to be a subsurface water pipe response the has a NW-SE orientation and can be seen as the only persistent anomalous feature on the deeper slices.

LINE6 (Figure 23) reveals one anomaly that possibly needs to be followed up in future, namely the one at approximately 8.5-9 m, highlighted with the yellow circle. However, based on the evidence in the mini-3D survey described in the previous paragraph, this anomaly may simply be an extension of the suspected buried water pipe / utility anomaly. On the radargram of LINE7 (Figure 24), anomalous reflections can again be seen around 9 m, but it remains uncertain what the cause of these anomalies might be, but it is most likely also associated with a buried utility as was previously inferred. The increased interference effect of the nearby fence, when comparing LINE7 to LINE6, is also very evident.

LINE8 (Figure 25) reveals no prominent or noteworthy anomalies in the upper metre.

3.9 Selected profiles west of core yard

Despite several obstructions, including big trees, a test profile was also acquired just west of the western boundary fence of the core yard. This profile was located approximately 4 m away and parallel to the fence and extended N-S and across the grassed area, passing by the trunk of a big tree. The associated radargram is shown in Figure 26.

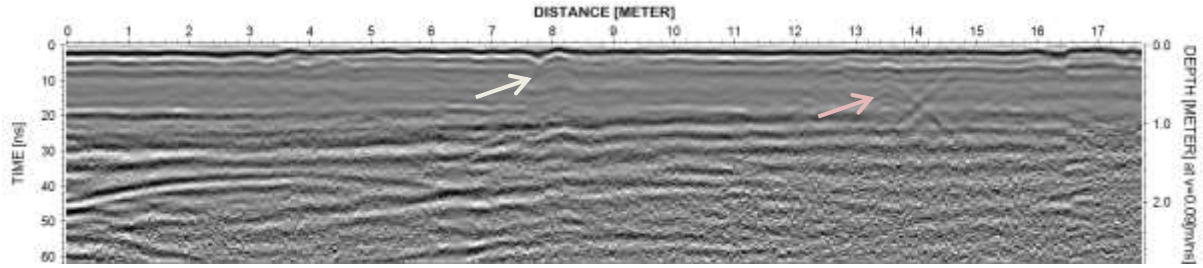


Figure 26: 2D profile from area west of western core yard boundary

Discussion

The prominent anomaly seen at 8 m (grey arrow) is attributed to a known buried high-voltage line, while the anomaly marked with the pink arrow is also characteristic of a buried utility. This area is not well suited to detailed GPR prospecting due to the interference from the various man-made sources on surface and in the subsurface.

4 Conclusions and recommendations

A GPR survey conducted at Glencore's Kroondal Mine Office Complex on 10 December 2018 produced some interesting and useful results, but could not provide conclusive evidence that there are any unmarked graves on the property. The main issue with the survey was that the site had already been developed due to production activities and the infrastructure present on surface and in the shallow subsurface compromised the acquisition and interpretation of GPR surveys.

Ideally, the site would have been covered by a detailed 3D survey. However, as was explained in the results section of this report, the abundance of infrastructure and associated obstacles – both on surface and buried in the near-surface, made meaningful 3D surveying very difficult. Furthermore, the nature of the site also resulted in a high level of unwanted reflections and radar responses that rendered the discrimination of possible localised grave anomalies very challenging.

A few localised anomalies in the areas surrounding the existing fenced-off burials, which deserve further investigation, were identified; however, it is strongly recommended that more detailed follow-up GPR surveys be done in the areas in question, but that these areas be better prepared for such follow-up GPR surveys. The ideal preparation would involve removing as much of the interfering surface obstacles and infrastructure as is realistically possible and also levelling the ground surface so that GPR profiling can be done more efficiently and also with an improved positioning accuracy.

Although it is not realistically possible to clear and prepare the entire area for GPR surveying as suggested above, it would probably make sense to focus on the sub-area that includes areas A, B_1 and B_2 in the schematic in Figure 2. One should also consider the temporary removal of the fence around the existing graves as well as the rocks that have been placed to demarcate those graves. Although it may not be feasible, it would help a lot if the section of the concrete pathway that passes by areas A, B_1 and B_2 could also be removed. This would then enable a high-resolution 3D grid survey over the area delineated with a green dotted line in Figure 27 below. This would make sense from an intuitive perspective, since unmarked historic burials are arguably more likely to occur in close proximity to the existing ones. It would also make sense to try and extend this proposed focus area a bit further towards the north.

Another key requirement for any future GPR surveys on the property would be to obtain a map of known buried utilities and mining-related infrastructure on the property. This would help with the discrimination between potential grave responses (and possibly other features of archaeological interest) and those associated with utilities.

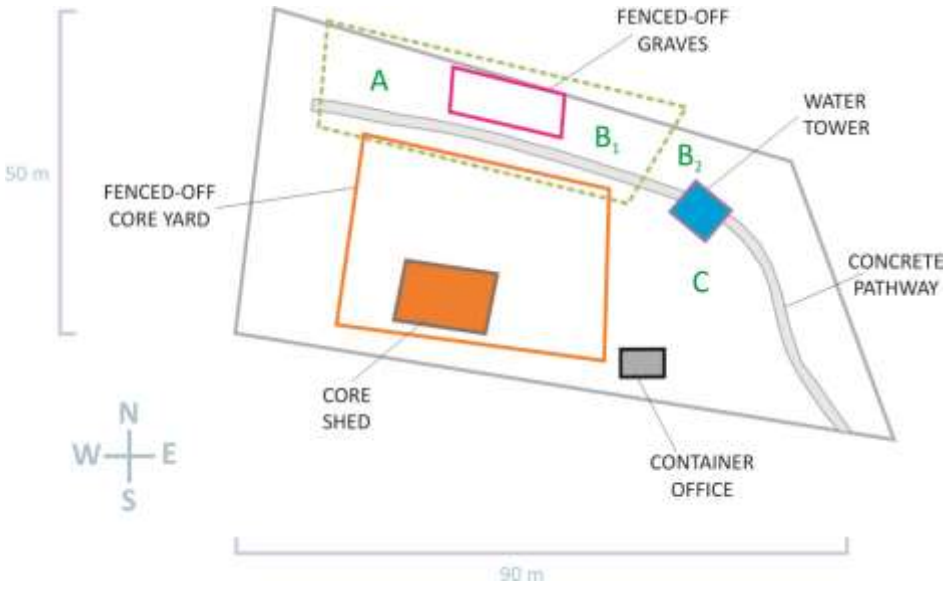


Figure 27: Schematic of the Kroondal Mine with a potential future focus area indicated

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