PHASE 1 PALAEONTOLOGICAL AND HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED NEW DORINGBERG 80 MW PHOTOVOLTIAC FACILITY NEAR PRIESKA, NORTHERN CAPE PROVINCE.

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Specialist Info
Lloyd Rossouw previously led the Archaeology and Florisbad Quaternary Research Departments at the National Museum in Bloemfontein and has more than 30 years of fieldwork experience in South African archaeology and Quaternary palaeontology. He earned a BA degree in Archaeology, completed an Honours programme in Stone Age Archaeology at the University of Stellenbosch, and received training in osteology and Quaternary palaeontology for his MSc at the Bernard Price Institute of Palaeontology (Wits). He also undertook instruction in human anatomy at Duke University in Durham, North Carolina, USA. For his PhD at the University of the Free State, he developed a palaeobotanical method that uses plant silica remains to reconstruct past environmental conditions. His fieldwork includes participation in various excavations and surveys, such as historical built environments and farmsteads (including Keerweder, Zomerlust, Boekenhoutskloof, Bien Donne, Sterhuis, Fredericksberg, Aurora), rock art surveys (Ceres, Vanrhynsdorp, Clanwilliam, Piketberg), industrial projects (coastal section for Mossgas Pipeline Project, Molenaars River crossing for Du Toitskloof Pass Tunnel Project), Stone Age sites (Hoedjiespunt, Klasies River Mouth, Erfkroon, Damvlei, Thyspunt, Sunnyside, Baden Baden, Florisbad, Cornelia), and palaeontological localities (Langebaanweg, Zwartklip, Besaansklip, Boesmansfontein, Spitskop, Cango Valley, Braamhoek, Gladysvale, Taung). He has surveyed and mapped multiple open sites in the central interior region, including the northern Karoo, lower Orange, Vaal, Modder, Vet and Sand River basins as well as the central Makgadikgadi basin.

Declaration of Independence
Paleo Field Services remains financially independent, with no personal stake in project activities or outcomes except for professional fees. Its sole remuneration comes from agreed-upon services for each project. Paleo Field Services accepts client-provided information as accurate.
Yours truly,

October 2025

SUMMARY

A Phase 1 Palaeontological and Heritage Impact Assessment (PIA & HIA) was conducted for the proposed Doringberg 80 MW Photovoltaic facility near Prieska, Northern Cape Province. This assessment, conducted by **Paleo Field Services** to comply with the National Heritage Resources Act, outlines the legal framework, terms of reference, and findings regarding potential impacts on heritage and palaeontological resources. The palaeontological assessment identified the area as underlain by banded iron formations (BIFs) of the Kuruman Formation, which lack conventional body fossils but include evidence of microbially induced sedimentary structures (MISS) suggesting early microbial life. Due to the presence of these structures and the potential for cumulative heritage impacts from disturbance, the development footprint was assigned a field rating of **Generally Protected A (Mitigation before destruction) for palaeontology**. Development can proceed, provided a qualified palaeontologist is appointed to systematically record and document any observable MISS through a transect-based sampling strategy prior to ground disturbance (protocols attached). The archaeological survey revealed no aboveground evidence of built heritage or graves, but isolated, low-density distributions of *cf.* Middle Stone Age lithic artefacts were found, which are significant as they reflect Stone Age activity in an environmentally marginal setting. Consequently, the development footprint was also assigned a field rating of **Generally Protected A (Mitigation before destruction) for archaeology**. Development may proceed, contingent upon a qualified archaeologist systematically mapping and recording the lithic artefact distributions within the project area prior to any ground disturbance (protocols attached).

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INTRODUCTION

A Phase 1 Palaeontological and Heritage Impact Assessment was conducted for a proposed new Doringberg 80 MW Photovoltaic development on the farm Portion 3 of 50, Farm Karabee, near Prieska, Northern Cape Province. The site lies on a flat summit flanked by rugged slopes of the Doringberg, located about 16 km south-southeast of Prieska (**Fig. 1 & 2**).

Map Reference: 1:50 000 topographical map 2922DD Redlands and 1:250 000 scale geological map 2922 Prieska.

Farm Reference: Portion 3 of 50 Karabee

Footprint size: 80 hectares

GPS Coordinates:

A) 29°48'33.72"S 22°46'39.57"E
B) 29°48'46.25"S 22°47'0.93"E
C) 29°48'57.14"S 22°47'3.88"E
D) 29°49'10.22"S 22°47'6.80"E
E) 29°49'27.68"S 22°47'15.22"E
F) 29°49'31.65"S 22°47'4.48"E
G) 29°49'12.95"S 22°46'39.66"E
H) 29°48'59.51"S 22°46'37.48"E

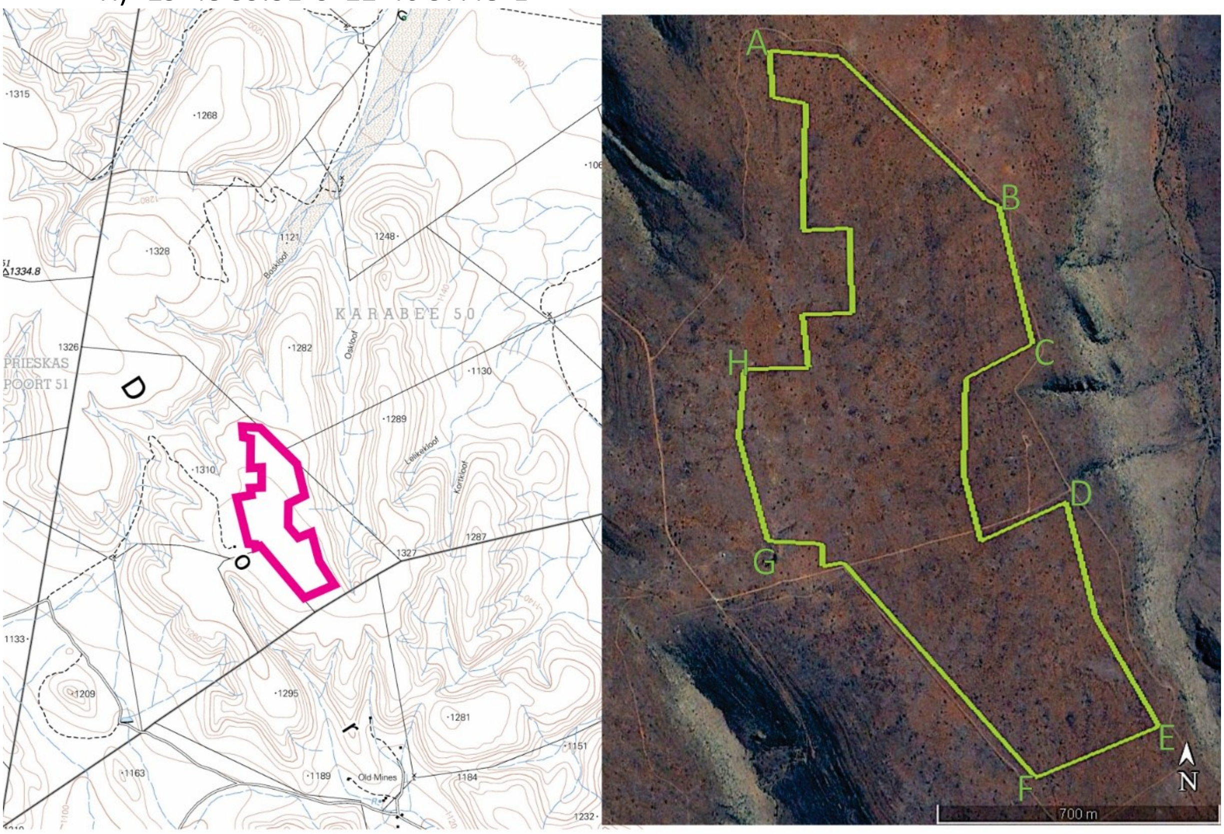

Figure 1. Site marked on portion of 1:50 000 scale topographic map 2922DD Redlands with aerial view on the right.

LEGAL FRAMEWORK

The assessment is required as a prerequisite for new development in terms of the National Heritage Resources Act (NHRA) 25 of 1999. The NHRA identifies what is defined as a heritage resource, the criteria for establishing its significance and lists specific activities for which a heritage specialist study may be required. The NHRA prescribes a system of grading of places/objects via Section 7 and makes provision for the general protection of heritage resources via Sections 34, 35, 36, and 37 (in respect of the built environment, archaeology/ palaeontology, burial grounds/graves and monuments/memorials, respectively), while Section 38 sets out guidelines under which heritage impact assessments are required when new developments may impact upon heritage resources.

Section 38(1) applies when a development *triggers heritage assessment requirements* but does not require an environmental authorisation from another regulatory authority including:

1. Construction of a road, powerline or pipeline, canal or other similar form of linear development or barrier longer than 300m.
2. Construction of a bridge or similar structure exceeding 50 m.
3. Development exceeding 5,000 m².
4. Rezoning of land exceeding 10,000 m², or
5. Any development that may impact recognized heritage resources (e.g., archaeological sites, graves, buildings older than 60 years).

Section 38(8) applies when a development requires environmental authorisation from another regulatory authority, such as:

1. Environmental authorisation under NEMA.
2. Water use licence under the National Water Act.
3. Mining right under the Mineral and Petroleum Resources Development Act (MPRDA).

Environmental Authorisation in terms of NEMA is necessary whenever an activity proposed falls under those listed in the Environmental Impact Assessment (EIA) Regulations of NEMA (Act 107 of 1998). These activities are grouped into Basic Assessments, Full Scoping and Environmental Impact Assessments—covering projects such as **major industrial or energy developments**—and Sensitive Areas, like protected areas and wetlands. Other activities relevant to Section 38 (8) include storing water such as building dams, or modifying the bed, banks or course of a watercourse through excavation, filling, or reshaping under the National

Water Act, and the exploration, prospecting and mining of minerals under the MPRDA (Act 28 of 2002).

METHODOLOGY

The site assessment was carried out in line with the National Heritage Resources Act (Act No. 25 of 1999) and the 2016 SAHRA Minimum Standards for Archaeological and Palaeontological Impact Assessments. Initial site ratings were based on existing field data, relevant databases, and published literature. Topographic, aerial and geological maps were used for illustrative purposes and to identify potential fossil-bearing formations. Fieldwork involved direct observation through foot surveys, with vehicle access where possible. A Garmin Etrex Vista handheld GPS (set to the WGS 84 datum) and a digital camera were used to record spatial and visual data throughout the survey. GPS coordinates are presented in *Degrees, Minutes, Seconds* format in the report.

Figure 2. General view of the Doringberg mountain plateau, looking south towards the site (top), and at the site looking south (centre left), east (centre right), west (below left) and north (below right).

TERMS OF REFERENCE

The Terms of Reference outlines the scope and objectives for assessing potential impacts on heritage resources—both tangible and intangible—arising from the proposed development, in accordance with relevant legislative standards.

1. Conduct site investigation for a Heritage *Impact Assessment (HIA)* to identify and map heritage sites and occurrences in the affected area(s) and provide an assessment of their significance. This must be done regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool,* as the Department of Environmental Affairs and its entities make no warranty—express or implied—regarding the accuracy, reliability, usefulness, or completeness of the *archaeological and cultural heritage theme layer.*

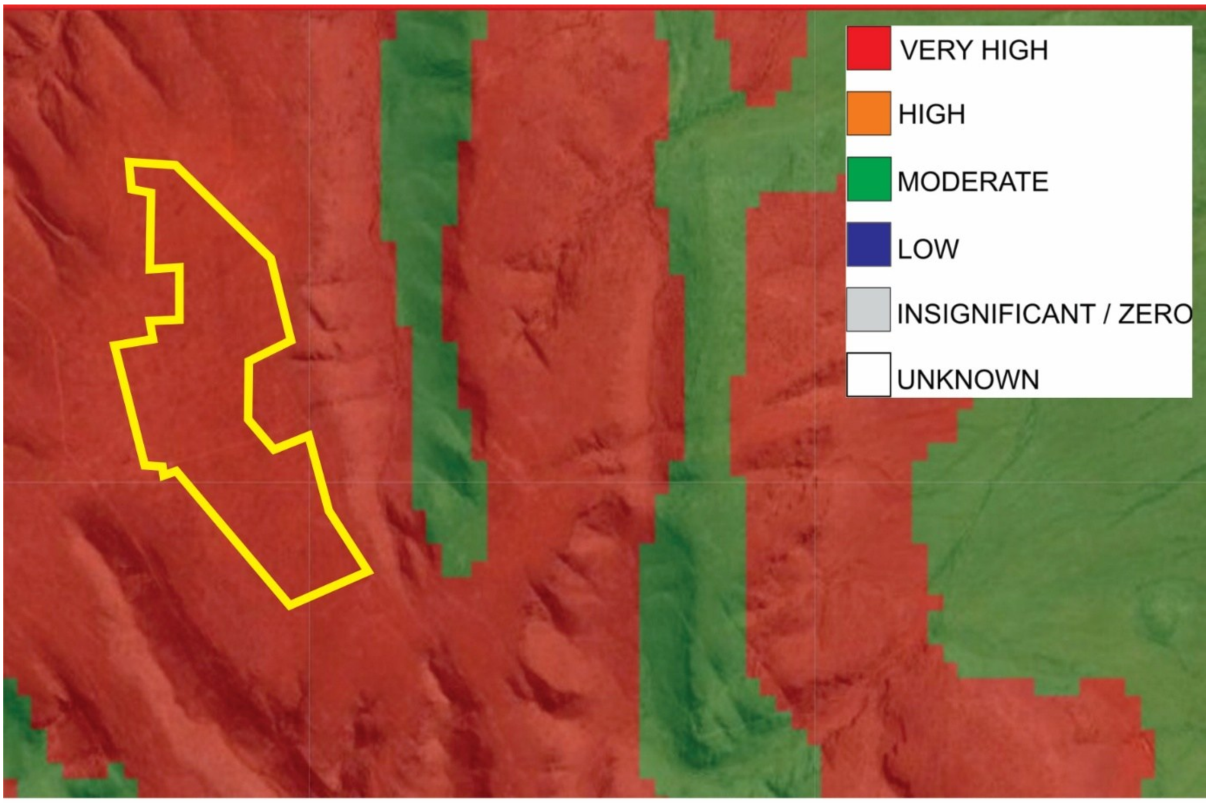

Figure 3. Proposed development area marked on portion of SAHRIS palaeosensitivity map.

2. Conduct a site investigation for a Palaeontological Impact Assessment (PIA) using the SAHRIS PalaeoSensitivity Map (**Fig. 3**), regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool*. Identify and map fossils or exposures in the area and assess their significance. This is required as the

Department of Environmental Affairs does not guarantee the accuracy or completeness of the *palaeontology theme layer*.

3. Assess impacts of the proposed development on heritage resources relative to the sustainable social and economic benefits to be derived from the development *if planned impacts will result in the loss of any resources*.
4. Provide a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories as prescribed under Section 7 of the NHRA (**Table 1**)

SITE SENSITIVITY CLASSIFICATION AS PER EIA SCREENING TOOL

In accordance with the requirements of the 2014 Environmental Impact Assessment (EIA) Regulations, the DESTEA National Web-Based Environmental Screening Tool identifies elevated sensitivity ratings for several environmental themes, including palaeontology and heritage resources. These ratings inform the requirement for specialist input and guide the scope and intensity of the heritage assessment.

The Screening Tool classified the site's sensitivity as **Low** for Archaeology and Cultural Heritage, and **Very High** for Palaeontology.

DISCLAIMER, ASSUMPTIONS AND LIMITATIONS

Information provided by the Client and/or Environmental Assessment Practitioner (EAP) was assumed to be accurate and complete for the purposes of this assessment. Observations presented in this report are based solely on aboveground visibility of features and outcrops as encountered during field survey. The reliability and completeness of these observations are subject to several inherent limitations:

- Fossiliferous outcrops are often limited to exposed lithologies and may be obscured by colluvium, vegetation, or soil mantling; the degree of weathering affects the preservation and visibility of fossil material, with heavily weathered surfaces potentially masking fossil content or fragmenting specimens; stratigraphic context is inferred from visible lithologies only; subsurface fossil-bearing horizons may remain undetected without trenching or coring; access limitations may restrict inspection of key geological exposures, particularly in rugged terrain or areas with restricted land access.

- The surface visibility of archaeological remains is variable and may be significantly reduced by vegetation cover, soil accumulation, or recent land disturbance (e.g., ploughing, erosion, construction); subsurface archaeological remains may not be detectable without excavation or remote sensing; weathering can obscure diagnostic features such as stone alignments, midden deposits, graves or other low-relief structures, especially in areas with high sedimentation or seasonal vegetation growth; accessibility constraints (e.g., fenced properties, steep terrain, or dense bush) may prevent systematic coverage, resulting in partial or biased spatial data.

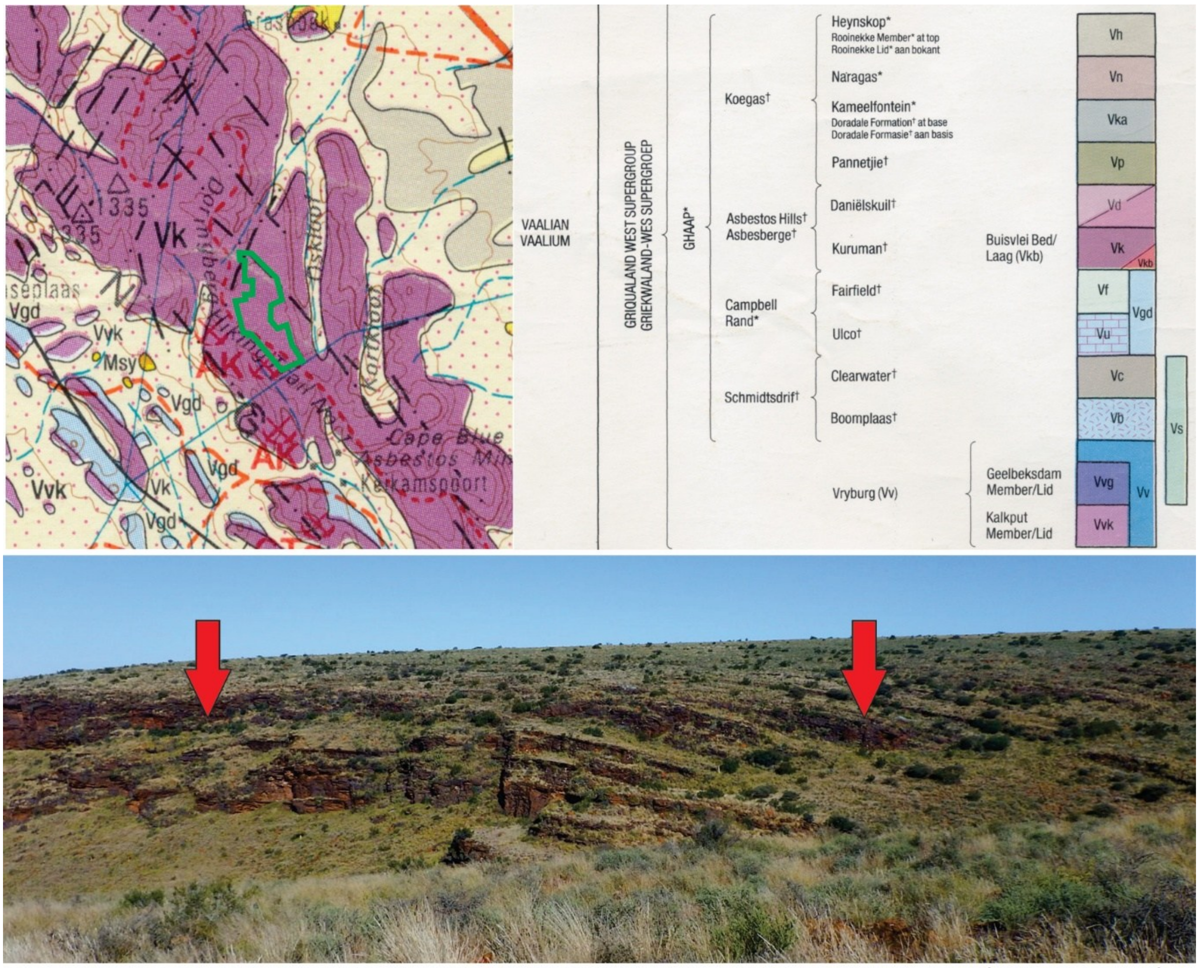

Figure 4. Figure 4. According to the 1:250 000 geological map 2922 Prieska the site (green polygon) is underlain by banded iron formations (BIFs) of the Archaean-Proterozoic Kuruman Formation (*Vk*), which forms part of the Asbestos Hills Subgroup within the Transvaal Supergroup (above). Outcrops of Kuruman Formation banded ironstone exposed along a steep mountain slope at Doringberg with ironstone bands traceable across the slopes, forming natural contour lines and erosion-resistant ledges (below).

BACKGROUND

Palaeontology: Doringberg, as delineated on the 1:250 000 scale geological map 2922 Prieska, is underlain by banded iron formations (BIFs) of the Kuruman Formation, which forms part of the Asbestos Hills Subgroup within the Transvaal Supergroup (**Fig. 4**). The BIF's reflect significant early Proterozoic environmental conditions following massive iron deposition because of the build-up of free oxygen in the oceans by cyanobacterial photosynthesis around 2450 Ma ago, also known as the Great Oxidation Event. While the Kuruman BIFs do not contain macrofossils, their palaeontological significance lies in the preservation of microbially induced sedimentary structures (MISS) as well as geochemical proxies tied to Earth's early oxygenation.

Archaeology: Tangible archaeological heritage in the broader Prieska region includes a well-defined Stone Age footprint and historical remnants dating to the late 19th century. Early, Middle, and Later Stone Age sites have been recorded in the region, particularly in association with pan settings, while open plains are characterised by low-density surface scatters. Isolated ESA and MSA artefact scatters are also found within overbank sediments of the Orange River between Douglas and Prieska, including sites such as Marksdrift, Kliphuis, Elswater, Brakfontein, Holsloot, and Nuwejaarskraal. Rock art sites occur along the steep slopes of the Asbes and Doringberge to the north and south of Prieska respectively, with notable examples at Wonderdraai, Omdraaisvlei, and Sandfontein. Archaeological records and historical accounts confirm the presence of Bushman hunter-gatherers and Khoi pastoralists in the region prior to European settlement. Early travellers frequently encountered Koranna, Griqua, and Bushman groups. The name "Prieska" derives from the Koranna term meaning "place of the lost she-goat." The principal Khoikhoi inhabitants of the Middle Orange River were the Einiqua, linguistically affiliated with the Namaqua and Korana as part of the Orange River Khoikhoi. The Einiqua occupied areas around and east of the Augrabies Falls, while the Korana were concentrated further east along the Middle to Upper Orange River near Prieska. Between 1800 and 1805, Xhosa-speaking groups active along the Middle Orange River engaged in both raiding and trade with neighbouring San, Korana, and Sotho-Tswana/ Tlhaping communities situated to the northeast. By approximately 1810, Xhosa speakers had established more permanent settlements in the Pramberg and

Karreeberg regions, located south of Prieska. Historical ruins and graveyards linked to the early 20th-century asbestos mining industry are also present at various locations north and south of Prieska, including sites at Karabee and Keikams Poort run by the Carn Brea Syndicate (west and south of the study area, marked Historical, **Fig. 5**), and Kliphuis on the Orange River northwest of Prieska run by the Good Hope Syndicate.

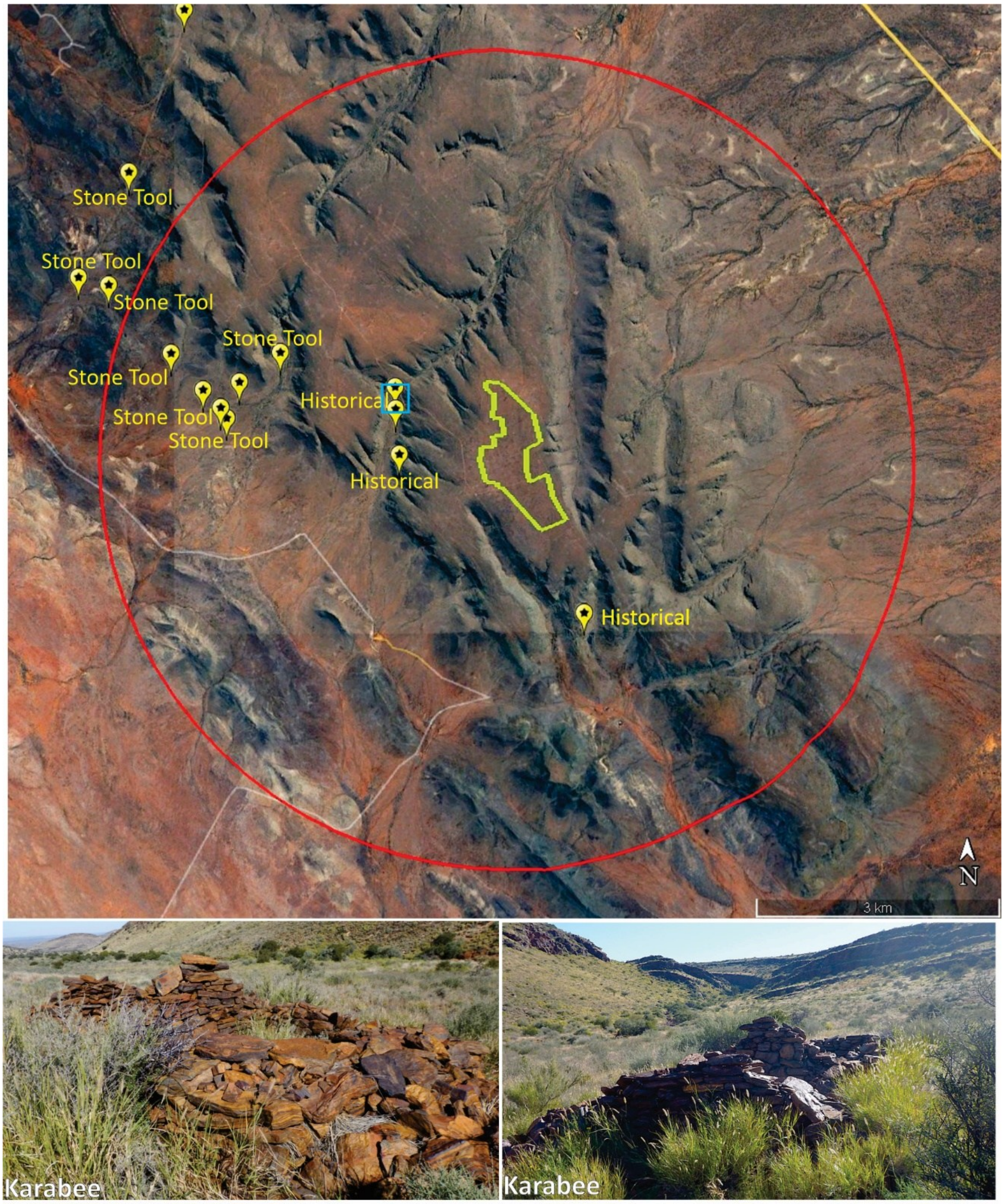

Figure 5. Heritage sites and features previously recorded near or within a 5 km radius of the proposed development area, indicated by yellow icons (above). A complex of historical ruins are located near the access point to the mountain plateau (below, highlighted by blue square on map).

FIELD ASSESSMENT

Palaeontology: The study area is underlain by ridge-forming outcrops of BIF's of the Kuruman Formation appearing as low, sinuous ridges or slabby exposures with alternating reddish-brown and black bands visible on weathered surfaces. The rocks are typically mantled by a loose regolith comprising residual soils and gravelly colluvium derived from in situ weathering of the underlying parent material (**Fig. 6**). Several large pieces of banded ironstone found in the study area show wrinkled surface textures and internal bands, which are signs of well-preserved ancient microbial structures and sedimentary features (**Fig. 7, Appendix 1**). These delicate, crinkled layers and winding microbands are believed to be traces of old microbial mats or ripple-like patterns formed by gentle marine processes and specific depositional settings. They provide indirect evidence of early microbial life and capture biogeochemical processes associated with Earth's oxygenation during the Palaeoproterozoic era.

Archaeology: The survey revealed no aboveground evidence of precolonial stone-walled structures, graves or built heritage features of historical significance, including buildings or infrastructure exceeding 60 years of age, within the footprint area. Ephemeral traces of cf. Middle Stone Age occupation are reflected in spatially discrete, low-density distributions of lithic artefacts made from banded ironstone, typically comprising isolated or sparsely clustered stone tool finds with limited lateral spread (**Fig. 8, Appendix 1**).

IMPACT STATEMENT AND RECOMMENDATIONS FOR PALAEONTOLOGY

Although the BIFs of the Kuruman Formation lack conventional body fossils, the presence of several rock fragments exhibiting *"microbially induced sedimentary structures"* within the study area suggests the presence of possibly intact exposures not recorded during the Phase 1 assessment. In the absence of appropriate mitigation measures, these exposures may be subject to direct impact from the proposed solar development. The BIFs of the Kuruman Formation serves as a reference point for comparative studies in Precambrian palaeobiology, sedimentology, and early Earth systems. Owing to its extensive distribution and recognised economic significance, the BIF is frequently subject to disturbance from mining operations and large-scale infrastructure development across the Northern Cape. Therefore, in areas where MISS-bearing surface exposures may coincide with proposed development footprints, the potential for cumulative heritage impacts is considered high, particularly in the absence of systematic mitigation. The development footprint is assigned a field rating of *Generally Protected A (Mitigation before destruction)*. It is **recommended that development proceed as planned**, provided a qualified palaeontologist is appointed to conduct systematic recording and documentation of any observable microbially induced sedimentary structures (MISS) and other depositional sedimentary features. Given the extent of the 80-hectare area, mitigation must be implemented through a transect-based sampling strategy, with transects spaced at appropriate intervals to ensure representative coverage within the footprint (**Appendix 2**).

Figure 6. The study area is underlain by ridge-forming outcrops of BIF's showing distinctive rhythmic layering of iron-rich and cherty bands with alternating reddish-brown and black bands visible on weathered surfaces (1, 2)). The rocks are typically mantled by a loose regolith comprising residual soils and gravelly colluvium derived from in situ weathering of the underlying parent material (3-5).
Scale 1 = 10 cm.

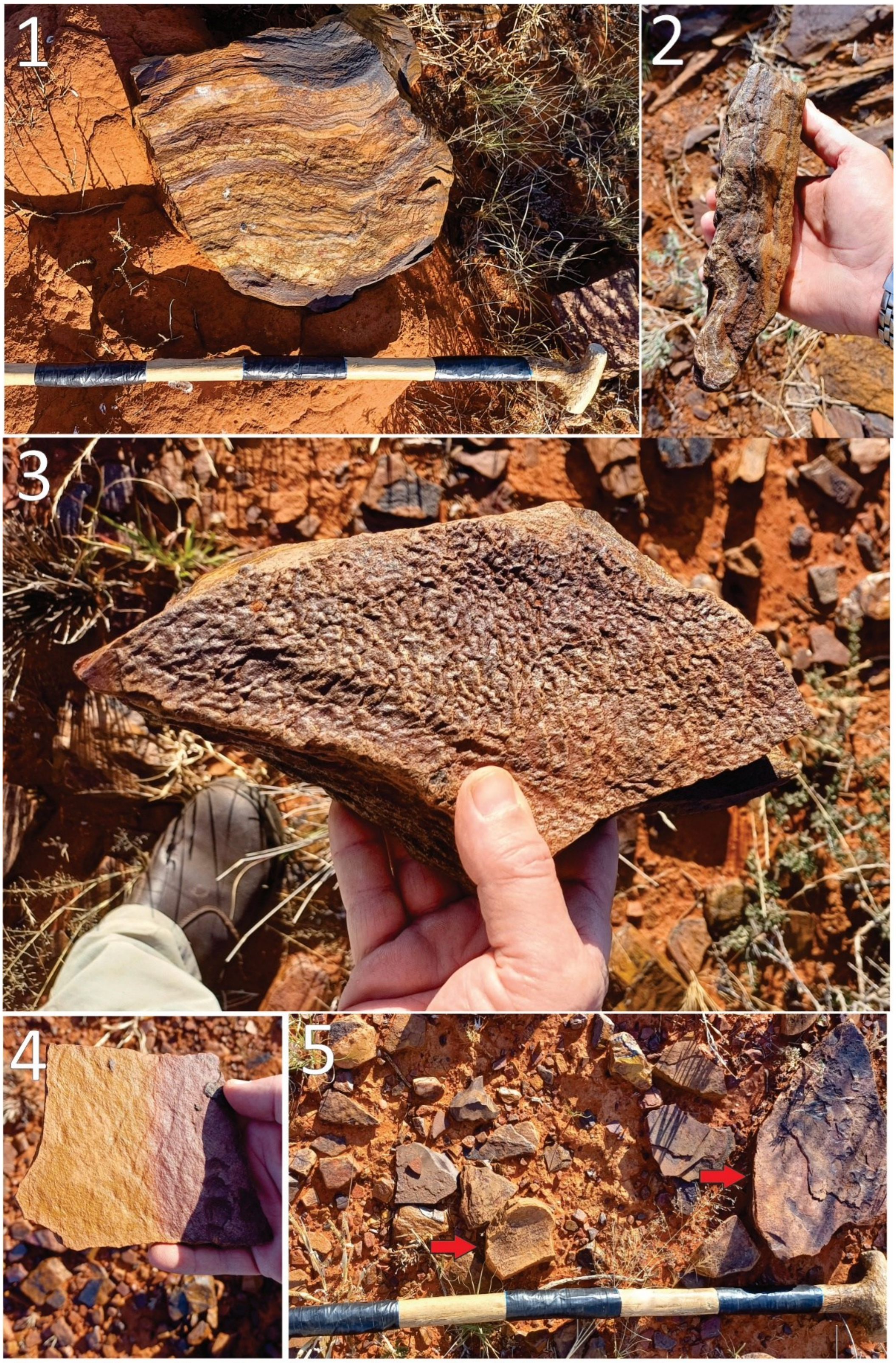

Figure 7. Banded ironstone fragments from the study area, showing preserved internal and surface textures, undulating laminae with irregular folding and sinuous microbands (1, 2), crinkling pattern consistent with fossilized microbial mat structures (3), asymmetrical ripple marks (4) and concavo-convex rock fragments exhibiting ripple-like contouring possibly consistent with low-energy marine conditions (5).Scale 1 = 10 cm.

This mitigation must occur prior to ground disturbance, ensuring that scientifically significant palaeontological data are captured and curated in accordance with best practice and relevant heritage legislation. In accordance with Section 35 of the National Heritage Resources Act (Act 25 of 1999), this monitoring is essential to identify, document, and safeguard any fossil material that may be negatively affected during earthworks.

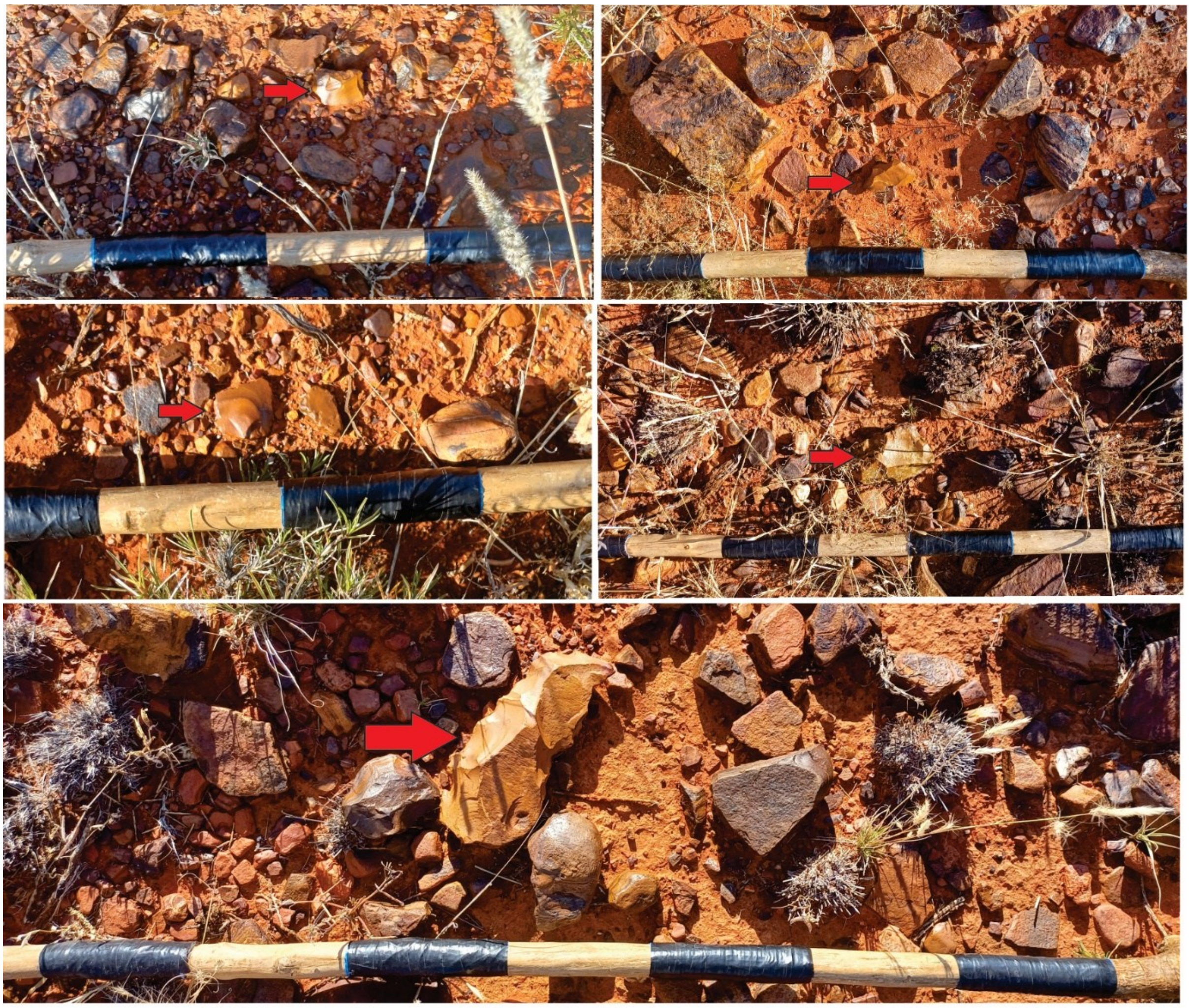

Figure 8. Lithic artefacts presenting as isolated or sparsely clustered stone tool finds.

IMPACT STATEMENT AND RECOMMENDATIONS FOR ARCHAEOLOGY

The occurrence of stone tool finds on the open mountain plateau is significant, as it reflects Stone Age activity in an environmentally marginal setting, notably distant from perennial water sources or natural shelters. Stone Age lithic finds on mountain tops offer critical insights into mobility, adaptation, or maybe symbolic landscape use in marginal environments, challenging assumptions about prehistoric settlement patterns.

The development footprint is assigned a field rating of Generally Protected A (Mitigation before destruction). It is **recommended that development proceed as planned**, provided a qualified archaeologist is appointed to conduct systematic mapping and recording of lithic artefact distributions observed within the project area (**Appendix 2)**. This mitigation must occur prior to ground disturbance, ensuring that scientifically significant archaeological data are captured and curated in accordance with best practice and relevant heritage legislation. In accordance with Section 35 of the National Heritage Resources Act (Act 25 of 1999), this monitoring is essential to identify, document, and safeguard any archaeological material that may be negatively affected during earthworks.

Table 1. Description of Field Rating categories as prescribed in Section 7(1) of the NHRA where SAHRA *must by regulation establish a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories— (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance; (b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; (c) Grade 3: Heritage resources which can be considered to have special qualities which make them locally significant; and Generally Protected: Other heritage resources which may require mitigation before destruction.*

Field Rating	**Grade (NHRA No. 25 of 1999, Section 7)**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation: national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation: provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation: mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A	-	High/medium significance	Mitigation before destruction
Generally Protected B	-	Medium significance	Recording before destruction
Generally Protected C	-	Low significance	Destruction

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APPENDIX 1 – ARCHAEOLOGICAL CHANCE FINDS

Locality	Coordinates	Item	Comments	Rating
1	29°48'37.35"S 22°46'45.23"E		Flake, dorsal view with multiple arrises and negative scars. Banded Ironstone	GP (A)
2	29°48'45.71"S 22°46'48.73"E		Flake, dorsal view with central arris running parallel to long axis. Banded Ironstone	GP (A)
3	29°48'44.19"S 22°46'49.95"E		Flake, dorsal view, with converging arrises. Banded Ironstone	GP (A)

4	29°48'51.38"S 22°47'1.39"E		Flake, ventral surface with large cracking ripples and flaking scar below striking platform. Banded Ironstone	GP (A)
5	29°49'8.71"S 22°46'38.69"E		Flake, ventral surface with flaking scars. Banded Ironstone	GP (A)
6	29°49'11.15"S 22°46'37.95"E		Flake; ventral surface, bulb of percussion with flaking scar.Banded Ironstone	GP (A)
7	29°49'8.52"S 22°46'37.62"E		Broken flakeblade; dorsal surface with parallel arrises, negative scar and conchoidal fracture below striking platform. Banded Ironstone	GP (A)

8	29°49'9.62"S 22°46'39.29"E		Flake, dorsal surface with parallel arrises and signs of retouch. Banded Ironstone	GP (A)
9	29°49'9.62"S 22°46'39.29"E		Flake; proximo-ventral aspect showing butt of striking platform and bulb of percussion. Banded Ironstone	GP (A)
10	29°49'10.72"S 22°46'36.66"E		Flake, ventral surface with cracking ripples. Located ~50 m south of development footprint boundary. Banded Ironstone	GP (A)
11	29°49'17.83"S 22°46'53.24"E		Flakeblade; dorsal surface with central arris and signs of unilateral retouch. Banded Ironstone	GP (A)

12	29°49'25.87"S 22°47'7.95"E		Flake, dorsal surface with parallel arrises and negative scars. Banded Ironstone	GP (A)
13	29°49'21.12"S 22°47'0.65"E		Production debris with multiple flaking scars. Banded Ironstone	GP (A)
14	29°49'29.03"S 22°47'3.36"E		Unifacially modified, symmetrical flake on Banded Ironstone, showing deliberate flake removal.	GP (A)
15	29°49'5.14"S 22°46'54.58"E		Flakeblade; dorsal surface with diverging arrises and large negative scars. Banded Ironstone	GP (A)

16	29°49'14.31"S 22°46'35.27"E		Small brick building located ~100 m south of development footprint boundary.	GP (A)

APPENDIX 2 - PROTOCOLS FOR GENERALLY PROTECTED (A) SITE RATING

Palaeontology

Prior to any ground disturbance associated with the installation of photovoltaic panels, a qualified palaeontologist must be appointed to undertake representative but systematic field recording with particular attention given to the identification, documentation, and sampling of any microbially induced sedimentary structures (MISS) and other ancient depositional sedimentary features exposed within the development footprint.

1. To ensure representative coverage of the 80-hectare development footprint, a qualified palaeontologist must implement a transect-based sampling strategy focused on identifying and documenting microbially induced sedimentary structures (MISS) and other depositional sedimentary features prior to ground disturbance.
2. Where MISS or other palaeontologically significant structures are identified, appropriate mitigation measures — including photographic documentation, and, where needed, controlled sampling — must be implemented.
3. All findings must be recorded in accordance with national heritage legislation and curated in an accredited repository such as the McGregor Museum in Kimberley or Iziko Museums in Cape Town.
4. All palaeontological observations must be georeferenced.
5. Attribute fields should include feature type, lithostratigraphic unit, preservation quality, and mitigation outcome (e.g., recorded and sampled or preserved *in situ*).

Archaeology

Prior to any ground disturbance associated with the installation of photovoltaic panels, a qualified aechaeologist must be appointed to undertake systematic field recording.

1. The appointed archaeologist must undertake a controlled pedestrian survey prior to any ground disturbance, focusing on areas where lithic artefacts have been identified or are likely to occur based on geomorphological context.
2. All artefacts must be georeferenced and recorded with appropriate attribute fields, including artefact type, raw material, condition, and spatial association.
3. Where artefact concentrations are encountered, detailed mapping of distribution patterns must be conducted to assess potential site integrity.
4. Artefacts should be collected only where necessary for diagnostic analysis, with all finds curated in an accredited repository such as the McGregor Museum in Kimberley or Iziko Museums in Cape Town.
5. Mapped distributions should inform sensitive areas and guide any further mitigation or avoidance strategies with regard to placement of solar panels.