HERITAGE IMPACT ASSESSMENT

In terms of Section 38(8) of the NHRA for the

Proposed development of the Paradys Solar PV 1 near Viljoenskroon, Free State

Prepared by CTS Heritage

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Jenna Lavin

For

Solis Environmental

August 2023

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EXECUTIVE SUMMARY

1. Site Name:

Proposed Paradys Solar PV 1 near Viljoenskroon, Free State Province

2. Location:

The project area is located between Orkney and Viljoenskroon in the Free State Province.

3. Locality Plan:

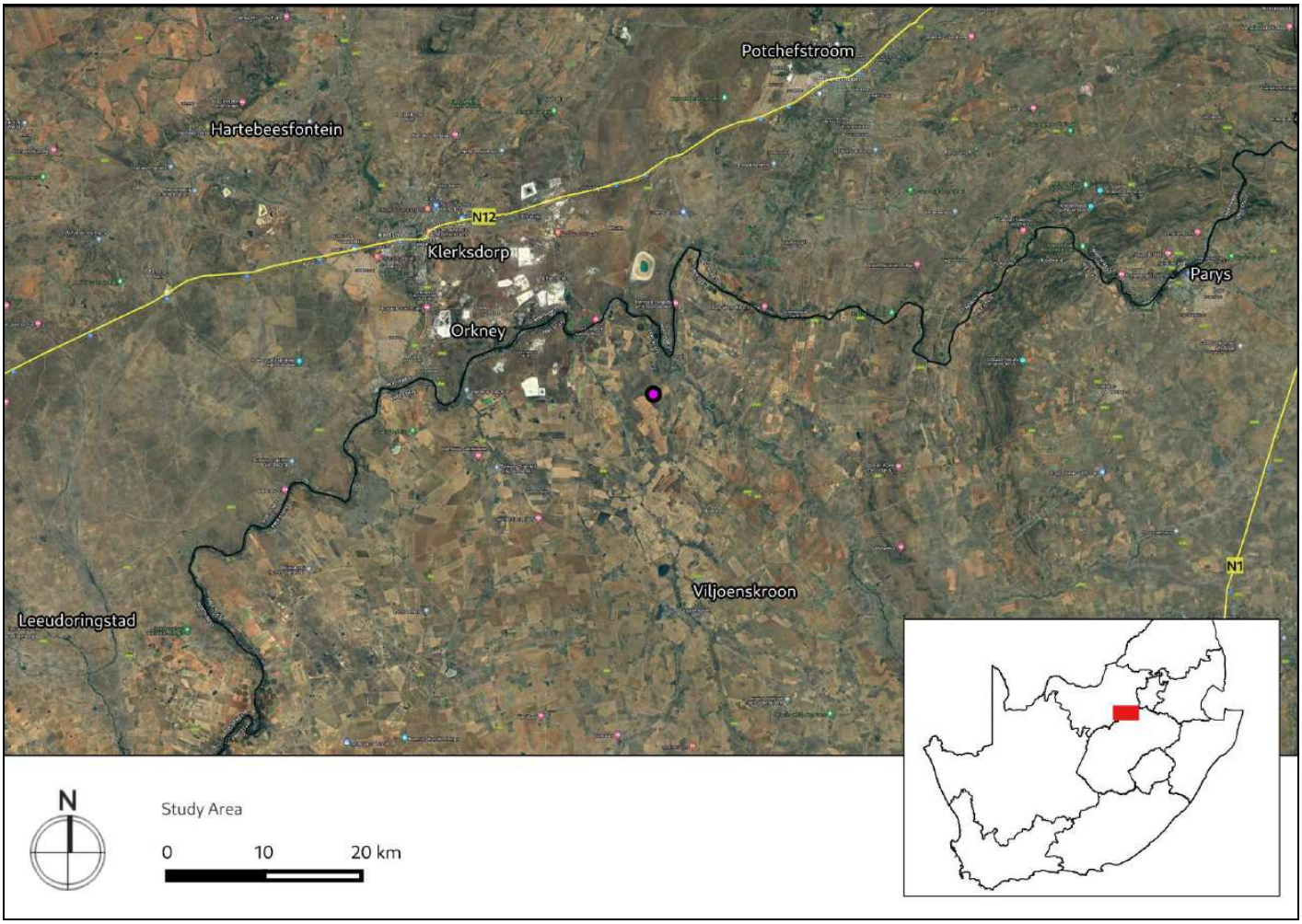

Figure A: Location of the proposed development area

4. Description of Proposed Development:

This report is drafted in support of the proposed development of the Paradys Solar PV 1 Facility that forms part of the Paradys Photovoltaic Solar Energy Cluster and its associated grid connection infrastructure located outside of Viljoenskroon in the Free State.

Table 1: Technical details for the proposed facility

Component	Description / dimensions
Height of PV panels	4.5 metres
Area of PV Array	1124 Hectares (Development footprint)
Area occupied by inverter / transformer stations / substations / BESS	BESS: Up to 6 ha Switching Substation: Up to 1 ha Collector Substation: Up to 1 ha
Capacity of on-site substation	132kV
Capacity of the power line	132kV
Area occupied by both permanent and construction laydown areas	Up to 4-5 ha
Area occupied by buildings	A 33 kV switch room, a gate house, ablutions, workshops, storage and warehousing areas, site offices and a control centre: Up to 12.5 ha
Battery storage facility	Maximum height: ~5m Storage capacity: 2500MWh
Length of internal roads	To be confirmed during the detailed EIA phase

5. Anticipated Impacts on Heritage Resources:

The survey proceeded with no major constraints and limitations, and the project area was comprehensively surveyed for heritage resources, and a number of significant archaeological material remains were documented. The significant heritage resources identified within the development area relate to the agricultural past and burial grounds and graves. Recommendations are made in Table 3 to ensure that these significant resources are not negatively impacted by the proposed development.

As is expected in this area, significant Iron Age resources were identified on top of the Paradys Koppie. Similar Iron Age sites are known from the nearby Harmony Gold Mining area. In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

In addition, two kraal features have been identified (046 and 047) within the restricted area for the Paradys Solar PV Facility 1. No impact is anticipated to these sites as they fall within the restricted development area.

Ongoing management of the significant Iron Age resources is required for the life of the PV facility. Additional recommendations are made in this regard below.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain body fossils or too young and friable to preserve fossils. Furthermore, the material to be excavated are soils and sands and they do not preserve fossils. Since there is an extremely small chance that fossils from below ground may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur below ground in the quartzites but this is very unlikely. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations for foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, so as far as the palaeontology is concerned, the project should be authorised.

6. Recommendations:

Based on the outcomes of this report, it is not anticipated that the proposed development of the solar energy facility and its associated grid connection infrastructure will negatively impact on significant archaeological heritage on condition that:

- The mitigation measures detailed in Table 3 and mapped in Figure 7 are implemented. These are adhered to in the final layouts provided and mapped herein.
- A Conservation Management Plan is developed for the ongoing management and conservation of the significant archaeological sites located within the development area
- The attached Chance Fossil Finds procedure must be implemented for the duration of construction activities
- Although all possible care has been taken to identify sites of cultural importance during the investigation of the study area, it is always possible that hidden or subsurface sites could be overlooked during the assessment. If any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils, burials or other categories of heritage resources are found during the proposed

development, work must cease in the vicinity of the find and SAHRA must be alerted immediately to determine an appropriate way forward.

8. Author/s and Date:

Jenna Lavin,

August 2023

Details of Specialist who prepared the HIA

Jenna Lavin, an archaeologist with an MSc in Archaeology and Palaeoenvironments, heads up the heritage division of the organisation since 2016, and has a wealth of experience in the heritage management sector. Jenna's previous position as the Assistant Director for Policy, Research and Planning at Heritage Western Cape has provided her with an in-depth understanding of national and international heritage legislation. Her previous 8 years of experience at various heritage authorities in South Africa means that she has dealt extensively with permitting, policy formulation, compliance and heritage management at national and provincial level and has also been heavily involved in rolling out training on SAHRIS to the Provincial Heritage Resources Authorities and local authorities.

Jenna is on the Executive Committee of the Association of Professional Heritage Practitioners (APHP), and is also an active member of the International Committee on Monuments and Sites (ICOMOS) as well as the International Committee on Archaeological Heritage Management (ICAHM). In addition, Jenna has been a member of the Association of Southern African Professional Archaeologists (ASAPA) since 2009.

Since 2016, Jenna has drafted over 250 Screening and Heritage Impact Assessments throughout South Africa.

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APPENDICES

1. INTRODUCTION

1.1 Background Information on Project

This report is drafted in support of the proposed development of the Paradys Solar PV 1 Facility that forms part of the Paradys Photovoltaic Solar Energy Cluster and its associated grid connection infrastructure located outside of Viljoenskroon in the Free State. The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e., semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current). The key components of the proposed project are described below:

- PV Panel Array - To produce up to 130MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a optimum angle in order to capture the most sun.
- Wiring to Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the proposed power line. It is expected that generation from the facility will connect to the national grid. Corridor will cover options to connect to Mercury Substation, Existing Eskom lines with capacity and Eskom Switching stations of other Mulilo projects currently under development.
- Electrical reticulation network – An internal electrical reticulation network will be required and will be lain 2-4m underground as far as practically possible.
- Supporting Infrastructure – The following auxiliary buildings with basic services including water and electricity will be required on site:
    - Operations & Maintenance Building / Office
    - Switch gear and relay room
    - Staff lockers and changing room
    - Security control
    - Offices

- Battery storage – Battery Storage Facilities with a maximum height of 5m and a capacity of 2500MWh will be installed in a 6-hectare area.
- Roads - Access is most likely to be obtained via R502 Regional Road. This will be confirmed in the Traffic Impact Assessment which has been commissioned. An internal site road network will also be required to provide access to the solar field and associated infrastructure.
- Fencing - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height between 4 metres will be used.

Table 1: Technical details for the proposed facility

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Length of internal roads	To be confirmed during the detailed EIA phase

1.2 Description of Property and Affected Environment

The Paradys PV development forms part of the Paradys PV Cluster. The Paradys PV Cluster lies just over 15km north of Viljoenskroon on the Free State Province side of the Vaal River. Orkney, which lies on the northern bank of the Vaal River and in the North West Province, is roughly 25km northwest of the study area and is accessed from the R76 tarred road before breaking off onto one of several gravel farm roads that service the various maize and cattle farms in the area.

The area is well-known for its intensive maize and cattle production. Grain silos storing maize for the export market dot the horizon and the roads were full of grain trucks hauling the latest harvest at the time of the survey. A number of mines are located near the development such as the Moab Khotsong gold mine immediately adjacent to the western end of the grid connection near the Mercury substation and these mines are collectively served by several very large overhead powerlines (mainly 400kV) that run along the Vaal Reefs goldfields.

Some eco-tourism farms and hunting lodges have also cropped up over the last 30 years in the area, particularly along the Vaal River. Areas that have not been cultivated are either on the slightly elevated ground formed by the ridge at Paradys where the soil is too shallow to plant maize, or in the wetlands that form near the Vaal floodplain and the Renosterrivier tributary that adjoins the Vaal River. These areas have instead been used extensively for the grazing of cattle and sheep.

The farm werfs typically have an older, late 19th century component in the form of stone walled kraals and very basic structures, and formalised development of the farms appears to have gathered speed in the 20th century along with the mining industry. Werfs in the area normally have several modern buildings and heavily altered buildings due to the strong commercial businesses that have expanded in the area. A few abandoned werfs and ruined farmworkers cottages are also becoming more common on the landscape as large farming corporates buy out the arable land due to the increasing tendency to scale up the agribusinesses.

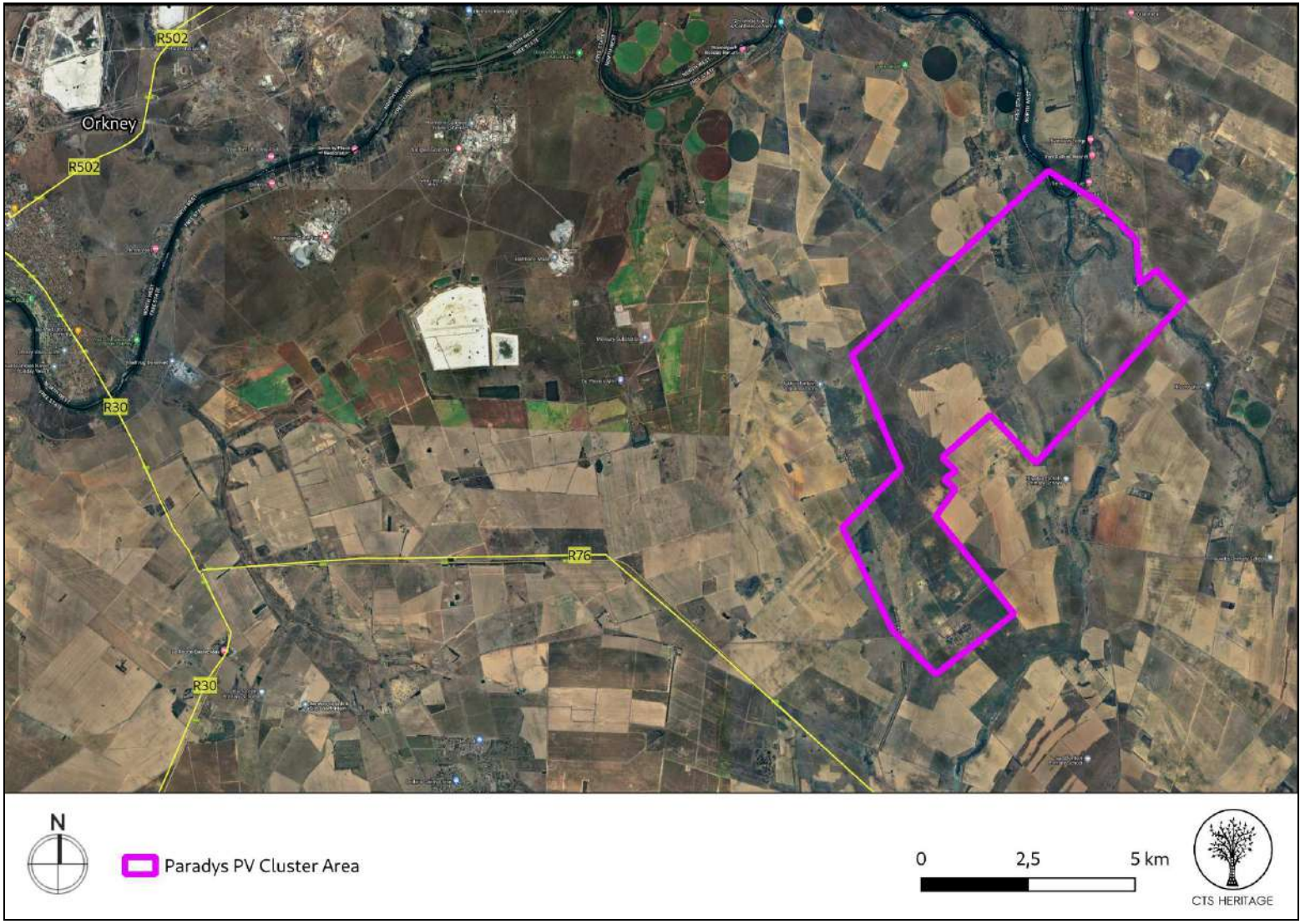

Figure 1.1: Proposed development relative to Orkney

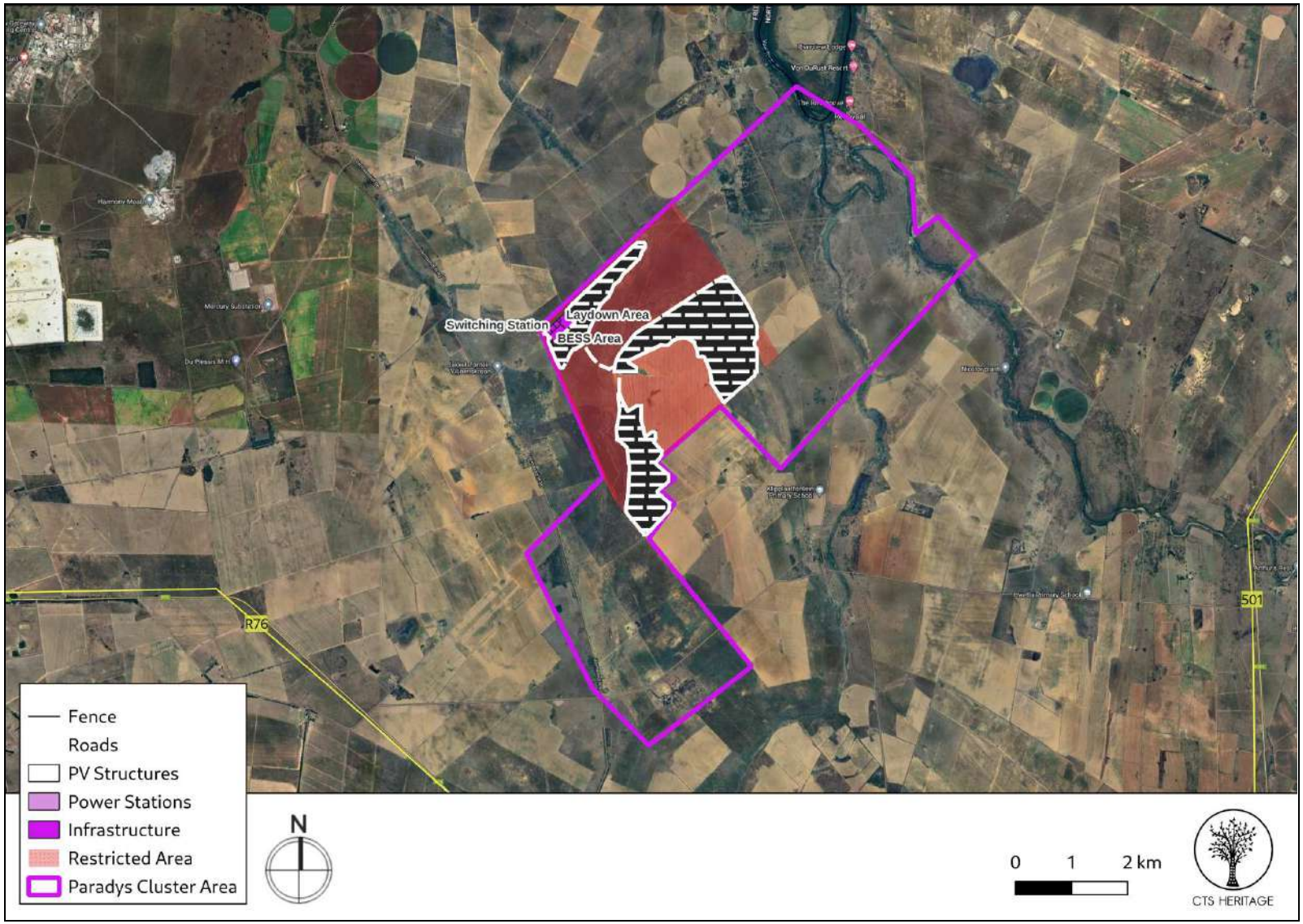

Figure 1.2: The proposed development layout

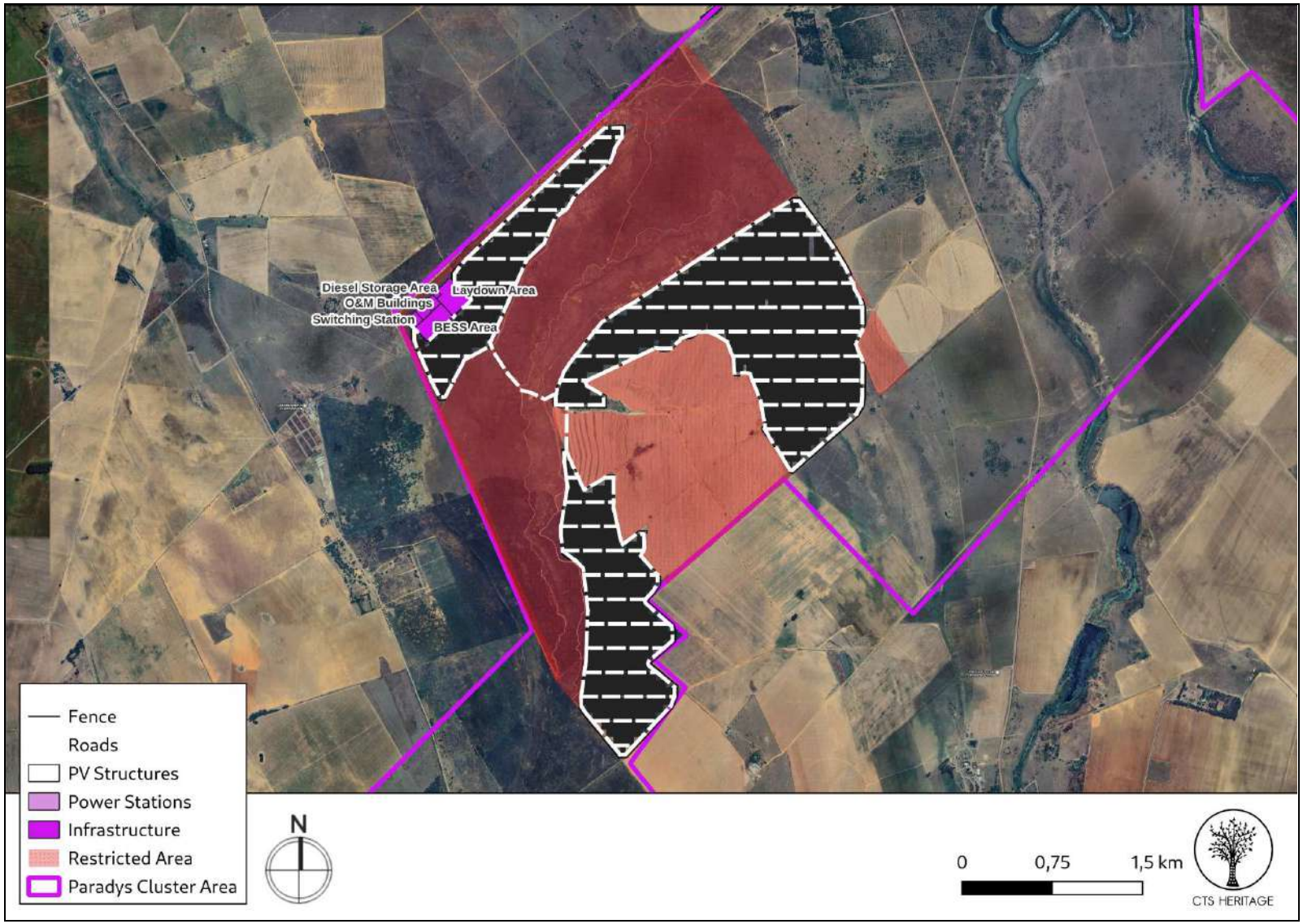

Figure 1.3: The proposed development layout of the Paradys Solar PV 1 Facility

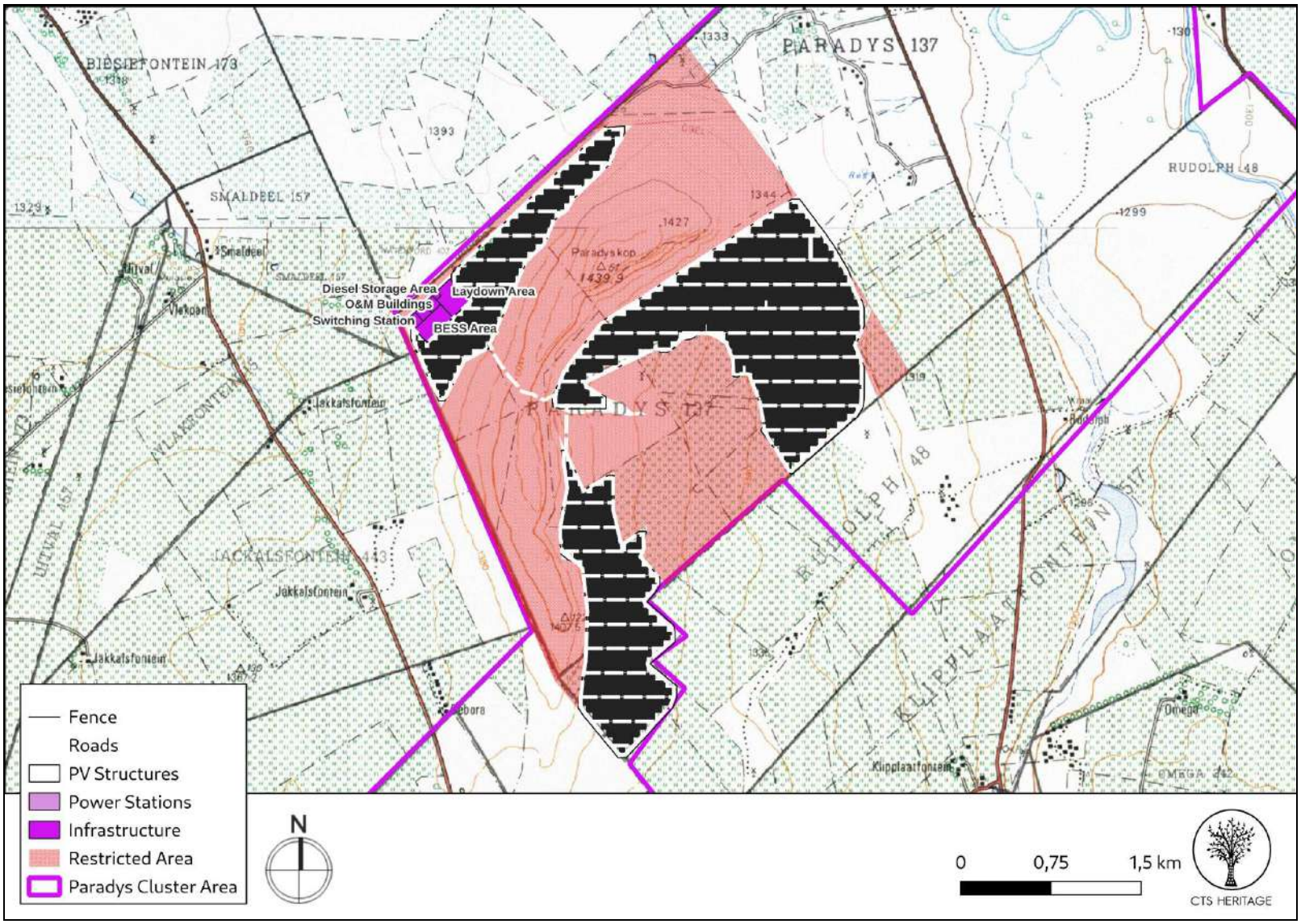

Figure 1.4: The proposed development layout on an extract of the 1:50 000 Topo Map

2. METHODOLOGY

2.1 Purpose of HIA

The purpose of this Heritage Impact Assessment (HIA) is to satisfy the requirements of section 38(8), and therefore section 38(3) of the National Heritage Resources Act (Act 25 of 1999).

2.2 Summary of steps followed

- A Desktop Study was conducted of relevant reports previously written (please see the reference list for the age and nature of the reports used)
- An archaeologist conducted an assessment of archaeological resources likely to be disturbed by the proposed development. The archaeologist conducted his site visit on 3 to 7 July 2023
- A palaeontologist conducted a desktop assessment of palaeontological resources likely to be disturbed by the proposed development.
- The identified resources were assessed to evaluate their heritage significance and impacts to these resources were assessed.
- Alternatives and mitigation options were discussed with the Environmental Assessment Practitioner

2.3 Assumptions and uncertainties

- The *significance* of the sites and artefacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their 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.

- It should be noted that archaeological and palaeontological deposits often occur below ground level. Should artefacts or skeletal material be revealed at the site during construction, such activities should be halted, and it would be required that the heritage consultants are notified for an investigation and evaluation of the find(s) to take place.

However, despite this, sufficient time and expertise was allocated to provide an accurate assessment of the heritage sensitivity of the area.

2.4 Constraints & Limitations

The development covers a large area and many of the fields that lie in between the planned PV laydown areas were in the final days of the maize harvest during the survey. Visibility on the curved ridgeline at Paradys improved somewhat and Iron Age kraals and Later Stone Age tools could be found with relative ease in these

areas despite the high stands of grass cover. Lower down the dormant patches of veld become entirely overgrown and visibility was reduced to the jeep tracks and exposed rocky ground where cattle had not reduced the cover sufficiently.

2.5 Solis Impact Assessment Methodology

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in the Table below.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Impact Rating System

Impact assessment must take account of the nature, scale and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the project phases:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact the following criteria is used:

Table 2: The rating system

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.

INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		

1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.
The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

3. HISTORY AND EVOLUTION OF THE SITE AND CONTEXT

3.1 Desktop Assessment

Background

This application is for the proposed development of one of 6x PV facilities and their respective grid connections located outside of Orkney along the R76 regional route connecting Orkney to Viljoenskroon. This regional route runs approximately 3km south of the development area.

Built Environment & Cultural Landscapes

The development areas are located in peri-urban farms just outside the towns of Orkney (North West) and Viljoenskroon (Free State). The town of Orkney was established in 1940 at the junction of the various railway lines. It was name after the old gold mine opened by Thomas Leask, who came from the Orkney Islands, in 1880 (SESA 1973 in Van Schalkwyk 2021). Viljoenskroon is a maize and cattle farming town located in the Free State province of South Africa. It was named after the original farm owner J. J. Viljoen and his horse Kroon. The town was laid out in 1921 on the farm "Mahemskuil" and became a municipality in 1925. A number of large gold and diamond mines are also located inbetween the three solar PV sites, namely Taulekoa Mine next to Goedgenoeg 433, Kopanong Gold Mine next to Pretorius Kraal 53 and Great Noligwa Mine next to Groot Vaders Bosch 592. Ruins of or intact avenues of trees, historical farmsteads and farm labourer's cottages may potentially be found within the proposed development areas. The cultural landscape is characterised by a agriculture with abrupt transitions into extremely heavy industrial areas in and around the mining compounds. The installation of solar PV plants will therefore not have any impacts on the landscape character of the area but a foot survey identifying potentially conservation-worthy built environment structures is recommended.

In his assessment of a PV Facility located less than 5km from this development area, Van der Walt (2016 SAHRIS ID 385181) noted that no scenic significant cultural landscapes or viewscapes were noted during the fieldwork within the area. The VIA for this nearby PV project also noted that there are no significant visual issues in the area. In 2022, CTS Heritage completed an HIA for an adjacent project known as the Mercury PV Cluster. The HIA noted that The broader cultural landscape of the development area has been assessed for cultural heritage significance, and found to have the following elements that contribute to the cultural value of the area:

- Dispersed farm werfs often associated with clusters of trees, with a consistent relationship between werfs, trees and roads
- Remnant areas of tree plantation
- Avenues of trees along roads, farm boundaries and access routes

This pattern seems to be repeated within this development area, and it is further noted that Paradyskop koppie falls within the broader development footprint.

Archaeology

Archaeological sites spanning the Earlier, Middle and Later Stone Age have been found in the region despite the extensive agricultural transformation of the area. In Dreyer (2005) and Van der Walt's (2007) heritage impact assessments of Pretorius Kraal 53 located in Orkney, various modern buildings were recorded that are located near the banks of the Vaal River that were deemed as not conservation worthy. Van der Walt identified some Middle to Later Stone Age artefacts scattered across the farm but did not map them. In Van Schalkwyk's (2021) impact assessment of the Siyanda Solar farm on Grootdraai 468 (which lies on the western border of Pretorius Kraal 53 in Orkney) is of relevant here due to the proximity of the study to this assessment area (SAHRIS ID 578029). Van Schalkwyk (2021) noted that visibility issues were a major problem, *"Due to the very dense vegetation cover that occur in the project area, natural as well as agricultural fields, it was impossible to obtain any ground visibility. The strategy was therefore to examine natural and man-made features that are usually associated with human habitation and activities such as clumps of trees and rock outcrops. The proposed power line corridor connecting the Solar Power Plant to the the existing Vaal Reef Substation was not surveyed as access to the relevant properties (Pretoriuskraal 53) was not possible. It is proposed that once the power line route has been confirmed within the 100m corridor a heritage walk-though needs to be undertaken."* Two burial sites were recorded during this survey despite the lack of Stone Age sites with the help of a local informant who had been working on the property for a number of years.

In his assessment, Huffman (2005, SAHRIS ID 7367) identified no sites of archaeological interest. In their assessment conducted in close proximity to this proposed development, Henderson and Koortzen (2007, SAHRIS ID 7340) noted that while no sites were found in the area surveyed, a number of previously excavated inspection pits yielded archaeological material in the form of stone artefacts. Henderson and Koortzen (2007, SAHRIS ID 7340) note that "These artefacts had been brought up from an unknown depth (probably no more than a metre or two), and were mostly undiagnostic flakes with one blade-like flake which could be Middle Stone Age. Raw material included cryptocrystalline, chert and quartz." Van der Walt (2016) conducted an archaeological field assessment for the Orkney PV Facility which will connect to this grid connection (2016, SAHRIS ID 385181). He made no archaeological observations but did identify two cemeteries. It is therefore highly likely that further burials may be located on the proposed solar PV areas as well as Stone Age material similar to the artefacts recorded but not mapped by Van der Walt. An archaeological field survey is therefore recommended.

In 2022, CTS Heritage completed an HIA for an adjacent PV project known as the Mercury PV Cluster. The archaeology assessment found a single archaeological site and very few isolated individual artefacts were documented. Cumulatively these findings indicate cultural evidence for MSA and LSA occupations of the area. The majority of finds were identified in disturbed surface contexts, and could not be tied chrono-culturally to a particular prehistoric period, however one site was relatively less affected by post-depositional processes, and

may have been exposed relatively recently. One isolated historic burial and an historic burial ground were identified within the vicinity of the Zaaiplaats farm werf. These resources have high levels of social and intrinsic cultural value and are graded IIIA. The presence of these burials highlights the possibility of further hidden or unmarked burials located throughout the development area. It is likely that similar archaeological resources will be present within this development area.

Palaeontology

According to the SAHRIS Palaeosensitivity Map the development sites are underlain by sediments of Low to Moderate fossil sensitivity (Figure 4). According to the extract from the Council of GeoScience Map 2726 Kroonstad, the area proposed for development is underlain by the Allanridge and Rietgat Formations of the Ventersdorp Subgroup. Butler (2016, SAHRIS ID 368565) completed a palaeontological assessment for the now approved Orkney PV facility to which this OHL is connected. Butler (2016) notes that the Ventersdorp Subgroup characterises a major occurrence of igneous extrusion that is associated with the fracturing of the Kaapvaal Craton approximately 2.7 Billion years ago.

An assessment completed by Almond (2021) for the nearby Siyanda Solar Power Plant is of relevance here due to its proximity to the development area. Almond (2021) noted that the broader area is "underlain near-surface or at depth by shallow marine carbonate bedrocks of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) of Precambrian age that are known to contain fossil stromatolites (laminated microbial bio-sedimentary structures) of various shapes and sizes (domes, columns etc). Indeed, stromatolite occurrences on Farm Grootdraai 468 are specifically mentioned in the Kroonstad 1: 250 000 geological sheet explanation by Schutte (1993). A combined desktop study and palaeontological site visit indicated that exposure levels of Precambrian bedrocks within the solar facility and grid connection project areas are generally very low due to low topographic relief and karstic weathering across an ancient land surface, widespread sandy soil cover and dense grassy vegetation. Well-preserved occurrences of stromatolites worthy of scientific interest are apparently rare, while the stromatolite varieties recorded here are likely to be of widespread occurrence within the bedrock units concerned (viz. the Oaktree and Monte Christo Formations). The thin to thick, Late Caenozoic (Pleistocene to Recent) unconsolidated sandy deposits mantling the carbonate bedrocks, especially in the south, are generally unfossiliferous and so far no fossil material has been found within them."

In the PIA completed for the adjacent Mercury PV Cluster by Bamford (2022), it is noted that "in terms of impacts to palaeontology, based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying deep soils and sands of the Quaternary. In the northernmost section (Kleinfontein PV1, only north of the grid connection) there is a very small chance that fossils may occur in the shales below ground of the early Permian Vryheid Formation so a Fossil Chance Find

Protocol should be added to the EMPr. The proposed PV projects are located entirely on moderately sensitive Quaternary sands." As such, neither the Allanridge Formation nor the Rietgat Formation are known to be fossiliferous. It is therefore very unlikely that the proposed development will impact on significant palaeontological heritage and no further assessment is recommended in this regard.

Table 3: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Johnson et al., 2006; Zeh et al., 2020). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary Kalahari Group	Aeolian sand	Quaternary, ca 1.0 Ma to present
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shale, sandstone, siltstone, coal seams	Early Permian Ca 290-280 Ma
Vdi	Diabase	Intrusive volcanic dykes and sills	Post Transvaal SG
Vsi	Silverton Fm, Pretoria Group, Transvaal SG	Shale, carbonaceous in places, hornfels, chert	Ca 2202 Ma
Vd	Daspoort Fm, Pretoria Group, Transvaal SG	Quartzite	<2240 Ma
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Andesitic lava (volcanic rocks)	Ca 2224 Ma

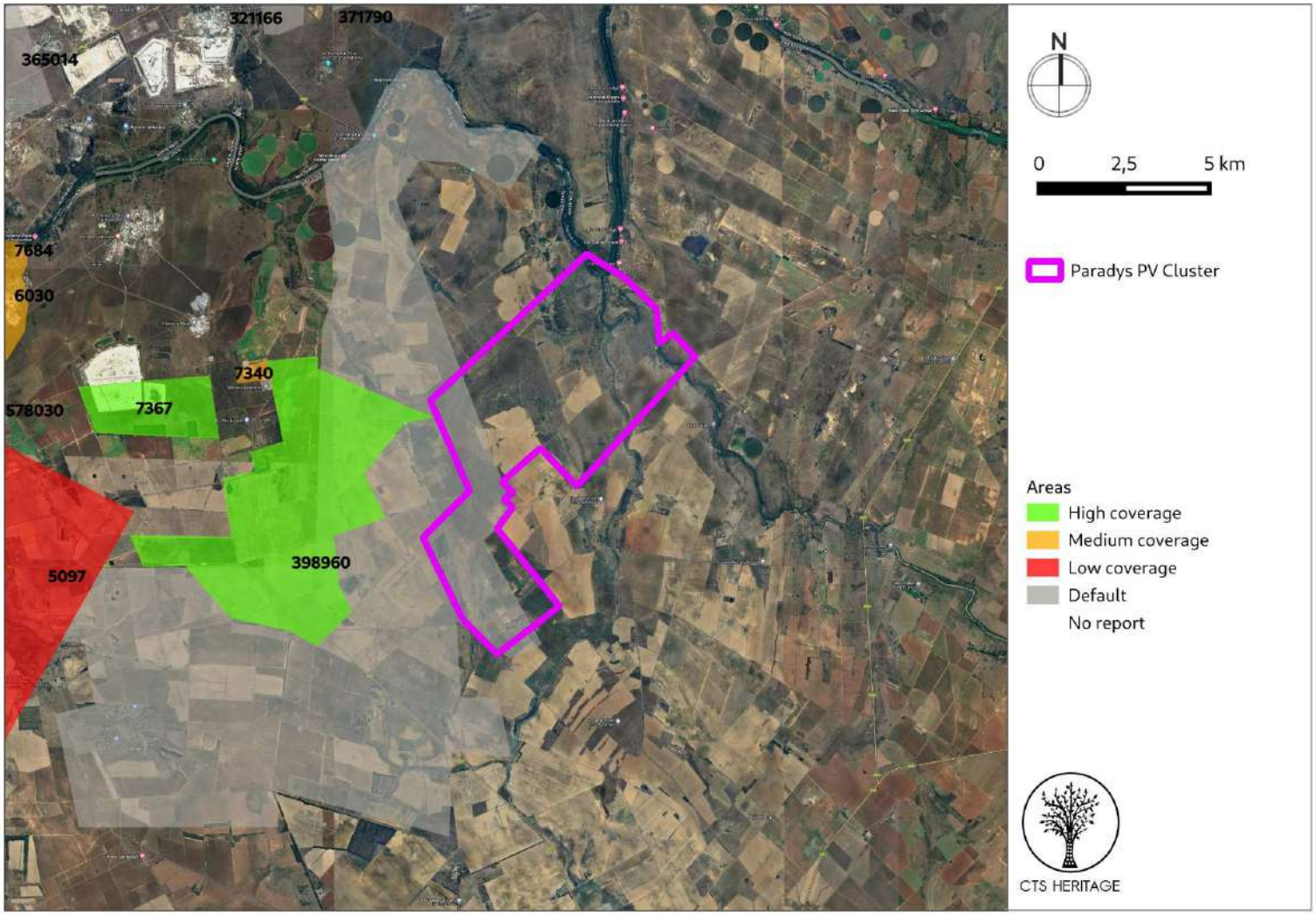

Figure 2: Spatialisation of heritage assessments conducted in proximity to the proposed development

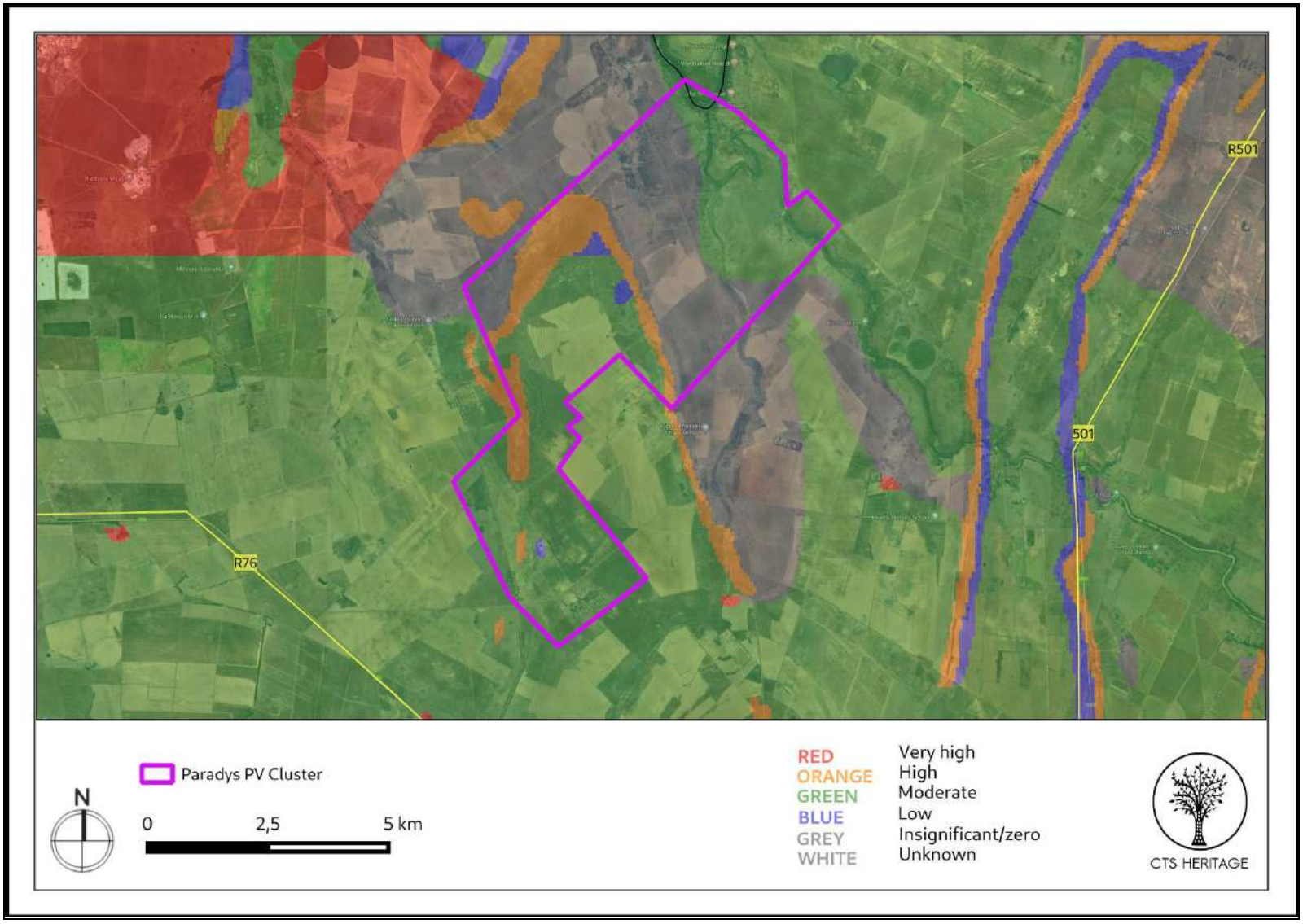

Figure 3.1: Palaeontological sensitivity of the proposed development area

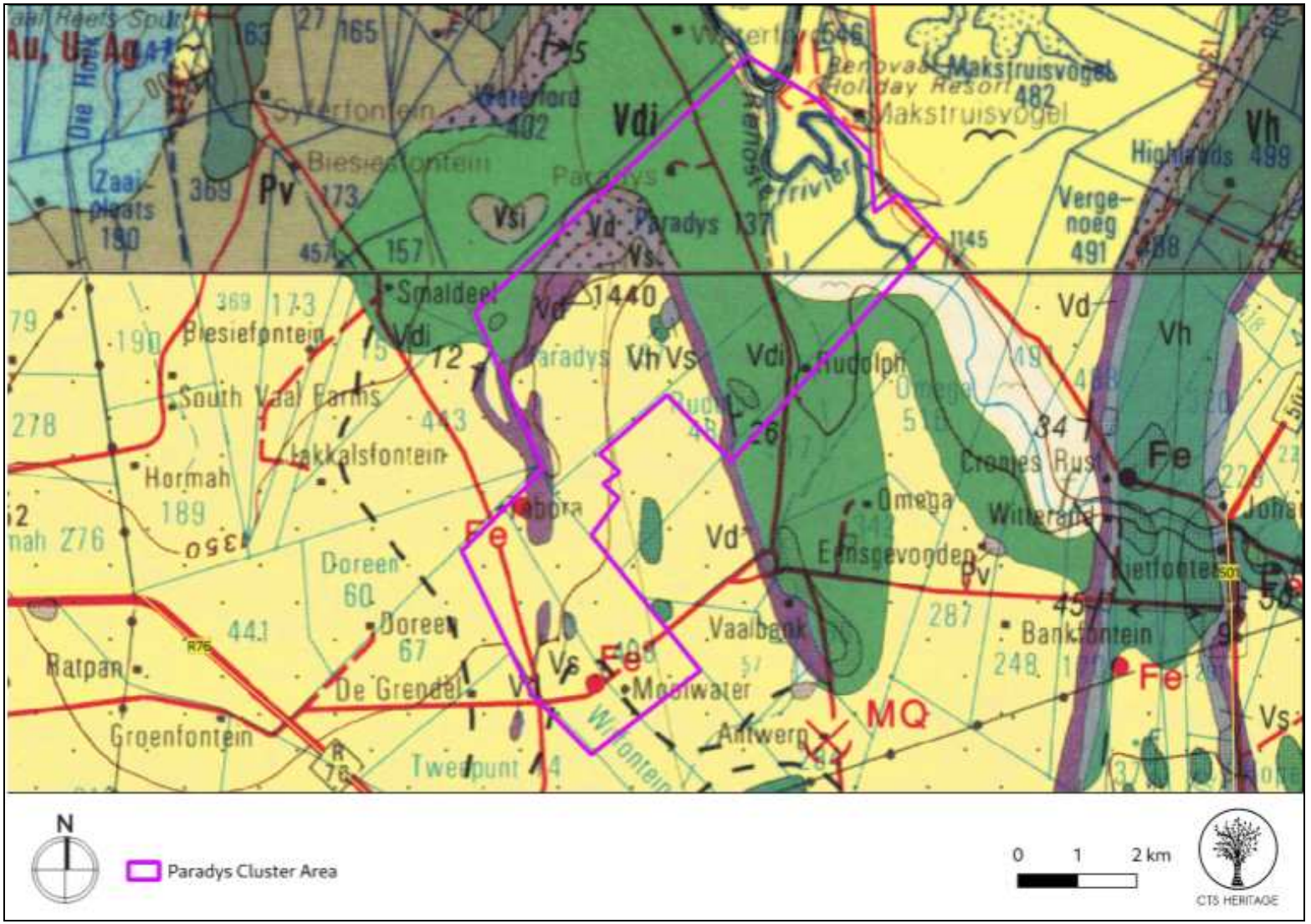

Figure 3.2. Geology Map. Extract from the CGS 2626 West Rand Geology Map and 2726 Kroonstad Map - The location of the proposed project is indicated within the blue polygon. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand (top) and 2726 Kroonstad (bottom).

4. IDENTIFICATION OF HERITAGE RESOURCES

4.1 Summary of findings of Specialist Reports

Archaeology (Appendix 1)

The archaeology field assessment was completed for the whole of the Paradys PV Cluster Facility and the results of the assessment are relevant to determine the overall archaeological context and sensitivity of the development area.

Nearly 50 observations were made during the survey that consisted mainly of buildings and graves at the various werfs included in the study area. At Paradys, the older, likely original settlement footprint was obscured by dense bush and a number of informal 20th century graveyards are located here. Iron Age stone walled kraals and Later Stone Age artefacts in hornfels, chert and quartz were found on and close to the ridge which arcs from the northeast around to the southwest. The kraal enclosures appear to be late, possibly 19th century and historical walling features are also present. Most of the ruins recorded on the various farms (eg Witfontein, Smaldeel, De Grendel, Deborah) were built from the 1940s onwards and typically consist of a row of staff cottages that have since been abandoned as the farms have changed hands and ownership has become more and more aggregated amongst the larger corporate agribusinesses.

In areas bordering the maize fields, isolated and disturbed finds of MSA material was also found and it is more than likely that these continued in the cultivated areas. Early MSA and Early Stone Age material is also buried beneath the topsoil but the proposed development is unlikely to require very deep excavations that will reveal material at these depths.

Palaeontology (Appendix 2)

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the moderately fossiliferous Kalahari sands (green) and moderately fossiliferous Daspoort Formation (orange) and non-fossiliferous Hekpoort Formation (grey).

Volcanic rocks such as diabase and andesitic lavas (Hekpoort Formation) do not preserve fossils as they have originated from below the earth's surface. No fossils have been reported from the Daspoort Formation quartzites but this formation is lumped together in the Palaeotechnical Report for the Free State (Groenewald et al., 2014) with the Magaliesberg, Timeball Hill and Silverton Formations, only some of which have recorded stromatolites. In addition, the area is covered with sols and has been cultivated for decades so any rocks have been removed.

Aeolian sands and alluvium are fairly mobile and very porous so they do not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, is there any chance of fossilisation. For example, roots can be encased in

calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

Note: in the southern part of the map in figure 3, there is a disjunction between the Vryheid Formation rocks ending abruptly along the line that joins the maps. The southern map shows the surface rocks, Quaternary sands and alluvium in this case, while the northern map shows the rocks from borehole core information, i.e. the underlying rocks. Since this project will be on the surface only, it is advisable to use the surface strata – the moderately fossiliferous Quaternary sands.

4.2 Heritage Resources identified

Table 4: Heritage Resources identified

Obs#	Description	Type	Period	Density	Latitude	Longitude	Grade	Mitigation
010	Large graveyard, at least 50 graves, 20th c. Many died in the 1970s	Graves/ Burial Grounds	Historic, Modern	n/a	-26.994494	26.902444	IIIA	100m Buffer
011	Stone circular kraal, Historical or Late Iron Age	Structure	LIA, Historic	n/a	-27.001716	26.890185	IIIA	100m Buffer
012	More stone walling, linear	Structure	LIA, Historic	n/a	-27.00212	26.889961	IIIA	100m Buffer
013	Large circular stone kraal, with secondary walled entrance	Structure	LIA, Historic	n/a	-27.002567	26.88903	IIIA	100m Buffer
014	More stone walling enclosures	Structure	LIA, Historic	n/a	-27.001857	26.888933	IIIA	100m Buffer
015	Rectangular stone kraal, part of larger site on hill	Structure	Historic	n/a	-27.004078	26.888923	IIIA	100m Buffer
046	More kraal features	Structure	Historic	n/a	-26.994738	26.897739	IIIC	50m Buffer
047	More kraal features	Structure	Historic	n/a	-26.996328	26.896836	IIIC	50m Buffer

4.3 Mapping and spatialisation of heritage resources

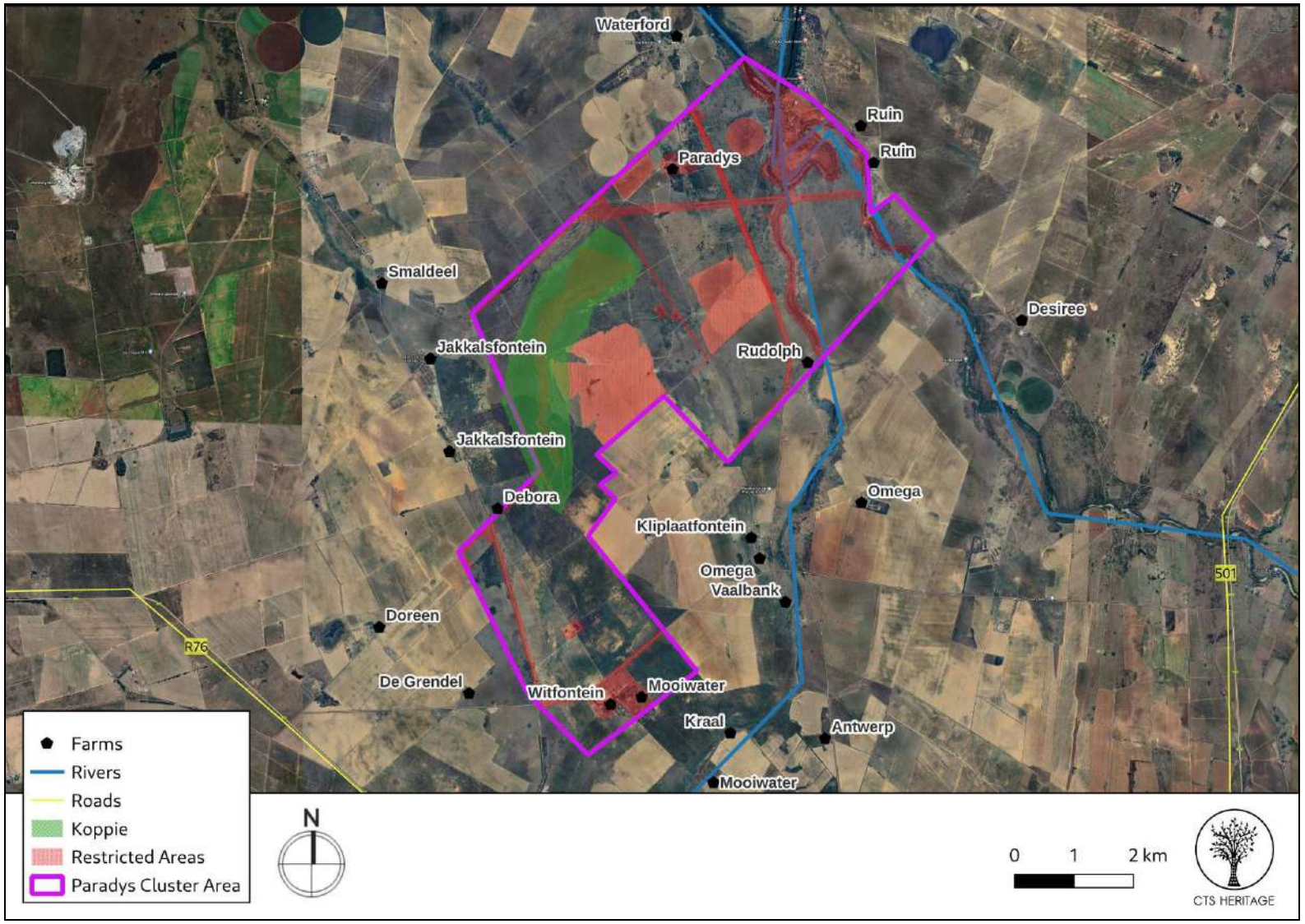

Figure 6.1: Map of potential heritage resources relative to the proposed development area extracted from the 1:50 000 Topo Map

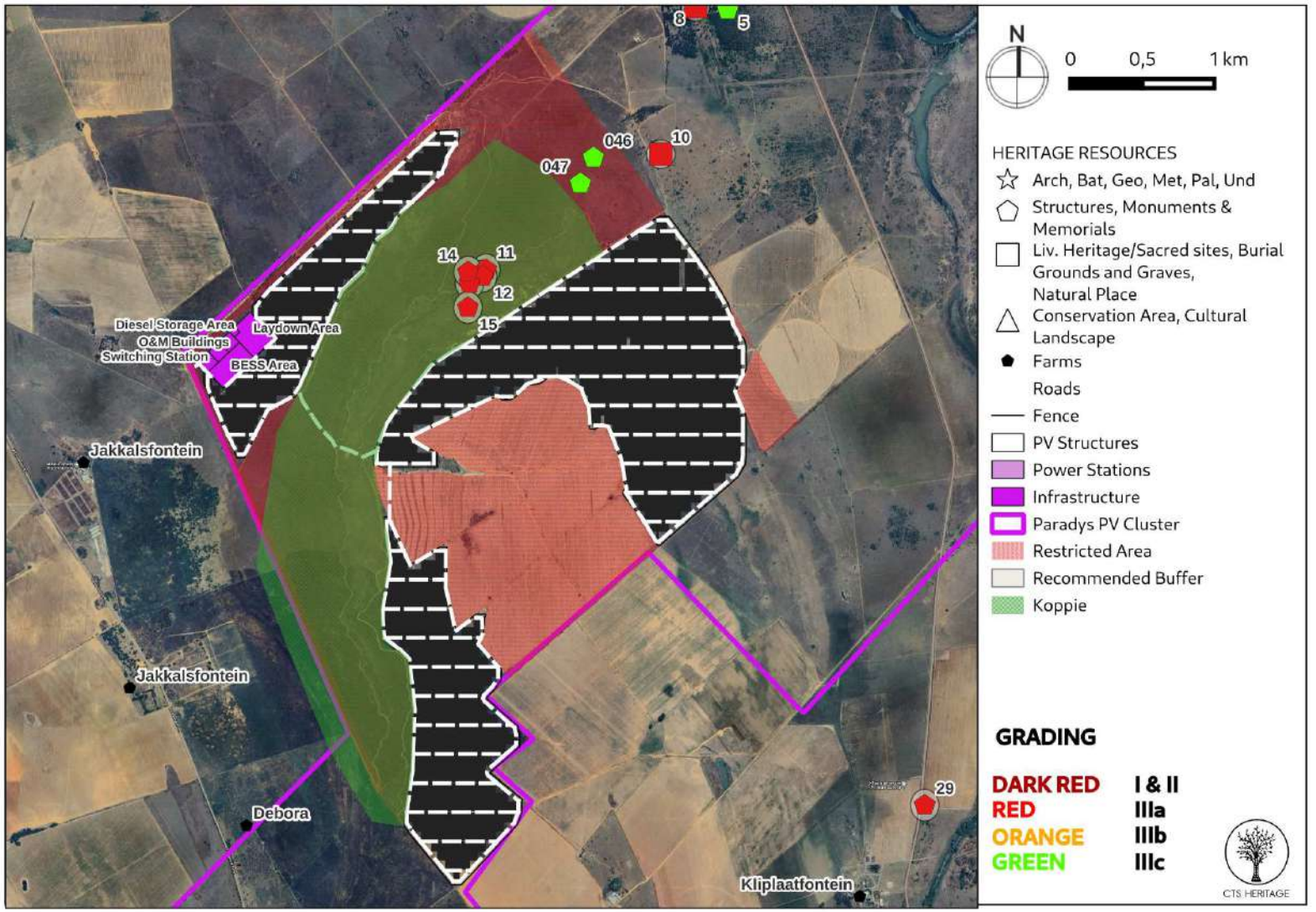

Figure 6.2: Map of all sites and observations noted within the development area with recommended mitigation measures

5. ASSESSMENT OF THE IMPACT OF THE DEVELOPMENT

5.1 Assessment of impact to Heritage Resources

Due to the nature of heritage resources, impacts to archaeological and palaeontological heritage resources are unlikely to occur during the PLANNING, OPERATIONAL and DECOMMISSIONING phases of the project. Potential impacts to the cultural landscape throughout the OPERATIONAL phase are discussed in the section below that deals with Cumulative Impacts. The impacts discussed here pertain to the CONSTRUCTION phase of the project.

The proposed Paradys PV facility is located all around the Paradys Koppie which presents a landmark feature in this area. Due to its landmark nature, it is not unexpected that people would have been drawn to this location in the past. The archaeological field assessment identified a number of stone-walled structures and kraals located on top of the Paradys Koppie (Sites 11, 12, 13, 14 and 15) which appear to be associated with the Late Iron Age occupation of this area. Similar Iron Age sites are known from the nearby Harmony Gold Mining area.

In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

In addition, two kraal features have been identified (046 and 047) within the restricted area for the Paradys Solar PV Facility 1. No impact is anticipated to these sites as they fall within the restricted development area.

Palaeontology

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain body fossils or too young and friable to preserve fossils. Furthermore, the material to be excavated are soils and sands and they do not preserve fossils. Since there is an extremely small chance that fossils from below ground may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur below ground in the quartzites but this is very unlikely. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible

person once excavations for foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, so as far as the palaeontology is concerned, the project should be authorised.

Table 5: Assessment of impacts

NATURE		
Destruction of significant archaeological and palaeontological heritage during the construction phase of development.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
4	Complete loss of resources	The impact results in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		

3	Medium cumulative impact	The impact would result in minor cumulative effects.

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.
The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.

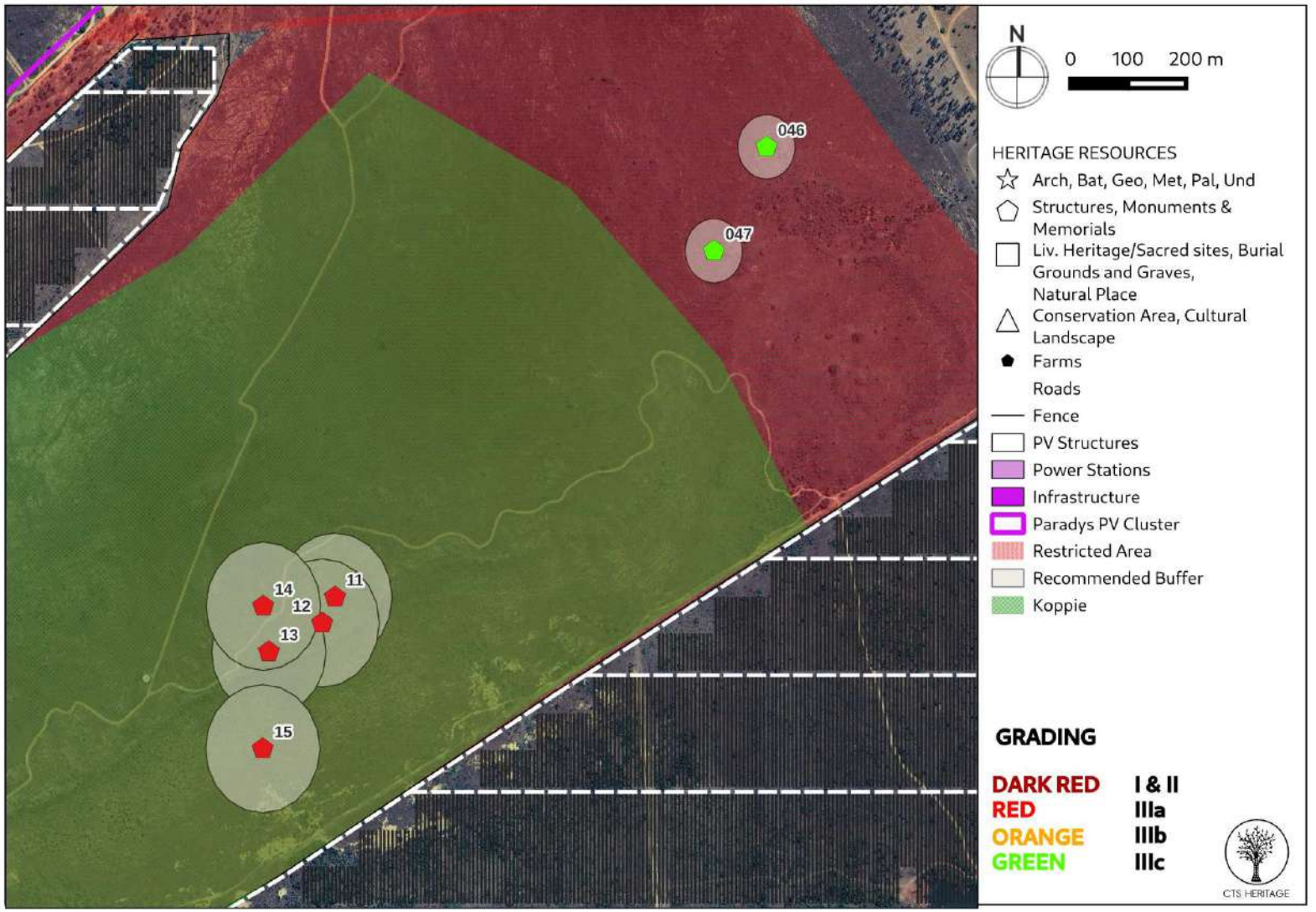

Figure 7: Map of all sites and observations noted within the development area with recommended mitigation measures

5.2 Sustainable Social and Economic Benefit

According to information received from the client, the operational phase will have a direct positive impact through the creation of employment opportunities and skills development, development of non-polluting, renewable energy infrastructure, contribution to Local Economic Development (LED) and social upliftment and increase in household earnings.

The proposed project will contribute to local economic growth by supporting industry development in line with provincial and regional goals and ensuring advanced skills are drawn to the Free State Province. The project will likely encounter widespread support from government, civil society and businesses, all of whom see potential opportunities for revenues, employment and business opportunities locally. The development of the solar PV facility will in turn lead to growth in tax revenues for local municipalities and sales of carbon credits, resulting in increased foreign direct investment.

The increase in the demand for services such as accommodation, transportation, security, general maintenance and catering will generate additional indirect socio-economic benefits for the local community members.

The main benefit of the proposed development operating in the area is that local companies or contractors will be hired for the duration of the construction period. The operational phase will provide permanent job opportunities to the local communities from the surrounding area since security guards and general labourers will be required on a full-time basis.

As such, the anticipated socio-economic benefits to be derived from the project outweigh any negative impacts to heritage resources on condition that the recommendations made below are implemented.

5.3 Proposed development alternatives

The DEAT 2006 guidelines on 'assessment of alternatives and impacts' proposes the consideration of four types of alternatives namely, the no-go, location, activity, and design alternatives. It is, however, important to note that the regulation and guidelines specifically state that only 'feasible' and 'reasonable' alternatives should be explored. It also recognizes that the consideration of alternatives is an iterative process of feedback between the developer and EAP, which in some instances culminates in a single preferred project proposal. An initial site screening was conducted by the developer; the affected properties and the farm portions were found favourable due to its proximity to grid connections, solar radiation, ecology and relatively flat terrain. These factors were then taken into consideration and avoided as far as possible.

The following alternatives were considered in relation to the proposed activity and all specialists should also make mention of these:

No-go alternative

This alternative considers the option of 'do nothing' and maintaining the status quo. The site is currently zoned for agricultural land uses. Should the proposed activity not proceed, the site will remain unchanged and will continue to be used for agricultural purposes. The potential opportunity costs in terms of alternative land use income through rental for energy facility and the supporting social and economic development in the area would be lost if the status quo persists.

Location alternatives

No other possible sites were identified on the farm Eden. This site is referred to as the preferred site. The Paradys Substation is located approximately 17 km from the preferred site. Connection to the grid plays a vital role in the site location for renewable energy facilities. The location of the preferred site shortens the length of the required grid connection in order to evacuate energy into the national grid. There are some limited sensitive features that occur on the site. However, the size of the site makes provision for the exclusion of any sensitive environmental features that may arise through the EIA process and will ensure that potential impacts are adequately mitigated.

Battery storage facility

It is proposed that a nominal up to 2500 MWh Battery Storage Facility for grid storage would be housed in stacked containers, or multi-storey buildings, with a maximum height of 5m with associated operational, safety and control infrastructure. Three types of battery technologies are being considered for the proposed project: Lithium-ion, Sodium-sulphur or Vanadium Redox flow battery. The preferred battery technology is Lithium-ion.

Battery storage offers a wide range of advantages to South Africa including renewable energy time shift, renewable capacity firming, electricity supply reliability and quality improvement, voltage regulation, electricity reserve capacity improvement, transmission congestion relief, load following and time of use energy cost management. In essence, this technology allows renewable energy to enter the base load and peak power generation market and therefore can compete directly with fossil fuel sources of power generation and offer a truly sustainable electricity supply option.

Design and layout alternatives

Design alternatives will be considered throughout the planning and design phase and specialist studies are expected to inform the final layout of the proposed development.

Technology alternatives

There are several types of semiconductor technologies currently available and in use for PV solar panels. Two, however, have become the most widely adopted, namely crystalline silicon (Mono-facial and Bi-facial) and thin film. The technology that (at this stage) proves more feasible and reasonable with respect to the proposed solar facility is crystalline silicon panels, due to it being non-reflective, more efficient, and with a higher durability. However, due to the rapid technological advances being made in the field of solar technology the exact type of technology to be used, such as bifacial panels, will only be confirmed at the onset of the project.

5.4 Cumulative Impacts

The cumulative impact of a development is the impact that development will have when its impact is added to the incremental impacts of other past, present or reasonably foreseeable future activities that will affect the same environment. It is important to note that the cumulative impact assessment for a particular project, like what is being done here, is not the same as an assessment of the impact of all surrounding projects. The cumulative assessment for this project is an assessment only of the impacts associated with this project, but seen in the context of all surrounding impacts. It is concerned with this project's contribution to the overall impact, within the context of the overall impact. But it is not simply the overall impact itself.

The most important concept related to a cumulative impact is that of an acceptable level of change to an environment. A cumulative impact only becomes relevant when the impact of the proposed development will lead directly to the sum of impacts of all developments causing an acceptable level of change to be exceeded in the surrounding area. If the impact of the development being assessed does not cause that level to be exceeded, then the cumulative impact associated with that development is not significant.

In terms of cumulative impacts to heritage resources, impacts to archaeological and palaeontological resources are sufficiently dealt with on a case by case basis. The primary concern from a cumulative impact perspective would be to the cultural landscape. The cultural landscape is defined as the interaction between people and the places that they have occupied and impacted. In some places in South Africa, the cultural landscape can be more than 1 million years old where we find evidence of Early Stone Age archaeology (up to 2 million years old), Middle Stone Age archaeology (up to 200 000 years old), Later Stone Age archaeology (up to 20 000 years old), evidence of indigenous herder populations (up to 2000 years old) as well as evidence of colonial frontier settlement (up to 300 years old) and more recent agricultural layers.

This proposed development is located within an identified REDZ. Modern interventions into such landscapes, such as renewable energy development, constitute an additional layer onto the cultural landscape which must be acceptable in REDZ areas. The primary risk in terms of negative impact to the cultural landscape resulting from

renewable energy development lies in the eradication of older layers that make up the cultural landscape. There are various ways that such impact can be mitigated.

In terms of impacts to heritage resources, it is preferred that this kind of infrastructure development is concentrated in one location and is not sprawled across an otherwise agricultural landscape. The proposed development is therefore unlikely to result in unacceptable risk or loss, as the proposed development is located within a REDZ area.

The landscape within which the proposed project areas are located, is not worthy of formal protection as a heritage resource and has the capacity to accommodate such development from a heritage perspective. The proposed development is located sufficiently far from significant roads and features that impact is unlikely. Additional mitigation measures to limit the negative impact to the cultural landscape are included below.

5.5 Site Verification

According to the DFFE Screening Tool analysis, the development area has High levels of sensitivity for impacts to palaeontological heritage and Low levels of sensitivity for impacts to archaeological and cultural heritage resources. The results of this assessment in terms of site sensitivity are summarised below:

- The cultural value of the broader area is moderate (MEDIUM)
- Some very significant archaeological resources were identified within the development area (HIGH)
- No highly significant palaeontological resources were identified within the development area, and the geology underlying the development area is not very sensitive for impacts to significant fossils (MEDIUM)

As per the findings of this assessment, and its supporting documentation, the outcome of the sensitivity verification disputes the results of the DFFE Screening Tool for Palaeontology - this should be MEDIUM - and disputes the results of the screening tool for archaeology and cultural heritage - this should be considered to be HIGH. This evidence is provided in the body of this report and in the appendices (Appendix 1, 2 and 3).

6. RESULTS OF PUBLIC CONSULTATION

As this application is made in terms of NEMA, the public consultation on the HIA will take place with the broader public consultation process required for the Environmental Impact Assessment process and will be managed by the lead environmental consultants on the project.

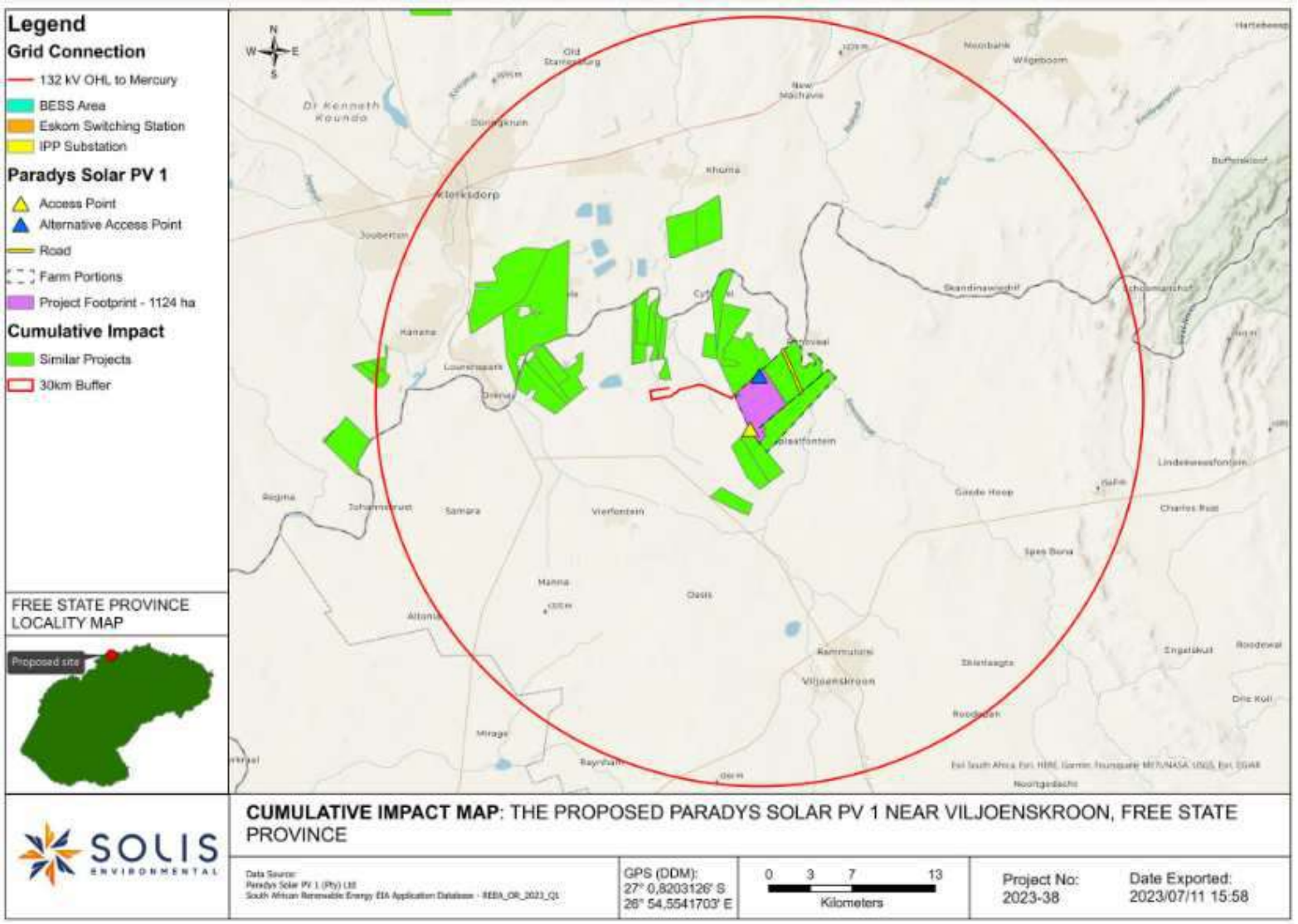

Figure 7: Cumulative Impact Map

7. CONCLUSION

The survey proceeded with no major constraints and limitations, and the project area was comprehensively surveyed for heritage resources, and a number of significant archaeological material remains were documented. The significant heritage resources identified within the development area relate to the agricultural past and burial grounds and graves. Recommendations are made in Table 3 to ensure that these significant resources are not negatively impacted by the proposed development.

As is expected in this area, significant Iron Age resources were identified on top of the Paradys Koppie. Similar Iron Age sites are known from the nearby Harmony Gold Mining area. In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

In addition, two kraal features have been identified (046 and 047) within the restricted area for the Paradys Solar PV Facility 1. No impact is anticipated to these sites as they fall within the restricted development area.

Ongoing management of the significant Iron Age resources is required for the life of the PV facility. Additional recommendations are made in this regard below.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain body fossils or too young and friable to preserve fossils. Furthermore, the material to be excavated are soils and sands and they do not preserve fossils. Since there is an extremely small chance that fossils from below ground may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur below ground in the quartzites but this is very unlikely. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations for foundations and infrastructure have commenced then they should be rescued and a

palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, so as far as the palaeontology is concerned, the project should be authorised.

8. RECOMMENDATIONS

Based on the outcomes of this report, it is not anticipated that the proposed development of the solar energy facility and its associated grid connection infrastructure will negatively impact on significant archaeological heritage on condition that:

- The mitigation measures detailed in Table 3 and mapped in Figure 7 are implemented. These are adhered to in the final layouts provided and mapped herein.
- A Conservation Management Plan is developed for the ongoing management and conservation of the significant archaeological sites located within the development area
- The attached Chance Fossil Finds procedure must be implemented for the duration of construction activities
- Although all possible care has been taken to identify sites of cultural importance during the investigation of the study area, it is always possible that hidden or subsurface sites could be overlooked during the assessment. If any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils, burials or other categories of heritage resources are found during the proposed development, work must cease in the vicinity of the find and SAHRA must be alerted immediately to determine an appropriate way forward.

9. REFERENCES

Heritage Impact Assessments				
Nid	**Report Type**	**Author/s**	**Date**	**Title**
345	Marion Bamford	18/05/2012	PIA Phase 1	Palaeontological Impact Assessment for Kabi Vaalkop Solar PV Facility
4974	Udo Kusel	02/04/2008	HIA Phase 1	Cultural Heritage Resources Impact Assessment of Portion 523 of the Farm Townlands of Klerksdorp 424 IP Matlosana Local Municipality Southern District Municipality, North West Province
5097	Johnny Van Schalkwyk	07/03/2003	AIA Phase 1	Mercury-Perseus 400 kV Transmission Line, Cultural Heritage Resources
6030	Cobus Dreyer	20/06/2005	AIA Phase 1	Archaeological and Historical Investigation of the Proposed Residential Developments on Subdivision 13 of the Farm Pretoriuskraal 53, Viljoenskroon, Free State
7684	Jaco van der Walt	25/09/2007	AIA Phase 1	Archaeological Impact Assessment. Township Development and Sub Division of AH18, Pretoriuskraal, Orkney, North West Province
7685	Jaco van der Walt	25/09/2007	AIA Phase 1	Archaeological Impact Assessment. Township Development on Sub Division of AH19, Pretoriuskraal, Orkney, North West Province
9124	Francois P Coetzee	01/04/2012	Heritage Study	Cultural Heritage Survey of the Proposed Kabi Vaalkop PV Facility near Orkney, Dr Kenneth Kaunda District, North West Province
118491	Anton Pelser	01/11/2012	HIA Phase 1	Report on a Phase 1 HIA for the Alabama Extension 4 Township Development on the Remaining Extent of Portion 1of Town and Townlands of Klerksdorp 424-IP near KLerksdorp (Matlosana), North West Province
136737	Bruce Rubidge	19/10/2013	PIA Desktop	Palaeontological Scoping Report - Proposed Alabama Township Development
365014	Sidney Miller	02/03/2015	HIA Phase 1	Cultural Heritage Impact Assessment for Shafts #1 to #7, Orkney, Northwest Province, South Africa, for CAPM Gold.
368533	Jaco van der Walt	29/03/2016	Archaeological Specialist Reports	Archaeological Scoping Report for the Proposed Orkney Solar Farm And Associated Infrastructure Orkney, North West Province
368535	Elize Butler	01/12/2015	PIA	Palaeontological Impact Assessment Of The Proposed Orkney Solar Farm And Associated Infrastructure On The Remaining Extent Of Portions 7 And 21 Of The Farm Wolvehuis 114, Near Orkney, North West Province
368543	Udo Kusel	09/06/2016	HIA Phase 1	Phase 1 Cultural Heritage Resources Impact Assessment Phase 1 Cultural Heritage Resources Impact Assessment for the

				proposed town development Alabama Extension 6 and the rezoning of Park Erf 19613, Jouberton Extension 19. The proposed township establishment is situated on a poriton of the Remaining Extent of Portion 1 of the farm Townlands of Klerksdorp No. 424-IP North West Province
375984	Anton Pelser	01/11/2013	HIA Phase 1	Report on a Phase 1 HIA for the proposed Matlosana Estates & Uraniaville Ext 2 developments on various portions of Poriton 1 of the farm Town and Townlands of Klerksdorp 424-IP in Klerksdorp North West Province

CTS HERITAGE

APPENDICES

APPENDIX 1: Archaeological Assessment (2023)

ARCHAEOLOGICAL SPECIALIST STUDY

In terms of Section 38(8) of the NHRA for a

Proposed Paradys Solar PV Facility Cluster and associated Grid Connections near Viljoenskroon, Free State

Prepared by

CTS HERITAGE
Jenna Lavin
And Nicholas Wiltshire

In Association with

Solis Environmental

July 2023

CTS HERITAGE

EXECUTIVE SUMMARY

This report is drafted in support of the proposed development of the Paradys Photovoltaic Solar Energy Cluster and its associated grid connection infrastructure located outside of Viljoenskroon in the Free State.

The survey proceeded with no major constraints and limitations, and the project area was comprehensively surveyed for heritage resources, and a number of significant archaeological material remains were documented. The significant heritage resources identified within the development area relate to the agricultural past and burial grounds and graves. Recommendations are made in Table 1 to ensure that these significant resources are not negatively impacted by the proposed development.

As is expected in this area, significant Iron Age resources were identified on top of the Paradys Koppie. Similar Iron Age sites are known from the nearby Harmony Gold Mining area. In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

Ongoing management of the significant Iron Age resources, human remains and burials is required for the life of the PV facility. Additional recommendations are made in this regard below.

Recommendations

Based on the outcomes of this report, it is not anticipated that the proposed development of the solar energy facility and its associated grid connection infrastructure will negatively impact on significant archaeological heritage on condition that:

- The mitigation measures detailed in Table 1 and mapped in Figures 6.1, 6.2 and 6.3 are implemented
- A Conservation Management Plan is developed for the ongoing management and conservation of the burials and significant archaeological sites located within the development area
- Although all possible care has been taken to identify sites of cultural importance during the investigation of the study area, it is always possible that hidden or subsurface sites could be overlooked during the assessment. If any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils, burials or other categories of heritage resources are found during the proposed development, work must cease in the vicinity of the find and SAHRA must be alerted immediately to determine an appropriate way forward.

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CONTENTS

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1. INTRODUCTION

1.1 Background Information on Project

This report is drafted in support of the proposed development of the Paradys Photovoltaic Solar Energy Cluster and its associated grid connection infrastructure located outside of Viljoenskroon in the Free State. The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e., semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current). The key components of the proposed project are described below:

- PV Panel Array - To produce up to 130MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a optimum angle in order to capture the most sun.
- Wiring to Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the proposed power line. It is expected that generation from the facility will connect to the national grid. Corridor will cover options to connect to Mercury Substation, Existing Eskom lines with capacity and Eskom Switching stations of other Mulilo projects currently under development.
- Electrical reticulation network – An internal electrical reticulation network will be required and will be lain 2-4m underground as far as practically possible.
- Supporting Infrastructure – The following auxiliary buildings with basic services including water and electricity will be required on site:
    - Operations & Maintenance Building / Office
    - Switch gear and relay room
    - Staff lockers and changing room
    - Security control
    - Offices
- Battery storage – Battery Storage Facilities with a maximum height of 5m and a capacity of 2500MWh will be installed in a 6-hectare area.
- Roads - Access is most likely to be obtained via R502 Regional Road. This will be confirmed in the Traffic Impact Assessment which has been commissioned. An internal site road network will also be required to provide access to the solar field and associated infrastructure.
- Fencing - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height between 4 meters will be used.

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1.2 Description of Property and Affected Environment

The Paradys PV Cluster lies just over 15km north of Viljoenskroon on the Free State Province side of the Vaal River. Orkney, which lies on the northern bank of the Vaal River and in the North West Province, is roughly 25km northwest of the study area and is accessed from the R76 tarred road before breaking off onto one of several gravel farm roads that service the various maize and cattle farms in the area.

The area is well-known for its intensive maize and cattle production. Grain silos storing maize for the export market dot the horizon and the roads were full of grain trucks hauling the latest harvest at the time of the survey. A number of mines are located near the development such as the Moab Khotsong gold mine immediately adjacent to the western end of the grid connection near the Mercury substation and these mines are collectively served by several very large overhead powerlines (mainly 400kV) that run along the Vaal Reefs goldfields.

Some eco-tourism farms and hunting lodges have also cropped up over the last 30 years in the area, particularly along the Vaal River. Areas that have not been cultivated are either on the slightly elevated ground formed by the ridge at Paradys where the soil is too shallow to plant maize, or in the wetlands that form near the Vaal floodplain and the Renosterrivier tributary that adjoins the Vaal River. These areas have instead been used extensively for the grazing of cattle and sheep.

The farm werfs typically have an older, late 19th century component in the form of stone walled kraals and very basic structures, and formalised development of the farms appears to have gathered speed in the 20th century along with the mining industry. Werfs in the area normally have several modern buildings and heavily altered buildings due to the strong commercial businesses that have expanded in the area. A few abandoned werfs and ruined farmworkers cottages are also becoming more common on the landscape as large farming corporates buy out the arable land due to the increasing tendency to scale up the agribusinesses.

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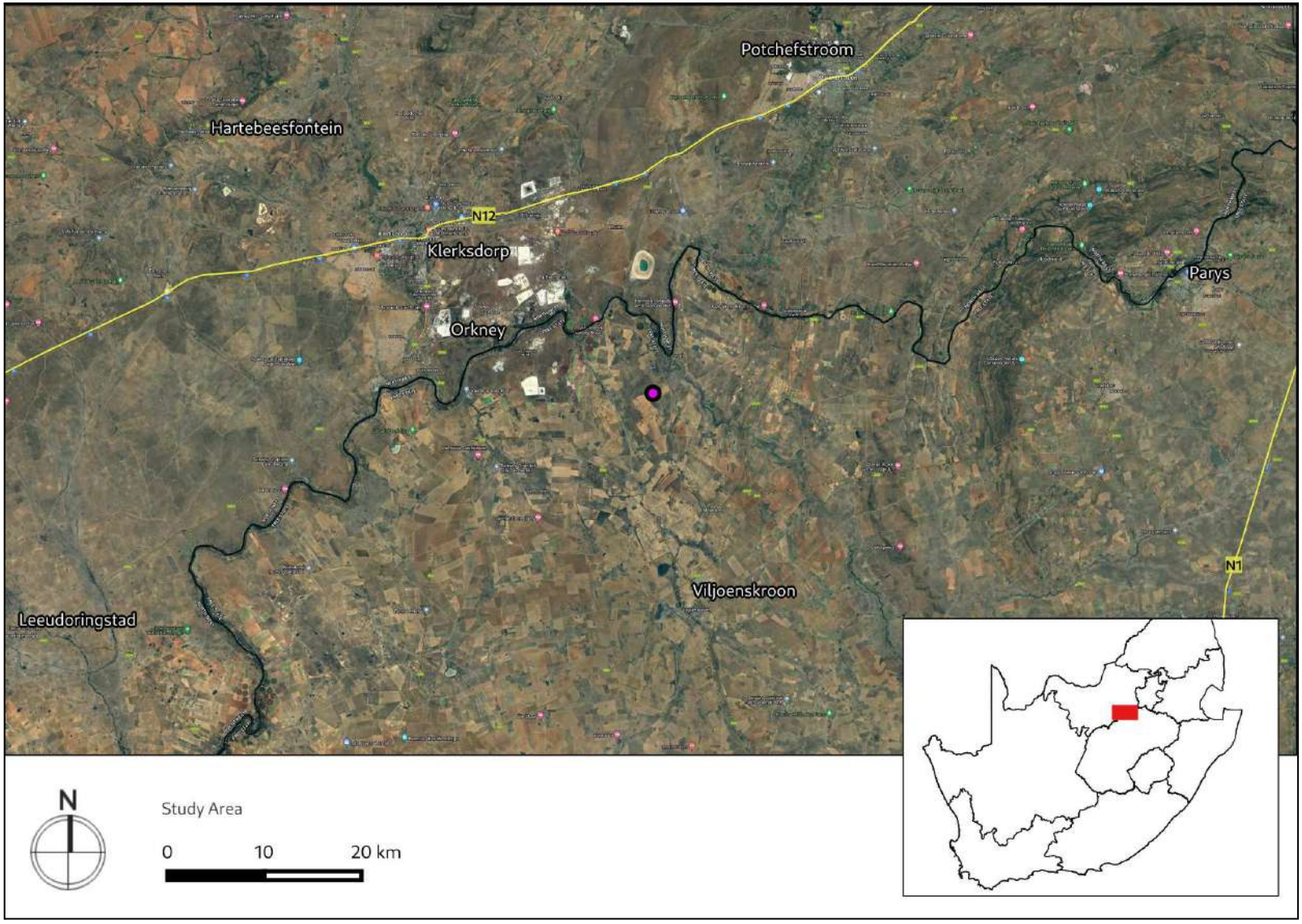

Figure 1.1: Satellite image indicating proposed location of development

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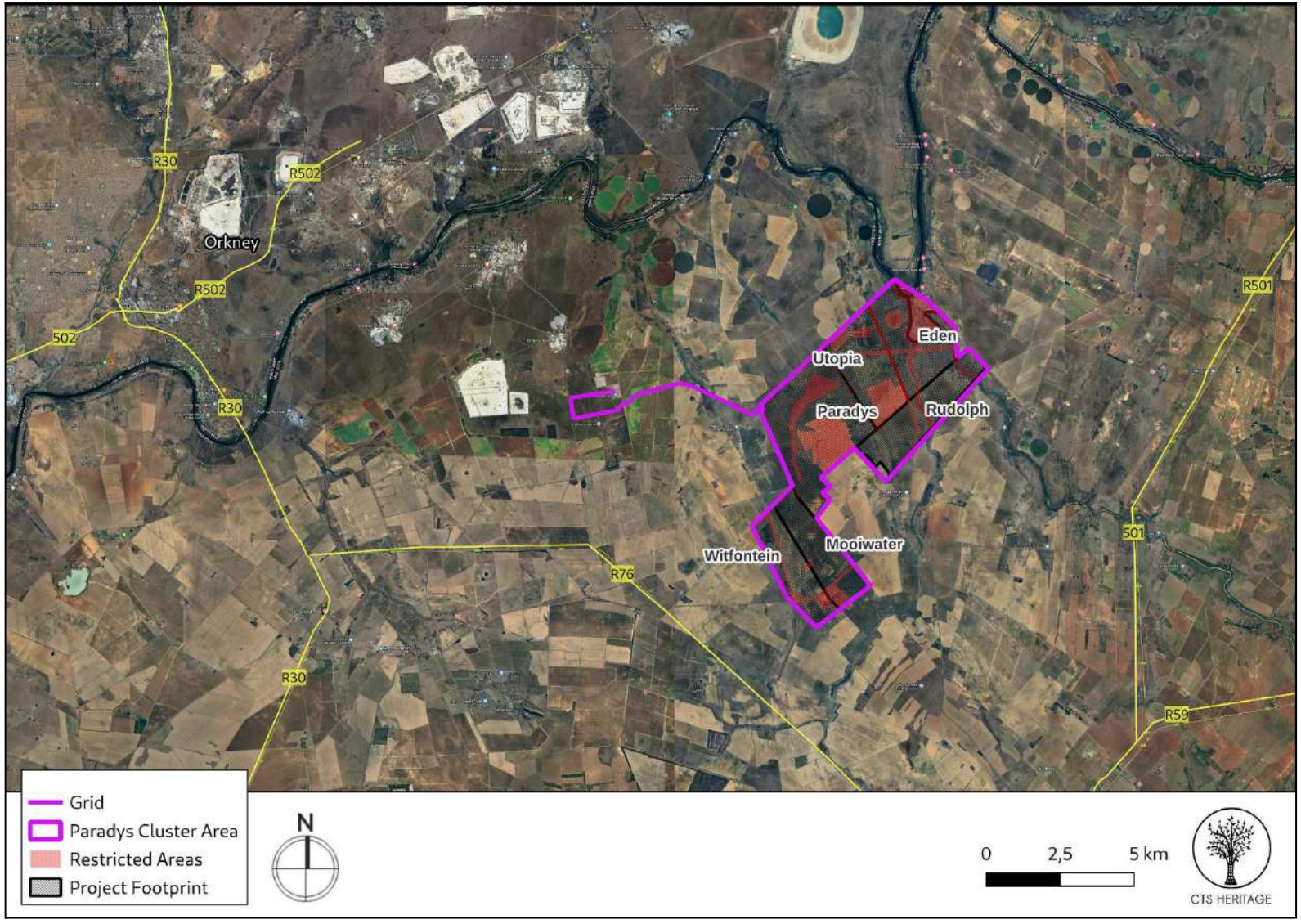

Figure 1.2: Proposed project boundary

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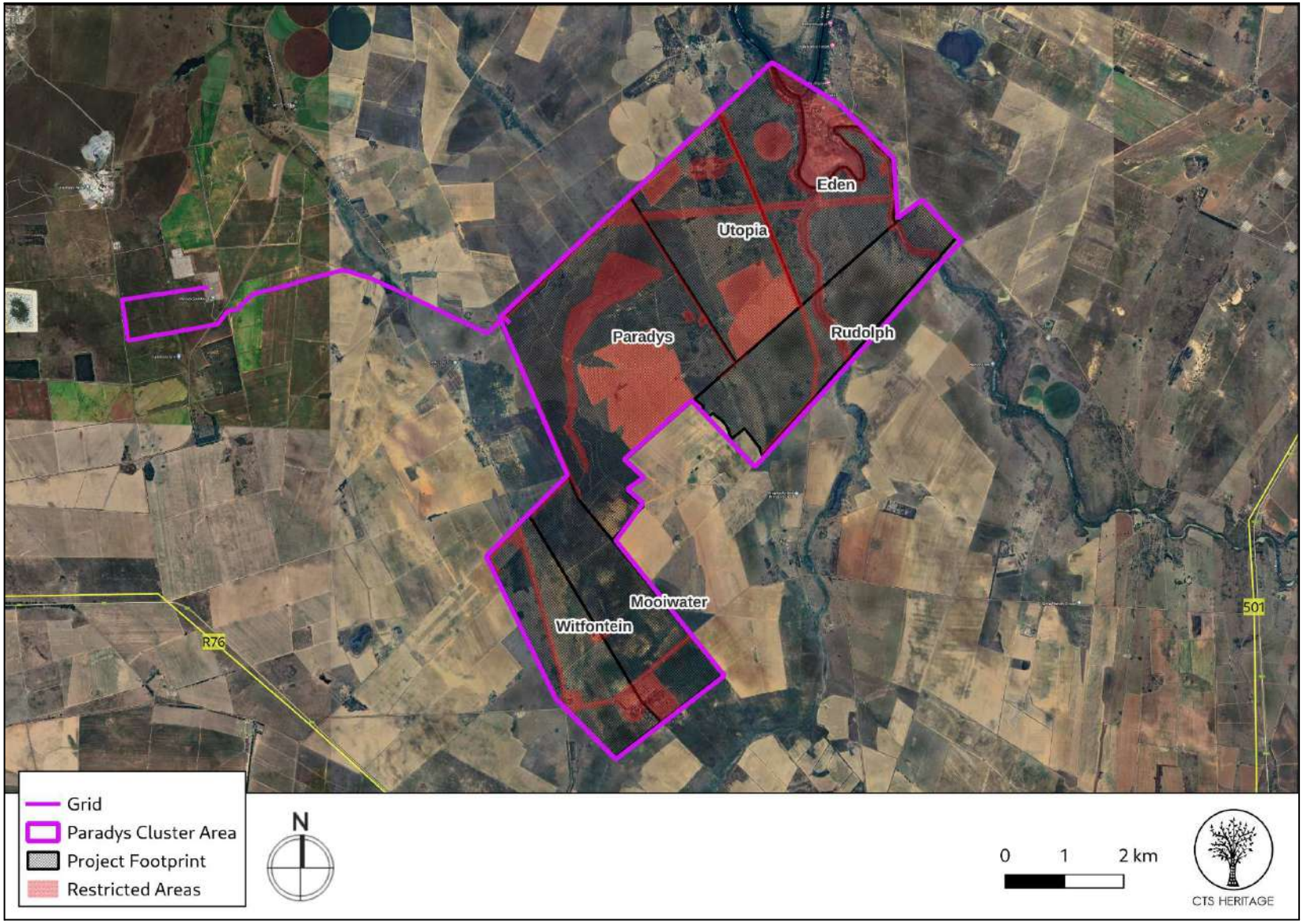

Figure 1.3. Overview Map. Satellite image (2023) indicating the proposed development area at closer range.

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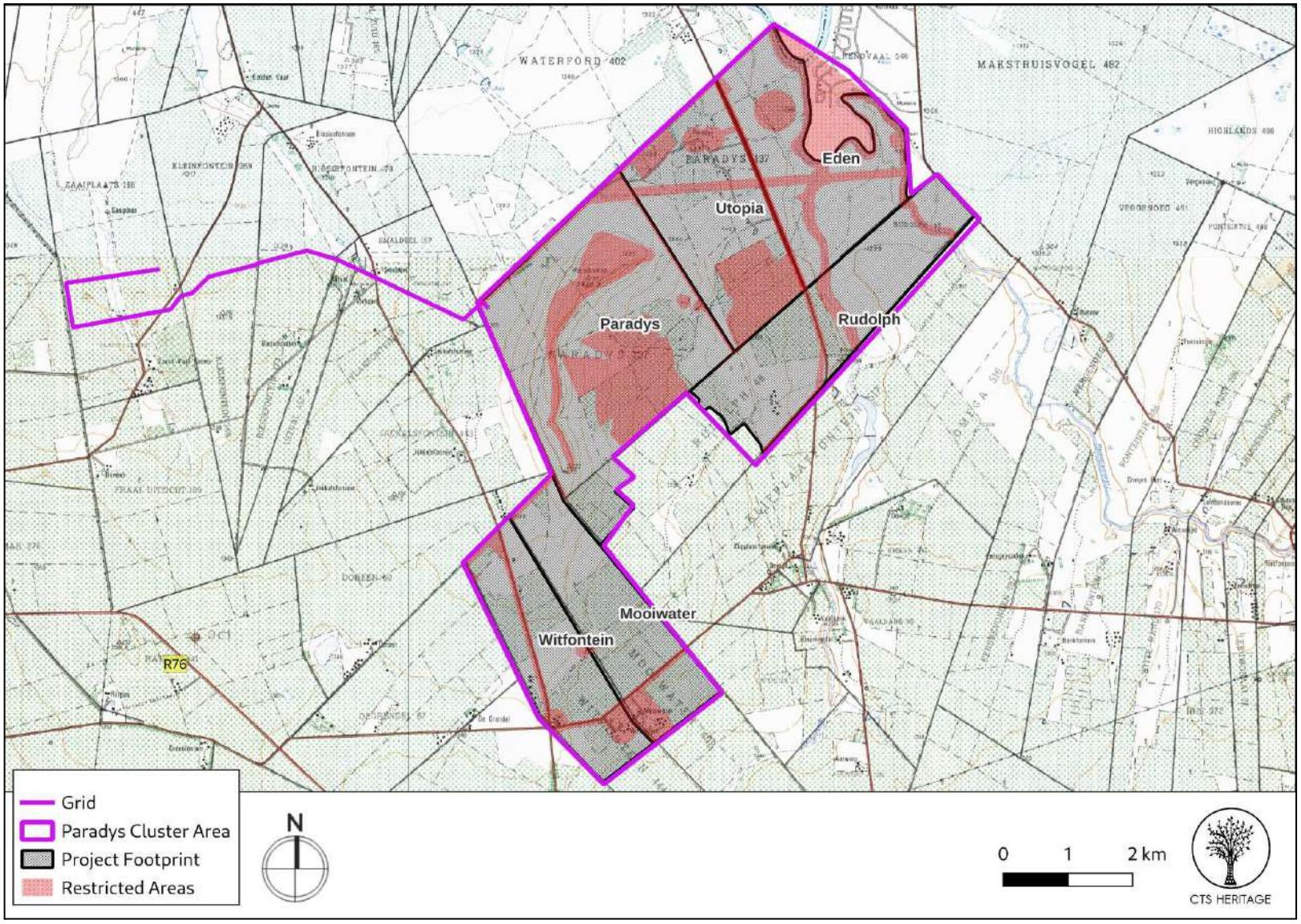

Figure 1.4. Overview Map. Extract from the 1:50 000 Topo Map for this area

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2. METHODOLOGY

2.1 Purpose of Archaeological Study

The purpose of this archaeological study is to satisfy the requirements of section 38(8), and therefore section 38(3) of the National Heritage Resources Act (Act 25 of 1999) in terms of impacts to archaeological resources.

2.2 Summary of steps followed

- An archaeologist conducted a survey of the site and its environs on 3 - 7 July 2023 to determine what archaeological resources are likely to be impacted by the proposed development.
- The area proposed for development was assessed on foot, photographs of the context and finds were taken, and tracks were recorded using a GPS.
- The identified resources were assessed to evaluate their heritage significance in terms of the grading system outlined in section 3 of the NHRA (Act 25 of 1999).
- Alternatives and mitigation options were discussed with the Environmental Assessment Practitioner.

2.3 Constraints & Limitations

The development covers a large area and many of the fields that lie in between the planned PV laydown areas were in the final days of the maize harvest during the survey. Visibility on the curved ridgeline at Paradys improved somewhat and Iron Age kraals and Later Stone Age tools could be found with relative ease in these areas despite the high stands of grass cover. Lower down the dormant patches of veld become entirely overgrown and visibility was reduced to the jeep tracks and exposed rocky ground where cattle had not reduced the cover sufficiently.

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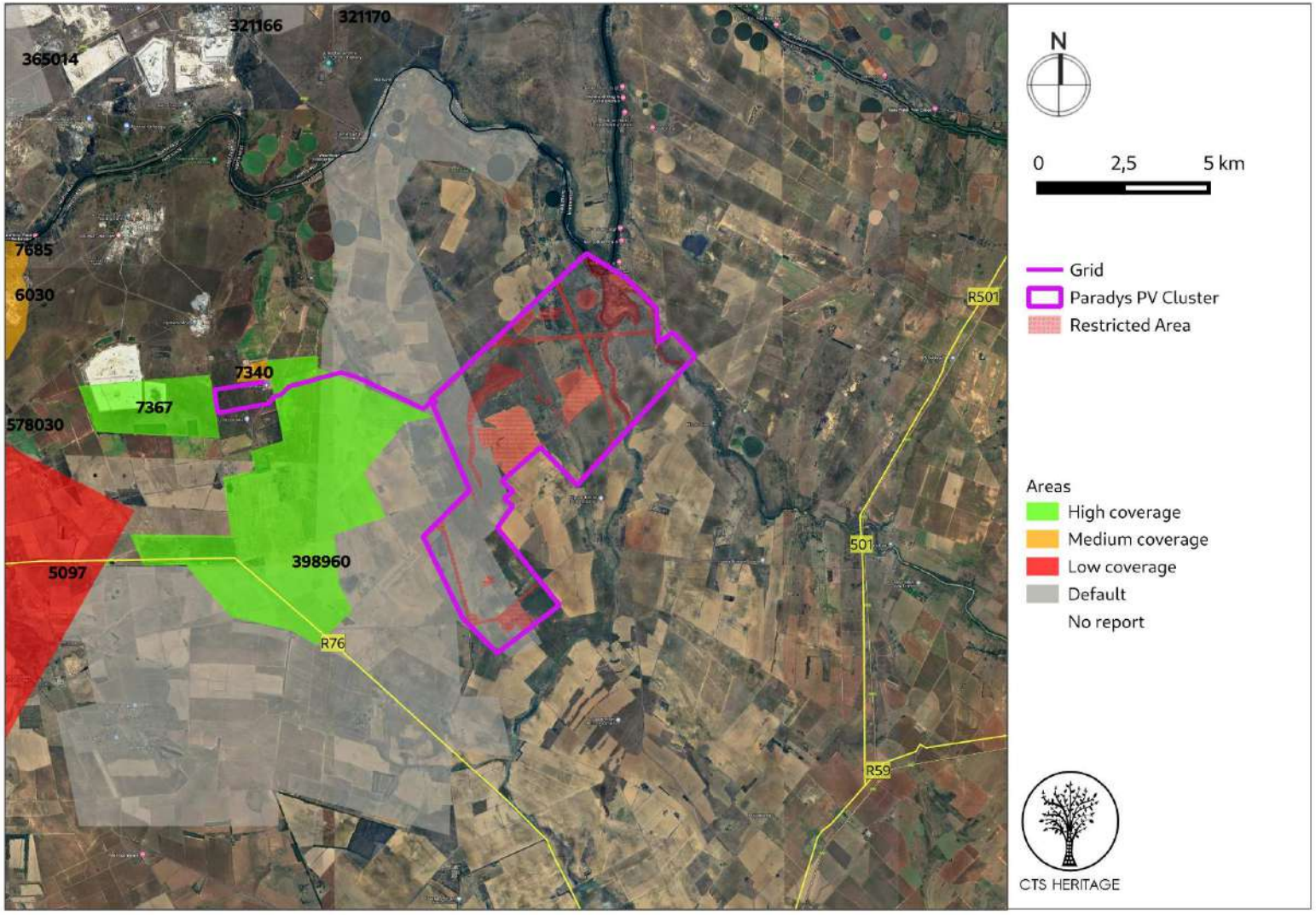

Figure 2: Close up satellite image indicating proposed location of development in relation to heritage studies previously conducted

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3. HISTORY AND EVOLUTION OF THE SITE AND CONTEXT

Background

This application is for the proposed development of a 6x PV facilities and their respective grid connections located outside of Orkney along the R76 regional route connecting Orkney to Viljoenskroon. This regional route runs approximately 3km south of the development area.

Built Environment & Cultural Landscapes

The development areas are located in peri-urban farms just outside the towns of Orkney (North West) and Viljoenskroon (Free State). The town of Orkney was established in 1940 at the junction of the various railway lines. It was name after the old gold mine opened by Thomas Leask, who came from the Orkney Islands, in 1880 (SESA 1973 in Van Schalkwyk 2021). Viljoenskroon is a maize and cattle farming town located in the Free State province of South Africa. It was named after the original farm owner J. J. Viljoen and his horse Kroon. The town was laid out in 1921 on the farm "Mahemskuil" and became a municipality in 1925. A number of large gold and diamond mines are also located inbetween the three solar PV sites, namely Taulekoa Mine next to Goedgenoeg 433, Kopanong Gold Mine next to Pretorius Kraal 53 and Great Noligwa Mine next to Groot Vaders Bosch 592. Ruins of or intact avenues of trees, historical farmsteads and farm labourer's cottages may potentially be found within the proposed development areas. The cultural landscape is characterised by a agriculture with abrupt transitions into extremely heavy industrial areas in and around the mining compounds.

Archaeology

Archaeological sites spanning the Earlier, Middle and Later Stone Age have been found in the region despite the extensive agricultural transformation of the area. In Dreyer (2005) and Van der Walt's (2007) heritage impact assessments of Pretorius Kraal 53 located in Orkney, various modern buildings were recorded that are located near the banks of the Vaal River that were deemed as not conservation worthy. Van der Walt identified some Middle to Later Stone Age artefacts scattered across the farm but did not map them. In Van Schalkwyk's (2021) impact assessment of the Siyanda Solar farm on Grootdraai 468 (which lies on the western border of Pretorius Kraal 53 in Orkney) is of relevant here due to the proximity of the study to this assessment area (SAHRIS ID 578029). Van Schalkwyk (2021) noted that visibility issues were a major problem, *"Due to the very dense vegetation cover that occur in the project area, natural as well as agricultural fields, it was impossible to obtain any ground visibility. The strategy was therefore to examine natural and man-made features that are usually associated with human habitation and activities such as clumps of trees and rock outcrops. The proposed power line corridor connecting the Solar Power Plant to the the existing Vaal Reef Substation was not surveyed as access to the relevant properties (Pretoriuskraal 53) was not possible. It is proposed that once the power line route has been confirmed within the 100m corridor a heritage walk-though needs to be undertaken."* Two burial sites were recorded during this survey despite the lack of Stone Age sites with the help of a local informant who had been working on the property for a number of years.

In his assessment, Huffman (2005, SAHRIS ID 7367) identified no sites of archaeological interest. In their assessment conducted in close proximity to this proposed development, Henderson and Koortzen (2007, SAHRIS ID 7340) noted that while no sites were found in the area surveyed, a number of previously excavated inspection pits yielded archaeological

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material in the form of stone artefacts. Henderson and Koortzen (2007, SAHRIS ID 7340) note that “These artefacts had been brought up from an unknown depth (probably no more than a metre or two), and were mostly undiagnostic flakes with one blade-like flake which could be Middle Stone Age. Raw material included cryptocrystalline, chert and quartz.” Van der Walt (2016) conducted an archaeological field assessment for the Orkney PV Facility which will connect to this grid connection (2016, SAHRIS ID 385181). He made no archaeological observations but did identify two cemeteries. It is therefore highly likely that further burials may be located on the proposed solar PV areas as well as Stone Age material similar to the artefacts recorded but not mapped by Van der Walt. An archaeological field survey is therefore recommended.

In 2022, CTS Heritage completed an HIA for an adjacent PV project known as the Mercury PV Cluster. The archaeology assessment found a single archaeological site and very few isolated individual artefacts were documented. Cumulatively these findings indicate cultural evidence for MSA and LSA occupations of the area. The majority of finds were identified in disturbed surface contexts, and could not be tied chrono-culturally to a particular prehistoric period, however one site was relatively less affected by post-depositional processes, and may have been exposed relatively recently. One isolated historic burial and an historic burial ground were identified within the vicinity of the Zaaiplaats farm werf. These resources have high levels of social and intrinsic cultural value and are graded IIIA. The presence of these burials highlights the possibility of further hidden or unmarked burials located throughout the development area.

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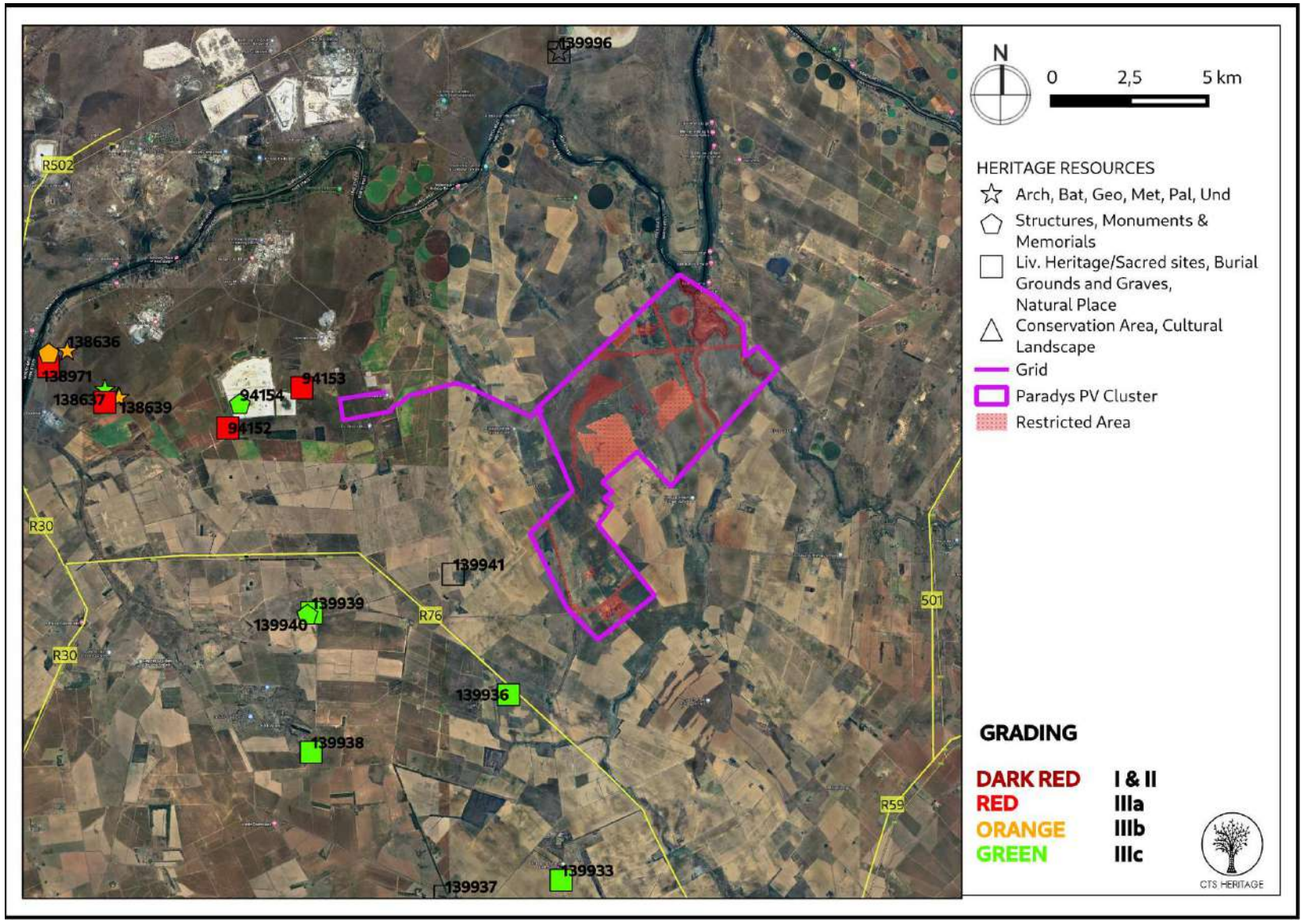

Figure 3.1 Heritage Resources Map. Heritage Resources previously identified in and near the study area, with SAHRIS Site IDs indicated

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4. IDENTIFICATION OF HERITAGE RESOURCES

4.1 Field Assessment

Nearly 50 observations were made during the survey that consisted mainly of buildings and graves at the various werfs included in the study area. At Paradys, the older, likely original settlement footprint was obscured by dense bush and a number of informal 20th century graveyards are located here. Iron Age stone walled kraals and Later Stone Age artefacts in hornfels, chert and quartz were found on and close to the ridge which arcs from the northeast around to the southwest. The kraal enclosures appear to be late, possibly 19th century and historical walling features are also present. Most of the ruins recorded on the various farms (eg Witfontein, Smaldeel, De Grendel, Deborah) were built from the 1940s onwards and typically consist of a row of staff cottages that have since been abandoned as the farms have changed hands and ownership has become more and more aggregated amongst the larger corporate agribusinesses.

In areas bordering the maize fields, isolated and disturbed finds of MSA material was also found and it is more than likely that these continued in the cultivated areas. Early MSA and Early Stone Age material is also buried beneath the topsoil but the proposed development is unlikely to require very deep excavations that will reveal material at these depths.

Figure 4.1: View of the existing OHL.

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Figure 4.2: Stands of eucalyptus trees and bush near the ruins at Paradys.

Figure 4.3: Large OHLs passing through Paradys.

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Figure 4.4: View east of the Paradyskop ridge where cattle have grazed the grass down near the graveyard.

Figure 4.5: View from northwest end of Paradys farm.

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Figure 4.6: Rocky ground on the ridgeline near the kraal enclosures.

Figure 4.7: View from Paradyskop looking northeast.

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Figure 4.8: View looking south from Paradyskop on the rocky ridgeline.

Figure 4.9: View looking southeast across the study site.

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Figure 4.10: Extensive grass covering much of the study site at Mooiwater.

Figure 4.11: Bush and veld cover nearer to the Vaal River (northeast end of study site).

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Figure 4.12: View of the large OHLs near the Renosterrivier.

Figure 4.13: Extensive grasscover and gum trees along the western end of the study area.

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Figure 4.14: View of the soy and maize fields at Rudolph farm. Paradyskop ridgeline in the distance.

Figure 4.15: View of the study site near the slopes of the Paradyskop ridge.

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Figure 4.16: View of the grassland typically encountered during the survey.

Figure 4.17: View over the Kleinfontein farm linking the grid line to the study area.

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Figure 4.18: View looking south from Mercury substation near the grid termination point.

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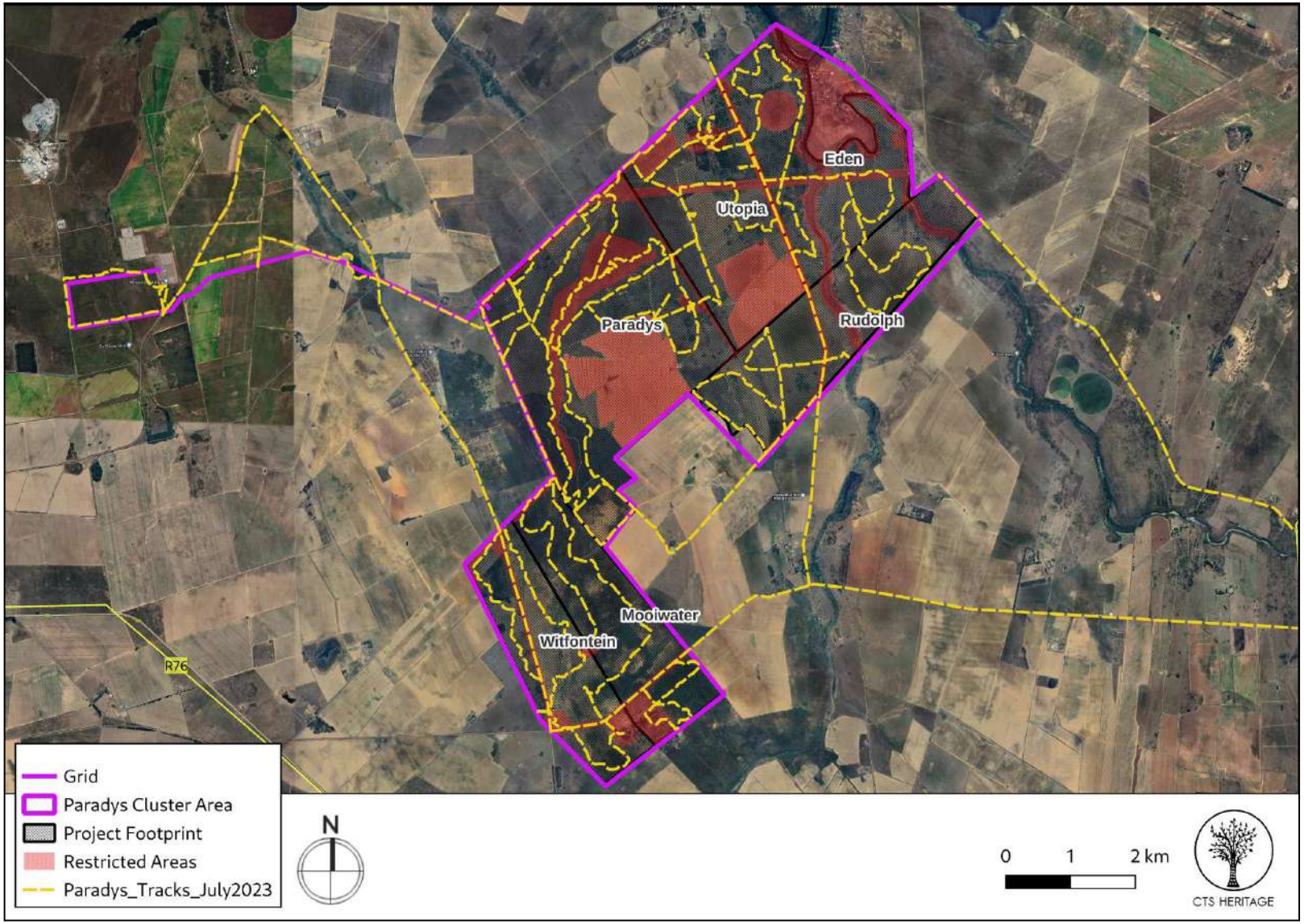

Figure 5.1: Overall track paths of foot survey for development

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4.2 Archaeological Resources identified

Table 1: Heritage Resources identified

Obs#	Description	Type	Period	Density	Latitude	Longitude	Grade	Mitigation
001	Paradys homestead, modern	Structure	Modern	n/a	-26.983772	26.905801	NCW	NA
002	Ruin, Paradys, early 20th century	Ruin	Modern, Historic	n/a	-26.981158	26.905434	NCW	NA
003	Ruined kraal, modern concrete floor	Ruin	Modern	n/a	-26.982269	26.904913	NCW	NA
004	Paradys ruins, completely demolished	Ruin	Modern, Historic	n/a	-26.988064	26.909721	NCW	NA
004	Paradys ruins, completely demolished	Ruin	Modern, Historic	n/a	-26.987939	26.910849	NCW	NA
005	Paradys original werf, extensive stone walling, vernacular ruin	Ruin	Historic	n/a	-26.98545	26.907134	IIIC	50m buffer
006	2 graves early 20th century	Graves/BurialGrounds	Historic	n/a	-26.984655	26.905413	IIIA	100m Buffer
007	Quartzite core	Artefacts	MSA	0 to 5	-26.984699	26.905236	NCW	NA
008	Smith, deceased 1918 and possibly 3 other graves next to jeep track	Graves/BurialGrounds	Historic	n/a	-26.985274	26.904884	IIIA	100m Buffer
009	Older stone building	Structure	Historic	n/a	-26.984779	26.903013	IIIC	50m Buffer
010	Large graveyard, at least 50 graves, 20th c. Many died in the 1970s	Graves/ Burial Grounds	Historic, Modern	n/a	-26.994494	26.902444	IIIA	100m Buffer
011	Stone circular kraal, Historical or Late Iron Age	Structure	LIA, Historic	n/a	-27.001716	26.890185	IIIA	100m Buffer
012	More stone walling, linear	Structure	LIA, Historic	n/a	-27.00212	26.889961	IIIA	100m Buffer
013	Large circular stone kraal, with secondary walled entrance	Structure	LIA, Historic	n/a	-27.002567	26.88903	IIIA	100m Buffer
014	More stone walling enclosures	Structure	LIA, Historic	n/a	-27.001857	26.888933	IIIA	100m Buffer
015	Rectangular stone kraal, part of larger site on hill	Structure	Historic	n/a	-27.004078	26.888923	IIIA	100m Buffer
016	LSA microliths in jeep track near Paradys Kop. Ccs, quartz, hornfels	Artefacts	LSA	5 to 10	-27.003587	26.886108	NCW	NA
017	Chert point	Artefacts	LSA	0 to 5	-27.00899	26.882004	NCW	NA
018	Quartz flake, hornfels point	Artefacts	LSA	0 to 5	-27.007768	26.90159	NCW	NA
019	Hornfels microlith	Artefacts	LSA	0 to 5	-27.005043	26.875466	NCW	NA
020	Hornfels flake	Artefacts	MSA	0 to 5	-27.020788	26.882317	NCW	NA
021	Hornfels core	Artefacts	LSA	0 to 5	-27.032983	26.886308	NCW	NA
022	Hornfels flake and quartzite point	Artefacts	LSA	0 to 5	-26.996707	26.913889	NCW	NA
023	Quartz flake	Artefacts	LSA	0 to 5	-27.034298	26.882483	NCW	NA
024	Kraal,windmill, brick dam near clump of gum trees	Structure	Modern	n/a	-27.004055	26.874023	NCW	NA
025	Brick dam and ruined service building	Structure, Ruin	Modern	n/a	-26.991986	26.887815	NCW	NA
026	Quartzite core	Artefacts	MSA	0 to 5	-26.989371	26.921032	NCW	NA
027	Quartzite flake	Artefacts	MSA	0 to 5	-26.975109	26.912173	NCW	NA

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028	Row of 8 ruined staff cottages	Ruin	Historic, Modern	n/a	-26.993484	26.94589	NCW	NA
029	Small farm church with corrugated iron roof	Structure	Historic	n/a	-27.03518	26.920948	IIIA	100m Buffer
030	Modern staff cottage	Structure	Modern	n/a	-27.021208	26.915433	NCW	NA
031	Stone walling, large kraal circa 1900-1930	Structure	Historic	n/a	-27.014385	26.926844	IIIC	50m Buffer
032	Rudolph werf, mostly modern buildings	Structure	Modern	n/a	-27.040224	26.899238	NCW	NA
032	Rudolph werf, mostly modern buildings	Structure	Modern	n/a	-27.038428	26.897606	NCW	NA
033	Mooiwater werf, modern	Structure	Modern	n/a	-27.06362	26.893668	NCW	NA
034	Staff cottages, some ruined	Structure, Ruin	Modern, Historic	n/a	-27.065146	26.897056	NCW	NA
035	Graves, born 1908, Johannes W? G? NG, completely overgrown, hard to tell how many are here	Graves/ Burial Grounds	Historic	n/a	-27.065817	26.899601	IIIA	100m Buffer
036	Witfontein farm, mostly modern buildings	Structure	Modern, Historic	n/a	-27.066715	26.890832	NCW	NA
037	Witfontein "Winkel", ruined shopping, general dealer buildings	Ruin	Historic	n/a	-27.065091	26.880933	NCW	NA
038	Quartz flakes exposed by jeep track	Artefacts	LSA	0 to 5	-27.059935	26.880804	NCW	NA
039	Quarry		Modern	n/a	-27.055118	26.885564	NCW	NA
040	Rectangular stone kraal with entrance feature, historical	Structure	Historic	n/a	-27.053338	26.882659	IIIC	50m Buffer
041	More kraal features	Structure	Historic	n/a	-27.051986	26.882445	IIIC	50m Buffer
042	De Grendel ruins mid 1950s, staff cottages, possible graves. Avoid area - Structures not significant but high possibility of overgrown graves	Ruin	Historic	n/a	-27.063659	26.878373	NCW	NA
043	Deborah ruins	Ruin	Historic	n/a	-27.038632	26.873171	NCW	NA
044	Smaldeel corrugated double storey structure	Structure	Modern	n/a	-27.002745	26.853491	NCW	NA
045	Smaldeel modern werf	Structure	Modern	n/a	-27.001715	26.853083	NCW	NA
046	More kraal features	Structure	Historic	n/a	-26.994738	26.897739	IIIC	50m Buffer
047	More kraal features	Structure	Historic	n/a	-26.996328	26.896836	IIIC	50m Buffer
048	Graves	Graves	Modern	n/a	-27.0608371	26.8767177	IIIA	100m Buffer

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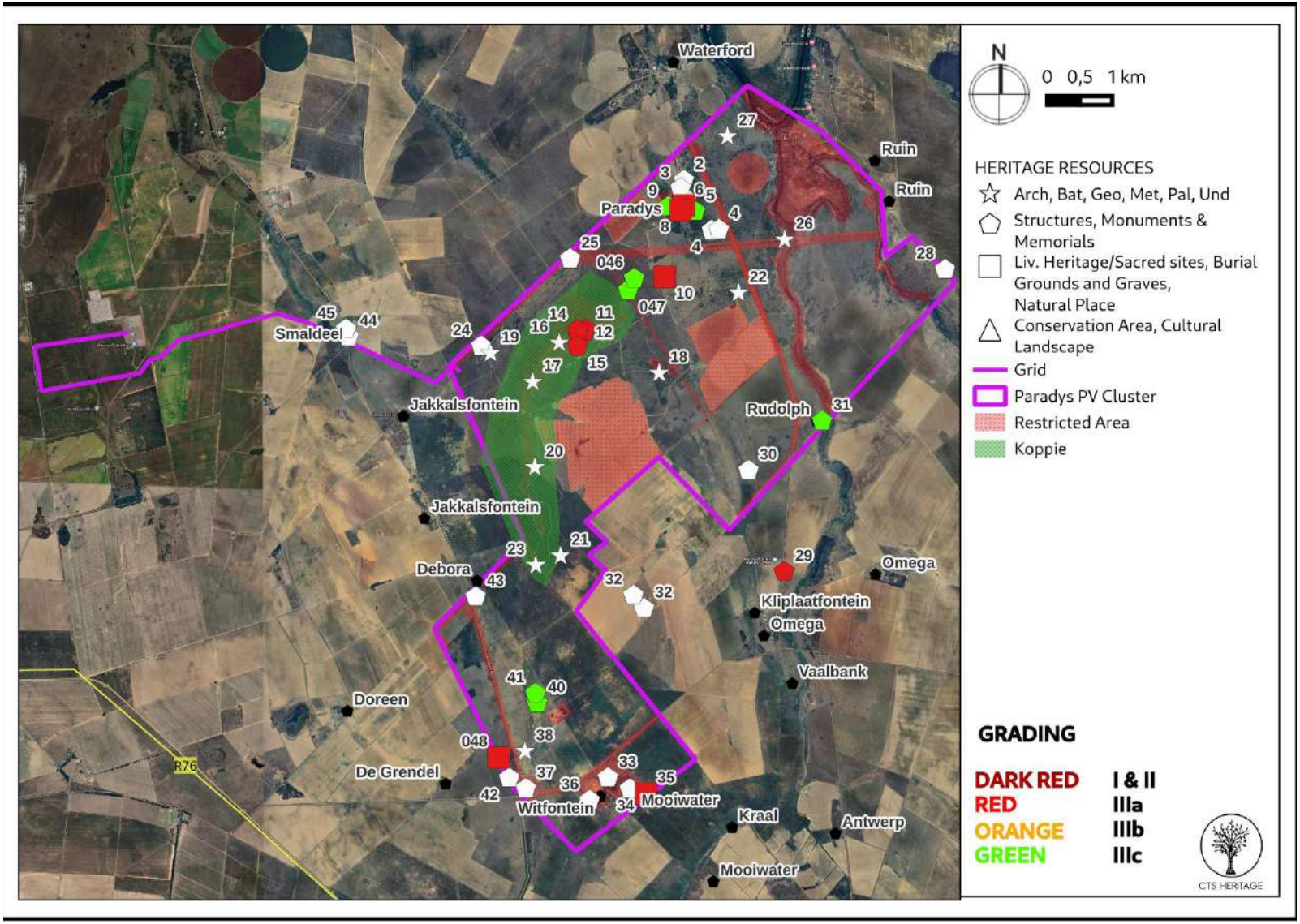

Figure 6.1: Map of all sites and observations noted within the development area

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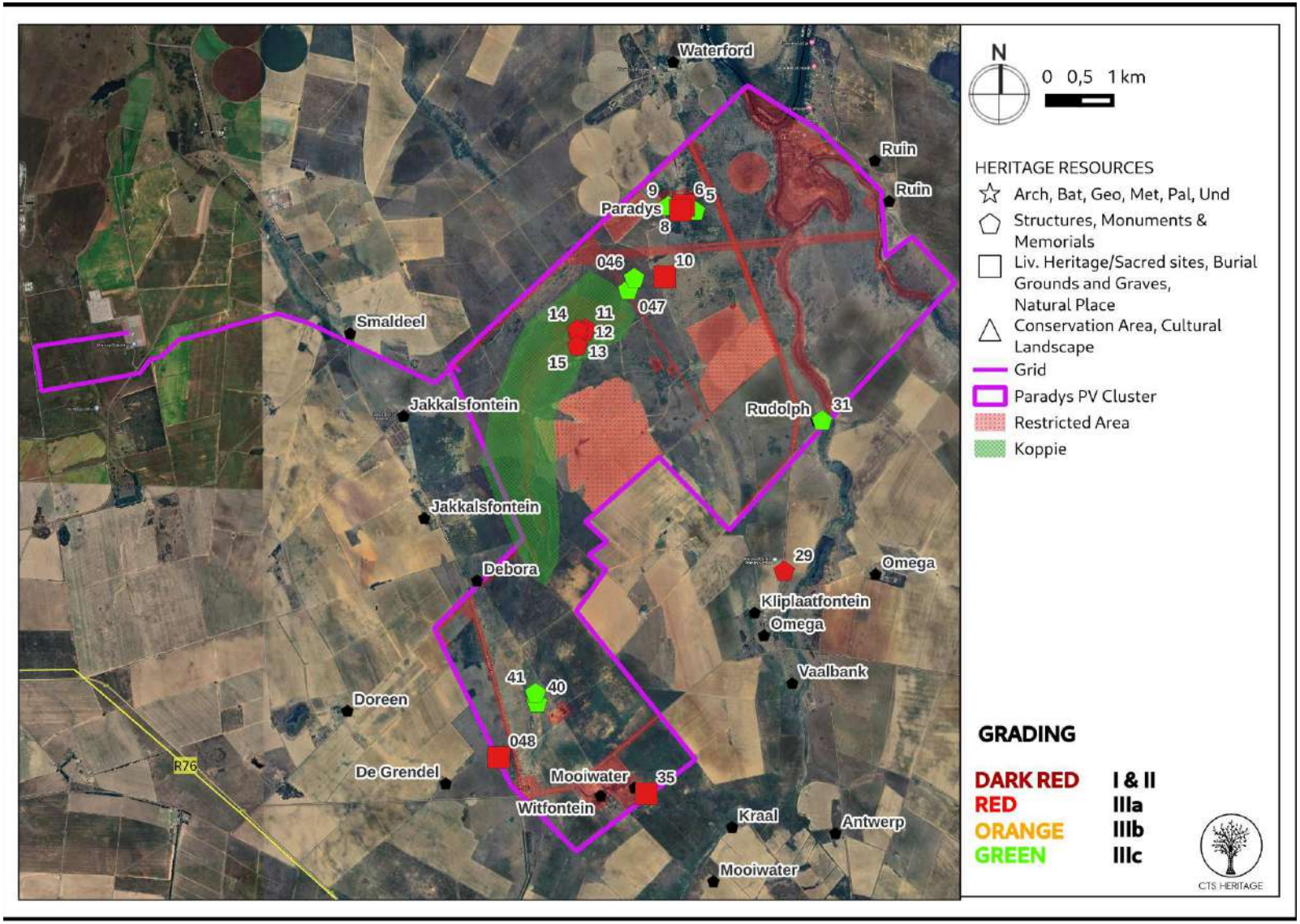

Figure 6.2: Map of all significant sites and observations noted within the development area

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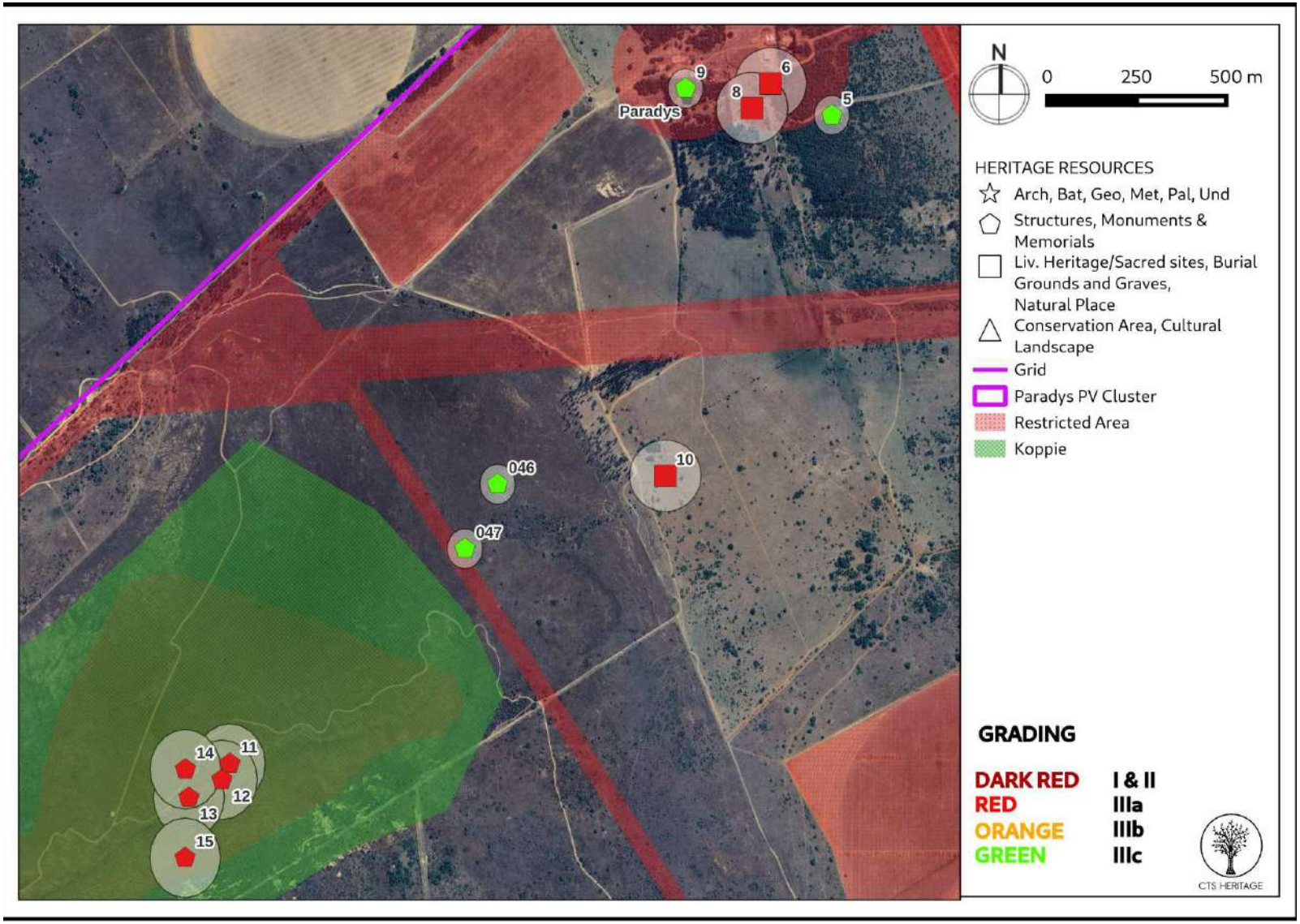

Figure 6.3: Map of all significant sites and observations noted within the development area

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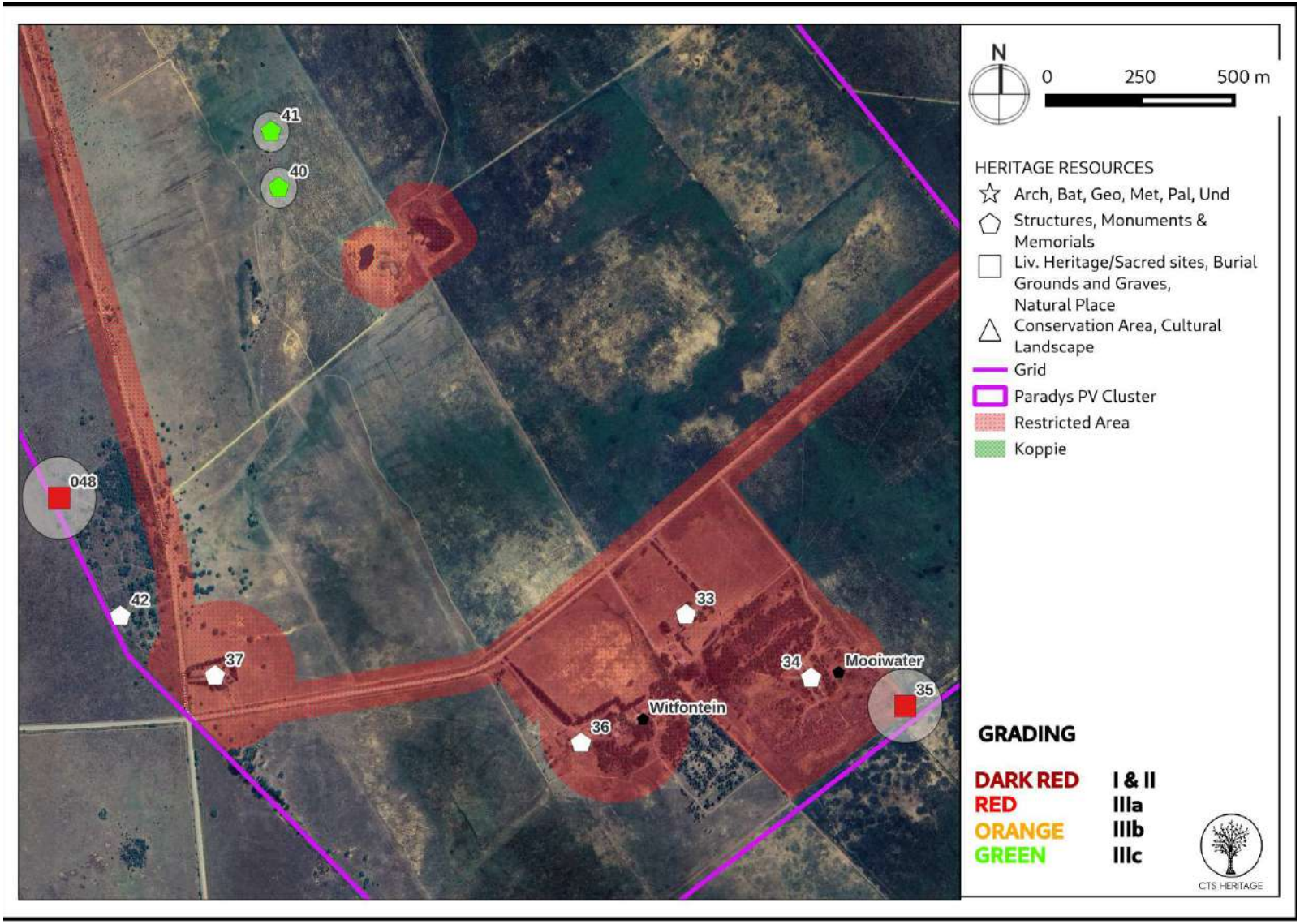

Figure 6.2: Map of all significant sites and observations noted within the development area

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4.3 Selected photographic record

(a full photographic record is available upon request)

Figure 7.1: Observation 005 - Ruin of Paradys Farm Werf

Figure 7.2: Observation 005 - Ruin of Paradys Farm Werf

Figure 7.3: Observation 006 - Graves

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Figure 7.4: Observation 008 - Graves

Figure 7.5: Observation 009 - Older Stone Building

Figure 7.6: Observation 010 - Large graveyard

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Figure 7.7: Observation 011 - Stone walling

Figure 7.8: Observation 012 - Stone walling

Figure 7.9: Observation 013 - Stone walling

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Figure 7.10: Observation 014 - Stone walling

Figure 7.11: Observation 015 - Stone walling

Figure 7.12: Observation 028 and 029 - Staff cottages and Farm Church

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Figure 7.13: Observation 031 - Kraal

Figure 7.14: Observation 035 - Graves

Figure 7.15: Observation 040 - Stone kraal

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Figure 7.16: Observation 041 - Kraal features

Figure 7.17: Observation 042 - Ruins of De Grendel Werf - high likelihood of graves

Figure 7.18: Observation 043 - Debora Ruins

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Figure 7.19: Observation 048 - Graves

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5. ASSESSMENT OF THE IMPACT OF THE DEVELOPMENT

5.1 Assessment of impact to Archaeological Resources

Eden PV and Grid

No significant archaeological resources were identified within the Eden PV footprint or near to its proposed grid corridor. No impact to significant archaeological heritage is anticipated here.

Mooiwater PV and Grid

The Mooiwater Farm Werf is located in the southern section of the PV facility. As with most historic farms, a farm burial area is located nearby to the Mooiwater werf. The Mooiwater Werf and its associated burial ground falls within the restricted area for this PV facility. Due to the high social cultural value associated with human remains, burials are determined to have high levels of local significance and are graded IIIA. It is recommended that, in order to retain some of the sense of place associated with burials and their social value, a 100m no development buffer should be implemented around this site. This no-development buffer is respected in the layout provided.

Paradys PV and Grid

The proposed Paradys PV facility is located all around the Paradys Koppie which presents a landmark feature in this area. Due to its landmark nature, it is not unexpected that people would have been drawn to this location in the past. The archaeological field assessment identified a number of stone-walled structures and kraals located on top of the Paradys Koppie (Sites 11, 12, 13, 14 and 15) which appear to be associated with the Late Iron Age occupation of this area. Similar Iron Age sites are known from the nearby Harmony Gold Mining area.

In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

No significant heritage resources were identified within the Paradys PV grid alignment.

Rudolph PV and Grid

The remains of the Rudolph Farm Werf is located in the southeastern section of the PV facility. Part of the remaining infrastructure associated with this farm was identified in the field assessment as Site 031. This site represents an historic kraal which contributes to the broader agricultural history of the context of the PV development area. This site has therefore been determined to have low levels of local significance and has been graded IIIC. It is recommended that a no-development buffer of 50m is implemented around this site to ensure that it is not damaged by the development of the PV infrastructure. This recommended buffer is largely respected in the layout provided. No significant heritage resources were identified within the Rudplph PV grid alignment.

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Utopia PV and Grid

The Paradys Farm Werf is located in the northern section of the PV facility (Sites 005 and 009). As with most historic farms, farm burial areas are located nearby to the Paradys werf (Sites 006 and 008). The Paradys Werf (Site 009) and its associated burial grounds (Sites 006 and 008) fall within the restricted area for this PV facility. Additional structures associated with the Paradys Werf (Site 005, Site 046 and Site 047) as well as another burial site (Site 010) are located within the PV development footprint.

Sites 005, 009, 046 and 047 represent historic farm infrastructure which contribute to the broader agricultural history of the context of the PV development area. These sites have therefore been determined to have low levels of local significance and have been graded IIIC. It is recommended that a no-development buffer of 50m is implemented around these sites to ensure that they are not damaged by the development of the PV infrastructure. This recommended buffer is not reflected in the layout provided for Site 005.

Due to the high social cultural value associated with human remains, burials (Sites 006, 008 and 010) are determined to have high levels of local significance and are graded IIIA. It is recommended that, in order to retain some of the sense of place associated with burials and their social value, a 100m no development buffer should be implemented around these sites. This recommended buffer is not reflected in the layout provided for Site 010.

No significant heritage resources were identified within the Witfontein PV grid alignment.

Witfontein PV and Grid

The field assessment identified two historic stone kraals located within the PV footprint for the Witfontein PV facility. These sites (Site 40 and 41). These sites represent historic kraals which contribute to the broader agricultural history of the context of the PV development area. These sites have therefore been determined to have low levels of local significance and have been graded IIIC. It is recommended that a no-development buffer of 50m is implemented around these sites to ensure that they are not damaged by the development of the PV infrastructure. This recommended buffer is not reflected in the layout provided.

The ruins of the De Grendel farm werf (Site 042) are located on the west edge of the Witfontein PV area. While the ruins themselves have very limited cultural value, the area around the ruins have a high likelihood for unmarked burials. Additionally, a burial site (Site 048) was identified some 300m from the werf ruins. The likelihood for impacts to burials remains high here and as such, an additional area of sensitivity has been identified which should be excluded from any development of PV infrastructure.

No significant heritage resources were identified within the Witfontein PV grid alignment.

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6. CONCLUSION AND RECOMMENDATIONS

The survey proceeded with no major constraints and limitations, and the project area was comprehensively surveyed for heritage resources. A number of significant archaeological material remains were documented. The significant heritage resources identified within the development area relate to the agricultural past and burial grounds and graves, as well as the Iron Age occupation of the broader area. Recommendations are made in Table 1 to ensure that these significant resources are not negatively impacted by the proposed development.

As is expected in this area, significant Iron Age resources were identified on top of the Paradys Koppie. Similar Iron Age sites are known from the nearby Harmony Gold Mining area. In general, sites such as these provide a significant amount of scientific information about the past when subject to appropriate analysis and as such, these sites have been determined to have high levels of scientific significance, and are graded IIIA. It is recommended that each of these identified sites have a no-development buffer area of 100m implemented around them. In addition, it is recommended that the entirety of Paradys Koppie be considered as a sensitive archaeological resource. Much of the higher elevations of the koppie, including the identified sites, fall within the existing restricted area for Paradys PV.

Ongoing management of the significant Iron Age resources, human remains and burials is required for the life of the PV facility. Additional recommendations are made in this regard below.

Recommendations

Based on the outcomes of this report, it is not anticipated that the proposed development of the solar energy facility and its associated grid connection infrastructure will negatively impact on significant archaeological heritage on condition that:

- The mitigation measures detailed in Table 1 and mapped in Figures 6.1, 6.2 and 6.3 are implemented
- A Conservation Management Plan is developed for the ongoing management and conservation of the burials and significant archaeological sites located within the development area
- Although all possible care has been taken to identify sites of cultural importance during the investigation of the study area, it is always possible that hidden or subsurface sites could be overlooked during the assessment. If any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils, burials or other categories of heritage resources are found during the proposed development, work must cease in the vicinity of the find and SAHRA must be alerted immediately to determine an appropriate way forward.

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7. REFERENCES

Heritage Impact Assessments				
Nid	**Report Type**	**Author/s**	**Date**	**Title**
4974	Udo Kusel	02/04/2008	HIA Phase 1	Cultural Heritage Resources Impact Assessment of Portion 523 of the Farm Townlands of Klerksdorp 424 IP Matlosana Local Municipality Southern District Municipality, North West Province
5097	Johnny Van Schalkwyk	07/03/2003	AIA Phase 1	Mercury-Perseus 400 kV Transmission Line, Cultural Heritage Resources
6030	Cobus Dreyer	20/06/2005	AIA Phase 1	Archaeological and Historical Investigation of the Proposed Residential Developments on Subdivision 13 of the Farm Pretoriuskraal 53, Viljoenskroon, Free State
7684	Jaco van der Walt	25/09/2007	AIA Phase 1	Archaeological Impact Assessment. Township Development and Sub Division of AH18, Pretoriuskraal, Orkney, North West Province
7685	Jaco van der Walt	25/09/2007	AIA Phase 1	Archaeological Impact Assessment. Township Development on Sub Division of AH19, Pretoriuskraal, Orkney, North West Province
9124	Francois P Coetzee	01/04/2012	Heritage Study	Cultural Heritage Survey of the Proposed Kabi Vaalkop PV Facility near Orkney, Dr Kenneth Kaunda District, North West Province
118491	Anton Pelser	01/11/2012	HIA Phase 1	Report on a Phase 1 HIA for the Alabama Extension 4 Township Development on the Remaining Extent of Portion 1of Town and Townlands of Klerksdorp 424-IP near KLerksdorp (Matlosana), North West Province
365014	Sidney Miller	02/03/2015	HIA Phase 1	Cultural Heritage Impact Assessment for Shafts #1 to #7, Orkney, Northwest Province, South Africa, for CAPM Gold.
368533	Jaco van der Walt	29/03/2016	Archaeological Specialist Reports	Archaeological Scoping Report for the Proposed Orkney Solar Farm And Associated Infrastructure Orkney, North West Province
368543	Udo Kusel	09/06/2016	HIA Phase 1	Phase 1 Cultural Heritage Resources Impact Assessment Phase 1 Cultural Heritage Resources Impact Assessment for the proposed town development Alabama Extension 6 and the rezoning of Park Erf 19613, Jouberton Extension 19. The proposed township establishment is situated on a poriton of the Remaining Extent of Portion 1 of the farm Townlands of Klerksdorp No. 424-IP North West Province
375984	Anton Pelser	01/11/2013	HIA Phase 1	Report on a Phase 1 HIA for the proposed Matlosana Estates & Uraniaville Ext 2 developments on various portions of Poriton 1 of the farm Town and Townlands of Klerksdorp 424-IP in Klerksdorp North West Province

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APPENDIX 2: Palaeontological Assessment (2023)

Palaeontological Impact Assessment for the proposed Paradys Solar Energy Cluster, Renoval, Free State Province

Desktop Study (Phase 1)

For

CTS Heritage (Pty) Ltd

02 August 2023

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 34 years research and lecturing in Palaeontology
26 years PIA studies and over 350 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by CTS Heritage, Simonstown, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Paradys Photovoltaic Solar Energy Cluster on Farms Vlakfontein 15, Smaldeen 157, Biesiefontein 173, Zaaiplaats 190, Kleinfontein 369 and Uitval 457, south of Renoval and southeast of Orkney, Free State Province. The facility will produce up to 130 MW and have a grid connection to the existing ESKOM Mercury substation.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the Quaternary sands (underlain by the Vryheid Formation) and on the non-fossiliferous Hekpoort Formation. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations, drilling or mining activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High to moderate	Low to very low	Paleontological Impact Assessment	Section 7.2. SAHRA Requirements

Table of Contents

1. Background

This report is drafted in support of the proposed development of the Paradys Photovoltaic Solar Energy Cluster and its associated grid connection infrastructure located outside of Viljoenskroon in the Free State. The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e., semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current).

The key components of the proposed project are described below:

- PV Panel Array - To produce up to 130MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a optimum angle in order to capture the most sun.
- Wiring to Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the proposed power line. It is expected that generation from the facility will connect to the national grid. Corridor will cover options to connect to Mercury Substation, Existing Eskom lines with capacity and Eskom Switching stations of other Mulilo projects currently under development.
- Electrical reticulation network – An internal electrical reticulation network will be required and will be lain 2-4m underground as far as practically possible.
- Supporting Infrastructure – The following auxiliary buildings with basic services including water and electricity will be required on site:
- Operations & Maintenance Building / Office
- Switch gear and relay room
- Staff lockers and changing room
- Security control
- Offices
- Battery storage – Battery Storage Facilities with a maximum height of 5m and a capacity of 2500MWh will be installed in a 6-hectare area.
- Roads - Access is most likely to be obtained via R502 Regional Road. This will be confirmed in the Traffic Impact Assessment which has been commissioned. An internal site road network will also be required to provide access to the solar field and associated infrastructure.

- Fencing - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height between 4 meters will be used.

The properties included in the Paradys Cluster are (Figures 1-2):

Farm	Portion	Property Name
15	RE	Vlakfontein
157	RE	Smaldeel
173	RE	Biesiefontein
173	1	Biesiefontein
190	RE	Zaaiplaats
190	2	Zaaiplaats
190	3	Zaaiplaats
369	1	Kleinfontein
457	RE	Uitval

A Palaeontological Impact Assessment was requested for the Paradys PV Cluster project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

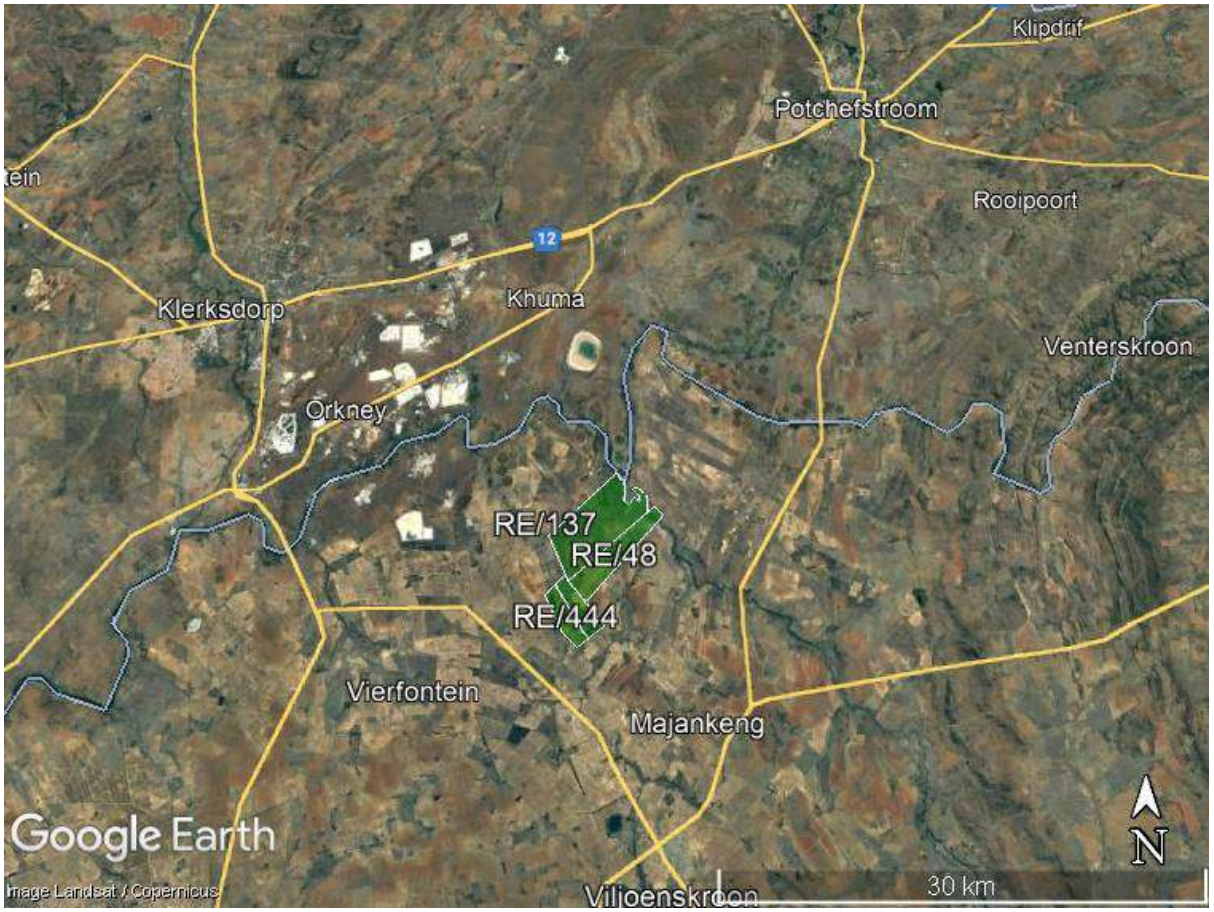

Figure 1: Google Earth map of the general area to show the relative landmarks. The Paradys Cluster general area is shown by the green polygons but see Figure 2 for details.

Figure 2: Google Earth Map of the proposed development of the Paradys Solar Energy Cluster (green polygons) and the grid connection to the Mercury Substation (red line).

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

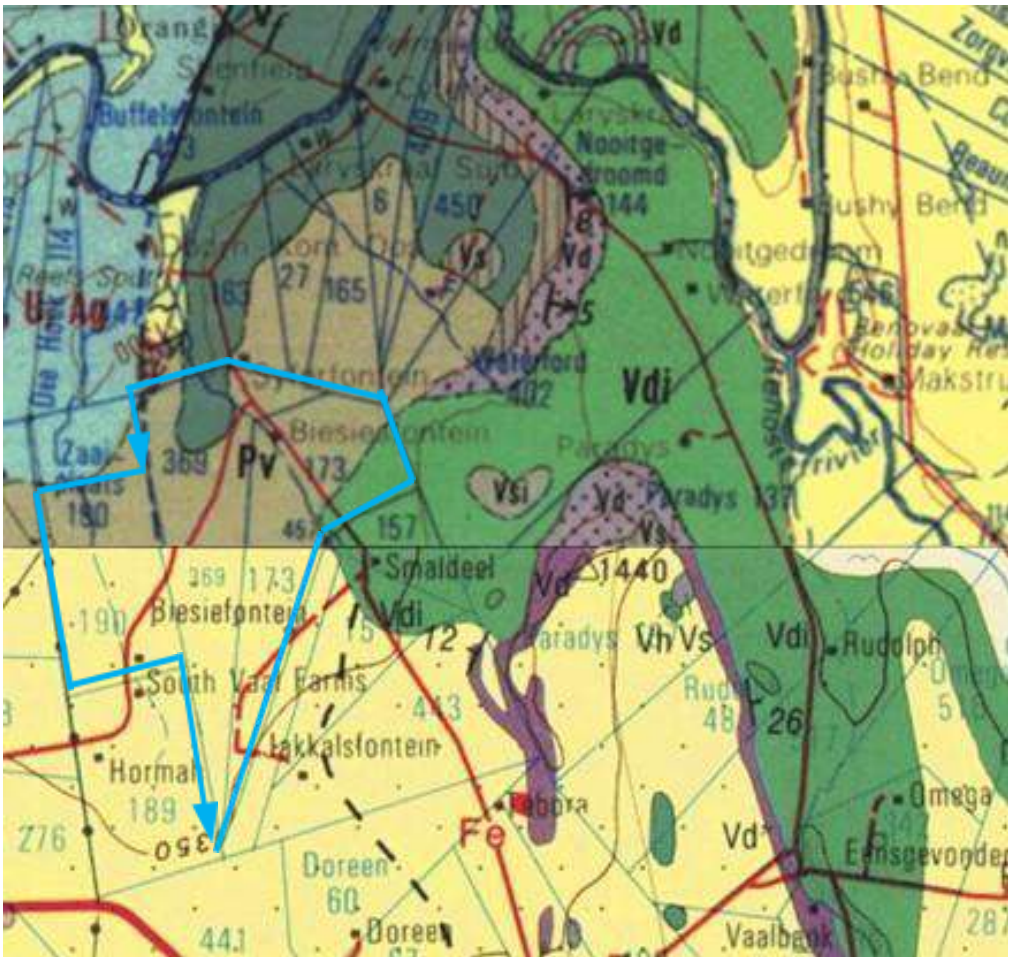

Figure 3: Geological map of the area around the Paradys PV Cluster. The location of the proposed project is indicated within the blue polygon. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand (top) and 2726 Kroonstad (bottom).

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Johnson et al., 2006; Zeh et al., 2020). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary Kalahari Group	Aeolian sand	Quaternary, ca 1.0 Ma to present
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shale, sandstone, siltstone, coal seams	Early Permian Ca 290-280 Ma
Vdi	Diabase	Intrusive volcanic dykes and sills	Post Transvaal SG
Vsi	Silverton Fm, Pretoria Group, Transvaal SG	Shale, carbonaceous in places, hornfels, chert	Ca 2202 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vd	Daspoort Fm, Pretoria Group, Transvaal SG	Quartzite	<2240 Ma
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Andesitic lava (volcanic rocks)	Ca 2224 Ma

The project lies in the southern part of the Transvaal Basin with some rocks of the Transvaal Supergroup that unconformably overlain by the much younger Quaternary sands and alluvium of the Kalahari Group. Karoo supergroup rocks are known only from boreholes, not surface exposures, so the lower map's Quaternary sands should also be reflected on the upper map, rather than the Vryheid Formation.

The Late Archaean to early Proterozoic Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal Malmani Subgroup that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the Duitschland Formation.

Making up the lower Pretoria Group are the Timeball Hill Formation and the Boshoek Formation. The **Hekpoort**, Dwaalheuwel, Strubenkop and **Daspoort Formations** form a sequence as the middle part of the Pretoria Group, Transvaal Supergroup, and represent rocks that are over 2060 million years old. The Hekpoort Formation is a massive lava deposit and is overlain by the Dwaalheuwel conglomerates, siltstone and sandstone (not present here). A hiatus separates the Strubenkop Formation slates and shales from the overlying quartzites of the Daspoort Formation. Upper Pretoria Group formations are the Silverton, Magaliesberg, Vermont, Lakenvalei, Nederhorst, Steenkampsberg and Houtenbek Formations

The Transvaal sequence has been interpreted as three major cycles of basin infill and tectonic activity with the first deep basin sediments forming the Chuniespoort Group, the second cycle deposited the lower Pretoria Group, and the sediments in this area are from the interim lowstand that preceded the third cycle. These sediments were deposited in shallow lacustrine, alluvial fan and braided stream environments (Eriksson et al., 2012).

The model of Eriksson et al., 2006, 2012 and collaborators shows the Transvaal Basin to have experienced three major tectonically controlled transgressive-regressive sequences. The first shallow seaway with a carbonate and a BIF platform is represented by the Chuniespoort Group followed by an 80 Ma gap. The second shallow embayment with clastic sediments is represented by the Rooihoogte and Timeball Hill Formations,

and the third shallow embayment is represented by the Daspoort, Silverton and Magaliesberg Formations.

The basal **Rooihoogte Formation** overlies a deeply weathered palaeotopography that developed on the carbonates of the Chuniepoort Group. Composition of the rocks of this formation vary locally but generally comprise chert conglomerate, chert-rich sandstones, mudrocks and sandstones. An alluvial fan and fluvial braid-plain depositional setting has been interpreted from the conglomerates and sandstones, and a shallow lacustrine basin has been interpreted for the mudrocks and dolomites (Eriksson et al., 2006).

Overlying the Rooihoogte Formation is the **Timeball Hill Formation** which is composed of thick shales and subordinate sandstones that were deposited in a fluvio-deltaic basin-filling sequence (Eriksson et al., 2006). A number of facies are included in this formation. At the base is black shale facies associated with subsurface lavas and pyroclastic rocks of the Bushy Bend Lava Member. Above these are rhythmically interbedded mudstones/siltstones and fine-grained sandstones that have been interpreted as turbidite deposits (Eriksson et al., 2006). These fine-grained sediments grade up into the medial Klapperkop Quartzite Member that has been interpreted as fluvio-deltaic sandstones which fed the more distal turbidites (ibid). Above this is an upper shale member and rhythmite facies. In the east of the Transvaal Basin the Upper Timeball Hill shales have undergone extensive soft-sediment deformation caused by the onset of tectonic instability that led to the eventual fan deposits of the Boshoek Formation and the flood basalts of the Hekpoort Formation (ibid).

The **Hekpoort Formation** is composed of subaerial lavas that intruded into the Boshoek sandstones. These basaltic-andesitic lavas are thickest in the south of the Transvaal basin, thinning to the west and thinnest in the northeast (Eriksson et al., 2006).

There is an unconformity between the Strubenkop shales and the overlying **Daspoort Formation**. In the east of the Transvaal Basin the latter is composed of mature quartz arenites and subordinate mudrocks and ironstones, but in the west of the basin it is mostly made up of immature sandstones, pebbly arenites, conglomerates and mudrocks (Eriksson et al., 2006). This formation probably represents a fluvial setting succeeded by a shallow marine setting that was the precursor to a major transgression that formed the succeeding Silverton Formation (Erikson et al., 2006). At the top of the Daspoort Formation are localised occurrences of stromatolitic carbonates and cherts (ibid).

Within the **Silverton Formation** are the lower Boven Shale Member, Machadorp Volcanic Member and upper Lydenburg Shale Member. The lower shales are alumina-rich and best represented in the eastern part of the Transvaal Basin. Shallow subaqueous eruptives formed the tholiitic basalts and then the tuffaceous shales that are high in CaO-MnO-MgO formed the Lydenburg Member (Eriksson et al., 2006). The Silverton Formation has been interpreted as a high-stand facies tract that reflected the advance of an epeiric sea onto the Kaapvaal Craton from the east, so the Daspoort Formation would represent a lowstand facies tract or a transgressive systems tract (ibid).

There were two large basins dominating southern Africa during the Cenozoic, with the Kalahari Basin to the west and the Bushveld basin to the east. Both basins are bounded along their southern extent by the more or less west-east trending Griqualand-Transvaal Axis (Partridge et al., 2006). These sediments are not easy to date but recent attempts are gradually filling in the history of the sands, sand dunes and inter-dunes (Botha, 2021).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Most geological maps indicate these sands simply descriptively (aeolian sand, gravelly sand, calcrete) or they are lumped together as the Gordonia Formation because the detailed regional lithostratigraphic work has not been done, Nonetheless, these sands have eroded from the interior and have been transported by wind or water to fill the basin. Reworking of the sands or stabilisation by vegetation has occurred. Probable ages of dune formation are around 100 kya (thousand years), 60 kya, 27-23 kya and 17-10 kya (in Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the moderately fossiliferous Kalahari sands (green) and moderately fossiliferous Daspoort Formation (orange) and non-fossiliferous Hekpoort Formation (grey).

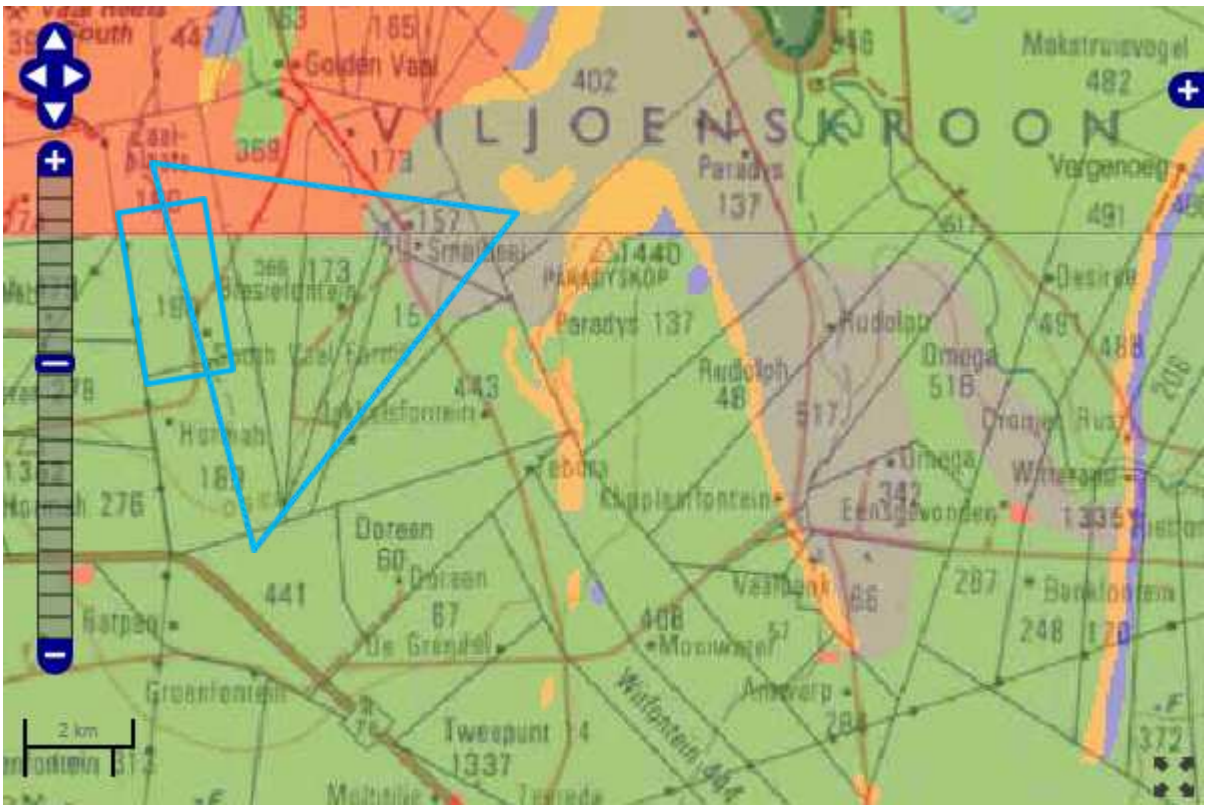

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Paradys PV Cluster shown within the blue polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Volcanic rocks such as diabase and andesitic lavas (Hekpoort Formation) do not preserve fossils as they have originated from below the earth's surface. No fossils have been reported from the Daspoort Formation quartzites but this formation is lumped together in the Palaeotechnical Report for the Free State (Groenewald et al., 2014) with the Magaliesberg, Timeball Hill and Silverton Formations, only some of which have recorded stromatolites. In addition, the area is covered with sols and has been cultivated for decades so any rocks have been removed.

Aeolian sands and alluvium are fairly mobile and very porous so they do not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, is there any chance of fossilisation. For example, roots can be encased in calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

Note: in the southern part of the map in figure 3, there is a disjunction between the Vryheid Formation rocks ending abruptly along the line that joins the maps. The southern map shows the surface rocks, Quaternary sands and alluvium in this case, while the northern map shows the rocks from borehole core information, i.e. the underlying rocks. Since this project will be on the surface only, it is advisable to use the surface strata – the moderately fossiliferous Quaternary sands.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

Table 3a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 3b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Soils do not preserve fossils; so far there are no records from the Daspoort Fm or the Quaternary sands of trace fossils, plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-

PART B: Assessment		
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trace fossils in the Daspoort Fm quartzites or in the Quaternary cemented sands, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the rocks below ground. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain body fossils or too young and friable to preserve fossils. Furthermore, the material to be excavated are soils and sands and they do not preserve fossils. Since there is an extremely small chance that fossils from below ground may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolorites, sandstones, shales and sands are typical for the country and only some contain trace fossils or may cover younger fossil plant, insect, invertebrate and vertebrate material. The soils and sands of the Quaternary period would not preserve fossils. See note about the Vryheid Formation on p 13.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur below ground in the quartzites but this is very unlikely. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other

responsible person once excavations for foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, so as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	High to moderate	Low to very low	Paleontological Impact Assessment	Section 7.2. SAHRA Requirements

7. References

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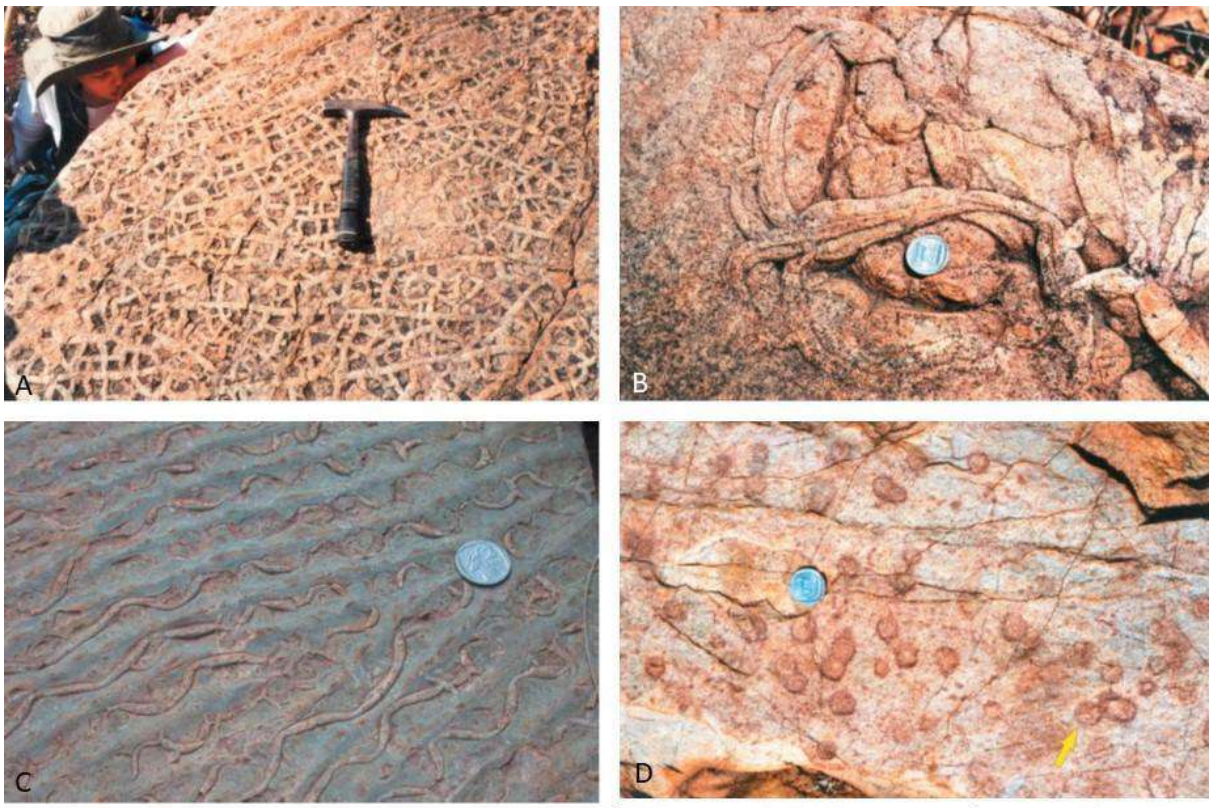
8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.

2. When excavations begin the rocks must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the trace fossils such as stromatolites or microbially features (trails, curls, rip-ups, mudcracks) trace fossils in the dolomites, limestones, shales and mudstones (for example see Figures 5-6). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Pretoria Group



Magaliesberg Fm trace fossils, near Pretoria (all from Bosch & Eriksson, 2008): A – cracks,. B – sinuous structure, C – *Manchuriphycus*, D – circular structures. R1 coin for scale.

Figure 5. Photographs of microbial features from the Magaliesberg Formation (in Bosch and Eriksson, 2008).

Figure 6: Photographs of trace fossils that can be found in Kalahari sands if there is a water source such as a palaeo-spring or palaeo-pan.

9. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2023

Present employment:		Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone	:	+27 11 717 6690
Cell	:	082 555 6937

E-mail : marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) **Academic qualifications**
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) **Professional qualifications**
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) **Membership of professional bodies/associations**
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12 - 20 students per year.

vii) **Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor

Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
25 years' experience in PIA site and desktop projects

- Selected from recent projects only – list not complete:
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage

ix) **Research Output**
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 30; Google Scholar h-index = 39; -i10-index = 116 based on 6568 citations.
Conferences: numerous presentations at local and international conferences.

CTS HERITAGE

CHANCE FINDS OF PALAEONTOLOGICAL MATERIAL

(Adopted from the HWC Chance Fossils Finds Procedure: June 2016)

Introduction

This document is aimed to inform workmen and foremen working on a construction and/or mining site. It describes the procedure to follow in instances of accidental discovery of palaeontological material (please see attached poster with descriptions of palaeontological material) during construction/mining activities. This protocol does not apply to resources already identified under an assessment undertaken under s. 38 of the National Heritage Resources Act (no 25 of 1999).

Fossils are rare and irreplaceable. Fossils tell us about the environmental conditions that existed in a specific geographical area millions of years ago. As heritage resources that inform us of the history of a place, fossils are public property that the State is required to manage and conserve on behalf of all the citizens of South Africa. Fossils are therefore protected by the National Heritage Resources Act and are the property of the State. Ideally, a qualified person should be responsible for the recovery of fossils noticed during construction/mining to ensure that all relevant contextual information is recorded.

Heritage Authorities often rely on workmen and foremen to report finds, and thereby contribute to our knowledge of South Africa's past and contribute to its conservation for future generations.

Training

Workmen and foremen need to be trained in the procedure to follow in instances of accidental discovery of fossil material, in a similar way to the Health and Safety protocol. A brief introduction to the process to follow in the event of possible accidental discovery of fossils should be conducted by the designated Environmental Control Officer (ECO) for the project, or the foreman or site agent in the absence of the ECO It is recommended that copies of the attached poster and procedure are printed out and displayed at the site office so that workmen may familiarise themselves with them and are thereby prepared in the event that accidental discovery of fossil material takes place.

Actions to be taken

One person in the staff must be identified and appointed as responsible for the implementation of the attached protocol in instances of accidental fossil discovery and must report to the ECO or site agent. If the ECO or site agent is not present on site, then the responsible person on site should follow the protocol correctly in order to not jeopardize the conservation and well-being of the fossil material.

Once a workman notices possible fossil material, he/she should report this to the ECO or site agent.Procedure to follow if it is likely that the material identified is a fossil:

- The ECO or site agent must ensure that all work ceases immediately in the vicinity of the area where the fossil or fossils have been found;
- The ECO or site agent must inform SAHRA of the find immediately. This information must include photographs of the findings and GPS co-ordinates;
- The ECO or site agent must compile a Preliminary Report and fill in the attached Fossil Discoveries: Preliminary Record Form within 24 hours without removing the fossil from its original position. The Preliminary Report records basic information about the find including:
    - The date
    - A description of the discovery
    - A description of the fossil and its context (e.g. position and depth of find)
    - Where and how the find has been stored
    - Photographs to accompany the preliminary report (the more the better):
        - A scale must be used
        - Photos of location from several angles
        - Photos of vertical section should be provided
        - Digital images of hole showing vertical section (side);
        - Digital images of fossil or fossils.

Upon receipt of this Preliminary Report, SAHRA will inform the ECO or site agent whether or not a rescue excavation or rescue collection by a palaeontologist is necessary.

- Exposed finds must be stabilised where they are unstable and the site capped, e.g. with a plastic sheet or sand bags. This protection should allow for the later excavation of the finds with due scientific care and diligence. SAHRA can advise on the most appropriate method for stabilisation.
- If the find cannot be stabilised, the fossil may be collect with extreme care by the ECO or the site agent and put aside and protected until SAHRA advises on further action. Finds collected in this way must be safely and securely stored in tissue paper and an appropriate box. Care must be taken to remove the all fossil material and any breakage of fossil material must be avoided at all costs.

No work may continue in the vicinity of the find until SAHRA has indicated, in writing, that it is appropriate to proceed.

CTS HERITAGE

FOSSIL DISCOVERIES: PRELIMINARY RECORDING FORM		
Name of project:		
Name of fossil location:		
Date of discovery:		
Description of situation in which the fossil was found:		
Description of context in which the fossil was found:		
Description and condition of fossil identified:		
GPS coordinates:	*Lat:*	*Long:*
If no co-ordinates available then please describe the location:		
Time of discovery:		
Depth of find in hole		
Photographs (tick as appropriate and indicate number of the photograph)	*Digital image of vertical section (side)*	
	Fossil from different angles	
	Wider context of the find	
Temporary storage (where it is located and how it is conserved)		
Person identifying the fossil Name:		
Contact:		
Recorder Name:		
Contact:		
Photographer Name:		
Contact:		

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