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A PHASE 1 HERITAGE IMPACT ASSESSMENT DESKTOP STUDY FOR AN AREA OF PROPOSED EXPLORATION PROJECT AND ASSOCIATED INFRASTRUCTURE

REFERENCE NUMBER: NC30/5/1/1/2/10372PR

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1. Introduction

The author was requested by the company “The Jaspairs Trading and Projects (Pty) Ltd” to undertake a desktop HIA for the site for the purpose of fulfilling the requirements of a prospecting licence application. It was also through consultation with local communities that there was verbal confirmation and confirmation of a believe that there is presence of a diamond at the crater like depression.

A site visit was undertaken on the 14th of July 2012. Observations made on site, together with a review of relevant historical information, are presented below, with recommendations.

2. Aims with this report

The following is the aim of the report:-

- To detail a desktop analysis of the status of heritage resources, as outlined in the National Heritage Resources Act, Act No. 25 of 1999, in the area earmarked for the proposed development;
- To establish whether any of the types of heritage resources as outlined in Section 3 of the National Heritage Resources Act, Act No. 25 of 1999 is likely to occur within the project area;
- If the above applies, to determine the significance of these heritage resources and the extent to which they are affected by the proposed development;
- To propose suitable mitigation measures for heritage resources that may be affected or impacted by the proposed development.

3. Legal Background

The Heritage Impact Assessment (HIA) is governed by national legislation as outlined below:

- National Heritage Resources Act, Act No. 25 of 1999 (NHRA) and associated guidelines
- Minerals and Petroleum Resources Development Act, Act No. 28 of 2002 (MPRDA)
- National Environment Management Act, Act No. 107 of 1998 (NEMA); and
- National Water Act, Act No. 36 of 1998 (NWA)

Section 3 of the National Heritage Resources Act, Act No 25 of 1999, lists the following as National Estates:-

(a) places, buildings, structures and equipment of cultural significance;

(b) places to which oral traditions are attached or which are associated with living heritage;
(c) historical settlements and townscapes;
(d) landscapes and natural features of cultural significance;
(e) geological sites of scientific or cultural importance;
(f) archaeological and palaeontological sites;
(g) graves and burial grounds, including—
(i) ancestral graves;
(ii) royal graves and graves of traditional leaders;
(iii) graves of victims of conflict;
(iv) graves of individuals designated by the Minister by notice in the Gazette;
(v) historical graves and cemeteries; and
(vi) other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
(h) sites of significance relating to the history of slavery in South Africa;
(i) movable objects, including—
(i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
(ii) objects to which oral traditions are attached or which are associated with living heritage;
(iii) ethnographic art and objects;
(iv) military objects;
(v) objects of decorative or fine art;
(vi) objects of scientific or technological interest; and
(vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

(3)Without limiting the generality of subsections (1) and (2), a place or object is to be considered part of the national estate if it has cultural significance or other special value because of—

(a) its importance in the community, or pattern of South Africa's history;
(b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(d) its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;

(e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;

(f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;

(g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and

(i) sites of significance relating to the history of slavery in South Africa.

4. Methodology

The methodology followed in the compilation of the report was as follows:

- Surveying of the proposed project area with a vehicle and selected areas of the site on foot;
- Literature research and data gathering relating to pre-historical and historical context of the project area;
- Review of maps (aerial, archaeological, topographical maps, including satellite imagery) of the proposed area;
- Consultation with nearby communities
- Synthesis of information from site observations, the literature review including relevant historical information, are presented with recommendations in the report

4.1 Field- work

A site visit was conducted on the 14th of July 2012. The project area was surveyed with a vehicle and on foot.

4.2 Desktop review

Literature relating to the pre-historic and the historic development of the region where the proposed site for development is earmarked was undertaken. An analysis of the above will assist in the identification and assignment of meaning to the heritage potential of the site. The site was also studied in relation to the maps on which it appears, i.e. the 1:250 000 map [2722 KURUMAN] including Google Earth Images showing the project site.

4.3 Assumptions and limitations

An assumption based on the size and nature of the landscape, with its moderately sparse vegetation and shallow soil profiles, some sense of the archaeological traces to be found in

the area of proposed development would be readily apparent from surface and visual observations. It was not considered necessary to conduct excavations at this first phase of the project to establish the potential of sub-surface archaeology.

A proviso is however, routinely given that, should sites or features of significance be encountered during construction (this could include an unmarked burial or a high density of stone tools, for instance), specified necessary steps are (cease work, report immediately to relevant heritage authority), undertaken as per prescribed SAHRA protocols and procedures.

The geology locally is Pre-Cambrian and lacking in features such as secondary travertine deposits and hence it is unlikely that palaeontological heritage (fossils) would occur or be impacted by the proposed activity.

There is a possibility that the study undertaken may have missed heritage resources existing in the project area, as heritage sites may occur in clumps of vegetation and also below the earth's surface. These may be exposed only during the construction phases of the development.

Should heritage resources be uncovered during the construction and / or operational phase of the development, the following is the protocol to be followed:

- All development activity to stop immediately at the site of discovery;
- SAHRA to be notified immediately,
- An accredited archaeologist by the Association of South African Professional Archaeologists (ASAPA) must be appointed and notified of the discovery and commissioned to determine appropriate mitigation measures for the discovered finds. The work of the archaeologist may include the acquisition of the necessary permit from SAHRA to conduct the mitigation measures suggested.

The geology locally is Pre-Cambrain and lacking in features such as secondary travertine deposits and hence it is unlikely that palaeontological heritage (fossils) would occur or be impacted by the proposed activity.

5. The Project Area

5.1 Location

The project area comprises of twelve farms namely are Portion 1 and Portion 2 and Portion 3 and the Remainder extent of the farm Lower Kuruman 219 (23°16'8.174"E 27°21'57.571"S), Portion 1 and Remainder extent of the farm Eldoret 274 (23°5'58.241"E 27°13'30.081"S), farm England 318 (23°7'24.873"E 27°15'25.049"S), farm MT.Vera 319 23°9'4.942"E 27°17'9.803"S), Portion 1, 2 and the remainder of the farm Riries 320 (23°10'46.409"E 27°19'23.817"S), farm MT.Roper 321 (23°12'27.872"E 27°21'6.299"S), Portions 1, 2 and remainder extent of the farm Exit 377 (23°15'32.501"E 27°24'18.035"S), Portion 1 and remainder extent of the farm Exit T 754 (23°15'37.781"E 27°23'2.416"S), Portions 1,2 and remainder extent of the farm Gamohaan 438 (23°17'18.978"E 27°23'23.9"S) and farm Annex Exit 376 (23°13'17.717"E 27°23'58.198"S). See figure 1 below.

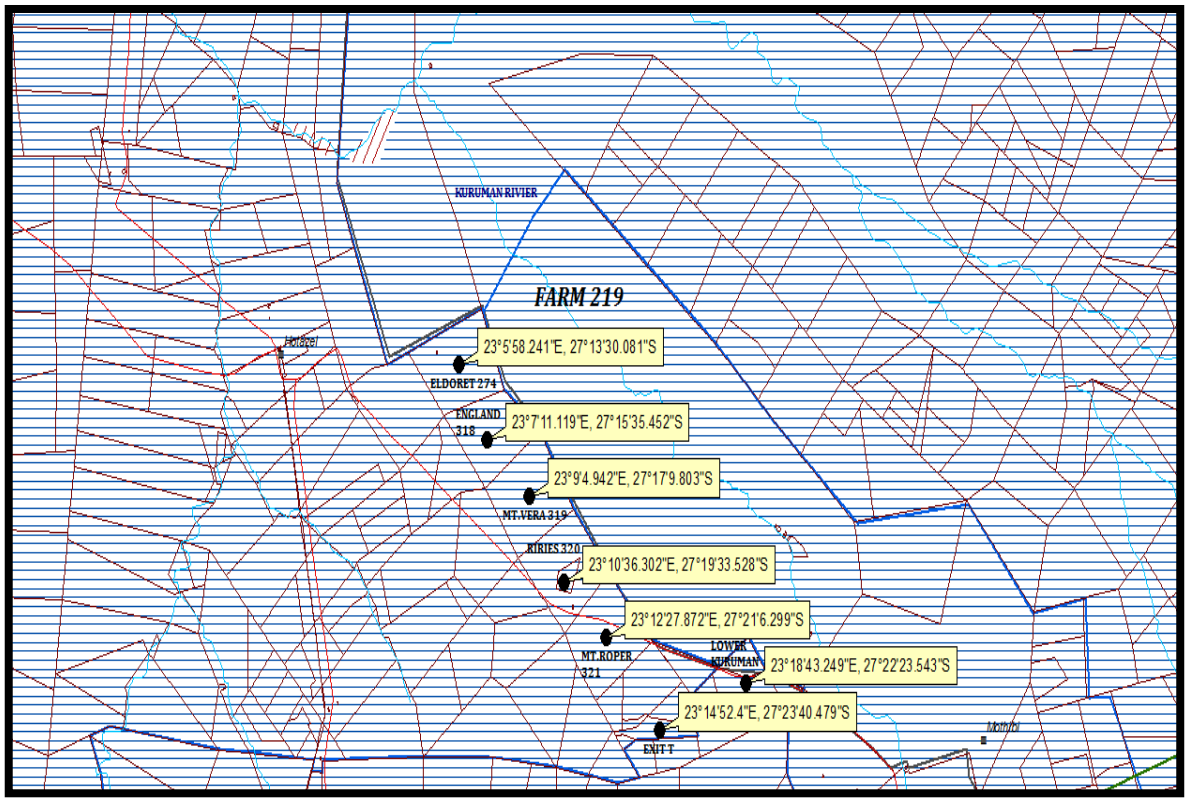

Figure 1 : Locality Map of the study area with GPS coordinates

5.2 Regional Setting

According to the published 1: 250 000 geological map, **2722 KURUMAN**, the area is underlain by rocks of the Griqualand – West Sequence type. This rock type comprises mainly dolomite with chert and dolomitic limestone, overlain by banded Iron Formation. Aeolian sand covers the plains.

The Figure 2 attached below shows the tribal authorities within the study area.

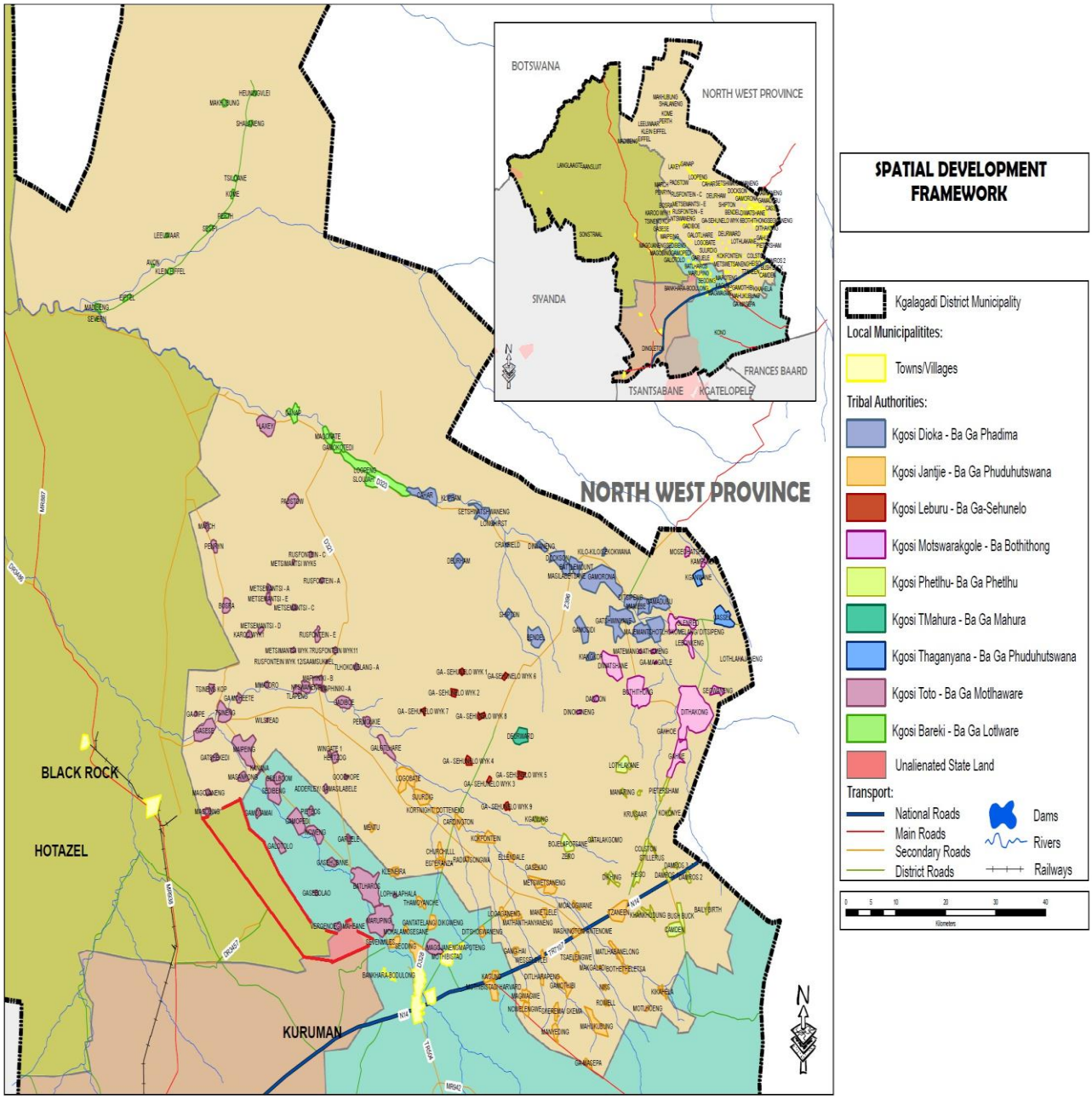

Figure 2: Tribal Authorities within the study area

5.3 Local Observations

The villages located near the northern end of a N – S striking range of hills comprised of banded iron formations (BIF) as depicted in Figure 3a and b below.

Immediately to the NW of the village, a crater – like depression measuring 80 x 120 meters along its major axes exists (refer to Figure 3a and 3b below). According to the local chief, a prospector recovered diamonds from this feature a few years ago, but disappeared after allegedly finding an exceptionally large diamond.

The BIF outcrops immediately outside the perimeter of this crater – like depression deviate from the generally flat lying altitude dipping at 45 ° to 70 ° towards the depression. Inside the depression signs of an old borehole generating fine chips of BIF could be seen.

Figure 3a :Depression Structure observed by Google Earth

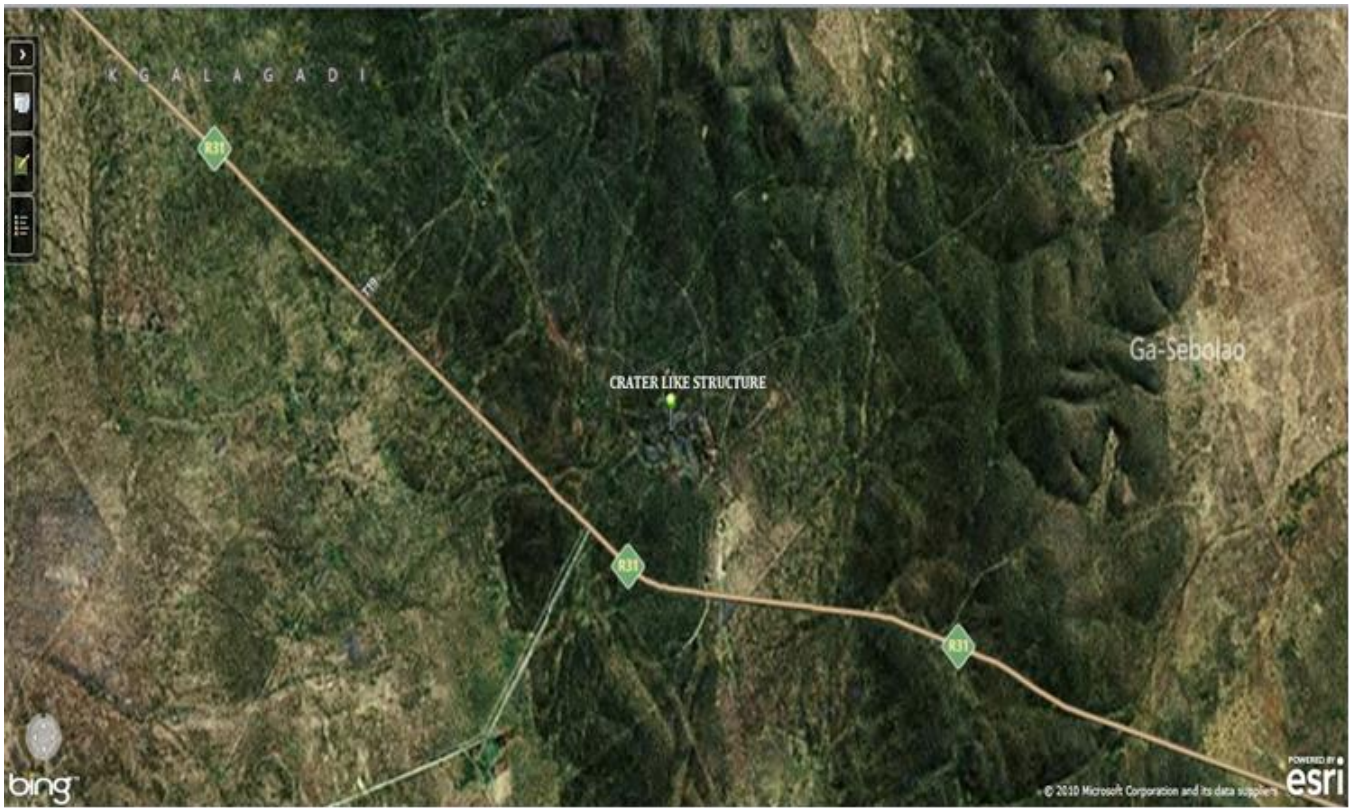

Figure 3b: Depression Structure observed by ArcGis

5.4 Property Description

Kuruman is the main town in the Kalahari region and is also known as the “Oasis of the Kalahari”. Kuruman is situated on the main route between Johannesburg and Namibia/Cape Town via Upington. The town of Kuruman is located approximately 132 kilometers southwest of Vryburg and 223 kilometers northeast Upington.

The properties fall within the area of Kuruman known as Ga-Mopedi currently under the Ga-Segonyana Local Municipality in the Kgalagadi District, Northern Cape Province.

5.5 Landscape and Geology Overview

The project area is underlain by the Kalahari Manganese Field (KMF), the largest known land-based manganese deposit in the world. The KMF is comprised of five erosional relicts of the manganese bearing Hotazel Formation of the Paleoproterozoic Transvaal Supergroup. The manganese ore is of sedimentary origin. The Hotazel Formation, which is the host rock to the manganese ores of the KMF, comprise of three (3) symmetrical iron formation, hematite-lutite-braunite-lutite sedimentary cycles that can be traced across the entire KMF and displays a remarkably uniform fine-scale litho-stratigraphy. Geological

surveys for the project have indicated other minerals found in the Kalahari Manganese Field formation which includes the following:

- sand,
- clay,
- limestone,
- tillite,
- quartzite,
- red and grey shales,
- dolomite, and
- iron ore.

The area is located on slightly hilled plains with an elevation of approximately between 1150 and 1200 m, and with an elevation marker of 1192 m located near the northern border of the study area. The plain has a general gentle North Westerly slope.

The area as a whole lies within Kalahari Desert, with distinct characteristic vegetation type belonging to the Kalahari Thornveld. The Kalahari Thornveld is characterised by low bushes and shrubs and grasses, however, some bigger acacias also do occur sporadically.

The nearest water stream is Kuruman River, situated at an approximate 0.75 km, southwest of the site. The area is located on a top relatively low hill resembling a paleovalcano which has a relative elevation of about 30-40 meters in relation to the Ga-Mopedi village, located approximately 0.5 km to the south.

The resemblance to a volcano is stressed by a crater-type depression (~20 m) on the top of the hill. On the other hand the well-exposed country rocks are banded ironstone shales and quartzite with a sub-vertical dip and a general north easterly (NE) strike. The presence of these rocks on the top of the hill eliminates a true volcanic origin of the hill and could be an uplifted zone surrounding a Kimberlite pipe – feature documented at a number of known poorly eroded Kimberlite pipes (e.g. Orapa, Yubileynaya etc.).

The relatively flat surface of the central depression (crater?) is covered with grass and debris of the ironstone composing the hill. According to previous prospecting activity, the crater like depression marked on the ground by rock fragments, could be the only indicator of the presence of kimberlitic material.

These crater-like sediments can have thickness up to few tens of meters or even over hundred meters in case of large pipe (e.g. Catoca, Angola – 260 m). The crater-like sediments representing volcanogenic–sedimentary rocks are not always easily distinguished from ordinary sedimentary rocks (subject to a detailed laboratory study). It is therefore, only through cutting into true Kimberlite that the presence of this potentially diamond-carrying rock, can be established.

A staged sampling programme is therefore recommended, with stage one representing the sinking of a single borehole near the centre of the pipe to prove a presence of Kimberlite, followed by other accredited and known procedures.

6. Discussion

In the author's opinion the depression (crater like), is not the result of an extrusion by an igneous rock like a Kimberlite. If it was, then the older beds would have been upturned away from the depression. The fact that the beds are dipping inwards, towards the depression, rather indicate slumping into an underlying solution cavity in the dolomite and dolomitic limestone. This however, does not mean that the feature is necessarily devoid of diamonds, as ancient fluvial systems flowing at higher elevations than present, might have concentrated heavy minerals, such as, diamond in fixed trap sites like these.

In the Sishen/Postmasburg region similar features (but orders of magnitude larger) were instrumental in the transformation of BIF debris into high grade haematitic iron ore.

7. Recommendation

If the community is certain that diamonds were indeed recovered from this feature, a Prospecting Right application is justifiably lodged to enable proper evaluation and investigation of the occurrence. Thereafter a single percussion borehole should be used to confirm the presence or absence of Kimberlite. This will assist in the determination and indication of the thickness and nature of the sediments that could be investigated for alluvial diamonds.

8. Climate and Physiology

8.1 Climate

In general the climate within the study area can be categorized as semi-arid, based on the unfavourable rainfall for growing crops, with average annual rainfall. The average annual evaporation rate exceeds the mean annual precipitation by more than four (4) times.

The area experiences relatively extreme climate, characterized by hot days and cold nights. Temperatures vary between -9°C and 42°C, with an average of 18°C. The average maximum temperature for January, the warmest month, is 32, 9°C, and the average minimum for July, the coldest month, is 3, 1°C.

The mean average precipitation (MAP) taken from the closest weather station, Kuruman, is 379mm. The weather station is located approximately 60 km South-east of the site.

8.2 Surface Water

The study area itself can clearly be defined as a region with only periodic water flow. It is known that the Kurumanrivier and Matlhwaring River flows through the site.

8.3 Ground Water

The regional aquifer is the fractured rock aquifer, which under confined conditions can be a major aquifer. It is noted that the Sishen mine, located approximately 60 km south of the site, is located within a major aquifer. Preliminary borehole investigations indicate that parts of the project site may be underlain by either minor to poor aquifers. The indication from the groundwater use survey is that the average water level is at 45 m below surface and that the use is widespread with average yields of less than 0.1 L/s, which indicates that the local site is underlain to a large extent by a renewable minor aquifer which may be used as a local source but seldom produces sufficient water for large abstractions.

The overall groundwater quality is good to poor with some boreholes showing elevated concentrations of chloride and fluoride. There is also the possibility of encountering ground water with unusually high concentrations of dissolved carbon dioxide (CO_2), Manganese Oxide (Mn_3O_4), Iron Oxide (Fe_2O_3), Magnesium Oxide (MgO), Phosphorous, and Boron. This is due to the natural soil chemistry existing on site.

8.4 Topography

The area is characterized by a typical Kalahari landscape characterized by flat plains. The study area is typified by relatively flat and monotonous topography. The Kuruman Hills are located 20 km east of the site, with the Korana Mountains located 20 km west of the site.

8.5 Soil

The dominant soil type is characterised and constituted by fine sand with very low fertility levels. In terms of the soil-landform resources, sensitive areas are typically identified on account of, *inter alia*, water and wind erosion hazards, soil compaction, prevalence of dust and the loss of high potential arable land.

8.6 Ecology

The project site falls within the Kalahari Plains Thorn Bushveld, with the characteristic terrestrial ecology which is inherently poor from a floristic point of view. The ecological sensitivity of the site was determined by assessing the ecological function and conservation importance of each ecological zone. The site is however, to a greater extent still in a natural condition supporting many plant and faunal species. The species are also able to function with little human interference. Consequently, approximately 97 % of the site is considered to be of medium ecological function and medium conservation importance. The Kurumanrivier River and its associated vegetation makes up the remaining three (3) percent, and will also support many plant and faunal species. The large trees in the river systems provide indispensable and essential microhabitats for wildlife in these harsh climatic conditions. Consequently, this area has been classified as being high in Ecological Function and medium Conservation Importance.

The site does not host red-data list plant species (plant species that are considered to be under threat of extinction) were observed on site. However, given the erratic flowering and growth patterns of Kalahari plants, the possibility of their occurrence on the site cannot be ruled out or dismissed.

8.7 Cultural Heritage

As part of the Heritage Impact Assessment (HIA), an archival study revealed important aspects about the history of the area. The area is characterized by relatively low human presence, with a physical concentration of human settlements located on or near water courses. Notably, a grave site, a number of lithic artefacts are located within the 15 km buffer

zone. Development will therefore be restricted in this zone, with no development taking place.

9. Current Land Use

The proposed new development falls in the Kgalagadi District Municipality, one of the five district municipalities in the Northern Cape Province. Described as a cross-border municipality, the largest part of the district area is characterized as rural land and extensively used for grazing, game farming and mining activities. Consequently, all privately howned/held land is used for cattle, sheep and game farming.

The vast mineral wealth of the province attracted Kumba Resources, Samancor, and Associated Manganese into the province to mine manganese and iron ore. The following farm areas make up the concession area of Kalahari (portion 1 and remainder extent of the farm Eldoret 274), England 318, MT.Vera 319, portion 1, 2 and the remainder of the farm Riries 320, MT.Roper 321, portions 1, 2 and remainder extent of the farm Exit 377, portions 1 and remainder extent of the farm Exit T 754, Portions 1,2 and remainder extent of the farm Gamohaan 438, Annex Exit 376, and portions 1 and 2 of the farm Lower Kuruman 219) is quite some distances from the surrounding town; Black Rock (40 km North west); Kuruman (35 km South east); Kathu (45 km South); Hotazel (20 km West); and Sonstraal (40 km North West).

10. Socio-economic Conditions

In 2001, a census was conducted that put the population of Kgalagadi Municipal District at approximately one hundred and eighty one thousand people (181, 000). The population mostly consists of African people with smaller populations of whites and coloured people also living in the area. Unemployment is more than 50%, as the majority of people survive on pension/welfare payments and labour intensive jobs (i.e Expanded Public Works Projects – EPWP which jobs are temporary in nature).

Education and skills development is a real challenge for both the province and the district. The Human Resource Development Strategy for the Northern Cape Province indicated that 18.2% of the population was categorized as functionally illiterate. Significant for this province, however, is that almost half of the potential work force is younger than 30 years. At the same time, unemployment is highest among the youth with unemployment rates of 54%. There is also a shortage of basic infrastructure such as transport, housing, water and electricity, which contributes to the lack of economic development in the region.

Until 1998, South Africa had one of the fastest expanding epidemics in the world, but HIV prevalence now appears to have stabilized and may even be declining slightly. Among teenage girls, the rate fell from 16.1% in 2004 to 12.9% in 2007, possibly indicating a drop in the rate of new infections. This has been attributed to a change to safer health practices among younger women. The Northern Cape Province, in which the Kalagadi District Municipality falls, has HIV prevalence statistics which are lower than the national average.

The main economic activities are farming and mining. Mining activities are mostly iron, manganese, stone and quartzite. According to the Human resource development strategy for the Northern Cape Province (2004: 8), the Northern Cape Province has the biggest deposits of the afore mentioned precious metals, minerals etc. in the found world. Accordingly the Northern Cape is the largest of the nine (9) South African provinces but has the smallest population at only 822 727. The province accounts for some 7 % of global diamond exports (by carat), 13 % of all zinc and lead exports and more than 25 % of the world's manganese exports. Mining giants like Iscor, Samancor, Goldfields, PPC Lime, Alpha and Assmang operate in the Northern Cape. The province also supplies most of the country's iron ore production.

Other important metals and minerals produced in the Northern Cape, include copper, limestone, gypsum, rose quartz, tiger's eye, mica, verdite and semi-precious stones. To a large extent, the processing of these metals and minerals takes place outside the province. Opportunities exist for investors to establish processing plants to add value to these minerals within the Northern Cape. The surrounding land uses in the area comprise primarily other neighbouring mines as well as game farms.

11. Description of the Affected Environment

The area earmarked for development environment is a rural area that developed as a result of socio-political imperatives in the twentieth century and hence is an artefact of South Africa’s geography.

11.1 Description of Heritage Features in the Region

The Northern Cape has a wealth of pre-colonial archaeological sites (Beaumont & Morris 1990; Morris & Beaumont 2004). Archaeological sites in the region include the world renowned long-sequence Wonderwerk Cave, the major Tswana town and the pre-colonial stone-walled settlements of Dithakong. More locally, the two shelters on the northern and

southern faces of Gamohaan (in the Kuruman Hills north west of the town) contain Later Stone Age remains and rock paintings.

Historically, Kuruman boasts one of the longest trajectories of African-colonial interaction centred on the nearly two-century old Moffat Mission, characterised by what Comaroff and Comaroff as a “long conversation”. Locally, the ‘Eye’ and the water course springing from it has been the focus of utilization and settlement and it was in its immediate vicinity that the town of Kuruman, evolved in the late nineteenth century.

11.2 Environmental Issues and Potential Impacts

Heritage resources including archaeological sites and colonial era features are in each instance unique and non-renewable resources. Area and linear developments as envisaged and anticipated can have a permanent destructive impact on these resources. The objective of this assessment is to evaluate the sensitivity of such resources where present, to assess the significance of potential impacts on these resources and, if and where appropriate, to recommend no-go areas and measures to mitigate or manage the impacts.

The destructive impacts that are possible in terms of heritage resources would tend to be direct, once-off events occurring during the project construction phase. In the longer term secondary impacts may occur as a result of expansion, as a result of associated uses to the proposed mining activity.

11.3 Potentially Significant Impacts to be Assessed

Any area or linear, primary and secondary, disturbance of surfaces in the proposed development could have a destructive impact on heritage resources, where present. Where found, such resources may be so significant or so sensitive that no development (or development that leads to their preservation) should occur in the places where they occur. In other instances it may be possible to mitigate their disturbance or destruction by way of documentation and/or salvage, or protection of the heritage find, following approval and permitting by the South African Heritage Resources Agency or, in the case of any built environment features, by Ngwao Bošwa ya Kapa Bokone (the Northern Cape Heritage Authority).

Disturbance of surfaces may include but is not limited to the following:-

- any construction: of a building, a road, erection of a power line,
- or any other *clearance* of, or *excavation* into, a land surface.

In the event of archaeological or other heritage materials being present such activity would alter or destroy their context (even if the artefacts themselves are not destroyed, which is also obviously possible). Without context, archaeological and heritage traces are of much reduced significance. It is the contexts as much as the individual items that are protected by the heritage legislation.

A number of broad expectations/concerns were expressed for assessment. The following was predicted that:

• Based on previous experience in the area, the gently undulating terrain away from features such as rock shelters and water sources is likely to include a generally low density and possibly widespread occurrence of 'off-site' Stone Age material.

• Traces of earlier episodes of Kuruman's urban development would be found.

• A burial ground was known to exist near the western edge of the area.

• Significant intangible heritage values may be attached to remaining traces of former 'location' spaces.

• The envisaged development could incorporate and enhance 'memory spaces' in this landscape.

11.4 Determination of Archaeological Significance

In addition to guidelines provided by the National Heritage Resources Act (Act No. 25 of 1999), a set of criteria based on Deacon (nd) and Whitelaw (1997) for assessing archaeological significance has been developed for Northern Cape settings (Morris 2000a). These criteria include estimation of landform potential (in terms of its capacity to contain archaeological traces) and an assessment of the value of any archaeological traces (in terms of their attributes or their capacity to be construed as evidence, given that evidence is not given but constructed by the investigator). These significance assessment criteria are appended in table form at the conclusion of this report. These criteria suggest generally low significance for pre-colonial archaeology in the area in question.

12. Observations

The proposed development area was visited in 14 July 2012. Historical records (e.g. Snyman 1992) provide important background relating to the evolution of the town of Kuruman, a history which gave rise to the buffer zone which is now to be incorporated (for some parts incorporated *again*) as urban space. In summary, observations can be reported in relation to predictions made prior to fieldwork (see above): A generally high density and possibly widespread occurrence of outcropped rocks. Refer to figure 4 below.

Figure 4 Showing the rocky outcrops

Age material: Rocks found at 23°17'18.978"E 27°23'23.9"S. Rock Age material occurs in extremely High density, much higher than 1 per 10 x10 m.

Traces of earlier episodes of Kuruman's urban development: These are clearly visible in Google Earth images of the area under consideration.

Two former 'Locations' have left a footprint in the landscape which depict the twentieth century history of Kuruman and the workings of segregationist and, later, Apartheid trajectories (as well as social imperatives within Coloured and African communities of the day, as Snyman points out – 1992:107) which led, locally, to the development of racially separated urban areas including Vaaldraai (later Wrenchville) and Mothibistad, and ultimately the political entity known as Bophuthatswana. What remained here as part of this process, under the Group Areas Act, was a buffer zone immediately east of the white town. It is this buffer zone that is to be developed and within it lie the traces of two former 'Locations' as well as the burial ground referred to.

12.1 Fossils within the Kalahari Group

The fossil record of the **Kalahari Group** is generally sparse and low in diversity. The **Gordonia Formation** dune sands were mainly active during cold, drier intervals of the Pleistocene Epoch that were inimical to most forms of life, apart from hardy, desert-adapted species. Porous dune sands are not generally conducive to fossil preservation. However, mummification of soft tissues may play a role here and migrating lime-rich groundwaters

derived from underlying lime-rich bedrocks may lead to the rapid calcretisation of organic structures such as burrows and root casts.

Occasional terrestrial fossil remains that might be expected within this unit include calcretized rhizoliths (root casts) and termitaria (e.g. Hodotermes, the harvester termite), ostrich egg shells (Struthio), tortoise remains and shells of land snails (e.g. Trigonephrus) (Almond 2008, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (e.g. Corbula, Unio) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with local watercourses and pans. Microfossils such as diatoms may be blown by wind into nearby dune sands (Du Toit 1954, Dingle et al., 1983). These Kalahari fossils (or subfossils) can be expected to occur sporadically but widely, and the overall palaeontological sensitivity of the Gordonia Formation is therefore considered to be low. Underlying calcretes might also contain trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways. Mammalian bones, teeth and horn cores (also tortoise remains, and fish, amphibian or even crocodiles in wetter depositional settings) may be expected occasionally expected within Kalahari Group sediments and calcretes, notably those associated with ancient alluvial gravels.

Younger (Quaternary to Recent) surface gravels and colluvium are probably unfossiliferous. No fossil remains were observed within the superficial deposits on Groenwater during field assessment.

13. Conclusion and Recommendations

Impacts on fossil heritage are normally confined to the prospecting phase of a development. This phase development will normally entail excavations into the superficial sediment cover (soils, alluvial gravels etc) and perhaps also into the underlying potentially fossiliferous bedrock. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good. Once constructed, the operational and decommissioning phases will not involve further adverse impacts on palaeontological heritage.

The proposed study area is underlain by Precambrian iron-rich basinal sediments of the Ghaap Group (Kuruman and Daniëlskuil Formations) as well as by glacial and volcanic rocks

of the younger Postmasburg Group (Makganyene and Ongeluk Formations) See Table 1 attached as annexure A of this report. These rocks are extremely ancient - some 2.2 -2.5 billion years old – and in most cases are unlikely to contain substantial macrofossil remains. Cherty layers (fine grained siliceous rocks) and carbonate rocks here may contain microfossil assemblages but these have not yet been recorded in the scientific literature. Large stromatolites (microbial mounds) within the Makganyene Formation have recently become the focus of research interest because they are intimately associated with cold-water glacial rocks, suggesting that tropical warm waters are not, as previously supposed, a pre-requisite for stromatolite reef development in Proterozoic times.

However, these stromatolitic reefs do not seem to have developed in the shallower marine platform settings represented at Groenwater, and no carbonate rocks or stromatolites were observed during field assessment.

Aeolian (wind-blown) sands of the Gordonia Formation (Kalahari Group) and other Quaternary to Recent superficial deposits overlying Precambrian bedrocks in the study region (e.g. alluvium, colluvium, surface gravels, wind-blown sands) are generally sparsely fossiliferous. No fossils were observed within the various superficial sediments during field assessment.

It is concluded that the proposed project is very unlikely to have a significant impact on local palaeontological heritage resources. Should substantial fossil remains be exposed during prospecting, such as well-preserved stromatolites, the ECO should safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.

ANNEXURE A

GEOLOGICAL UNIT	ROCK TYPES & AGE	FOSSIL HERITAGE	PALAEONT-OLOGICAL SENSITIVITY	RECOMMENDED MITIGATION
Gordonia Formation **KALAHARI GROUP** ***plus*** **SURFACE CALCRETE**	Mainly aeolian sands *plus* minor fluvial gravels, freshwater pan deposits, calcretes PLEISTOCENE to RECENT	calcretised rhizoliths & termitaria, ostrich egg shells, land snail shells, rare mammalian and reptile (*e.g.* tortoise) bones, teeth freshwater units associated with diatoms, molluscs, stromatolites *etc*	LOW	none recommended any substantial fossil finds to be reported by ECO to SAHRA
Makganyene & Ongeluk Fms **POSTMASBURG GROUP**	Glacial diamictites (tillites), volcanic lavas, dolomites, ironstones EARLY PROTEROZOIC (*c.* 2.2 Ga)	Stromatolites associated with glacial deposits within the Makganyene Formation (Prieska Sub-basin)	GENERALLY LOW with exception of stromatolitic units	reporting and documentation of ancient stromatolites in surface exposures of Makganyene Fm
Asbestos Hills Subgroup (Kuruman & Daniëlskuil Fms) **GHAAP GROUP**	BIF (banded iron formations) with cherty bands EARLY PROTEROZOIC (*c.* 2.5-2.4 Ga)	important early microfossil biotas	LOW	none recommended