HERITAGE SURVEY OF THE KAMEELHOEK 477, ADMINISTRATIVE DISTRICT OF HAY,

FOR DOORNRIVIER MINERALS LIMITED

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INTRODUCTION

Umlando cc was contracted by Doornrivier Minerals Limited to undertake an archaeological impact assessment of a proposed prospecting on the farm Rem. of Kameelhoek 477, Postmasburg, N. Cape. While the company holds prospecting rights for the area, they are undecided as to the type of mining that would occur, e.g. open versus shaft mines. This report focuses on the prospecting aspect of the project. The mining aspect was included so that there can be a general Heritage Impact Assessment for the farm. No significant sites were observed to limit proposed prospecting activity, however, some mitigation would be required if mining were to occur

The study area is located 14km west of Postmasburg (see figures 1 – 3). The immediate landscape is relatively flat with a few small raised hills. Larger hills do occur on the landscape, and many of these are being mined. Parts of the study area have been minimally mined in the 1950s. Between these small hills are several small natural dams allowing for water catchments. The environment is mostly arid with small thorn bush vegetation. The thorn bush occurs throughout the study area, and is some places it is so dense one cannot walk through it. These occurred mostly in the middle of the study area and on the hills.

Archaeological visibility was very good in most of the areas due to the lack of ground vegetation. The surface geology of the area consists of manganese deposits, Dwyka outcrops, and the Whitehill Shale (Dr. G. Groenewald pers. comm.). The Whitehill Shale contains some important palaeontological species.

The impacts on the area will be:

- Prospecting areas (
- Mining
- Access roads
- Excavations for mining activity

METHOD

The method for Heritage assessment consists of several steps.

The first step forms part of the desktop assessment. Here we would consult the database that has been collated by Umlando. This databases contains archaeological site locations and basic information from several provinces (information from Umlando surveys and some colleagues), most of the national and provincial monuments and battlefields in Southern Africa (http://www.vuvuzela.com/googleearth/monuments.htm) and cemeteries in southern Africa (information supplied by the Genealogical Society of Southern Africa). We use 1st and 2nd edition 1:50 000 topographical and 1937 aerial photographs where available, to assist in general location and dating of buildings and/or graves. We also consult with an historical architect, palaeontologist, and an historian where necessary. The database is in Google Earth format and thus used as a quick reference when undertaking desktop studies. Where required we would consult with a local data recording centre, however these tend to be fragmented between different institutions and areas, and thus difficult to access.

The field survey consists of walking the affected area noting where heritage sites occur. These sites are given a GPS location and a general statement of content and significance. This is in the form of a site record (see Appendix A)

The survey results will define the significance of each recorded site, as well as a management plan.

All sites are grouped according to low, medium, and high significance for the purpose of this report. Sites of low significance have no diagnostic artefacts or features. Sites of medium significance have diagnostic artefacts or features and these sites tend to be sampled. Sampling includes the collection of artefacts for

future analysis. All diagnostic pottery, such as rims, lips, and decorated sherds are sampled, while bone, stone, and shell are mostly noted. Sampling usually occurs on most sites and is part of a Phase 2. Sites of high significance are excavated and/or extensively sampled and form part of a Phase 2 and/or Phase 3. Those sites that are extensively sampled have high research potential, yet poor preservation of features.

Defining significance

Heritage sites vary according to significance and several different criteria relate to each type of site. However, there are several criteria that allow for a general significance rating of archaeological sites.

These criteria are:

1. **State of preservation of:**
   - 1.1. Organic remains:
     - 1.1.1. Faunal
     - 1.1.2. Botanical
   - 1.2. Rock art
   - 1.3. Walling
   - 1.4. Presence of a cultural deposit
   - 1.5. Features:
     - 1.5.1. Ash Features
     - 1.5.2. Graves
     - 1.5.3. Middens
     - 1.5.4. Cattle byres
     - 1.5.5. Bedding and ash complexes
2. **Spatial arrangements:**
   - 2.1. Internal housing arrangements
   - 2.2. Intra-site settlement patterns
   - 2.3. Inter-site settlement patterns

3. **Features of the site:**
   3.1. Are there any unusual, unique or rare artefacts or images at the site?
   3.2. Is it a type site?
   3.3. Does the site have a very good example of a specific time period, feature, or artefact?
4. **Research:**
   4.1. Providing information on current research projects
   4.2. Salvaging information for potential future research projects
5. **Inter- and intra-site variability**
   5.1. Can this particular site yield information regarding intra-site variability, i.e. spatial relationships between various features and artefacts?
   5.2. Can this particular site yield information about a community's social relationships within itself, or between other communities?
6. **Archaeological Experience:**
   6.1. The personal experience and expertise of the CRM practitioner should not be ignored. Experience can indicate sites that have potentially significant aspects, but need to be tested prior to any conclusions.
7. **Educational:**
   7.1. Does the site have the potential to be used as an educational instrument?
   7.2. Does the site have the potential to become a tourist attraction?
   7.3. The educational value of a site can only be fully determined after initial test-pit excavations and/or full excavations.
8. **Other Heritage Significance:**
   8.1. Palaeontological sites
   8.2. Historical buildings
   8.3. Battlefields and general Anglo-Zulu and Anglo-Boer sites
   8.4. Graves and/or community cemeteries
   8.5. Living Heritage Sites
   8.6. Cultural Landscapes, that includes old trees, hills, mountains, rivers, etc related to cultural or historical experiences.

The more a site can fulfill the above criteria, the more significant it becomes. Test-pit excavations are used to test the full potential of an archaeological deposit. This occurs in Phase 2. These test-pit excavations may require further excavations if the site is of significance (Phase 3). Sites may also be mapped and/or have artefacts sampled as a form of mitigation. Sampling normally occurs when the artefacts may be good examples of their type, but are not in a primary archaeological context. Mapping records the spatial relationship between features and artefacts.

Survey Method

The database did not yield any known heritage sites in the study area.

I began the survey in the western corner of the study area. This area was less dense with thorn bush and was relatively easy to survey. I undertook the survey walk paths close to each other working on the assumption that I would be able to observe many of the artefacts. This would allow me to make assumptions on artefact density and similarities/differences in the study area. That is if one area is intensely surveyed and yields the same types of artefacts, then other areas need not be as surveyed as intensely if they still yield the same material.

The survey yielded consistently similar types of artefacts across the entire study area. I believe this to be a representative sample of the study area. Any additional work would only be recording more of the same type of material. Figure 4 illustrates the walk paths over a three day period.

FIG. 1: GENERAL LOCATION OF THE PROPOSED MINE

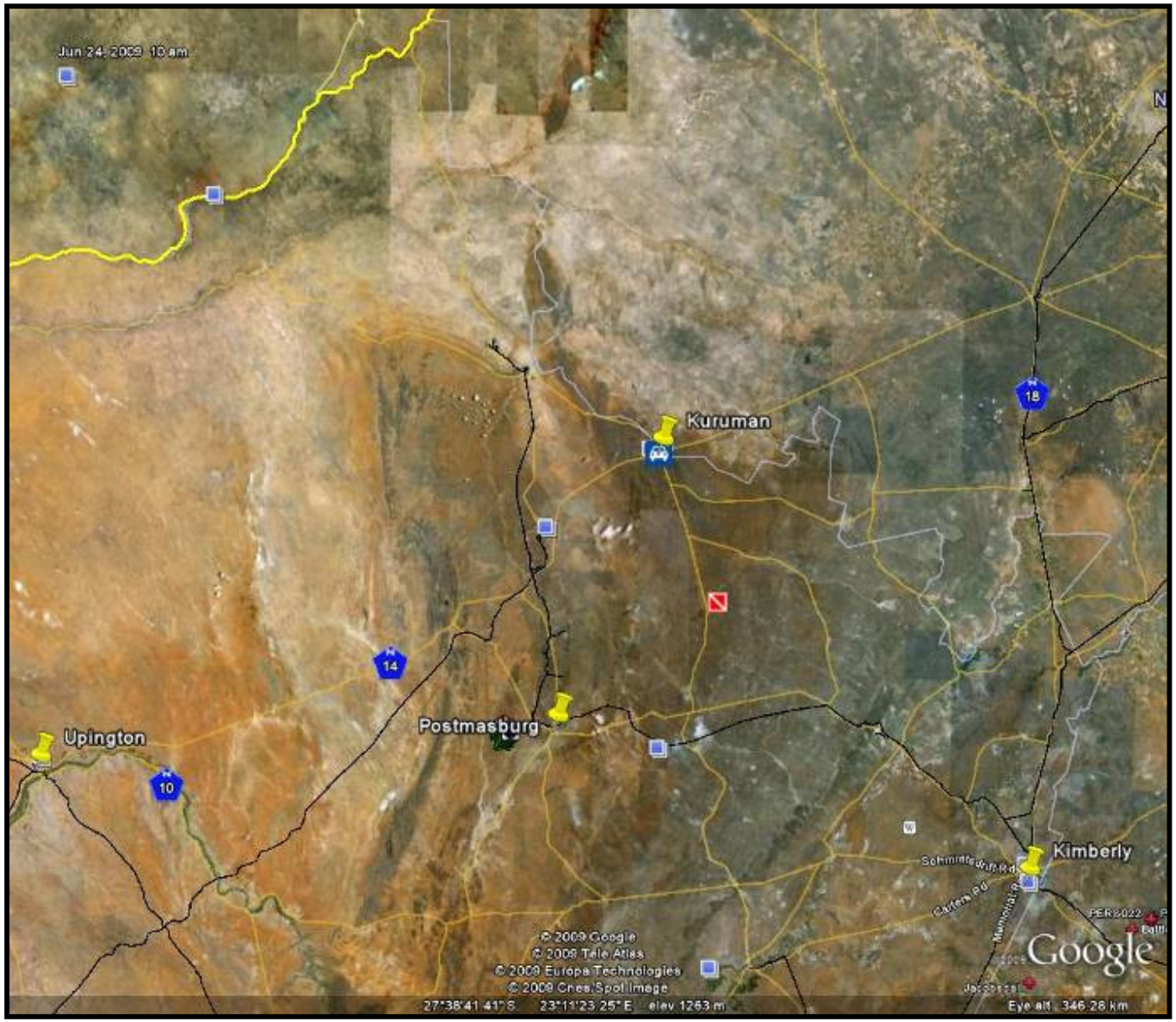
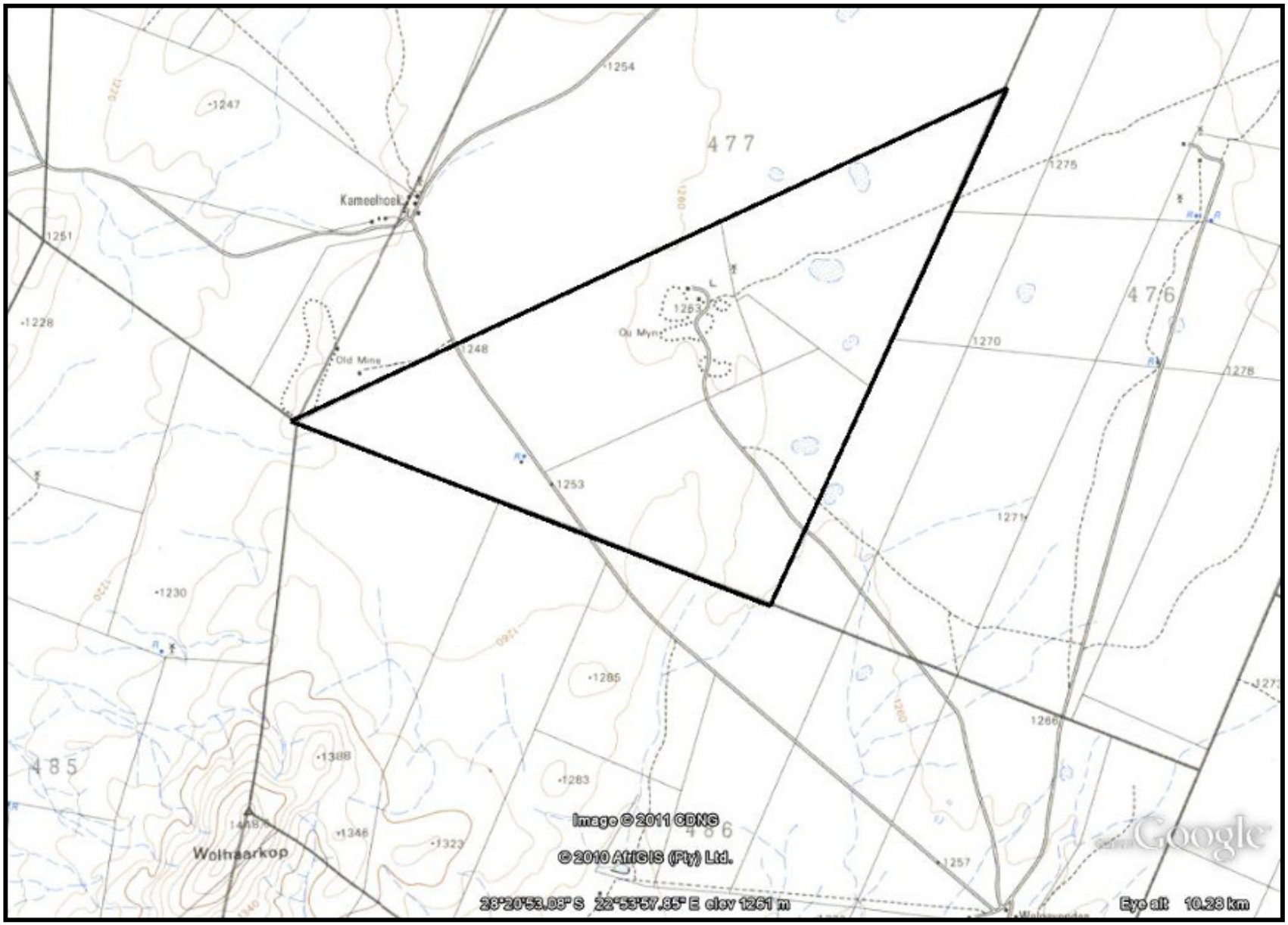


FIG. 2: LOCATION OF KAMEELHOEK

FIG. 3: LOCATION OF KAMEELHOEK ON THE 1982 TOPOGRAPHICAL MAP



RESULTS

My definition of a Stone Age site requires at least ten stone tools in a specified area. The occurrence of other artefacts, such as pottery, beads, rock art, engravings, etc. adds to the definition of a site. This definition is mainly for the Late Stone Age (LSA), but it can be adapted for the Middle Stone Age (MSA), and Early Stone Age (ESA).

A total of 375 sites and/or artefacts were recorded during the survey. Figure 5 illustrates these finds. Appendix A lists these sites according to their categories and co-ordinates.

For the purpose of this survey, I recorded artefacts and sites with the following definitions:

- LSA
  - Areas with 3 or less artefacts are considered as isolated scatters
  - Areas with 10 or more stone tools are considered sites. These included stone knapping areas, quarries, and scatters of artefacts
  - Includes engravings
- MSA
  - Artefacts that have facetted platforms and are generally ascribed o the MSA. This excludes MSA artefacts that have been re-used in the LSA
- ESA
  - These would generally consists of hand-axes or cleavers
- Quarries
  - This refers to previous prospecting that occurred in the 1950s
- Features
  - These are small structures made by humans and excluded houses, but may relate to houses
- Houses
  - Houses built for domestic or agricultural purposes and are older than 60 years in age.

In general, the entire area consists of an extended scatter of stone tools from varying ages and types. The archaeological deposit is minimal and thus the artefacts may not necessarily be in a primary context. This is more obvious in those areas taht have been mined in the past. The density of stone tools varies and the concentrations of tools may be a result of human factors, such as a manufacturing site, or natural factors, such as accumulation along drainage lines. These types of sites tend to be of low significance in that they can only provide a quantitative result. These stone tools occur all over southern Africa, and any form of collection would only be to increase the number of stone tools that are already in storage.

Having said the above, the stone tool concentrations should be at least sampled in terms of a statistical analysis and/or collected as an example of the area, if they are to be irreversibly affected. Since this report deals specifically with the prospecting of the affected area, the stone tools concentrations will not be damaged, and their locations can become part of the prospecting footprint.

It is for this reason that the results below are only general results, as a more detailed analysis would become part of the Phase 2 Archaeological Impact Assessment. The aim of the survey is to note the locations of artefacts and assess them in terms of basic content and significance.

Stone tool typologies and their associated ages are relatively well known. I have used Deacon's (1982, 1984) classification system, as well as those of other archaeologists who have worked on stone tool typologies and their chronology in the Western Cape (e.g. Anderson 1995, Manhire 1987, Manhire et al 1987, Parkington 1980, Parkington and Poggenpoel 1987)

FIG. 4: WALKPATH FOR THE KAMEELHOEK SURVEY

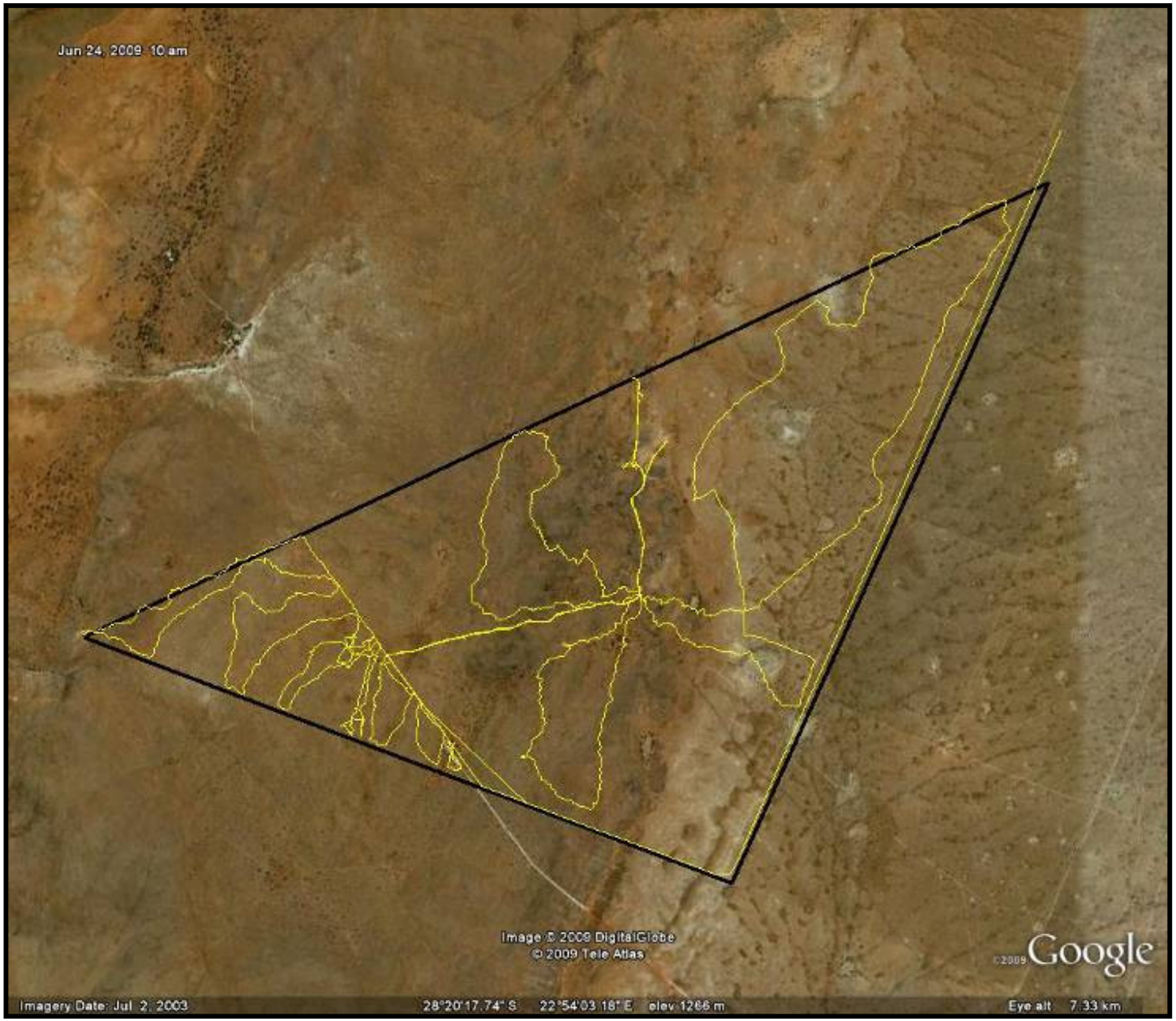
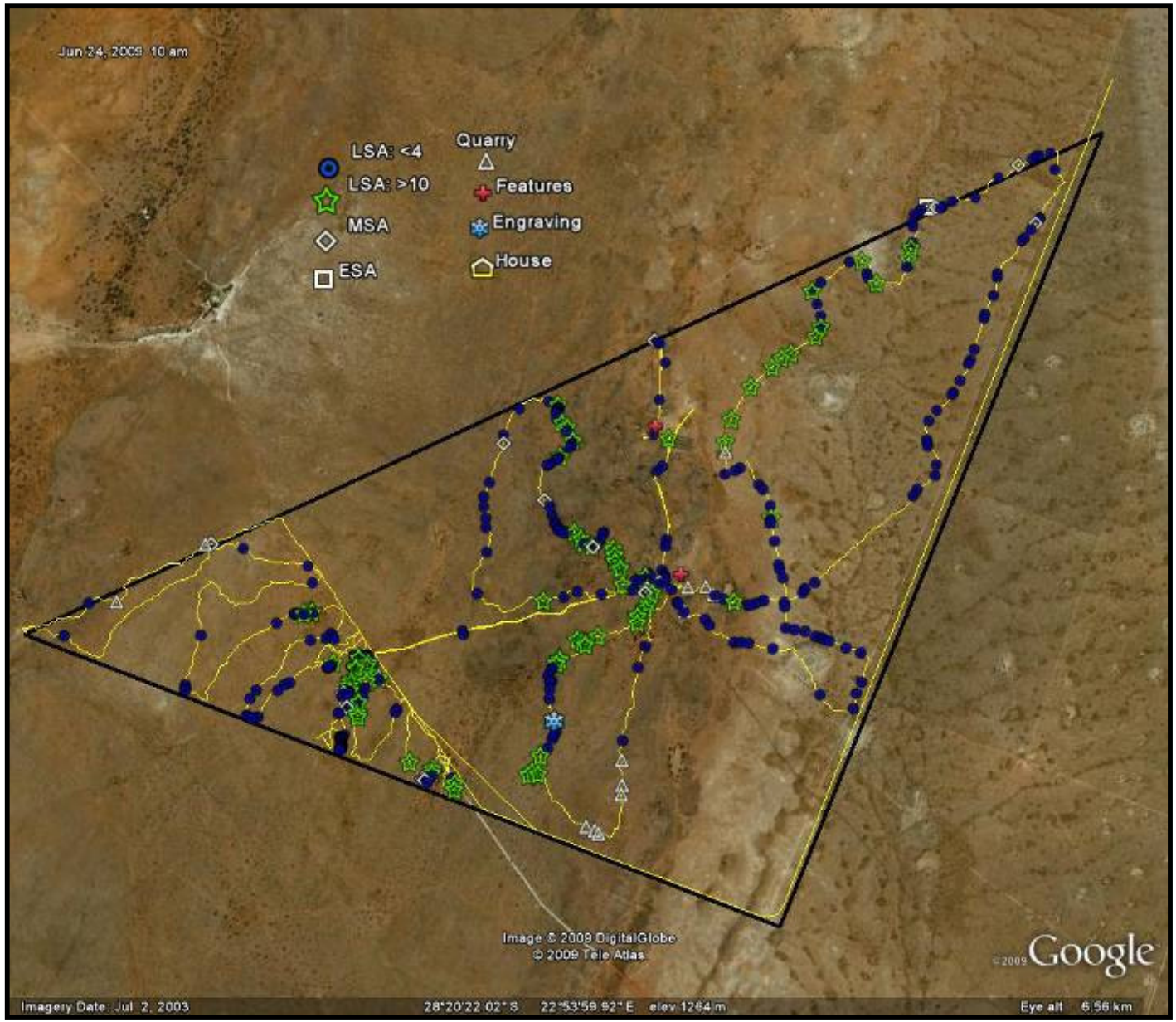


FIG. 5: LOCATION OF ARTEFACTS AND SITES FOR THE KAMEELHOEK SURVEY



LATE STONE AGE

The LSA dates from ~25 000 years ago to the 19th century.

A total of 261 areas had fewer than four artefacts: most of these are individual artefacts. Of these individual artefacts, most are formal tools[1], and include backed blades[2], adzes[3], and scrapers[4]. The adzes tend to be made on MSA flakes. The adzes may date from 4000 years ago to the recent historical past. The scrapers vary in size and style; some are medium 'duck-bill scrapers, but none were related to the small thumbnail scrapers. This suggests that some of the scrapers predate 4000 years ago. The other types of stone tools observed were (utilised) flakes and various types of cores. The most common type of core is the irregular core, although I did observe two bladelet cores.

The LSA sites, i.e. >10 stone tools, were surprisingly numerous. A total of 78 scatters were observed. The scatter consisted mostly of Wilton artefacts, although a few pre-Wilton stone tools were observed, e.g. a medium round scraper, and a few backed flakes. Most of the artefacts were (utilised) flakes, while some formal tools were observed.

The scatters were concentrated in two types of areas: those with manganese and other hard rock outcrops, and just above watering holes. At the rocky outcrops, there was a variety of stone tools, and some of the sites were either stone knapping or stone tool quarry sites. That is, these are areas where the outcrops are used to obtain and then manufacture stone tools. These areas tend to have more cores and flakes. Those areas above watering holes tended to have (utilised) flakes and formal tools, with no cores. The latter appears to be more of a hunting activity area, as opposed to a manufacturing area.

It appears that all of the ridges have a continual scatter of stone tools with varying densities. There is little, if any, archaeological deposit along these ridges.

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[1] This means that they have been purposefully modified into a certain shape for a specific function.
[2] Generally used for cutting
[3] Used for wood working
[4] Used for the removal of fat from animal hides

Significance: The individual occurrences of artefacts are of low significance. The sites, especially the manufacturing and possible “hunting activity” areas are of low to medium significance.

Mitigation: No mitigation is required for the individual scatters of stone tools. A selection of the sites with >10 tools should be systematically sampled if they are to be disturbed – see MANAGEMENT PLAN.

ENGRAVINGS

One piece of rock was located in the open and had several striations on it (fig. 6). It appears that these are engraved with a sharp object, as opposed to natural grooves. The former is V-shaped and the latter tends to be U-shaped.

Significance: The engraved stone is of high significance.

Mitigation: The engraving should be sampled.

MIDDLE STONE AGE

A total of 18 MSA artefacts were observed: this excludes MSA tools that have been modified in the LSA. All of these artefacts were isolated instances except for two areas where three MSA tools were observed near each other. The MSA tools consisted of flakes of which some had signs of utilisation. The MSA tools were defined by a facetted platform, size, and/or heavy patination.

The MSA dates from ~250 000 years ago to ~25 000 years ago.

Significance: The artefacts are of low significance.

Mitigation: No further mitigation is required; however, if the area is going to be sampled, then a few MSA artefacts should be included in the sample.

FIG. 6: ENGRAVED ROCK

EARLY STONE AGE

Only one small hand-axe was observed during the survey. By definition, the hand-axe is associated with the ESA.

The ESA dated from ~1 million years ago to ~250 000 years ago.

Significance: The artefact is of low significance.

Mitigation: No further mitigation is required, although it should be sampled, as it was the only one observed in the area.

QUARRIES

The term 'quarry' is broadly used to define the excavated prospecting holes. The quarries relate to the initial prospecting that occurred in the area in the 1950s (according to a local informant). I recorded a total of 13 quarries, although there may be more. In terms of the heritage legislation all features, or structures, older than 60 years may be protected. Since these quarries are on the border of the 60-year mark, I recorded them anyway.

Some of these quarries are visible on the 1982 1:50 000 orthophoto (fig. 3).

Significance: The quarries are of low significance, as there is nothing unique or special about the way in which they were excavated.

Mitigation: No further mitigation is required.

HOUSE

One house was observed in the study area (fig. 7). It does not appear to be older than 60 years, and the artefacts in the rubbish dump around the house attests to this. There is one area behind the main house that consists of eroded mud bricks. These probably predate the main house. The house occurs on the 1982 1:50 000 orthophoto (fig. 3).

Significance: The house is of low significance and is not older than 60 years.

Mitigation: No further mitigation is required.

FIG. 7: HOUSE AND ERODED MUD BRICK FEATURE

FEATURES

Two small features were observed. The first one is an oval-shaped area of manganese ~1.5m x 0.5m (fig. 8). The manganese has been broken, and placed into its formation. The second feature is of similar size and near the only house in the study area. This feature is almost rectangular, and is situated between the house and the ash dump.

Both features are probably only functional features of the general area; however, they may also be human graves.

Significance: The significance of the features needs to be tested.

Mitigation: While I do not believe these features are graves, this will need to be verified. Small test excavations can be undertaken to determine this.

FIG. 8: TWO SMALL FEATURES

PALAEONTOLOGY

Dr R Prevec states (see Appendix B for palaeontological report):

> "Although generally sparse, there is an important fossil record preserved within the shales of the Permocarboniferous, glacial deposits of the **Dwyka Group** and particularly the lowermost unit of the **Ecca Group (Prince Albert Formation)**. In this area, these units may well be present subsurface.
>
> The degree of disturbance created by exploration drilling on the property would be minimal, although not insignificant given the amount of surface disturbance involved in the creation of access roads to position drill rigs, support vehicles etc. The impact of mining activities on the terrain would depend on the type of mining undertaken. In the case of open cast mining, the impact would be profound.
>
> However, because the palaeontological significance of the rock strata likely to be encountered during these activities is low, the envisaged palaeontological impact, even of open cast mining is accordingly rated as **low**. However, if Ecca Group or Dwyka Group deposits are encountered, the rating would change to **moderate."**

Significance: The significance of the palaeontological remains may be high if the Dwyka levels are affected.

Mitigation: Prospecting is unlikely to have a significant impact on palaeontological remains. If mining were to occur then the impact may increase, especially if the Dwyka levels are mined. If the Dwyka levels are mined, then a palaeontologist would need to be on site to undertake inspections and sample.

MANAGEMENT PLAN

There are two types of management plans for Kameelhoek: prospecting and mining.

The activity associated with prospecting is unlikely to damage, or impact, the heritage sites: The cores for prospecting are small and will not affect the palaeontological sites either. No further management will be required for the prospecting activity, provided that

it does not occur on the two features that may (not) be graves, and they do not occur on the stone tool concentrations.

The management plan for the various types of sites is related to the type of mining that is planned for the study area. If there is opencast mining then every heritage resource in the study area will be affected and all sites (not individual artefacts) would require some form of mitigation. If the mining operation is via shafts, then only the areas where there are shafts and related infrastructure (such as roads, buildings, stockpiles, etc) would need mitigation. For the latter, the final construction footprints will need to be assessed in terms of their impact on the various sites, and these sites will need to be managed.

With the above in mind, the mitigation for the various types of sites and finds are as follows.

The possible human graves need to be tested: i.e. I would suggest that these two are excavated until either human remains are observed, or bedrock is reached. If human remains are observed, the excavations would need to stop, and a social impact assessment will need to be undertaken. I do not believe these are graves, but would suggest that this is verified. It is often too difficult to assess this without an excavation.

If open cast mining is favoured then I would suggest that at least 50% of sites (i.e. have >10 artefacts) are sampled. Open cast mining will destroy every site and thus needs to be adequately managed. The sampling size may be between 25m^2 – 50m^2 in size. The sampling would remove every artefact in that specified area. The sampling should also note the various types sites (e.g. manufacture versus hunting) in the area and ensure that these are equally sampled. These samples may be given to the regional recording centre such as the McGregor Museum.

If the shaft mining option was chosen, then only a selected few areas would be affected. These areas would thus require immediate mitigation in the form of sampling or excavation. The numbers of sites affected will depend on the mining footprint.

The calcrete and Dwyka formations in the study area are of palaeontological significance. The type of mining operations will determine the type of mitigation required. If there will be open cast mining, then a palaeontologist should access the site after bush clearance and possibly during mining operations. This will need to be built into the safety regulations for the mine. This is because open cast mining will expose, and damage, the entire fossil horizon. Only a competent palaeontologist would be able to assess the horizons for palaeontological remains. If shafts are used, then a palaeontologist will need to assess only those areas that are affected by mining construction.

CONCLUSION

Umlando undertook an archaeological impact assessment of the farm Rem. of Kameelhoek 477, for Doornrivier Minerals Limited, near Postmasburg, N. Cape. The area currently has prospecting rights and the type of mining to be undertaken is undecided. The type of mining that will occur will determine the type of management plan that is undertaken. The area is currently marked for prospecting, and no further mitigation would be required.

While the sites are of low to medium significance, they should be sampled if they are going to be affected. Similarly, the palaeontological remains occur over the entire study area and need to be systematically sampled and monitored during construction activity. Two areas will need to be partially excavated to ensure that they are not graves.

If the archaeological management plan becomes part of the general management plan for the mine, then there is no reason for the archaeology and palaeontology to limit the proposed mining.

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APPENDIX A

LOCATIONS OF ARTEFACTS AND FEATURES

The location of each site, and its category are summarised below. A phase 2 would undertake sampling at the more important sites.

NAME	LATITUDE	LONGITUDE	ALTITUDE (m)	SYMBOL	DESC
006	-28.3461990	22.8882310	1260.9	LSA <5	07-DEC-09 11:24:53AM
007	-28.3461680	22.8881490	1261.1	LSA <5	07-DEC-09 11:26:07AM
008	-28.3461860	22.8879900	1261.1	LSA <5	07-DEC-09 11:26:50AM
009	-28.3461780	22.8878670	1260.9	LSA <5	07-DEC-09 11:27:52AM
010	-28.3461850	22.8874370	1260.4	LSA <5	07-DEC-09 11:29:53AM
011	-28.3453720	22.8859110	1258.2	LSA <5	07-DEC-09 11:35:39AM
012	-28.3451620	22.8861680	1259.0	LSA <5	07-DEC-09 11:37:00AM
013	-28.3452070	22.8862580	1259.9	LSA <5	07-DEC-09 11:37:35AM
014	-28.3454530	22.8863600	1260.4	LSA <5	07-DEC-09 11:40:20AM
015	-28.3467010	22.8873200	1263.0	LSA <5	07-DEC-09 11:59:22AM
016	-28.3479420	22.8869210	1265.2	LSA <5	07-DEC-09 12:03:57PM
017	-28.3479420	22.8869190	1265.5	MSA	07-DEC-09 12:04:04PM
018	-28.3480910	22.8868720	1265.5	LSA <5	07-DEC-09 12:05:21PM
019	-28.3488610	22.8867100	1263.5	LSA <5	07-DEC-09 12:07:38PM
020	-28.3488430	22.8867370	1263.3	LSA <5	07-DEC-09 12:08:04PM
021	-28.3499210	22.8868240	1258.7	LSA <5	07-DEC-09 12:52:53PM
022	-28.3499620	22.8868280	1258.7	LSA <5	07-DEC-09 12:53:08PM
023	-28.3499730	22.8868570	1258.5	LSA <5	07-DEC-09 12:53:17PM
024	-28.3500230	22.8868650	1259.2	LSA <5	07-DEC-09 12:53:48PM
025	-28.3500430	22.8868800	1258.7	LSA <5	07-DEC-09 12:54:01PM

026	-28.3500590	22.8869120	1259.2	LSA <5	07-DEC-09 12:54:22PM
027	-28.3501750	22.8868830	1259.7	LSA <5	07-DEC-09 12:55:25PM
028	-28.3502990	22.8868810	1259.9	LSA <5	07-DEC-09 12:55:56PM
029	-28.3503500	22.8869230	1259.9	LSA <5	07-DEC-09 12:56:15PM
030	-28.3503570	22.8869350	1259.7	LSA <5	07-DEC-09 12:56:23PM
031	-28.3503840	22.8869080	1260.2	LSA <5	07-DEC-09 12:56:36PM
032	-28.3504290	22.8869180	1259.9	LSA <5	07-DEC-09 12:56:52PM
033	-28.3504350	22.8869270	1260.2	LSA <5	07-DEC-09 12:57:08PM ROUNDSCRAPER
034	-28.3504820	22.8868710	1261.1	LSA <5	07-DEC-09 12:58:53PM
035	-28.3505160	22.8868360	1261.6	LSA <5	07-DEC-09 12:59:20PM
036	-28.3504660	22.8868500	1260.2	LSA <5	07-DEC-09 1:00:19PM
037	-28.3504570	22.8868480	1260.9	LSA <5	07-DEC-09 1:00:30PM
038	-28.3502310	22.8869340	1260.7	LSA <5	07-DEC-09 1:00:56PM
039	-28.3499590	22.8869520	1259.4	LSA <5	07-DEC-09 1:01:30PM
040	-28.3498270	22.8870300	1261.1	LSA <5	07-DEC-09 1:01:47PM
041	-28.3486160	22.8871270	1259.7	MSA	07-DEC-09 1:04:13PM
042	-28.3486080	22.8871270	1260.7	LSA <5	07-DEC-09 1:04:42PM
043	-28.3481760	22.8872030	1260.4	LSA <5	07-DEC-09 1:05:46PM
044	-28.3479510	22.8872430	1261.1	LSA <5	07-DEC-09 1:06:18PM
045	-28.3478790	22.8872220	1261.4	LSA <5	07-DEC-09 1:06:37PM
046	-28.3478610	22.8872280	1261.4	LSA <5	07-DEC-09 1:06:45PM
047	-28.3478450	22.8872460	1260.2	LSA <5	07-DEC-09 1:06:55PM
048	-28.3478280	22.8872610	1261.1	LSA >10	07-DEC-09 1:07:04PM

049	-28.3477710	22.8872530	1263.0	LSA >10	07-DEC-09 1:07:36PM
050	-28.3476060	22.8872180	1262.1	LSA >10	07-DEC-09 1:08:07PM
051	-28.3474360	22.8872810	1261.4	LSA >10	07-DEC-09 1:08:28PM
052	-28.3473440	22.8872990	1261.4	LSA >10	07-DEC-09 1:08:47PM
053	-28.3468020	22.8875350	1259.2	LSA >10	07-DEC-09 1:11:15PM
054	-28.3467250	22.8875730	1259.9	LSA >10	07-DEC-09 1:11:35PM
055	-28.3463180	22.8876690	1259.9	LSA >10	07-DEC-09 1:13:16PM
056	-28.3465380	22.8863230	1259.7	LSA >10	07-DEC-09 1:20:03PM
057	-28.3466600	22.8862560	1260.9	LSA <5	07-DEC-09 1:20:46PM
058	-28.3466770	22.8862140	1261.1	LSA <5	07-DEC-09 1:21:04PM
059	-28.3467550	22.8860930	1262.3	LSA <5	07-DEC-09 1:22:41PM
060	-28.3467500	22.8860260	1262.1	LSA <5	07-DEC-09 1:23:08PM
061	-28.3474430	22.8840640	1258.5	LSA <5	07-DEC-09 1:28:03PM
062	-28.3475410	22.8837860	1258.2	LSA <5	07-DEC-09 1:28:40PM
063	-28.3478050	22.8834270	1258.0	LSA <5	07-DEC-09 1:29:40PM
064	-28.3490240	22.8824340	1257.8	LSA <5	07-DEC-09 1:32:21PM
065	-28.3490800	22.8821230	1256.8	LSA <5	07-DEC-09 1:33:06PM
066	-28.3491020	22.8820970	1257.3	LSA <5	07-DEC-09 1:33:18PM
067	-28.3489920	22.8818760	1256.6	LSA <5	07-DEC-09 1:34:02PM
068	-28.3489570	22.8818220	1256.1	LSA <5	07-DEC-09 1:34:13PM
069	-28.3481870	22.8819660	1255.8	LSA <5	07-DEC-09 1:36:02PM
070	-28.3477900	22.8822950	1256.3	LSA <5	07-DEC-09 1:36:58PM
071	-28.3454760	22.8850840	1254.4	LSA <5	07-DEC-09 1:44:59PM

072	-28.3442030	22.8851450	1256.6	LSA <5	07-DEC-09 1:52:24PM
073	-28.3441790	22.8850960	1256.8	LSA >10	07-DEC-09 1:52:41PM
074	-28.3441590	22.8850590	1256.8	LSA >10	07-DEC-09 1:53:00PM
075	-28.3442440	22.8846760	1257.8	LSA <5	07-DEC-09 1:53:54PM
076	-28.3442360	22.8846460	1257.3	LSA >10	07-DEC-09 1:54:16PM
077	-28.3442480	22.8843950	1257.8	LSA <5	07-DEC-09 1:55:13PM
078	-28.3442350	22.8843460	1257.3	LSA <5	07-DEC-09 1:55:28PM
079	-28.3442310	22.8841890	1257.3	LSA <5	07-DEC-09 1:56:07PM
080	-28.3442400	22.8841680	1257.0	LSA <5	07-DEC-09 1:56:19PM
081	-28.3446700	22.8832310	1257.0	LSA <5	07-DEC-09 1:58:31PM
082	-28.3478000	22.8784820	1255.4	LSA <5	07-DEC-09 2:12:08PM
083	-28.3477090	22.8784960	1252.5	LSA <5	07-DEC-09 2:16:59PM
084	-28.3475490	22.8784740	1252.0	LSA <5	07-DEC-09 2:17:55PM
085	-28.3452450	22.8791820	1248.2	LSA <5	07-DEC-09 2:23:37PM
086	-28.3427720	22.8850770	1240.5	LSA <5	07-DEC-09 2:48:07PM
087	-28.3419650	22.8848280	1240.0	LSA <5	07-DEC-09 2:50:33PM
088	-28.3411360	22.8812540	1238.3	LSA <5	07-DEC-09 2:57:47PM
089	-28.3452670	22.8718310	1238.3	LSA <5	07-DEC-09 3:16:58PM
090	-28.3437290	22.8730960	1241.2	LSA <5	07-DEC-09 3:32:27PM
091	-28.3436870	22.8745320	1238.8	Quarry	07-DEC-09 3:36:07PM
092	-28.3409460	22.8791680	1242.6	Quarry	07-DEC-09 3:46:04PM
094	-28.3409580	22.8795090	1243.1	MSA	07-DEC-09 3:47:08PM
095	-28.3465540	22.8881830	1249.6	LSA >10	08-DEC-09 10:01:02AM

096	-28.3466950	22.8881180	1249.6	LSA >10	08-DEC-09 10:03:02AM
097	-28.3474000	22.8881290	1250.8	LSA >10	08-DEC-09 10:06:50AM
098	-28.3476850	22.8880900	1250.8	LSA <5	08-DEC-09 10:07:57AM "MSA" ADZE
099	-28.3480800	22.8879800	1250.5	LSA <5	08-DEC-09 10:09:38AM
100	-28.3483710	22.8877310	1251.0	LSA <5	08-DEC-09 10:10:49AM
100	-28.3483710	22.8877310	1251.0	LSA >10	08-DEC-09 10:10:49AM
101	-28.3488611	22.8876667		LSA >10	
102	-28.3490250	22.8877170	1250.5	LSA >10	08-DEC-09 10:13:11AM
103	-28.3488100	22.8897260	1250.3	LSA <5	08-DEC-09 10:23:58AM
104	-28.3486590	22.8898030	1250.5	LSA <5	08-DEC-09 10:24:22AM
105	-28.3511120	22.8905060	1252.2	LSA >10	08-DEC-09 10:30:52AM
106	-28.3518710	22.8912130	1248.6	LSA <5	08-DEC-09 10:33:33AM
106	-28.3518710	22.8912130	1248.6	MSA	08-DEC-09 10:33:33AM
107	-28.3519440	22.8913070	1248.6	MSA	08-DEC-09 10:34:05AM
108	-28.3520240	22.8914790	1247.4	LSA <5	08-DEC-09 10:34:58AM
109	-28.3517170	22.8917310	1248.2	LSA <5	08-DEC-09 10:36:24AM
110	-28.3515950	22.8916880	1248.9	LSA >10	08-DEC-09 10:37:11AM KNAPPING
111	-28.3514160	22.8917210	1248.6	LSA >10	08-DEC-09 10:39:15AM
112	-28.3523530	22.8928760	1248.2	LSA >10	08-DEC-09 10:45:16AM
113	-28.3520590	22.8929170	1247.7	LSA >10	08-DEC-09 10:47:44AM
114	-28.3518220	22.8927590	1247.7	LSA <5	08-DEC-09 10:50:12AM
115	-28.3472990	22.8888060	1252.7	LSA <5	08-DEC-09 11:02:18AM
116	-28.3472570	22.8887780	1252.2	LSA >10	08-DEC-09 11:02:38AM

117	-28.3465580	22.8884740	1251.8	LSA <5	08-DEC-09 11:04:25AM
119	-28.3430920	22.9044200	1254.2	LSA <5	08-DEC-09 11:17:04AM
120	-28.3436830	22.9047100	1253.9	LSA <5	08-DEC-09 11:18:45AM
121	-28.3437470	22.9047930	1254.4	LSA <5	08-DEC-09 11:19:02AM
122	-28.3441300	22.9051010	1254.2	Quarry	08-DEC-09 11:20:45AM
123	-28.3441590	22.9050890	1254.9	LSA <5	08-DEC-09 11:21:06AM
124	-28.3444930	22.9062080	1254.4	LSA <5	08-DEC-09 11:23:59AM
125	-28.3447750	22.9064440	1254.6	LSA <5	08-DEC-09 11:24:53AM
126	-28.3455810	22.9077520	1256.3	LSA <5	08-DEC-09 11:27:41AM
127	-28.3455690	22.9081160	1256.6	LSA <5	08-DEC-09 11:28:18AM
128	-28.3456110	22.9085350	1257.8	LSA <5	08-DEC-09 11:28:50AM
129	-28.3458630	22.9098050	1261.8	LSA <5	08-DEC-09 11:30:51AM
130	-28.3480080	22.9122660	1259.9	LSA <5	08-DEC-09 11:39:15AM
131	-28.3486420	22.9140120	1261.1	LSA <5	08-DEC-09 11:43:00AM
132	-28.3479350	22.9141970	1263.0	LSA <5	08-DEC-09 11:44:02AM
133	-28.3474210	22.9144830	1261.6	LSA <5	08-DEC-09 11:44:54AM
134	-28.3460660	22.9144990	1260.7	LSA <5	08-DEC-09 11:47:18AM
135	-28.3458360	22.9137180	1259.4	LSA <5	08-DEC-09 11:48:15AM
136	-28.3455080	22.9128500	1261.1	LSA <5	08-DEC-09 11:49:34AM
137	-28.3454230	22.9125140	1260.9	LSA <5	08-DEC-09 11:50:18AM
138	-28.3453460	22.9124010	1260.2	LSA <5	08-DEC-09 11:50:30AM
139	-28.3453010	22.9121120	1261.6	LSA <5	08-DEC-09 11:51:03AM
140	-28.3450650	22.9115670	1262.1	LSA <5	08-DEC-09 11:51:42AM

141	-28.3449910	22.9109970	1263.5	LSA <5	08-DEC-09 11:52:22AM
142	-28.3449000	22.9105210	1265.5	LSA <5	08-DEC-09 11:54:13AM
143	-28.3439070	22.9104980	1265.0	LSA <5	08-DEC-09 11:55:41AM
144	-28.3436970	22.9104770	1265.2	LSA <5	08-DEC-09 11:55:58AM
145	-28.3425430	22.9104390	1264.0	LSA <5	08-DEC-09 11:57:37AM
146	-28.3421380	22.9102800	1264.2	LSA <5	08-DEC-09 11:58:13AM
147	-28.3419160	22.9102320	1265.9	LSA <5	08-DEC-09 11:58:40AM
148	-28.3407920	22.9100300	1264.7	LSA <5	08-DEC-09 12:00:12PM
149	-28.3399420	22.9098420	1264.5	LSA <5	08-DEC-09 12:01:31PM
150	-28.3397630	22.9098290	1264.5	LSA <5	08-DEC-09 12:01:59PM
151	-28.3397070	22.9098520	1263.5	LSA >10	08-DEC-09 12:02:21PM
152	-28.3390960	22.9098510	1264.2	LSA <5	08-DEC-09 12:03:18PM
153	-28.3383080	22.9094710	1263.8	LSA <5	08-DEC-09 12:04:35PM
154	-28.3380760	22.9092370	1264.0	LSA <5	08-DEC-09 12:05:01PM
155	-28.3372630	22.9082370	1265.9	LSA <5	08-DEC-09 12:07:19PM
156	-28.3374080	22.9079600	1265.7	LSA <5	08-DEC-09 12:07:40PM
157	-28.3375660	22.9073960	1264.2	LSA <5	08-DEC-09 12:08:30PM
158	-28.3365130	22.9074320	1265.7	Quarry	08-DEC-09 12:14:56PM
159	-28.3360310	22.9074340	1265.9	LSA >10	08-DEC-09 12:15:56PM
160	-28.3349150	22.9077780	1266.7	LSA >10	08-DEC-09 12:18:14PM
161	-28.3332970	22.9088850	1266.4	LSA >10	08-DEC-09 12:21:10PM
162	-28.3323230	22.9100890	1265.5	LSA >10	08-DEC-09 12:23:29PM
163	-28.3318790	22.9106170	1265.7	LSA >10	08-DEC-09 12:24:32PM

164	-28.3316380	22.9111430	1264.0	LSA >10	08-DEC-09 12:28:17PM
165	-28.3307840	22.9125490	1264.0	LSA >10	08-DEC-09 12:30:33PM
166	-28.3303040	22.9128480	1263.5	LSA >10	08-DEC-09 12:31:50PM
167	-28.3302530	22.9129080	1264.2	LSA <5	08-DEC-09 12:32:00PM
168	-28.3297340	22.9128710	1264.5	LSA <5	08-DEC-09 12:33:14PM
169	-28.3291370	22.9126860	1265.2	LSA <5	08-DEC-09 12:34:07PM
170	-28.3284890	22.9124110	1264.2	LSA >10	08-DEC-09 12:35:27PM
171	-28.3283430	22.9125210	1264.5	LSA <5	08-DEC-09 12:35:46PM
172	-28.3280200	22.9129380	1264.0	LSA <5	08-DEC-09 12:36:31PM
173	-28.3269840	22.9145670	1264.2	LSA <5	08-DEC-09 12:39:10PM
174	-28.3269480	22.9152340	1263.3	LSA >10	08-DEC-09 12:41:08PM
175	-28.3275640	22.9155150	1263.3	LSA <5	08-DEC-09 12:43:55PM
176	-28.3278100	22.9155940	1263.0	LSA <5	08-DEC-09 12:44:30PM
177	-28.3280830	22.9160110	1262.1	LSA >10	08-DEC-09 12:45:33PM
178	-28.3272310	22.9178020	1260.2	LSA <5	08-DEC-09 12:49:56PM
179	-28.3268600	22.9178680	1260.2	LSA >10	08-DEC-09 12:51:14PM
180	-28.3262640	22.9180310	1261.8	LSA >10	08-DEC-09 12:52:49PM
181	-28.3259740	22.9181530	1261.1	LSA <5	08-DEC-09 12:53:36PM
182	-28.3251700	22.9182200	1261.4	LSA <5	08-DEC-09 12:54:56PM
183	-28.3249200	22.9181940	1261.8	LSA <5	08-DEC-09 12:55:35PM
184	-28.3245360	22.9183070	1262.1	LSA <5	08-DEC-09 12:56:25PM
185	-28.3242820	22.9186670	1261.8	LSA <5	08-DEC-09 12:57:18PM
186	-28.3242780	22.9187010	1261.8	LSA <5	08-DEC-09 12:57:30PM

187	-28.3241600	22.9189580	1262.3	MSA	08-DEC-09 12:58:21PM
188	-28.3241490	22.9189850	1262.6	MSA	08-DEC-09 12:59:10PM
189	-28.3241730	22.9190070	1262.3	ESA	08-DEC-09 12:59:31PM
190	-28.3241990	22.9195160	1262.6	MSA	08-DEC-09 1:00:55PM
191	-28.3242070	22.9198350	1263.3	LSA <5	08-DEC-09 1:01:43PM
192	-28.3240970	22.9199410	1262.8	LSA <5	08-DEC-09 1:02:17PM
193	-28.3238590	22.9204770	1263.5	LSA <5	08-DEC-09 1:03:12PM
194	-28.3236530	22.9218000	1264.5	LSA <5	08-DEC-09 1:05:19PM
195	-28.3226280	22.9231570	1266.9	LSA <5	08-DEC-09 1:08:24PM
196	-28.3220210	22.9242800	1268.3	MSA	08-DEC-09 1:11:24PM
197	-28.3216600	22.9250970	1269.1	LSA <5	08-DEC-09 1:13:41PM
198	-28.3214960	22.9253410	1269.3	LSA <5	08-DEC-09 1:14:59PM
199	-28.3214720	22.9255280	1269.5	LSA <5	08-DEC-09 1:15:18PM
200	-28.3213600	22.9261580	1270.7	LSA <5	08-DEC-09 1:18:54PM
201	-28.3222180	22.9263450	1271.0	LSA <5	08-DEC-09 1:22:26PM
202	-28.3247450	22.9253430	1272.2	LSA <5	08-DEC-09 1:27:14PM
203	-28.3247580	22.9253420	1271.9	LSA <5	08-DEC-09 1:27:22PM
204	-28.3250550	22.9250510	1271.5	MSA	08-DEC-09 1:28:02PM
205	-28.3253280	22.9248180	1271.2	LSA <5	08-DEC-09 1:28:41PM
206	-28.3257580	22.9244270	1269.3	LSA <5	08-DEC-09 1:29:27PM
207	-28.3259280	22.9242540	1270.3	LSA <5	08-DEC-09 1:29:47PM
208	-28.3275880	22.9228090	1270.0	LSA <5	08-DEC-09 1:32:38PM
209	-28.3277770	22.9227800	1270.3	LSA <5	08-DEC-09 1:32:55PM

210	-28.3287020	22.9225290	1269.5	LSA <5	08-DEC-09 1:34:19PM
211	-28.3296430	22.9219940	1269.8	LSA <5	08-DEC-09 1:35:43PM
212	-28.3298610	22.9219350	1270.0	LSA <5	08-DEC-09 1:35:58PM
213	-28.3314140	22.9213260	1268.3	LSA <5	08-DEC-09 1:38:11PM
214	-28.3319330	22.9210870	1270.0	LSA <5	08-DEC-09 1:38:58PM
215	-28.3321440	22.9209490	1269.3	LSA <5	08-DEC-09 1:39:20PM
216	-28.3329780	22.9204550	1268.6	LSA <5	08-DEC-09 1:40:45PM
217	-28.3335500	22.9200560	1267.8	LSA <5	08-DEC-09 1:41:36PM
218	-28.3336600	22.9199620	1267.8	LSA <5	08-DEC-09 1:41:46PM
219	-28.3344430	22.9191020	1267.8	LSA <5	08-DEC-09 1:43:22PM
220	-28.3349510	22.9186480	1265.7	LSA <5	08-DEC-09 1:44:13PM
221	-28.3358750	22.9184830	1266.7	LSA <5	08-DEC-09 1:45:35PM
222	-28.3360550	22.9185310	1267.1	LSA <5	08-DEC-09 1:45:51PM
223	-28.3361970	22.9185350	1266.4	LSA <5	08-DEC-09 1:46:02PM
224	-28.3371130	22.9189580	1267.4	LSA <5	08-DEC-09 1:47:36PM
225	-28.3376370	22.9188760	1266.2	LSA <5	08-DEC-09 1:48:24PM
226	-28.3382880	22.9178690	1266.2	LSA <5	08-DEC-09 1:49:59PM
227	-28.3386210	22.9176200	1265.7	LSA <5	08-DEC-09 1:50:37PM
228	-28.3427660	22.9121570	1267.8	LSA <5	08-DEC-09 2:00:08PM
229	-28.3430450	22.9116150	1266.7	LSA <5	08-DEC-09 2:01:00PM
230	-28.3432540	22.9114820	1267.4	LSA <5	08-DEC-09 2:01:31PM
231	-28.3436160	22.9093710	1265.9	LSA <5	08-DEC-09 2:04:39PM
232	-28.3436100	22.9093400	1265.7	LSA <5	08-DEC-09 2:04:47PM

233	-28.3437390	22.9089480	1265.0	LSA <5	08-DEC-09 2:05:30PM
234	-28.3438270	22.9086630	1265.0	LSA <5	08-DEC-09 2:06:08PM
235	-28.3438220	22.9085010	1264.7	LSA <5	08-DEC-09 2:06:29PM
236	-28.3436770	22.9077540	1261.4	LSA >10	08-DEC-09 2:10:41PM KNAPPING
237	-28.3435470	22.9072480	1260.4	LSA <5	08-DEC-09 2:14:05PM
238	-28.3433710	22.9067680	1261.1	LSA <5	08-DEC-09 2:16:39PM
239	-28.3433550	22.9066800	1261.4	Quarry	08-DEC-09 2:17:01PM
240	-28.3429670	22.9062590	1260.7	Quarry	08-DEC-09 2:19:10PM
241	-28.3430120	22.9052960	1260.7	Quarry	08-DEC-09 2:23:07PM
242	-28.3429110	22.9049030	1260.7	Features	08-DEC-09 2:24:37PM
243	-28.3457610	22.9030200	1255.1	LSA <5	08-DEC-09 3:02:54PM
244	-28.3467370	22.9026040	1255.8	LSA <5	08-DEC-09 3:04:30PM
245	-28.3501080	22.9017760	1259.9	LSA <5	08-DEC-09 3:11:28PM
246	-28.3509980	22.9016950	1263.0	Quarry	08-DEC-09 3:14:12PM
247	-28.3521240	22.9017070	1265.5	Quarry	08-DEC-09 3:18:30PM
248	-28.3525410	22.9016620	1265.2	Quarry	08-DEC-09 3:19:51PM
249	-28.3542940	22.9004620	1264.7	Quarry	08-DEC-09 3:27:34PM
250	-28.3541520	22.9002710	1263.5	Quarry	08-DEC-09 3:31:44PM
251	-28.3539890	22.8998110	1262.3	Quarry	08-DEC-09 3:33:45PM
252	-28.3516440	22.8972830	1251.8	LSA >10	08-DEC-09 3:41:19PM 2 KNAP
253	-28.3516900	22.8967790	1251.8	LSA >10	08-DEC-09 3:42:34PM
254	-28.3515510	22.8969780	1253.2	LSA >10	08-DEC-09 3:45:10PM
255	-28.3508240	22.8973950	1251.0	LSA >10	08-DEC-09 3:48:54PM

256	-28.3504650	22.8978080	1253.9	LSA <5	08-DEC-09 3:50:19PM
257	-28.3500300	22.8980610	1254.2	LSA <5	08-DEC-09 3:52:52PM
258	-28.3498900	22.8981190	1254.9	Engraving	08-DEC-09 3:53:51PM
259	-28.3498930	22.8981250	1253.7	LSA <5	08-DEC-09 3:53:58PM
260	-28.3496840	22.8982550	1253.0	LSA <5	08-DEC-09 3:55:11PM
261	-28.3482080	22.8978830	1251.0	LSA <5	08-DEC-09 4:00:32PM
262	-28.3477590	22.8979070	1251.3	LSA <5	08-DEC-09 4:01:33PM
263	-28.3473760	22.8980260	1251.5	LSA <5	08-DEC-09 4:02:54PM
264	-28.3473950	22.8978950	1251.5	LSA <5	08-DEC-09 4:03:11PM
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APPENDIX B

PALAEONTOLOGICAL ASSESSMENT

PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

KAMEELHOEK 477 REMAINDER,
POSTMASBURG DISTRICT, NORTHERN CAPE, RSA

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FOR DOORNRIVIER MINERALS LIMITED

DATE: 01 February 2011

INTRODUCTION

Umlando cc was contracted by Doornrivier Minerals Limited to undertake an archaeological impact assessment of a proposed mining area on Kameelhoek 477 Remainder property near Postmasburg in the Northern Cape. SAHRA subsequently requested a Palaeontological Impact Assessment of the area, and this study was accordingly commissioned, on behalf of the client, by Gavin Anderson of Umlando.

In compliance with the National Heritage Resources Act of 1999 a Phase I desktop survey of the potential palaeontological heritage of the area targeted for development was undertaken to:

1) identify exposed and subsurface rock formations that are considered to be palaeontologically significant;

2) assess the level of palaeontological significance of these formations

3) comment on the impact of the development on these actual/potential fossil resources

4) make recommendations as to how the developer should conserve or mitigate damage to these resources.

This desktop assessment represents the first step in the evaluation of the site for its potential to yield fossil material. Because of the age and nature of the deposits exposed at surface level, fieldwork to scope the area was considered unnecessary for the purposes of a Phase I assessment.

Location of proposed prospecting/development

The Kameelhoek 477 Remainder is situated approximately 85km south of Sishen Mine and 14 km west of Postmasburg in the Northern Cape Province (Fig. 1). The property is situated on the Northern boundary of the Welgevonden 476, and the western boundary of the Welgevonden 486 property which both form part of the Kolomela Mining rights area in the Postmasburg district. The Kameelhoek 477 Remainder property forms a triangular shaped area of approximately 700ha (Fig. 2).

FIG. 1 GENERAL LOCATION OF THE PROPOSED MINE

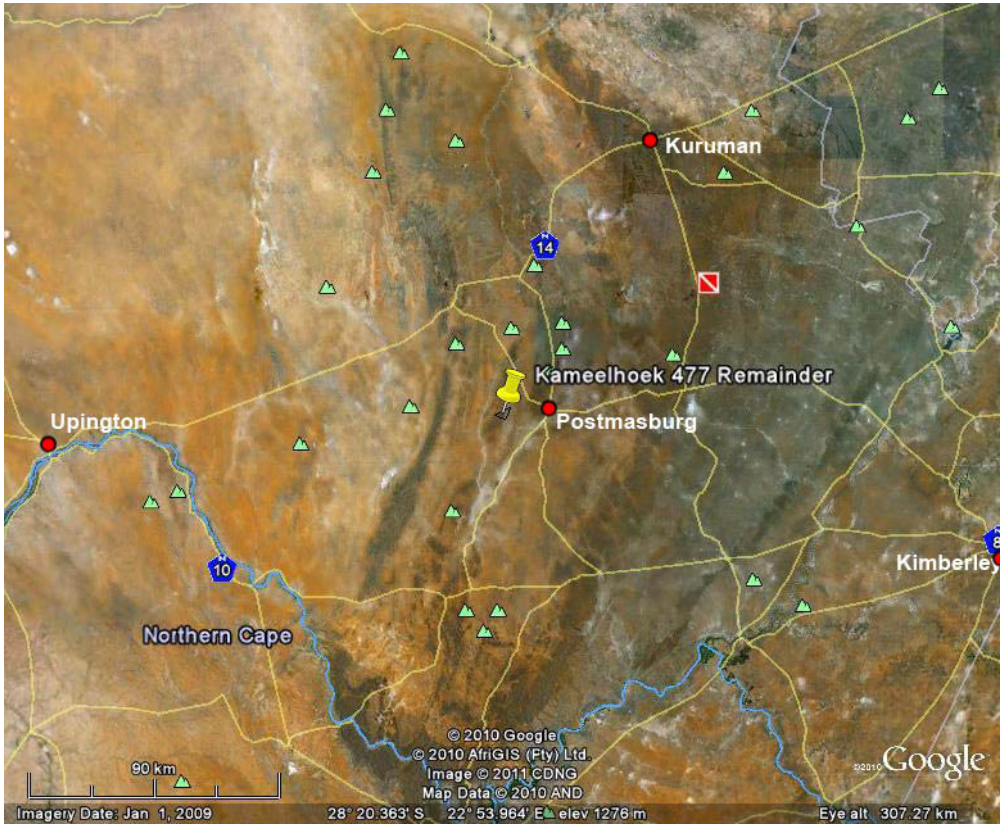


FIG. 2 LOCATION OF KAMEELHOEK 477 REMAINDER PROPERTY

Regional geology

The surface geology of the region is illustrated and summarised in Fig. 3. As described in the explanatory notes of the 1:250 000 geological map of the Postmasburg District (2822; Moen, 1977), and numerous papers and books characterising this economically important region (e.g. Beukes, 1984, 1987; Moore *et al.*, 2001; Tsikos et al., 2001) the Transvaal Supergroup (formerly the Griqualand West Supergroup) in this area comprises a thick basal sequence of carbonate rock (the Campbell Rand Subgroup), overlain by large volumes of iron formation of the Asbestos Hills Subgroup, which are unconformably capped by the glacial diamictites of the Makganyene Formation. These glacial deposits are in turn overlain by lavas of the Ongeluk Formation (2.2 Ga before present), followed by the economically important, manganese-rich Vöelwater Subgroup, including the iron-rich Hotazel Formation. The latter is capped by the carbonates and cherts of the Mooidraai Formation. This is unconformably overlain by the Olifantshoek Supergroup, a succession of shales, quartzites, conglomerates and andesitic lava.

Although mainly cropping out further to the south-east, the glacial deposits of the Permocarboniferous Dwyka Group of the Karoo Supergroup are known from the area, in the form of green shales, tillites and mudstones with poorly rounded dropstones. According to Visser *et al.* (1990) and Von Brunn and Visser (1999) the Dwyka rocks found towards the northern edge of the main Karoo Basin belong to the Mbizane Formation. In some places along the Vaal River, these deposits are conformably overlain by a thin black carbonaceous shale with several concretion horizons (Moen, 1977). This latter facies may well belong to the lowermost unit of the Ecca Group, as the Ecca and Dwyka Group deposits are not mapped separately in this region at 1:250 000, for reasons of scale. Detailed regional studies (McLachlan and Anderson, 1973; Von Brunn and Visser, 1999) indicate the presence of laminated mudrocks of the Early Permian Prince Albert Formation (previously known as the ‘Upper Dwyka Shales’) in this part of the Karoo Basin.

A vast unconformity separates these deposits from the underlying rocks of the Transvaal Supergroup.

Much of the region is overlain by Tertiary to Quaternary deposits of the Kalahari Group, comprising mainly sands and surface limestones (calcrete). Diatomaceous limestone and diatomite or kieselguhr, consisting of fossilized remains of diatoms, are found in depressions in the area (Moen, 1977; Haddon & McCarthy, 2005). Keiselguhr has been mined in the area for building material. River terrace gravels of various ages are found in the vicinity of existing rivers. In some areas (towards the west) reddish-brown wind-blown sands form seif dunes.

Geology within the Kameelhoek 477 Remainder

The 1:250 000 geological map of the Postmasburg district (1977) indicates the following strata exposed at surface within the property boundaries (Fig. 3):

Tertiary to Quaternary calcretes of the **Kalahari Group** (Ql) – surface limestone (calcrete)

Transvaal Supergroup (Late Archaean to Palaeoproterozoic):

Olifantshoek Sequence

Postmasberg Group

Vöelwater Formation (Vv)

Gamagara Formation (Vg)

Ghaap Group

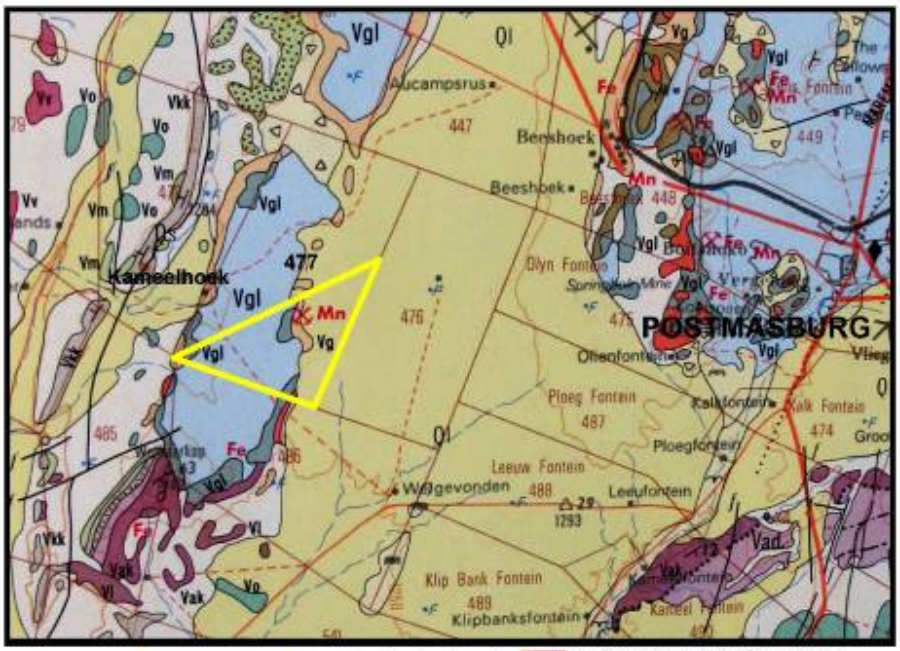
Campbell Rand Subgroup

Ghaapplato Formation, Lime Acres Member (Vgl)

Although not mapped at surface within the Kameelhoek 477 Remainder property, there is a possibility that (**Karoo Supergroup) Dwyka Group (Mbizane Formation)** or basal **Ecca Group (Prince Albert Formation)** deposits may be found at depth during future mining activity, as has been the case at Sishen mines to the north-east.

FIG. 3 REGIONAL GEOLOGY – POSTMASBURG AREA

(1:250 000 geological map, 2822; Moen, 1977; Council for Geoscience, Pretoria)



TERTIARY/ QUATERNARY	Ql	Surface limestones	KALAHARI GROUP
VAALIAN	Vl	Predominantly quartzite, with subordinte flagstone, dolomitic limestone, shale and conglomerate,	Lucknow Fm.
	Vv	Banded ironstone, massive and banded red jasper, dolomite and chert, lava	Voelwater subgrp
	Vo	Amygdaloidal andesitic lava with interbeds of tuff, agglomerate, chert and red jasper	Ongeluk Fm.
	Vm	Diamictite, banded jasper, siltstone, mudstone, dolomite with chert, graywacke	Makganyene Fm.
	Vg	Shale, flagstone, quartzite, conglomerate	Gamagara Fm.
	Vkk	Brown jasper,banded ironstone with crocidolite, quartzite dolomite, flagstone, chert, shale	Koegas subgrp
	Vad	Brown jaspilite and crocidolite with alternating layers of shale and mudstone near top	Asbestos Hills subgrp
	Vak	Brown jaspilite and chert Banded ironstone with bands of amphibolite and lenses of flat-pebble conglomerate in places; crocidolite; tuff	
	Vgl	Chert and chert breccia	Campbell Rand subgrp
	Vgl	dolomitic limestone (puckered limestone) with subordinate coarsely crystalline dolomite, chert and lenses of limestone	

TRANSVAAL SUPERGROUP

Assessment of palaeontological potential and significance

The Transvaal Supergroup was deposited during the Vaalian Era, in the range of 2.65 to 2.2 Ga before present. The sequence was deposited in a variety of marine settings, ranging from shallow epeiric sea to fresh water lake and intertidal environments (Beukes, 1984). The only life known to have been in existence at this time, were the Bacteria and Archaea, with the emergence of the first simple eukaryotic organisms. The first recognizable animals only appeared much later, between 500 and 600 Ma, during the Cambrian explosion that gave rise to most of the groups of modern animals (see McCarthy and Rubidge, 2005 for an overview). Cyanobacteria (so-called blue-green algae) were probably the dominant forms of life at this time, and they were responsible for vast deposits of calcium carbonate, through the formation of stromatolites – columnar features created through the sequential accumulation of thin crusts of calcium carbonate deposited by successive generations of algal mats.

Well preserved, permineralized filamentous microfossils *(Siphonophycus transvaalensis* n. sp.) were described by Klein et al. (1987) as the constituents of algal mats in stromatolites of the **Campbell Rand Subgroup**, estimated to have grown 2.5-2.3 Ga before present. Archaean stromatolite occurrences within the Gaap Group were reviewed by Schopf (2006).

These stromatolite deposits and early microfossil biotas are of great interest, and globally famous. In cases where particularly well-preserved examples of stromatolites are encountered during site development, these should be recorded and reported to SAHRA by the responsible Environmental Control Officer. However, the broad distribution and common occurrence of these fossils makes them of generally low palaeontological significance, and no additional mitigation could be reasonably expected on the part of the developers.

Although generally sparse, there is an important fossil record preserved within the shales of the Permocarboniferous, glacial deposits of the **Dwyka Group** and particularly the lowermost unit of the **Ecca Group (Prince Albert Formation)**. In this area, these units may well be present subsurface.

The fossil record within the Dwyka Group is generally very poor, but within the uppermost **Mbizane Formation**, there is the potential to find arthropod trackways and plant remains (McLachlan & Anderson, 1973, Anderson & McLachlan, 1976, Von Brunn & Visser, 1999). Recorded are trace fossils of invertebrates, fish, as well as the first evidence of the *Glossopteris* flora that emerged during the postglacial period in Gondwana (Anderson, 1975; Anderson and McLachlan, 1976; Anderson, 1981; Anderson & Anderson, 1985). Mosses, lycopods. and gymnosperms such as *Noeggerathiopsis* and glossopterid leaves attributed to *Gangamopteris* have been recorded from the northern parts of the Karoo Basin, in coal-associated deposits (Plumstead,, 1969; Anderson & Anderson, 1985). The record from the southern and western parts of the basin is very limited, and the nature of the floras in these areas remains an important question that needs to be addressed in the field of palaeobotany. Any fossil found within this unit would be of great palaeontological interest and value.

Further to the south-east of the Kameelhoek property, a thin band of what are probably deposits of the Prince Albert Formation (lowermost unit of the Ecca Group) crops out along the Vaal River. Fish remains and plant fossils have been reported to occur in silica-rich concretions within this layer (Moen, 1977).

A sparse but important biota has been reported within the Prince Albert Formation in other parts of the Karoo Bain, including trace fossils, rare shark remains, various invertebrates (sponges, protozoans, bivalves) coprolites, as well as miospores and fossil wood (McLachlan & Anderson, 1973; Oelofson, 1986).

Overall, because of the sparse occurrence of fossils within the Mbizane and Prince Albert Formations, these units are here ranked as being of low to moderate palaeontological significance. Should these formations be intercepted during mining activity, an appropriate palaeontological expert must be brought in to monitor excavations, and make collections of any fossiliferous material exposed.

Within the **Kalahari Group**, the fossil record is sparse and of low diversity. The dune sands of the **Gordonia Formation** contain rare calcretised root casts, burrows, termitaria, ostrich egg shells, shells of land snails (Almond & Pether, 2008). Underlying or surface calcretes/surface limestones may contain trace fossils, rhizoliths, burrows or

even mammalian trackways (Almond & Pether, 2008). Diatomaceous deposits are potentially of palaeontological/biological interest. Diatoms are microscopic algae, one of the major components of phytoplankton. Their cell walls are silica rich, predisposing them to preservation in the fossil record. Although the study of both fossil and extant diatoms is an important field of research (greatly neglected in South Africa), particularly in palaeoclimatic studies (Bradbury, 1988; Leng & Barker, 2006), deposits of this nature should probably be placed in a similar class to stromatolites, and pollen-rich strata, i.e. of low significance in terms of mitigation due to their abundance and broad, scattered distribution.

Table 1: Palaeontological significance of geological units present on site

Geological unit	**Rock types and ages**	**Fossil Heritage**	**Palaeontological sensitivity (low-medium-high)**	**Recommended Mitigation**
Gordonia Formation, and surface limestones KALAHARI GROUP	Aeolian sands, calcretes and diatomite PLEISTOCENE TO RECENT	Diatoms, calcretized rhizoliths and termitaria, ostrich egg shells, land snail shells, rare mammalian and reptile bones and teeth	low	None Any fossil finds to be reported by Environmental Control Officer to SAHRA
Prince Albert Formation ECCA GROUP	Mudrocks with calcareous concretions EARLY PERMIAN	Trace fossils, wood, plant material (leaves), aquatic invertebrates (bivalves, molluscs)	Medium to high (in this region)	alert Environmental Control Officer if mining activities expose Dwyka deposits; inspection for and collection of fossil material to be conducted at regular intervals during excavation
Mbizane Formation DWYKA GROUP	Tillites, shales, sandstones LATE CARBONIFEROUS-EARLY PERMIAN	trace fossils, fish, plants (wood, leaves)	Low to Medium	alert Environmental Control Officer if mining activities expose Dwyka deposits; inspection for and collection of fossil material to be conducted at regular intervals during excavation
Campbell Rand Subgroup TRANSVAAL SUPERGROUP	dolomitic limestone PRECAMBRIAN (EARLY PROTEROZOIC)	Stromatolites	Low to Medium	recording and sampling of stromatolites in development footprint

NATURE AND PREDICTED IMPACT OF PROPOSED DEVELOPMENT

The proposed development involves prospecting (boreholes) and possible mining activity, either via shafts or open cast pits, for iron and manganese ore.

The degree of disturbance created by exploration drilling on the property would be minimal, although not insignificant given the amount of surface disturbance involved in the creation of access roads to position drill rigs, support vehicles etc. The impact of mining activities on the terrain would depend on the type of mining undertaken. In the case of open cast mining, the impact would be profound.

However, because the palaeontological significance of the rock strata likely to be encountered during these activities is low, the envisaged palaeontological impact, even of open cast mining is accordingly rated as **low**. However, if Ecca Group or Dwyka Group deposits are encountered, the rating would change to **moderate.**

CONCLUSIONS AND RECOMMENDATIONS

Of the rock units likely to be encountered during mining activity on Kameelhoek 477 Remainder, only the **Dwyka Group** and **Ecca Group** require any mitigation on behalf of the developers. Geological faulting and the patchy distribution of these deposits in the area make it difficult to predict the occurrence of the units. Fossils are relatively rare in these Formations (although locally they may be concentrated), but are of moderate to high palaeontological significance. If Dwyka or Ecca Group rocks are excavated, the Environmental Control Officer must be notified, so that regular surveys of the excavation may be conducted, and any exposed fossils can be appropriately protected and removed for curation.

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