

MANAGEMENT, MONITORING AND EVALUATION OF THE CRADLE OF HUMANKIND FOSSIL SITES



UPDATED FOSSIL SITE MANAGEMENT PLAN
FOR

DRIMOLEN

2009 - 2013



UPDATED SITE PLAN FOR DRIMOLEN

FOR PERIOD 2009 – 2014

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1 INTRODUCTION

The privately-owned Drimolen Fossil Site is situated some 5.5km to the north-north-east of the famous Sterkfontein fossil site on a 'landlocked' property access to which is indirect, via an adjacent privately owned property known as 'The Rhino and Lion Nature Reserve' (Fig 1). Access to Drimolen is one of the key management issues as the adjacent game reserve has free-ranging wild animals including several potentially dangerous species as its name suggests. This precludes pedestrian access from the nearest public road, making vehicular access obligatory. This is problematic for the field assistants that do not own cars.

Drimolen is a relatively new fossil site first discovered in 1992 by Dr André Keyser. Sustained excavation by Dr Keyser and Dr Colin Menter has revealed an astonishing wealth and variety of fossils, including well over 100 hominin specimens. This excavation has revealed significant potential and has brought a considerable measure of fame to the Drimolen site which is now second only to Swartkrans in terms of numbers of the robust australopithecine, *Paranthropus robustus*. Its many preserved fossils provide a glimpse into past interactions between carnivores and early hominins in the time period 1.6 to 2.5 million years ago. Although relatively new and unexplored in comparison with the older more established excavated sites elsewhere, Drimolen has rapidly caught up in terms of discoveries made and scientific importance.

Like many of the other fossil sites in the COH WHS, Drimolen was mined for its deposits of travertine. Some fine relics of this early mining phase of its history are preserved on site.

"Drimolen" applies to the fossil site as a whole, including the amphitheatre (the 'Main Quarry') where excavations are presently being carried out as well as a subterranean system. The subterranean system was mined for its travertine (calcite) during the first half of the previous century. All the hominin fossils derive from the Main Quarry area of the deposit. The entrance to the subterranean system is located in the fossil elephant tusk area, along the western flank of the Main Quarry wall. There is another extensive subterranean system nearby, about 40 m from the "Drimolen Cave", but still within the heritage boundary. The Drimolen Fossil Site therefore comprises a surface excavation and two associated subterranean systems.

The presence of these underground caves suggests that the breccia currently being worked is "perched", i.e. it is in all likelihood situated above a subterranean void. The rapid drainage of water accumulating in the floor area of the current excavation pit underground is additional evidence for this. This does not necessarily mean that the floor of the excavation is unstable, but the possibility might need to be mentioned to a professional site safety expert when the site is next inspected.

The Drimolen Fossil Site is ideally situated to form part of a comprehensive palaeo-ecotour. It is close to Wonder Cave, which forms a good modern analogue for processes which took place in ancient dolomitic caves, and it is located within a property which has a variety of resident mammals. The surrounding vegetation retains many pristine features of the grassland biome. This juxtaposition, i.e. modern analogous show cave, actively researched fossil site, resident animal population and well-preserved grassland vegetation, as well as rocky ridges where stromatolites can be seen, endows Drimolen with special educational and tourism opportunities. However, because Drimolen is 'landlocked', this might necessitate entrance fees having to be paid twice: once to traverse the Rhino and Lion park, and again to enter the n'Gomo Safari's property.

1.1 Objectives

- To preserve the full range of natural and cultural heritage values, the site significance and authenticity of the Drimolen fossil site
- To identify and understand the issues that threaten site significance and to provide management measures and monitoring to address them
- To balance opportunities for research, education and tourism without compromising the integrity of the site or the aspirations of the landowner
- To recommend appropriate infrastructure and management strategies to achieve the above goals
- To preserve as much as possible of site context and sense of place in an area that is subject to unprecedented development. Drimolen is excellently situated to demonstrate the Highveld rocky grassland habitat and biological interactions characteristic of this biome
- To foster and maintain communication links between management bodies, landowners and researchers as partners in management and conservation of the fossil site.

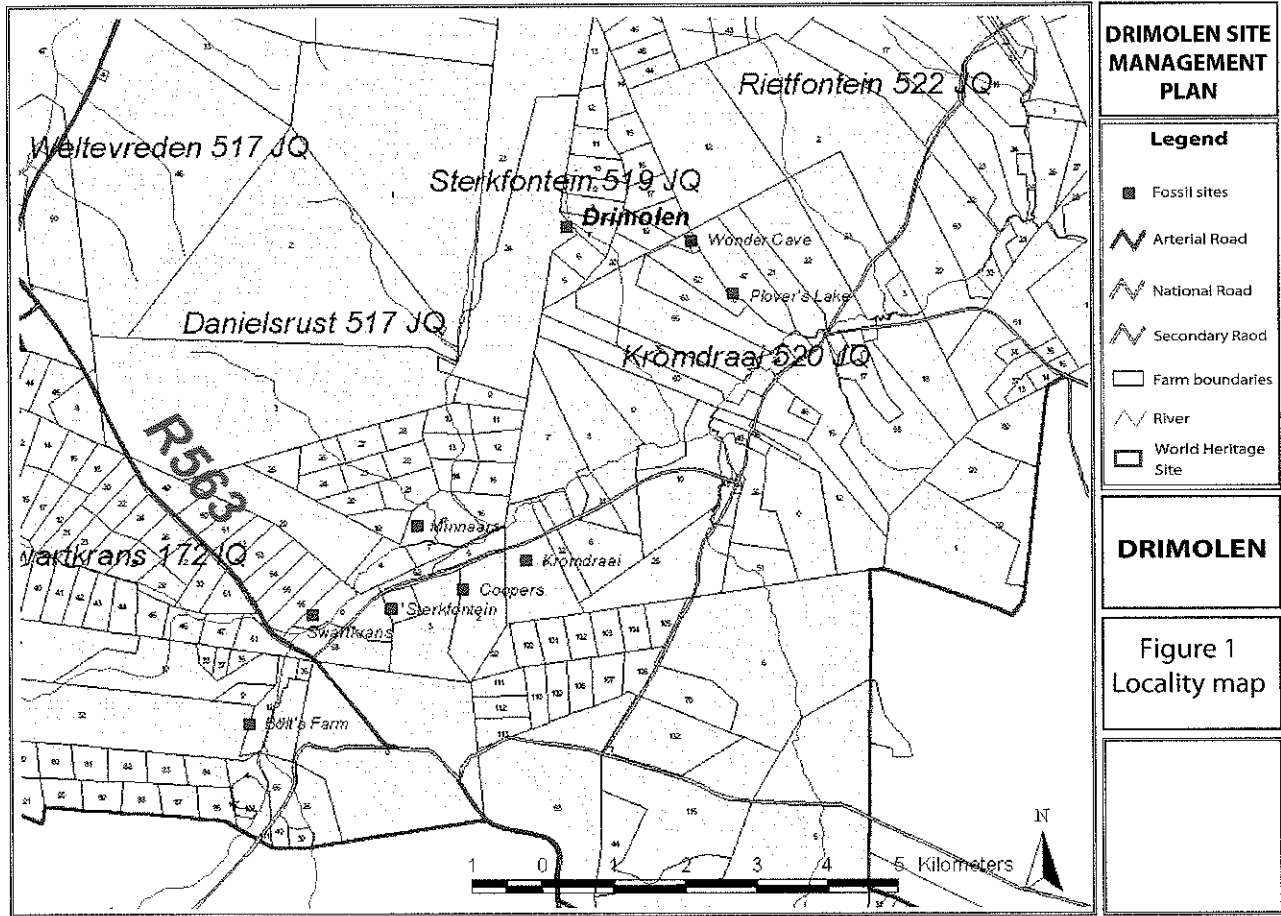
1.2 Method

- Consult with landowners, researchers, repository institutions and support institutions to reveal concerns, contentious issues, requirements and future plans
- Research and understand the full range of natural, cultural, scientific, educational and ecological values of the site. Collation of information gained from a series of fossil site inspections has been incorporated.
- Provide an updated list of site values
- Refresh statement of site significance, in consultation with scientists
- Provide an illustrated status quo report against which change can be assessed
- Update the list of risks and threats
- Define desired states and management objectives
- Provide a new management table with management strategies backed, where possible, by operational guidelines for use in the field
- Monitor and evaluate progress at each fossil site inspection, review management strategies where necessary

1.3 Administrative information and legal status



Site:	Drimolen
Farm Name & No.:	Remainder of Portion 24 of Sterkfontein 519- JQ
Owner:	Dean Smith
Contacts	Dean and Jackie Smith of n'Gomo Safaris Lodge PTY Ltd. Rhino & Lion Nature Reserve Kromdraai Road Cradle of Humankind, 1735 Gauteng Tel: (011)662-4900 Fax-email: 086 656 5219 Cell: 0823002906 e-mail: ngomo@mweb.co.za
Legal status	National Heritage Site, November 2004 World Heritage Site, 1999
Servitudes &	To be investigated.

restrictions	
Boundaries	See Proclamation diagram, Fig 3, ABCD, a trapezium marked with 20 mm steel pegs (Figs 2, 3).
Co-ordinates	25° 58' 08" S 27° 45' 21" E, Fig 1 See proclamation Diagram, Fig 3; off Meridian/Equator
Map reference:	1:50 000 2527DD Broederstroom
Altitude:	1370m
Area:	3.7827 ha
Permit holders	Dr. C. Menter in association with Dr Andre Keyser
Designated repository	University of the Witwatersrand, Institute for Human Evolution
Access to public	Not presently open to the public. Tour groups by private arrangement with permitted scientist





**DRIMOLEN SITE
MANAGEMENT
PLAN**

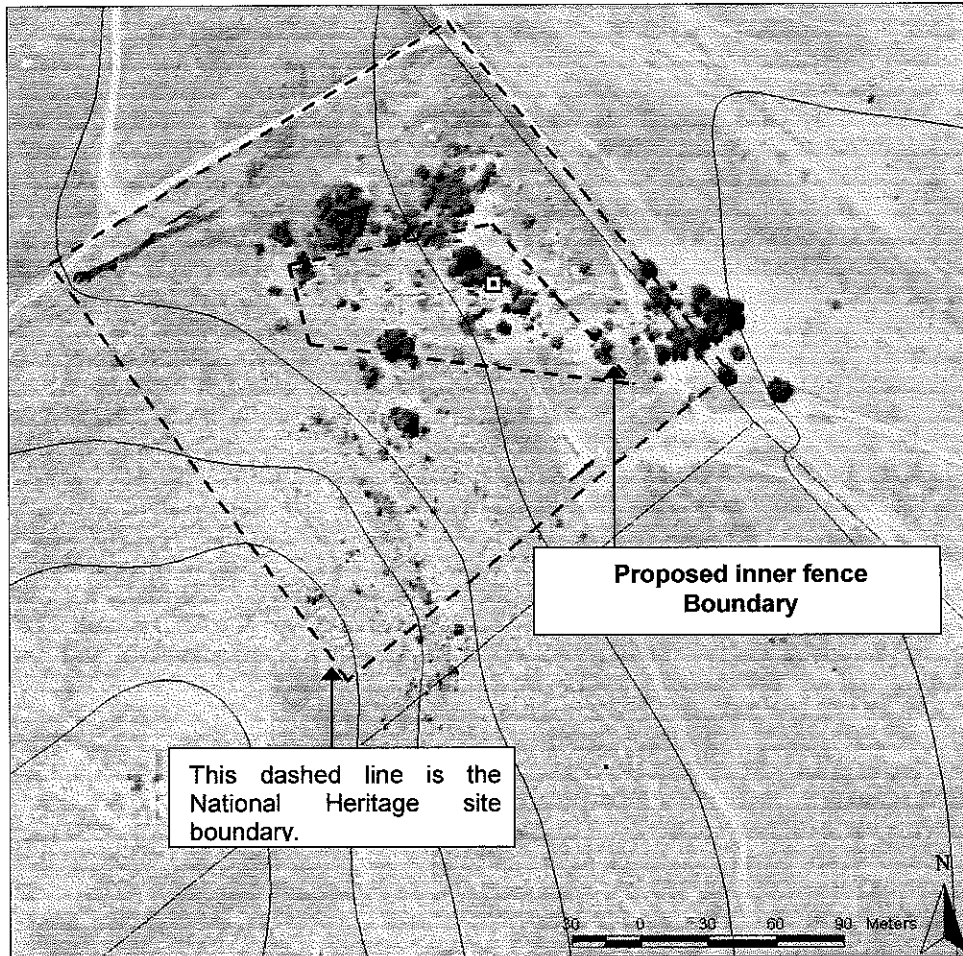
- Legend**
-  approximate position of site boundary
 -  palaeontological site

DRIMOLEN

Figure 2
Aerial view
of site



Fig. 2a: Proposed Drimolen inner fence boundary



PROCLAMATION DIAGRAM

REGISTRATION COPY

SIDES metres	ANGLES OF DIRECTION	CO-ORDINATES			
		Y	System: WG 27° X		
		Constants	+0,00	+2 800 000,00	
A B	188,56	238.51.10	A	-75 532,80	+73 589,90
B C	182,67	321.15.20	B	-75 694,18	+73 492,37
C D	200,00	51.16.10	C	-75 808,50	+73 634,84
D A	207,97	144.52.00	D	-75 652,48	+73 759,98
TRIGONOMETRICAL BEACONS					
STERKFORTEIN 8		84 Δ		-75 558,23	+74 089,49
KRUG 117		412 Δ		-69 559,89	+81 488,68

SG No.

2298/2004

Approved



J.S. WEYERS
for

SURVEYOR-
GENERAL

2004-04-16

BEACON DESCRIPTIONS

A, B, C, D ... 20mm iron peg

DRIMOLEN PALAEOANTHROPOLOGICAL SITE

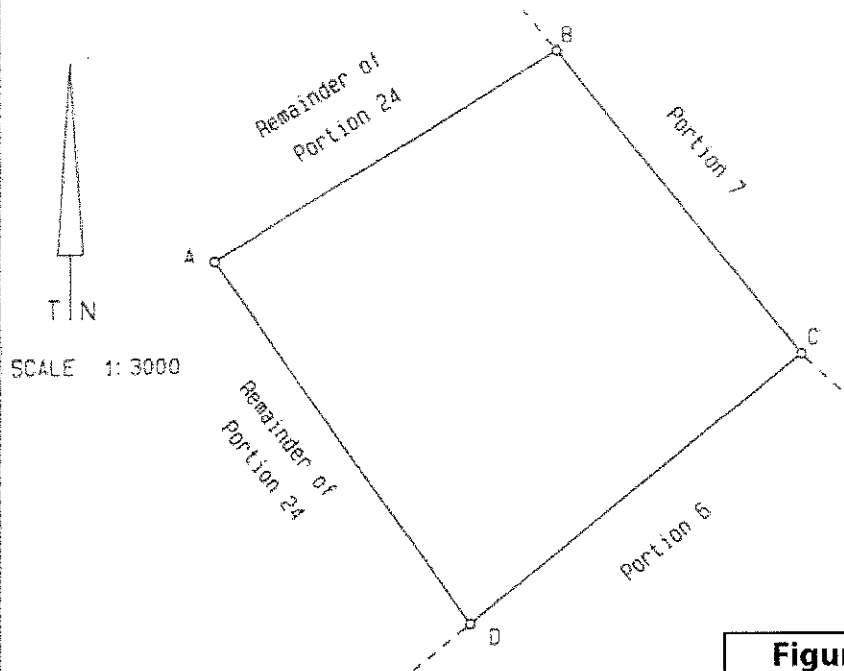


Figure 3
Proclamation
diagram

The figure A B C D A represents 3,7827 hectares of land being a declared area over the Remainder of Portion 24 of the farm STERKFORTEIN No. 519-JQ Province of Gauteng Framed for National Heritage Site declaration purposes in terms of the National Heritage Resources Act No 25 of 1999

Surveyed in January 2004

by me P.H. KOHRS
Professional Land Surveyor PLS0314

This diagram is annexed to No. d.d. i.f.o.	The original diagram is No. A 7685/1985 Transfer No. T41291/1987 Grant C.C.T.	File -/A
		S.R. No. 922/2004 T.P. Comp. JQSY - 42

PTA
Registrar of deeds

1.4 Existing site management

Access to the site is controlled and is by appointment only. First access is to the adjacent Rhino and Lion Nature Reserve, via a security checkpoint. Pedestrians are not allowed to walk through the reserve, for obvious reasons. There is a second gate through an electrified fence providing access to the n'Gomo Safaris Lodge property but the Drimolen fossil site itself is not fenced. The landowners' preference is for as natural an appearance possible and they are opposed to a perimeter fence (i.e., a fence erected on the gazetted heritage boundary), which in his opinion, would detract from the natural landscape. The remains of an old fence, which once partially surrounded the site, have been removed. However, the site is reasonably secure from unauthorized visitors as the landowner always accompanies his private visitors and all other persons visit by appointment only. Further surveillance is provided by the excavation team's resident field assistants.

The Drimolen property is also stocked with game and this has posed some management problems for a site which has no fence. Large antelopes and warthogs trample the excavation area in search of browse – most trees on the Highveld grassland occur within or near the mouths of sinkholes or at the entrance to dolomitic caves and this is precisely where the present excavation is situated.

After much debate by management, an inner enclosure fence (fence erected to exclude the landowner's game) has been decided upon but has not yet been erected, leaving the site open to trampling and damage by animals.

The Management Authority is challenged by the lack of a dedicated Heritage Officer who could provide the necessary follow-up and ensure that decisions taken at the site inspections are acted upon.

Many management functions are provided by the landowner, such as rangeland and erosion management, upkeep of access roads, control of alien vegetation and weeds, game management and fire management (although the Drimolen fossil site has been subject to a destructive fire).

Drimolen is less infested with alien invasive species than many other of the fossil sites

Visual impact is managed by the COH WHS MA which assesses the visual impact of any proposed developments. ESKOM power lines are very conspicuous in this part of the COH WHS and it is recommended that in time, this issue be addressed. There are no power lines within the gazetted Drimolen site and nor is there electricity on site.

A considerable management function is performed by the permitted research scientists. Their research budget funds two, sometimes more, resident field assistants who provide essential surveillance of the site and excavation equipment. Rising crime rates in the area have led to theft and loss of infrastructure at other sites and the role that on-site excavators/caretakers play is becoming essential. The field assistants can report fires on the property and unauthorized visitors. The researchers provide transport and their regular liaison with the landowner is important from a management point of view.

Additional existing site management includes:

- Tourists are confined to a non-sensitive route through the site, and are under constant supervision of an archaeology or palaeo-anthropology graduate student, and/or the permitted scientists (Drs. André Keyser and Colin Menter).
- The site is not open to the general public. Visits are by appointment only and most people are unaware of the whereabouts of Drimolen.
- A SAHRA Permit Committee member inspects the excavation site and ongoing excavations on a twice-annual basis, particularly with a view to assessing compliance with terms and conditions of the permit and to monitor the National Heritage Site.
- The permit holders manage and supervise the activities of the excavators and support staff of preparators.
- The site inspection team, including COH WHS MA, SAHRA and GDACE officials, plus a contracted specialist service provider, inspects the entire site on a twice-annual basis, monitoring the management criteria noted in the generic site management plan (see Table 1, generic management plan) and particularly Table 1 of this document.
- The COH WHS MA monitors development within the surrounding COH WHS properties with a view to protecting heritage values such as sense of place and visual aesthetics.
- A site safety inspection will be provided for. This is meant to take place on an annual basis. However, there is no easily accessible subterranean environment at Drimolen except for specialist visitors such as cavers. The subterranean part of the cave is not at present being excavated. It is only the safety of surface features that need be considered in this report.
- GDACE is available for advice to landowners regarding erosion control, fire management, alien vegetation and weed clearance, and preservation of biodiversity.
- The landowner burns firebreaks from time to time, but uncontrolled fires sometimes occur and these have the potential to cause extensive and expensive damage.
- The Heritage Agreement is an important management tool.
- The Landowner / Scientist Agreement required in terms of the permit is another tool.

2 SITE DESCRIPTION: PHYSICAL FEATURES, SITE VALUES AND SIGNIFICANCE

2.1 General site description

The site is situated in rolling open rocky grassland against the east-facing flank of a low rocky hillock. There are excellent views all round, looking across the Cradle of Humankind to the east and south.

The presence of two large metal shipping containers which function as accommodation and store room create a strongly negative visual impact (Fig 4). The negative impact has to be balanced against the fact that the metal containers are at least fire-resistant in a fire-prone environment. An additional container is to be added soon, but this will be placed in such a way so as to minimize its impact – the intention is to align it precisely parallel with and next to one of the existing containers in order that the same area and aspect is exposed to view.

The opening of the ancient cave is marked, at a distance, by the presence of several large *Celtis* trees and a number of limeworkers' dumps. Adjacent to the cave is an old exploration trench, running roughly east-west.

A small clump of *Acacia karroo* trees provide a shady work and rest area. The old mine workings, the Main Quarry with its excavation, and clusters of trees are like an island in a sea of surrounding grassland (Fig 9).

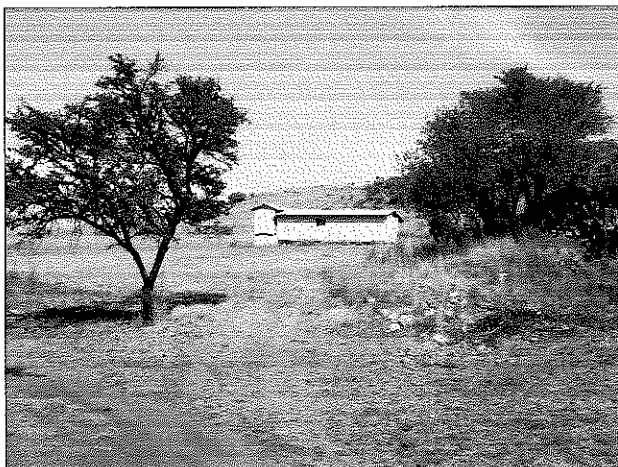


Fig 4: Photograph showing the strong visual impact of the shipping containers used as on-site storage and accommodation. A new container is required and will be added on adjacent and parallel to the one with a single window



Fig 5: Constructed ramp and support for the lime-burning kiln made by lime workers, which is built in to the thick end of the wedge-shaped loading ramp. The kiln is built so as to enable top loading with alternating layers of fuel and broken limestone, and withdrawal of calcined lime from a drawhole at the base.

2.2 Site values and significance

The fossil site management plan adopts a values-based approach and seeks to ensure that the many and various values of the site are conserved. Site values extend beyond those formally recognized as being of 'universal value' and this section seeks to provide an updated list of old, new and previously unrecorded or unrecognized values (3.1). Section 3.2 provides an updated statement of site significance which was prepared in consultation with permitted scientists working on site.

Certain values, particularly the World Heritage Values are well documented but others have not been sufficiently recognized until now. Six sets of values have been identified: landscape values, palaeontological and archaeological values, mining and historical values, research values, biodiversity and ecological values and finally, educational and tourism values. The relative importance of these values differ – there are several that have allowed for World Heritage Status and National Heritage Site status while others are of a more regional or local value.

2.2.1 Landscape: Geological and geomorphological values

The key geological and landscape values of Drimolen include the following:

- The proposed lookout site (see old management plan and Fig 2.) offers magnificent views over the Cradle of Humankind and provides a perspective on the geology of the surrounding dolomitic country
- The occurrence of caves can be demonstrated by referring to the isolated and discrete copses of trees growing from the mouths of sinkholes and shafts
- The excavation site demonstrates a still-open subterranean system as well as the calcified fill of an ancient cavern system
- The depositional sequence normally occurring in dolomitic caves can be easily demonstrated
- Geological concepts such as debris cones and outwash siltstones can be demonstrated
- The 'hollow' in which the cave occurs can be explained in terms of collapse into an immense underground system of as yet unknown proportions
- The nearby rising landform preserves well-exposed bands of chert, pisolites and a few ripple marks
- There are well-preserved stromatolites which can be demonstrated – these cyanobacteria represent some of the earliest living organisms on the planet
- The uncluttered open space is in itself an asset in a rapidly developing crowded urban environment
- Wonder Cave nearby is a wonderful modern analogue for processes which took place in ancient caves, and is open to the general public.

2.2.2 Palaeontological and archaeological values

Drimolen is potentially one of the richest of the fossil sites in the Cradle of Humankind. It has already yielded well over 100 hominin fossils, and only a small fraction of the very large reserve of fossiliferous cave fill has been removed as yet.

Its key palaeontological and archaeological values are as follows:

- The site has yielded one of the most complete skulls of an adult *Australopithecus robustus* yet known

- This skull (DNH 7) is one of the first definitive female specimens of this species yet discovered
- *Australopithecus robustus* specimens recovered have shown that the species was more variable in cranial morphology than previously thought
- Drimolen is one of only two fossil sites in the COH WHS which have yielded large samples of the hominin *Australopithecus robustus* as well as a contemporary species of early *Homo*.
- Specimens of the latter species of *Homo* are all of juvenile animals which is in itself a rarity
- Fossiliferous deposits ranging in age from 1.6 to 2.5 million years are preserved – older and /or younger material may yet be uncovered
- Drimolen has yielded the largest sample of isolated hominin deciduous incisors of all the fossil sites in the COH WHS, probably an indication of rigorous sieving of decalcified sediment.
- The site is unusual in that a large proportion of the hominin fossil material consists of infants and juveniles
- The specimen DNH 47 is one of the youngest (in biological age) fossil *Australopithecus robustus* individuals yet found.
- Among other young specimens is DNH 50 which represent the youngest neonate postcranial elements yet found from the Plio-Pleistocene of Africa
- None of the other dolomitic caves exhibit a similar age distribution of hominin fossils and it is probable that Drimolen had a different taphonomic history; i.e., this distribution hints at a different bone-accumulating agent or agents.
- Drimolen provides evidence that the cave may have been used as a sleeping haven for hominins and baboons
- The site provides useful confirmatory evidence that *Australopithecus robustus* and *Homo* co-existed
- Drimolen and Swartkrans are the only two of the COH WHS fossil sites to have demonstrated large samples of used bone tools
- The site is unusual because of a remarkable dearth or absence of suid and equid fossils (only two of the latter found so far), and an explanation is still outstanding
- Other fossils seem to suggest a grassland habitat similar to that of today
- Stone artefacts have been discovered

The above attributes provide Drimolen with considerable degree of site significance and authenticity, in that many of the processes which gave rise to the fossiliferous deposits and which preserved bones in the first place can be demonstrated first hand on site. It provides visitors with the opportunity to interact with a real environment and to see fossils still *in situ* in actively excavated deposits. Drimolen provides the circumstances for a very high quality tourist experience, much enhanced by active scientists on site. The active excavation is a potent drawcard.

2.2.3 Mining and historical values

Drimolen is situated in a shallow hollow – probably the remains of a doline or swallow-hole depression - near the base of a dolomite hillock which is rich in stromatolitic and chert bands and which contains intercalated tuffs not present at most of the other hominin sites. Erosion of the hillside has exposed the subterranean cavern systems to the surface and is busy eroding the rather decalcified deposit of breccia in which the fossils occur.

Drimolen was mined for the travertine (calcite) flowstone walls and floor of the ancient cave which formed by dissolution of the dolomitic host rock of the Monte Christo Formation of the Malmani Subgroup of the Chuniespoort Group.

Mining probably began in the final years of the 19th Century and resumed after the South African war until the price of lime dropped during the Great Depression and immediate pre- World War II years. During this early mining period of the site's history, cave sediment was exposed in about 20 holes blasted out by miners.

Many relics of this mining period are preserved. There are several miners' exploratory pits and trenches. There are the remains of a substantial haulage ramp and adit out of the Main Quarry which terminates in an upper loading ramp below which is situated the remains of a relatively well-preserved oval kiln which tapers towards the bottom (Figs 5, 6 and 7). The base of the kiln had a door or draw-hole through which burnt or calcined lime could be drawn. This was then loaded onto ox-wagons and transported to Johannesburg where the gold mines would have provided a ready market.

Limeworkers often belonged to a class impoverished by the ravages of the scorched earth policy of the South African War, the 1995/6 outbreak of Rinderpest and the advent of the railway which deprived the 'transport riders' of business. It is said that they planted prickly pears (*Opuntia* spp.) for their fruit, and several plants occur at the lower loading area (Fig 8). There is as yet no policy to provide the basis of decisions concerning historical plantings which also happen to be scheduled alien invasive species.

It is recommended that steps be taken to record and contextualize the remaining relics of mining and to incorporate these into tourist experiences of the site. The mining relics add considerable value and meaning to site interpretation and it should be demonstrated that mining was responsible for exposing the fossiliferous deposits in the first place.

Key mining and historical values include;

- Demonstrable haulage ramps
- Many pieces of calcite as well as calcined lime lying about
- Upper loading ramp
- Well-preserved oval kiln built against the side of an artificial support
- Lower loading area with *Opuntia* trees
- Many abandoned miners' dumps
- Test pits and trenches which assist in understanding the geology and sedimentary history of the fossil site
- Possible to demonstrate the link between lime mining and fossil site discovery



Fig 6: View of the unusual oval kiln top. The Ficus tree roots have invaded the brickwork and will get a stranglehold if not eradicated.



Fig 7; View of the drawhole side of the kiln base, where calcined lime was withdrawn from the kiln. An old Opuntia tree growing close to the draw-hole of the kiln. Prickly pears were a favoured food of lime-miners

2.2.4 Research values

The Drimolen site has huge research potential. Well over 100 specimens of hominin have been recovered in the 15 years or so that excavations have been ongoing, and only a very small proportion of a very extensive potentially fossiliferous deposit has been removed. The site most definitely holds research potential for many decades to come.

It is recommended that the COH WHS MA do all in its power to secure funding in order that the scientific potential locked in the sediments of the Drimolen cave can be realised.

2.2.5 Biodiversity and ecological values

The Highveld grassland biome of the Gauteng Province is everywhere subject to pressure from rampant development. This gives the open space of the Drimolen property an enhanced value as an open area, particularly one which has the added asset of a hominin site.

The grassland around Drimolen is likely to contain at least 500 species although there is no adjacent wetland or stream to push species numbers up. It is recommended that a plant and animal species list be drawn up for Drimolen as at the time of writing no such lists exist.

The rocky grassland is likely to harbour many significant edible, medicinal, poisonous and otherwise economically important species such as "Mrs Ples' food", the tuberous *Brachystelma barberae*, usually found well-concealed on rocky grassland hillsides, the medicinal and poisonous *Boophane disticha* and *Eucomis autumnalis*, as well as *Haemanthus* spp. and *Scadoxus puniceus*, both used medicinally.

Within the central excavation area and adjacent mining areas, the positions of sinkholes and vegetation-choked avens is marked by typical dense copses of vegetation, notably *Celtis* trees, as well as *Olea* and *Cussonia*. A clump of *Acacia karoo* trees (unfortunately infested with a debilitating disease) provides shade and a comfortable sieving area for workers.

Both underground systems have active biological processes still intact. The cave situated about 40 m from the main Quarry is known to host breeding colonies of two species of bat, *Miniopterus schreibersii* (now *M natalensis*) and *Rhinolophus clivosus*. The first species is rapidly becoming rare, and it is recommended that care be taken when the excavation is extended into this region because human presence over the last 15 years appears to have displaced the colony of *Miniopterus* formerly known to be present in the main Quarry cave.

Porcupines use both caves from time to time as evidenced by their droppings and shed quills, as well as the occasional gnawed bone. Porcupines are important taphonomic agents and it is an additional bonus that this element of site interpretation can be authentically demonstrated on site.

The biodiversity values of this site are inadequately understood and it is recommended that faunal and plant species lists be drawn up in order that these values can be better understood, protected and interpreted.

Summary:

- Resident bat colonies and breeding hibernacula, two species
- Resident porcupines
- Free-ranging large mammals on property
- Many species of edible, medicinal and economically significant plants

- Open grassland with Highveld trees
- Owl roost (sporadic)

2.2.6 Educational, tourism and economic values

Summary:

- The site offers an unique combination of tourism and educational attributes for site visitors
- The site offers special and unique educational and student and technical training opportunities
- The site preserves a substantial volume of fossiliferous breccia which will provide research opportunities for decades to come
- The site is authentic, with many geological, palaeontological, mining and historical heritage assets preserved
- Active excavation which includes digging, sieving and preparation is a major draw card
- Full range of fossil site attributes can be demonstrated in an authentic way
- Professional scientists are usually on site when tourists visit and can give first hand high quality and accurate information
- Visitors can have a close look at a real excavation site because there is no intervening fence.
- The nearby Wonder Cave provides visitors with a modern analogue for ancient cavern systems which makes Drimolen cave remnant more readily understandable
- Mining relics on-site help visitors to understand the connection between mining and fossils
- Sense of place is potent and the remoteness of the site provides a wilderness type of experience for most tourists
- Site is situated in grassland biome which has the bonus attraction of resident large mammals
- Many biological interactions are still present onsite active bat breeding colony, porcupines, etc.

2.3 Revised statement of site significance (update Nov. 2008)

The fossil site known as Drimolen has been the source of the second highest number of *Paranthropus robustus* specimens, and of the third highest number of all hominin fossils, found in the Cradle of Humankind. It is unique in the number of juveniles that include at least two individuals assigned to the genus *Homo*, and in the find of a cranium of an adult female *Paranthropus robustus* with an articulated mandible.

It was recommended by ICOMOS in 1999 that the fossil sites in the Cradle of Humankind be declared a World Heritage Site because they "contain an exceptionally large and scientifically significant group of sites which throw light on the earliest ancestors of humankind. They constitute a vast reserve of scientific information, the potential of which is enormous."

Drimolen also qualifies for National Heritage status because of its:

- (a) **Importance in the pattern of South Africa's history.** The hominin fossils from Drimolen demonstrate conclusively that this part of South Africa was home to some of our earliest human ancestors about 1.6 million years ago.
- (b) **Possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage.** Hominin fossils are rare worldwide because of their limited

geographical distribution and the rarity of natural conditions for fossilisation and preservation. The unusually large number of juvenile hominin fossils in the Drimolen calcified and decalcified breccias of both *Paranthropus robustus* and *Homo ergaster/habilis* is of national and international significance.

- (c) **Potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.** There has been no detailed analysis of the full suite of fossil animal species found at Drimolen, but this could yield valuable information about environmental conditions between 1.6 and 2.5 million years ago. Bovids and carnivores have been studied and published.
- (d) **Importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects.** Drimolen is one of only a few sites in the world where the principal characteristics of juvenile robust australopithecines and early *Homo* can be studied from fossils recovered there.
- (e) **Importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.** The aesthetic qualities of Drimolen as a limestone cave were destroyed by lime mining activities in the early twentieth century but the caving fraternity still visits both subterranean systems present
- (f) **Importance in demonstrating a high degree of creative or technical achievement at a particular period.** Several stone tools and more than 20 bone tools have been found at Drimolen.
- (g) **Strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.** There are no special associations with a particular community or cultural group at Drimolen. It is, however, important to all South Africans who are interested in the history of our species.
- (h) **Strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa.** No special association has yet been established.
- (i) **Significance relating to the history of slavery in South Africa.** The age of the deposits at Drimolen places it well before the time period of slavery in South Africa.

3 SITE ANALYSIS: STATUS QUO, RISKS AND THREATS JULY 2008

In order to provide a basis against which change can be assessed, a status quo report is necessary. Ideally, change is assessed by means of comparison of 'fixed point photography' and such fixed points are in the process of being selected and installed. For scientific excavations, the datum point has been used where possible.

In order to assess the management strategies that may be necessary in order to preserve site values, threats and risks to site values have been analysed as part of the status quo, and the next section (Section 4) describes desired states and management outcomes.

3.1 Physical Environment: Surface status quo

This section addresses the status quo of seven elements of the physical environment, namely physical and legal access to the property, rangeland or veld condition, erosion, fire management, rare plants and animals, alien invasive species and visual aesthetics.

3.1.1 Access, physical and legal

Access has been and continues to be a problem at this site. The site is 'landlocked' and access at present is reluctantly permitted, by arrangement, via the Rhino and Lion park gate. The presence of rhinos and other valuable animals necessitates tight access control because of possible poaching. The Rhino and Lion Park and the surrounding properties have free ranging wild animals which are dangerous. A rhino gored a pedestrian to death during 2007. The on-site permanent excavators are not permitted to traverse adjacent properties on foot in order to reach the nearest public road and have to be taken in and out by car to fetch supplies, go out on weekend visits, etc. The former access road via Wonder Cave has been disallowed and the alternative access via the 'dolomite road' has fallen into disuse and is impassable. In any case, the terminus of the dolomite road is not on a preferred route or where people need to be. All workers are faced with the same problem. Legislation exists whereby the closest public road, by means of a registered servitude, becomes the access – the problem is that the surrounding legitimate land use (a game park) precludes pedestrian access wherever the road traverses camps with dangerous species.

It is recommended that the COH MA thoroughly research possible solutions for this long-standing problem. Satisfactory interim arrangements appear to be possible, but a long-term mutually agreed solution is desirable

Status quo:

- No viable registered servitude for access? (Please verify and correct if necessary, deleting highlight) It has not been possible to verify this point via the scientists. It is suggested that it be left for the landowners to comment on.
- No negotiated written agreements regarding access with adjacent landowners? There may be but it would not have included reference to scientific worker and their support team on site. Landowner to comment please

Risks and threats:

- Access may become even more problematic for researchers and their support staff and visitors than it is already
- Visitors have to pay two entrance fees, one to the Rhino and Lion Park and one to n'Gomo Safaris Lodge, making tourism very expensive. Furthermore, a situation where bona fide visitors and guests of a landowner have to pay in order to reach their hosts' property is untenable – legal free access should be possible.
- Re-instating the Dolomite Road may in itself bring unwanted complications to the COH WHS, such as accelerated development and requests for subdivisions. It would, however, reduce entrance fees.

3.1.2 Rangeland

The rangeland in the contextual area around the Drimolen fossil site appears to be in good condition and there are no signs of over-utilization by game, piosphere development (bald, devegetated and trampled areas), or patches of erosion (Fig 9). Rangeland management is provided for the property as a whole by the landowner.

Rangeland management within the fossil site itself is not an issue because at 3.7827 ha it represents only a tiny portion of a much larger property, and grazing impact by game within the fossil site is insignificant (although trampling of the excavation area is a problem).

Other aspects of the rangeland requiring management is the compilation of a list of plants and animals still occurring at Drimolen. For plant species, it should be noted which species are edible, which medicinal or magical, and which are of economic importance.

Such lists are in any case basic data important to recording the status quo, especially as pressures regarding traditional plant medicines and their collection are likely to increase. Target edible and medicinal species should be mapped and monitored and checks should be made to assess impact of collection, if any. This is not within the terms of reference of palaeo-anthropological research on the fossil sites but should be noted as an outstanding piece of research about which little is known, as are the pressures of 'multi-plant utilisation' and other impacts on plant species growing in the COH WHS.

Deleted:

The same is true of firewood collection (for heating in winter) by permanent residents on site, although cooking is mainly done on gas.

Monitoring of rangeland by means of fixed point photography does not appear to be necessary for this site

Status quo:

- Rangeland in good condition, managed as part of main property
- No plant species list available
- No faunal lists available
- Edible, medicinal and economically significant species need to be recorded and monitored

Risks and threats:

- Biological values of the site poorly or at best incompletely understood
- No means of assessing impacts of fire and plant utilisation



Fig 8: Toilet, parking area and work space at the Drimolen site. The *Acacia* trees are unfortunately afflicted with a disease and some appear to be dying.



Fig 9: Contextual view of the Drimolen site showing conspicuous clumping of trees and strong visual impact of containers on the open grassland

3.1.3 Erosion

Erosion is not a major issue on the Drimolen fossil site, although all excavations are prone to the effects of erosive forces. Erosion within the excavation area is discussed under 3.4, Research Environment.

The access track onto the site is fortunately not steep but part of a steeper track along the north-western edge of the heritage site is concentrating runoff and the soils of the drainage way are eroding.

It is recommended that this section of track be closed and rehabilitated (alternative tracks are available). Environmental legislation restricts the construction of new roads without a permit. GDACE can provide detailed information on road damage rehabilitation and on various methods for the rehabilitation of unnecessary roads. Coetzee (2005, see Generic Bibliography) provides detailed and illustrated operational field guidelines.

Status quo:

- Road tracks are channelling run-off which is causing erosion of susceptible soils and it is recommended that the track along northern margin of fossil site be closed and rehabilitated
- There are no other problems with erosion on site (excavation area treated separately)

Risks and threats:

- None, apart from the track mentioned.

3.1.4 Fire management

The management of uncontrolled grassland fires is part of the overall management policy for the greater property provided by the landowner. Despite this, there has been at least one damaging fire which caused considerable damage to property within the heritage site (Fig 10).

It is recommended that the landowner approach GDACE to ensure that an appropriate fire management program is applied to the site. Without detailed studies, the impact of fire on rangeland is difficult to assess.

It is recommended that fire incidence be recorded, and that the impacts of fire be monitored with the help of GDACE. Heritage inspectors can assist in this regard.

There is a risk of fire in the accommodation and storage area at the shipping containers. This is discussed under site safety and security

Status quo:

- It is recommended that a fire incidence recording for the property be instituted (landowner)
- It is recommended that a fire management plan for property be put in place (landowner)
- Create baseline rangeland data (generic, for COH WHS) against which the impact of fire can be assessed
- Fire management strategy within and around the accommodation area needs to be set up (see site safety), e.g. beaters provided.

Threats and risks:

- No formal (written) fire management policy for property and no framework for assessing the impact of fire as yet exists. This is a generic issue relevant to the whole of the COH WHS.
- Uncontrolled fires continue to pose a threat to property and rangeland

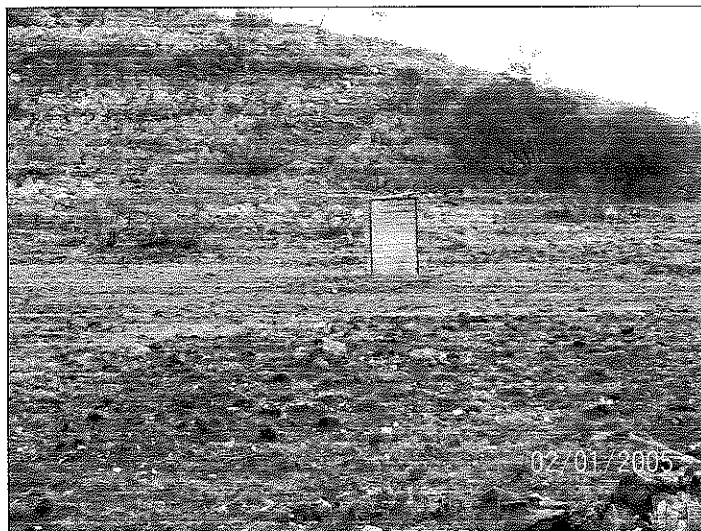


Fig 10: Fire damage to infrastructure on the Drimolen site: toilet destroyed by uncontrolled fire now demolished

3.1.5 Red Data Species, rare plants and animals

There are no botanical or faunal lists for Drimolen and no record of medicinal, edible or poisonous plants, although such economically important plants are known to occur (see Biodiversity and ecological values above). Such lists, and a record of the whereabouts of particular species, are essential to baseline studies of, for example, the impact of fire or wetland degradation.

Rare species have not yet been mapped. Rare plants and animals are difficult to protect if their whereabouts are unknown.

It is recommended that species lists of plants and animals be drawn up and the occurrence of economically significant species as well as medicinal and poisonous plants recorded on a map. Impact of collection and use should be noted.

Status quo:

- See summary for rangelands.
-

Threats and risks:

- There is no up-to-date list or mapping of vegetation – over 500 species are known to occur in the Sterkfontein area (Mogg 1975) in this type of Highveld grassland. Rare and endangered species cannot be protected if not located and mapped.
- Edible, medicinal and toxic plant species not recorded – full values of site not clearly understood

3.1.6 Alien vegetation and weeds

Drimolen is somewhat less infested with alien vegetation and weeds than most of the other sites. There is as yet no species list of alien species at Drimolen and it is recommended that such a list should be compiled.

Infestations have not yet been mapped and prioritized and this needs to be done, species by species, in order that systematic clearing and follow-up clearance can be done. It is further recommended that fixed point photography be set up to monitor infested patches. This will need to be done on a patch by patch basis.

The occurrence of *Opuntia* (prickly pear) is interesting – it has been suggested that the limeworkers often encouraged these plants because of their fruit. Many plants associated with old lime-mines may be considered as 'historical plantings'. A substantial infestation was noted at the base of the kiln (Fig 8) and there is debate as to whether it should be left and monitored for spreading (unfortunately, the digestion-resistant seeds are spread by baboons (none resident on or near fossil site) – and probably also humans - which eat the fruit and spread seed widely). However, the species is a scheduled invasive and control is a legal requirement.

It is recommended that the occurrence of prickly pear be recorded, after which it should be eradicated according to eradication procedures recommended by GDACE.

GDACE has field operational guidelines for alien plants; these are noted in the generic site management plan Appendix. A guideline on the use of herbicides is also being prepared.

Weed management at Drimolen is excellent and there are few weeds in the excavation area or elsewhere on site.

Status quo:

- There is no list of alien invasive species or of weeds occurring on the Drimolen site
- Infestations by different species have not yet been mapped
- Infestations have not been prioritized for clearance
- Field operational guidelines for appropriate eradication treatments for each species are not yet available
- There is no agreed plan of management or budget for control or a maintenance level of clearance or rehabilitation of cleared spaces
- There is no broader plan for alien vegetation control covering the COH WHS as a whole so that re-infestation is likely (by baboons and other widely-ranging mammalian seed dispersal agents)
- Photographic monitoring for clearance programme needs to be set up.
- Weeds in and around the excavation site and work area are being effectively controlled by the researchers and their field staff

Threats and risks:

- Continued presence and spread of invasive species throughout individual sites and COH WHS, making eradication and control ever more difficult and expensive.

3.1.7 Visual aesthetics, site context

The key sensitivities, management precautions and some solutions to issues concerned with visual aesthetics are provided in the Generic Management Plan.

The Drimolen fossil site has a huge viewshed. Current land use of the surrounding area is rangeland for game animals and at present and fences, powerlines and gateway/entrances are the only intrusive structures. The most visually disturbing elements on the Drimolen landscape are the containers and toilets on the fossil site itself (Figs 4 and 9).

It is recommended that some form of camouflage or screening be considered to soften the stark and potent visual impact of two (soon it will be three) large containers parked on an exposed grassland

Status quo:

- Contextual landscape of the site is visually pleasing
- The COH WHS MA screens all proposed new developments and protects visual integrity wherever possible
- The strongest visual impact is from structures on the Drimolen site itself: the containers used for storage and accommodation
- Alternative options for the placement of the containers has been considered and there is apparently no alternative (they would in any case be obtrusive elsewhere)
- Camouflage and/or screening could be considered

Threats and risks:

- Open rolling grassland country with 360-degree views increases sensitivity of contextual area to visual impact of new developments

- Inappropriate structures and land use have the potential to spoil the relatively unspoilt sense of place. However, the metal containers are fire-resistant and this should be taken into consideration.
- Shipping containers used as storage and for accommodation on site themselves create a conspicuous visual impact

3.2 Physical Environment: Subterranean

There are two subterranean systems in close proximity to one another. The Drimolen Cave has its entrance, a low slit-like opening, in the Main Quarry. This cave is about 20m x 40m and has been stripped of its speleothem decorations by early lime-mining activities. The attendant blasting operations have rendered the cave fractured and unstable, and it is not recommended that its interior be incorporated in any visits. The same range of stalactites and other formations are on view at the nearby Wonder Caves in any case. Fossils are evident in the walls of the cave wherever breccia deposits occur. These are not being excavated at present. In the recent past, the cave has been used by bats and porcupines, but human activities in the vicinity seem to have displaced the bats. The presence of porcupine droppings and quills suggests that these creatures are still present. Porcupines are important bone-accumulators, and their continued presence would allow their contribution to cave taphonomy to be demonstrated to visitors.

The second cave is about 40m from the Drimolen Cave. It is biologically significant in that two species of bat, the long-fingered bat (*Miniopterus schreibersii* now *natalensis*) and the horseshoe bat (*Rhinolophus clivosus*) are known to use the cave as a roost. The planned extension of the fossil excavation in the direction of this cave will pose a threat to the continued use of the cave by bats.

A proper bat study covering the entire COH WHS is required in order to establish the status of rare bat species resident in the karstic landscape. This is necessary in order that excavations are not unnecessarily held up by uncertainties regarding the significance and sensitivity of bat populations in caves adjacent to important excavation areas

As is the case at the Drimolen cave, this cave is shattered by blasting and dangerous. It is not recommended to introduce visitors into the underground system.

Status quo:

- There are two subterranean systems at Drimolen
- Both are off-limits to tourists
- The caving fraternity explores the caves from time to time, conducting mapping exercises
- Neither cave is being excavated at present. The Main Quarry cave breccias are known to be fossiliferous
- One of the cave systems is used as a hibernaculum for a rare species of bat (*Miniopterus natalensis* – numbers are rapidly declining) (Source: active CROSA member, pers comm.)
- Care should be taken if excavations are extended into this region of the site because human activity appears to have disturbed bat occupation of the Main Quarry cave
- The subterranean systems are used by porcupines as lairs
- Presence of the subterranean systems adds value to the educational potential of the site
- Site safety of the subterranean systems is not an issue because of non-use at present

Risks and Threats:

- Disturbance of subterranean environment could displace rare bat population

3.3 Infrastructure

3.3.1 Access roads, culverts, bridges, etc.

Please see section on erosion above (3.1.3) because of overlap.

The access road is a gravel track which passes for several kilometres through adjacent private properties before reaching the site. Maintenance of the track is the responsibility of the landowners except for the short branch used by the researchers to reach the Drimolen fossil site itself. This part of the access road is fortunately along contour, erosion is not problematic, and the road surface is acceptable at present.

The track which extends across the north-western boundary line of the fossil site (already mentioned in section 3.1.3) should be closed because the road is in the drainage way and an erosion gully is forming since the track channels water. The erosion gully is fairly well advanced and is clearly visible on the aerial photograph (Fig 2). This track is not usually used by the researchers and there is an alternative route so that closure would not be a serious inconvenience.

A more serious problem is physical access to the property across properties belonging to neighbours. Neighbours are difficult about allowing access and this affects, in particular, support excavation staff that have to find lifts in and out. The presence of dangerous animals precludes pedestrian transport which is in any case not sanctioned by the respective landowners. Site visitors to landlocked Drimolen are expected to pay an entrance fee to cross the adjacent property.

Status quo:

- See section 3.1.3 above

Risks and threats:

- Persistent use of the controversial access route could lead to soured relations with adjacent landowners
- Excavation staff are trapped without transport

3.3.2 Fencing and gates

Status quo:

- The outer perimeter of the host property is fenced.
- The landowner is not in favour of a perimeter fence around the proclaimed heritage site because of visual impact.
- The remains of an old partial (three-sided) fence around the fossil site have been removed except for the south-eastern corner post and a short piece of fencing
- This does not affect access control to the fossil site because access to the property as a whole is strictly controlled
- The lack of fencing around the excavation site allows large mammals to enter the excavation site area causing trampling damage to excavation edges, walls and base
- An inner enclosure fence has been agreed upon to protect the excavation from kudus, warthogs and other intrusive species but it has not yet been erected. Its efficacy has not yet been established

- SAHRA has agreed to assist with funding this fence in lieu of a perimeter fence and is awaiting quotes from the landowner/scientist. The fence and its design has been approved by the permit committee of SAHRA and will be erected as soon as the quote is presented and approved and funds become available.

Risks and Threats:

- Without the inner fence, the deposit and fossils may be damaged by trampling and animal activity

3.3.3 Parking

Status quo:

- Researchers habitually park underneath the cluster of *Acacia* trees. Parking is causing worn patches and care should be taken that the surface does not erode.
- It is recommended that the area be watched and appropriate action taken if necessary

Risks and Threats:

- None at present

3.3.4 Built environment

Status Quo:

Sheds and storage

- Lock-up storage is available in part of one of two containers parked on site. The other portion provides somewhat cramped accommodation for the Drimolen excavation staff as well as the n'Gomo Safari lodge staff in the second container.

Accommodation

- Accommodation is currently provided by two shipping containers, one of which also functions as a store room for excavation equipment (Fig 4). A shed close to the borehole (off-site) serves as a preparation area: the power supply at the latter venue allows air-scribes to be used.
- One container, originally dedicated to accommodating researchers' excavation staff, is now occupied full-time by the landowners' staff so that the second container now serves a dual purpose as a store and sleeping quarters
- The excavation staff needs to be increased and a third container is envisaged to provide the necessary space and separation of sleeping and storage and preparation functions
- Alternative accommodation for the landowner's farm workers off the heritage site is apparently not possible
- The containers are visually intrusive but alternative parking is problematic. They would be obtrusive anywhere.
- Camouflage and/or screening is difficult but should be considered
- Support facilities for residents such as ablution and toilet facilities are also problematic. Farm workers and excavation staff use their own pit toilet., Tourists and visitors use the second pit toilet erected by the research team. There are no proper ablution facilities
- On-site surveillance is an advantage for both the landowner and research team
- Residents cook on gas or on open fires. Fire is therefore a risk and there should be extinguishers available – at least one for each container. Flammable substances are being stored

- Training on the use of the extinguishers is necessary (this is usually provided by suppliers) and extinguishers need to be checked annually

Pathways, walkways and viewing platforms

- Pathways around and through the site have been cleared. High-pedestrian areas have been given a capping of thin lime-cement where they are laid close to excavation edges.
- Safe access steps have been created to reach the excavation base. These too have been capped to prevent erosion
- The edge of the excavation is protected and can be used as a perfectly adequate viewing platform without visitors having to enter the excavation base. There is no need for a special viewing platform at this stage.
- There are shady places where people can sit or stand

Tourist-related, including signage

- Limited tourism is taking place on site
- There is no site interpretation in the form of signage or site interpretation boards, but interpretation is provided by the site guide
- The site is marked by a sign at the entrance (Fig 11)
- All signage must be approved by SAHRA – see guideline, Generic Site management Plan, Appendix
- An appropriate place for a plaque indicating the National Heritage Site status of the site has been selected by mutual agreement between scientists, SAHRA and landowner.
- The tour operator needs to be registered with the COH WHS MA and have the written permission of the landowner

Deleted:

Ablutions and toilets

- There are no proper toilets, apart from two pit toilets, or ablution facilities

Risks and Threats:

- Visual impact of accommodation containers is considerable
- The lack of proper ablution and toilet facilities make living and working conditions uncomfortable
- Groundwater and site contamination from inappropriate sanitation
- Lack of infrastructure and support facilities makes excavation slower, more expensive and difficult



Fig 11: Signage announcing Drimolen excavation area.

3.3.5 Waste Management

Status quo:

Sewage

- There are no proper toilets, only two pit toilets which are used by the landowner's farm workers, the resident field assistants, research scientists, tourists and visitors (Fig 13). When there is a field school, students must use the toilet as well. It has been recommended that this situation be addressed.

Litter

- The permitted scientists see to the disposal and/or removal of litter from the site
- Waste removal from the accommodation site is unknown: there are more farm workers than excavators and the removal of litter would be a landowner responsibility
- Litter on site does not appear to be a problem at present

Risks and Threats:

- See 3.3.4 above

3.3.6 Energy

Status quo:

- There is no electricity supply directly to the site
- The nearest power point is 800 – 1000 m distant.
- Electricity would allow for improved excavation techniques. A two-stroke 'pioneer' drill is being used at present

- A budget would be required for electricity to be installed on site. As yet, there is no funding available for this project

Risks and Threats:

- None at present

3.3.7 Water

Status quo:

- There is no formal water supply directly to the site
- Water is available at a borehole about 800 m to 1 km away
- Previously, the needs of the 2-person scientific team and the 4-person excavator-preparator team was met by one 44 gallon drum weekly, but recently water has been piped in over this distance
- The pumphouse is also 800 m away and also serves as a rather inconvenient fossil preparation (with aircsribes) and fossil washing area. A proper work area is urgently needed.
- A secure and potable water supply is needed especially for the field schools and for tourists
- Water is also required for wet sieving and for dust control at the dry sieves
- Concealment of the water supply pipeline and concealment of the water reservoir is recommended
- A budget is required to stabilise water supply for the Drimolen site. The landowner's farm workers and excavators need ablution facilities, and water is required before responsible tourism can take place. Both parties (landowners and researchers) will benefit from a proper installation. Provision also needs to be made for a proper work area as envisaged in the original management plan, which recommended that a store-cum-workroom, ablution facilities and small interpretative area should be provided at all the sites that warrant such infrastructure. This was one of the many items that were to have been funded and made possible with funding from the Concessionaire.

Risks and threats:

- The lack of on-site running water is a hindrance to several on-site activities as well as living and working conditions

3.3.8 Telecommunications

Status quo:

- There is no land-line, telecommunications are possible by cellular telephone only.
- Telecommunications are necessary for responsible tourism in case of emergency

Risks and Threats:

- Emergencies may require rapid communication and response

3.4 Research Environment

The site is being excavated by Dr A Keyser and Dr C Menter and their permit (Number 80/05/08/023/51 – V.23) will expire on 1 January 2009. The fossils are curated at the University of the Witwatersrand.

3.4.1 Previous and ongoing research and excavations

The site was discovered in 1992 by Dr André Keyser (Fig 12) and excavations have continued since that time as research budgets have allowed. The finds made have been documented in section 2.1 and 2.2 above and will not be repeated here.

Status quo:

- Excavation is proceeding into decalcified collapsed material - the 'Collapsed Fill', derived from and adjacent to an *in situ* debris cone. Much of the material dumped by limeworkers has been removed, exposing undisturbed material in places.
- The Drimolen excavation follows standard archaeological methods and the decalcified material is excavated in 1 X 1 metre squares by 10 cm depth where possible.
- Identifiable macrofaunal remains recovered from grid squares are surveyed by total station to nearest 0.5 cm
- All material is screened through a series of 3 sieves, the smallest being 1 mm. the medium fraction is also wet-screened
- Heavily calcified blocks are removed using standard feather and wedge technique
- Preparation of fossils is by means of aircsribes with Tungsten Aircscribe bits. Power supply for the air compressor is available at premises nearby but off-site
- Several publications have already resulted from description and interpretation of material excavated and more are in press (see Bibliography). Many discoveries contributing to the field of study have been made and the site is third richest in the COH WHS despite the fact the first two sites (Sterkfontein and Swartkrans) have been excavated for many decades more.

Threats and risks:

- None at present

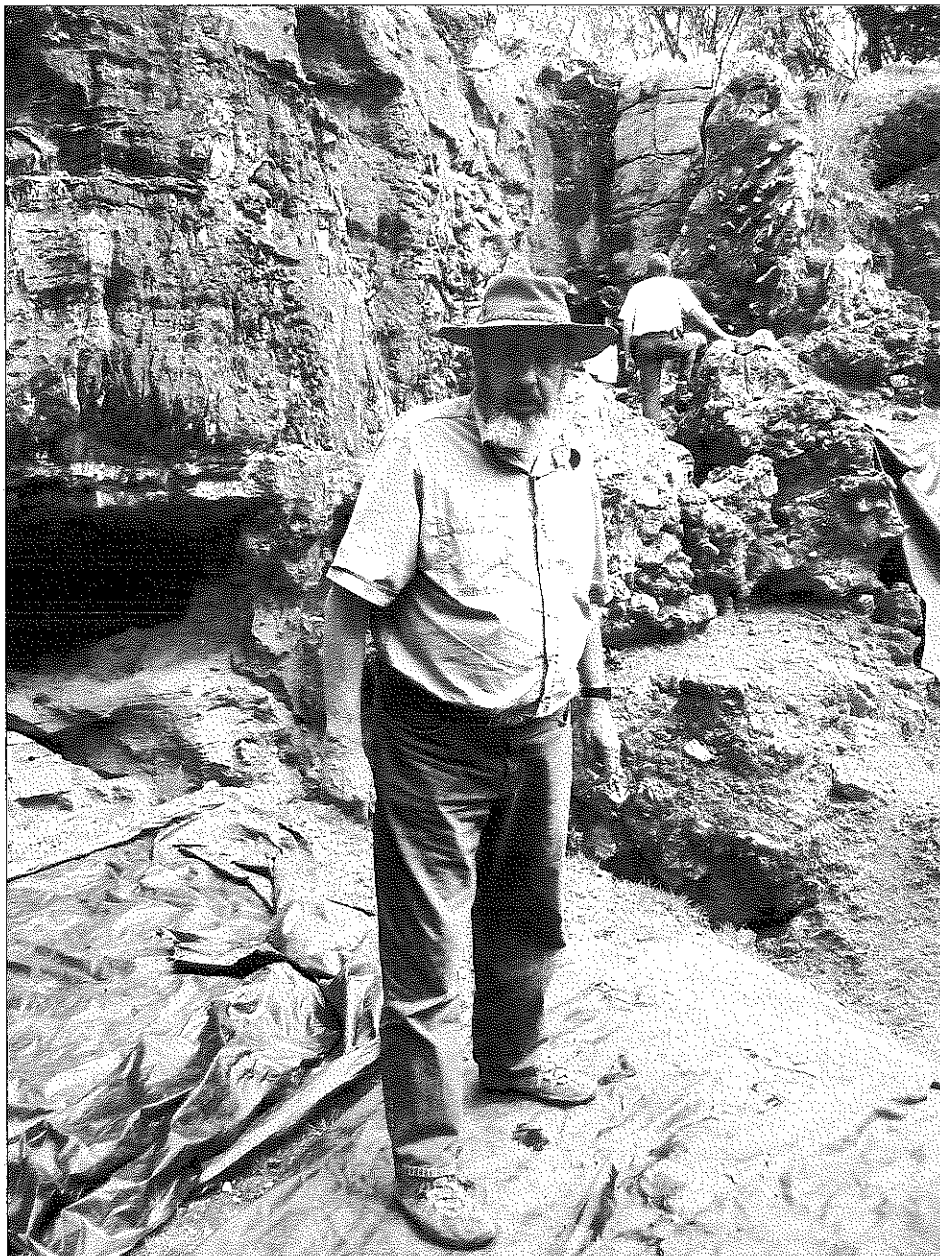


Fig 12: Dr. A. Keyser in the Main Quarry. The person with green trousers in the background is examining a witness section, in which the steeply-angled clasts disclose the angle of repose of the ancient debris cone of which it was once part. A second witness section, comprising finely stratified outwash fines, is behind Dr Keyser's right wrist.

3.4.2 Excavation edges

Status quo:

- There are several metres of excavation edge.
- These were originally friable because the excavation is de-roofed and the breccias are decalcifying. The permitted scientists have therefore capped the excavation edge where it is vulnerable with a removable lime-cement capping to protect it (Fig 13).
- Trampling by resident wild game is a problem as kudu, warthogs and other animals enter the site in search of forage.
- The planned enclosure fence will remedy this situation but it has not yet been installed
- There has been no significant collapse at the site since excavation began

Risks and Threats:

- See 3.3.2
- Friable edges liable to collapse
- Unprotected craters and holes could be dangerous to site users and animals

3.4.3 Excavation walls

Status quo:

- The permitted scientists are aware that walls must not become too high and have terraced their excavation appropriately
- The excavation walls are into decalcified material and nowhere exceed 2 metres before benching, except the back wall which was left standing after lime working ceased, and against the foot of which excavation is now proceeding.
- Stones embedded in the walls are a problem and should be removed if they become loose (Fig 15)
- There has been no significant collapse at the Drimolen excavation

Threats and risks:

- Overly high excavation spits may create dangerous drops
- Deep vertical trenches can become unstable and a danger to site users
- Overly high excavation walls may be difficult to stabilize when the excavation is complete
- Boulders and clasts embedded in friable walls can cascade causing damage to the excavation and site fabric
- The excavation base might become difficult to reach

NONE OF THESE IS A THREAT TO SITE VALUES AT PRESENT

3.4.4 Access to excavations: steps, ladders, lifts etc.

Status quo:

- The permitted scientists have constructed a series of safe steps by means of which the base of the excavation can be reached. These have been capped with lime cement in order to preserve their surface (Fig 14).

Risks and Threats:

- None at present

3.4.5 Erosion

Status quo:

- The only erosion on site has been discussed in sections 3.1.3 and 3.3.1 above. No serious erosion was noted in the excavation area. The presence of a lower cavern system is attested by the rapid drainage from the base and sides of the excavation area of the main Quarry.
- The permitted scientists cover all areas not immediately under excavation with industrial quality plastic (Fig 16) in order to protect the excavation edges and walls from the effects of heavy rain
- Care has been taken to drain runoff away from the excavation and distribute it over the landscape
- The Main Quarry constitutes a natural sump for rainwater but the presence of an underground void allows for rapid drainage so that there is no damming of water.

Risks and Threats:

- None at present

3.4.6 Compliance with conditions of excavation permit

The present permit expires in 2009:

- Recording method (a theodolite or EDM 'Total Station' is used)
- Check that the position of all existing and planned excavations has been committed to plan
- Check that copies of all published papers listed in the Bibliography hereunder have been lodged with SAHRA
- Check accessioning and preparation backlogs
- Check that witness sections and sampling localities have been recorded on a site plan

Threats and risks:

- Excavation is inevitably a destructive process. Inappropriate excavation techniques, recording techniques, recovery techniques, preparation techniques, inadequate subsequent publication and indifferent conservation of artefacts recovered is perhaps the greatest threat to the fossil sites. This is an issue generic to all the sites in the COH WHS, hence the SAHRA twice-yearly inspections. Non-compliance is not an issue at this site.

3.4.7 Witness sections

Status quo:

The fossiliferous sediments have been divided into two groups; a) *in situ* material and b) Collapsed Fill.

Two *in situ* lithologies have been differentiated – the so-called “Blocky Breccia” and the ‘Cave Siltstone’. The Blocky Breccia represents the decalcifying remains of an elongated debris cone and contains many clasts embedded in a pinkish-brown sandy matrix. The clasts are dolomite and chert, components of the local country rock. The unit is highly fossiliferous and all the hominins recovered to date derive from it.

The Cave Siltstone is reddish-brown, finely laminated and shows ripple-marks and desiccation cracks on bedding planes. It apparently formed around the debris cone and occupies the lower side passages of the original cave. It is probably a combination of residual material derived from

the dissolution of dolomite by chemical weathering and the washing of fines from the debris cone (Fig 17).

The Cave Siltstone is much less fossiliferous than the debris cone and contains mostly micro-mammalian material. Taphonomic studies will show whether or not this is due to small bones acting as sedimentary particles and being washed into the deeper recesses of the cave, or whether the micro-mammals collected beneath an owl roost.

The Collapsed Fill (i.e. not *in situ*) only occurs in the Main Quarry. This deposit comprises collapsed blocks of both lithologies described above and large blocks of collapsed dolomite. The voids between the collapsed blocks have become filled with dark brown dolomitic soil washed in from the adjacent hillside to the west.

- A witness section for the Blocky Breccia has been designated (Fig 18) and will not be excavated. It has been chosen because clasts embedded in its sides indicate the angle of repose of the original debris cone which it represents.
- Adjacent to the cone are the stratified residual sediments of the Cave Siltstone and some of this material is ear-marked for a witness section (Fig.19).

Risks and Threats:

- Stratigraphic conclusions reached should be independently verifiable. If no witness sections are preserved, this would not be possible
- Dating results need to be independently verifiable. If witness sample sections are not preserved, this will not be possible
- New techniques and analytical procedures are perpetually coming to light. These need to be applied to sites from which earlier conclusions were obtained, in order to verify and expand understanding. If there are no witness sections, this cannot be accomplished.

3.4.8 Dumps

Status quo:

- Dumps of excavated material are not much in evidence at Drimolen. Some sterile material has been built into retaining walls for small garden areas and sieved waste has been levelled and vegetated.
- Old dumps should be committed to plan
- New dumps need to follow the field operational guideline suggested in the Generic Site Management Plan

Risks and Threats:

- Loss of information concerning the source, author and content of dumps
- Loss of or languishing information, because dumps are not processed for fossil content



Fig 13: Capped excavation edges, in order to prevent friable decalcified breccia from crumbling

3.4.9 Repository

Status quo:

- The University of the Witwatersrand is the designated repository of the fossil material and artefacts recovered. This institution has been accredited by SAHRA as it has all the necessary controls in place and it conforms to the minimum standards laid down by SAHRA

Risks and Threats:

- Loss of, or deterioration of artefacts
- Loss of information concerning artefacts
- Lack of publicized information about artefacts.

None of these are an issue at present.



Fig 14: Capped steps provide access to excavation base. Plastic sheeting helps to protect excavation walls from erosion by heavy summer rains and trampling animals



Fig 15 Photograph showing large stones and boulders embedded in a matrix of decalcified sediment. Large clasts in decalcified material can become unstable and need to be removed before they cascade, causing site fabric to collapse



Fig 16 The main witness section in the main Quarry, showing, by means of the angle that clasts are embedded, the slope of the former debris cone.



Fig 17 : Stratified fine sediment, presumed outwash of fines from the adjacent debris cone (situated behind and to right of viewers, see previous Fig.), which contains mainly mammalian microfauna, although some well-preserved large mammal bones are preserved

3.5 Site safety and security

3.5.1 Physical safety

Status quo:

- The site is situated within an area where most people know each other and access is tightly controlled, and personal security is not likely to be a problem. Should this situation change, however, personal security could become a problem because of the extreme isolation of the site, far away from the nearest residents

Risks and Threats:

- Personal safety might become a risk
- Equipment and vehicles may become at risk

3.5.2 Safety of surface and built environment

Status quo

- The built environment is simple and informal and there are no permanent structures excepting the pit toilets and containers.
- The resident farm workers and excavators cook either on gas or on open fires and fire is a threat if not a hazard. Each of the three containers should be equipped with a fire extinguisher and the residents trained in their use. The equipment needs to be checked annually. The fire-fighting equipment is probably obligatory in terms of the Public Health and Safety regulations
- The pit toilets and even the containers (especially if aluminium) are susceptible to fires (Fig 10) and a fire-break is recommended all around the gazetted part of the Drimolen site to prevent uncontrolled fires started within this area from escaping

Risks and Threats:

- Domestic fire is a risk, particularly as residential and storage functions are combined in one hut
- Escaping domestic fire is a risk to the surrounding farmland

3.5.3 Safety of excavation area

Status Quo:

- Abstraction dewatering of the subterranean cavern system by installing a local borehole is not recommended as it is likely to further destabilize an already palpably unstable situation.
- Excavation edges are stable and protected
- Excavation walls are high but not unstable
- Excavation base can be safely reached
- No-go areas are protected with psychological barriers in the form of tapes or barricades
- There is no good telephonic connectivity and a first aid and evacuation procedure needs to be incorporated into the permitted scientists planning
- The excavators, sieving team and preparators need to be equipped with the obligatory protective clothing such as boots, gloves, eye goggles and filtering masks. This is probably a requirement of the Public Health and Safety regulations

- Scavenging of fossil is not a big problem but blocks of breccia have been known to disappear. On-site surveillance is a big deterrent

Risks and Threats

- The report of a site safety inspection is pending

3.5.4 Subterranean safety

Status Quo:

- Safety in the subterranean environment is not an issue at present because these are neither being excavated nor visited.
- Stability of the sedimentary material underground is not an issue because of a Conservation Principle which states that natural processes on site will be allowed to continue

Risks and threats:

- None at present

3.6 Site interpretation

3.6.1 Presentation of site values

Status quo:

- As much as the present permitted scientists would like to have a small site museum, accommodation and funding is a problem.
- There is no site interpretation in the form of signage or interpretation boards
- Limited tourism and thus limited site interpretation is taking place
- Site interpretation is entirely oral by the tour operator, tourist guide or permitted scientist
- The site does not have its many significant heritage values presented anywhere in the Cradle of Humankind and very few people know of the groundbreaking discoveries that have been made at this site. Much new information has come to light and this needs to be made public if palaeoanthropology is to be kept in the public psyche
- Tourism needs to have the written approval of the landowner
- Tourist activities on World Heritage Sites and National Heritage Sites needs the approval of the Management Authority and SAHRA
- There are restrictions on the filming and capturing of images on World Heritage Sites and a procedure needs to be put in place to regulate this requirement. The NHR Act (section 27(23)(b) already prohibits any "reproduction for profit without a permit issued by SAHRA")

Risks and Threats:

- Lack of presentation of site values to a wider audience prevents information concerning site significance from reaching public psyche
- Potential funders might not know about site significance
- Public not educated about full range of COH WHS values
- Mining relics not yet mapped and recorded – important for historical reasons. They might need to be removed or altered at some future date (for example trenches and pits) and they therefore require recording. Elements such as test pits and drives, dumps and excavations need to be included
- Failure to recognize mining history could diminish the value of tourist experience – mining values well acknowledged on this site.

3.6.2 Visitor numbers

Status quo:

- There is no regular mechanism for recording and reporting visitor numbers as yet

Risks and Threats

- The tourist numbers are required by management and are not currently available on record

4 MANAGEMENT OBJECTIVES, DESIRED OUTCOMES

This section notes desired states and management outcomes, and the section and Table that follow (Section 5) describe the management strategies required to achieve such outcomes. The management objectives have the preservation all site values as a goal.

4.1 Physical environment, surface

Desired outcomes for the physical environment include:

Access:

- To ensure that permitted access to the site (legal right to access) is compliant with the landowner-scientist agreement and that cordial relations are maintained
- To ensure that the alternative access route provided by the Dolomite Road – not presently negotiable – is pursued

Rangeland:

- To ensure that contextual veld conditions and rangeland in immediate vicinity of fossil site is maintained in as good a condition as possible, with regard to appropriate land use and management.

Erosion:

- To ensure that the fossil site and environs is free of active erosional problems and that existing areas of erosion are remedied, rehabilitated and monitored for follow-up action if necessary

Fire management:

- To ensure that a proper fire regime appropriate to bankenveld is maintained on the fossil site.
- To ensure that fossil site users are aware of fire hazards and can control on-site fires.
- To ensure that the fossil site does not harbour or create fire hazards
- To ensure that the necessary fire-fighting equipment is on hand in the event of a domestic fire (extinguishers and beaters)
- To ensure that the basic data necessary to assess the long-term impact of frequent fires is available, which information is necessary to feed back into appropriate fire management

Biodiversity, rare plants and animals:

- To ensure that a database of plant and animal species present on site is available, because biological values are as yet poorly understood
- To assess which of these are target species for use as food, medicines, economic reasons, etc., and to what extent they are being collected

- To identify, record and map special species in order to ensure their protection

Alien vegetation:

- Desired outcome is a fossil site which is free from alien invasive species, and, as far as possible, from weeds

Visual aesthetics:

- Desired outcome is protection of viewshed and contextual environment in order that the site does not become an island in a sea of inappropriate development or land use.

4.2 Physical environment, subterranean

- Desired outcome is a subterranean environment in which the cave atmosphere, substrate, biota and appearance is kept in as undisturbed and natural a condition as possible
- A further desired outcome is a subterranean environment which, if it is being visited or excavated, is safe for all site users.

Infrastructure, built environment

Desired outcomes include the following:

- Dedicated living space for the excavation support team. At present, their shipping container doubles as a storage area and cramped sleeping place.
- Minimise the visual impact of containers by screening or camouflage
- Redundant infrastructure removed and the foundations rehabilitated
- Adequate and environmentally acceptable toilet and ablution facilities
- The ultimate supply of water and energy to the site

4.3 Research environment, heritage values

Desired outcomes include the following:

- To ensure that the construction of the enclosure fence to exclude wild animals which trample and damage the site takes place
- To ensure that the activities of scientists on site are perceived as 'adding value' rather than as 'site users' and that authorities take cognizance of this, particularly with regard to funding items which are not directly research or science-orientated, such as the purchase of accommodation and storage containers, which items have little hope of being funded by the NRF or other funding bodies
- To ensure that lack of funding does not inhibit research opportunities
- To ensure that the Management Authority has in-house heritage expertise which allows for the follow-up of fossil site inspection observations and recommendations
- To ensure the mapping, recording, conservation and broader presentation of the well-preserved historical mining relics on site
- To ensure that all structures, excavations and site features are committed to a site plan which includes the gazetted proclamation boundary
- To ensure that all dumps, old and new, are committed to plan, with appropriate annotations
- To ensure that new dumps are appropriately sited and properly constructed

- To ensure that excavations are safely executed and compliant with permit terms and conditions
- To ensure that appropriate witness sections are left and stabilized
- To ensure that sample sites are properly recorded and that results are independently verifiable
- To ensure safe excavation edges, walls and bases, and that these are stabilized when work ceases
- To ensure that fossils are carefully and properly prepared, catalogued, curated and housed in a safe repository
- To ensure that regular site safety inspections take place

4.4 Site safety and security

Desired outcomes include:

- A surface environment, subterranean environment and work environment which is safe for all site users
- It is desirable that an evacuation policy in the event of accident or medical crisis be drawn up and that basic first aid is available on site

4.5 Presentation of site values

A desired outcome is:

- To ensure that the many heritage and natural values of the site are interpreted and made available to as wide a public as possible

5 MANAGEMENT AND MONITORING TASKS

The following are operational management tasks and issues that need to be addressed now or in the future as part of on-going management actions in order to achieve the desired outcomes detailed above.. Their funding is still problematic.

The development of research at the fossil sites has been limited by the unfortunate perceptions that the State may not fund development on privately owned property and that the scientists are 'site-users'. This needs to change as it must be seen as the responsibility of the authorities to foster research and necessary associated development on these sites. It is recommended that in future, scientists be viewed rather as 'value adders' and thus eligible for some easement for the funding of heritage site management interventions which they are currently expected to fund, for example, fencing. In effect, the state is expecting others to finance the protection of the COH WHS fossil sites.

Sites which have no active scientist are generally neglected – this is an indication of the positive influence which scientists have on fossil sites.

The following tables have been drawn up with the specific aim of clarifying who should do what, and when, on the heritage site. The Tables also provide some indication of priority ratings. They have been constructed in such a way as to incorporate all the key management issues, strategies and monitoring criteria so that they may be used independently of the text.

The relative priority of the management measures has been identified based on ICCROM definitions as follows:

- Immediate - to be attended to urgently as it constitutes a danger to the public or to a resource;
- Urgent - needs to be attended to urgently to protect the resource;
- Necessary - needs to be attended to as part of short-term planning, to protect the resource;
- Desirable - to be attended to from a longer term development perspective;
- Keep watch - to be monitored to see if the problem is serious.

**TABLE 1 FOLLOWS:
MANAGEMENT MEASURES AND MONITORING CRITERIA**

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Surface environment						
Access - legal access to property	<ul style="list-style-type: none"> • Pedestrian access is a sensitive issue, dangerous animals preclude pedestrian access • Adjacent landowners are particular about access 	Assured access to site, with dolomite road as an alternative (*) <ul style="list-style-type: none"> • Ensure that proper negotiated preferably written letters are obtained by all site users or those in charge • Re-open Dolomite Road upgrade as a possible alternative 	Necessary	All site users. MA to ensure that Dolomite road issue is being reviewed by the appropriate authorities	<ul style="list-style-type: none"> • Check if access issue has been addressed in MOU's between landowner and research scientists • Check if tour operator and tourist guides have same permissions 	Annual
Unauthorised access	<ul style="list-style-type: none"> • Removal of rock, fossils breccia and artefacts • Removal of edible and medicinal plants • Theft of moveable property 	Site safe from unauthorized visitors and tampering (*) <ul style="list-style-type: none"> • Research and field staff to maintain surveillance • Landowner to maintain surveillance 	Necessary	Permitted scientists, field staff, landowner	<ul style="list-style-type: none"> • Check stockpiled breccia • Check for signs of digging out of plants • Maintain surveillance over moveable property 	Ongoing
Rangeland condition	<ul style="list-style-type: none"> • Deterioration of rangeland due to overgrazing, trampling or too frequent fires 	Veld to be maintained in optimum condition for current land use (game) (*) <ul style="list-style-type: none"> • GDACE can advise on stocking rates and appropriate species • Plan for acquiring baseline data against which impacts can be assessed • Plant species list required 	Desirable	Landowner	<ul style="list-style-type: none"> • Check for trampled bare areas • Check for loss of palatable grasses and forbs 	Ongoing
Retention of topsoil, surface drainage, surface erosion	<ul style="list-style-type: none"> • Loss and dispersal of topsoil makes re-vegetation difficult 	Erosion-free fossil site (*) <ul style="list-style-type: none"> • Check all tracks and carpark • Check for surface drainage and distribution of runoff over surface • Check for signs of surface erosion 	Necessary	Research scientists	<ul style="list-style-type: none"> • Check for worn patches of vegetation where cars habitually park • Check for erosion gulleys in tracks • Check for patches of exposed soil 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Fire Management	<ul style="list-style-type: none"> • Too frequent fires have a negative effect on vegetation • Fire is a threat to moveable property 	<p>Maintain a fire frequency regime appropriate to Bankenveld (*)</p> <ul style="list-style-type: none"> • Implement a fire management policy • Record fire frequency and intensity • Take precautionary measures to contain domestic fires started on site • Brief residents on what to do in such a situation • Provide fire extinguishers, training in their use and annual checks of equipment • Provide suitable beaters for research staff and farm workers 	Urgent	Landowner, research scientist, GDACE	<ul style="list-style-type: none"> • Set up rangeland study for base data against which fire impact can be assessed • Set up a fire frequency recording programme • Check location and functionality of fire extinguishers • Ensure that annual check of equipment takes place • Ensure that residents, students and scientists know how to use equipment • Ensure that beaters are always on hand 	Ongoing
Red data species, rare and economically significant plants	<ul style="list-style-type: none"> • Loss of edible and medicinal plants. Many important plant species are not on RED DATA list. 	<p>List of red data species, rare and economically significant plants available (*)</p> <ul style="list-style-type: none"> • Surveillance of indigenous plant use • Draw up a species list of medicinal, poisonous, edible and economically significant species • Map occurrence and preferred microhabitats • Monitor collection and utilization 	Necessary	Landowner, GDACE	<ul style="list-style-type: none"> • Check for signs of digging geophytes out by the roots • Check local roadside vendors for plants on sale 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Invasive alien plant species.	<ul style="list-style-type: none"> Invasion of avens and other habitats by alien species Loss of biodiversity Unattractive landscape 	Fossil site free of alien species (*) <ul style="list-style-type: none"> Make a list of all invasive plant species Map and prioritise infestations Determine best eradication or control programme. GDACE available for assistance Assess costs and find budget Begin control according to guideline provided in generic management plan Enlist expertise of GDACE Implement control and clearance programme Monitor and follow up as required 	necessary	Landowner, GDACE, scientists (in work environment)	<ul style="list-style-type: none"> Visual checks for infestations and incidence density Monitor with fixed point photography 	Ongoing
Weeds & shrub growth in excavation site	<ul style="list-style-type: none"> Roots destabilize breccias in time Plants reduce visibility of noteworthy sections Weeds give a negative visual experience and project an air of dereliction 	Fossil site, especially excavation area, free of weeds (*) <ul style="list-style-type: none"> Pull weeds by hand, or 'skoffel' Destroy in a manner that does not spread seed further 	Necessary	Landowner, research scientists (in excavation environment)	<ul style="list-style-type: none"> Visual checks for weed infestations Fixed point photography for controls 	Ongoing
Visual impact: shipping containers	<ul style="list-style-type: none"> Strongly negative visual impact Strongly affects sense of place 	Diminished visual impact of containers (*) <ul style="list-style-type: none"> Discuss possible camouflage or screening Revisit possible re-location 	Necessary	Landowner, research scientists	<ul style="list-style-type: none"> Ongoing impact 	Watch
Development in 'viewshed'	<ul style="list-style-type: none"> Negative visual impact 	Pristine landscape of viewshed maintained (*) <ul style="list-style-type: none"> COH WHS to monitor all new development plans 	Necessary	COH WHS MA	<ul style="list-style-type: none"> Check plans for visual impact on viewshed of site 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Habitat protection: Removal of stromatolites.	<ul style="list-style-type: none"> Loss of Heritage material and site significance. Loss of micro-habitats (mosaic of sunny and shady areas). 	<ul style="list-style-type: none"> Preservation of stromatolites and peñindaba Stone, and associated microhabitats (*) Landowner, Research scientists and field staff to maintain surveillance Heritage Inspectors to be alerted 	Necessary	Landowner, permitted scientists, field staff, Heritage Inspectors	<ul style="list-style-type: none"> Check for signs of disturbed soil, exposed patches of soil, overturned and disturbed rock 	Ongoing
SUBTERRANEAN ENVIRONMENT						
Interpretation of subterranean environment	<ul style="list-style-type: none"> Lack of information regarding the significance of caves to science of palaeontology Lack of appreciation of the significance and sensitivities of the subterranean environment 	<ul style="list-style-type: none"> Incorporate caves and ecology of subterranean environment into site interpretation Liaise with caving groups and request assistance with education 	Necessary	Researchers, tourist guides	<ul style="list-style-type: none"> Check that subterranean environments are suitably interpreted 	Ongoing
Presence of breeding colonies of bats	<ul style="list-style-type: none"> Loss of colony – sensitive to human interference Species involved (<i>Myotis natalensis</i>) is declining in numbers 	<ul style="list-style-type: none"> Preservation of resident cave biota (*) COH-wide study is necessary to establish significance of various hibernacula Take care when extending excavations into the area of the hibernaculum Ensure that excavation only takes place when risk of disturbing breeding season is low Ensure that bats have free access into and out of cave GDACE can offer advice 	Necessary	Research scientists to exercise care, GDACE to monitor and initiate COH-wide bat study as originally planned	<ul style="list-style-type: none"> GDACE to establish monitoring criteria for breeding colony Check for presence and numbers of bats 	Ongoing, breeding season

Deleted:

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Porcupine lairs	<ul style="list-style-type: none"> Disturbance and displacement of animals Porcupine lairs are important as modern analogues for taphonomic processes of the past 	Conservation of porcupine lairs and owl roosts (*) <ul style="list-style-type: none"> Protect any porcupine lairs on site (*) Encourage that their behavior and lair contents are studied without disturbing animals Avoid disturbing owl roosts and warn site users to do the same 	Necessary	All site users	<ul style="list-style-type: none"> Check that porcupine lairs remain active – note presence of quills, droppings, gnawed bones 	Ongoing
INFRASTRUCTURE						
Access road	<ul style="list-style-type: none"> See erosion above 	<ul style="list-style-type: none"> See above 			<ul style="list-style-type: none"> 	
Culverts, bridges, drainage line crossings	<ul style="list-style-type: none"> None at Drimolen 	<ul style="list-style-type: none"> 	N/A	N/A	<ul style="list-style-type: none"> N/A 	N/A
Perimeter fence – see inner fence below	<ul style="list-style-type: none"> Landowner is opposed to perimeter fence Perimeter fences curb unauthorized access, tampering with fossils or equipment, vandalism and theft 	<ul style="list-style-type: none"> N/A, landowner is opposed to perimeter fence 	N/A	N/A	<ul style="list-style-type: none"> N/A 	N/A
Inner fence	<ul style="list-style-type: none"> Resident wild animals are trampling excavation area and causing damage Game and/or cattle can fall in – excavation is in a nice shady place 	Fossil excavation site safe from trampling wild animals (*) <ul style="list-style-type: none"> Danger to excavations identified by scientists Danger to animals identified by landowner Acquire necessary funding and quotes Design and erect a suitable fence 	Immediate	Landowner, scientist to provide quotes to SAHRA	<ul style="list-style-type: none"> Check installation Check efficacy of fence – does it exclude problem species? 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Car park – erosion of surface	<ul style="list-style-type: none"> Frequent parking can cause erosion of surface 	<ul style="list-style-type: none"> Erosion-free car park (*) Monitor and spread crushed stone gravel when necessary 	Keep watch	Researchers	<ul style="list-style-type: none"> Check surface and surrounds of car park for signs of erosion 	Ongoing
Visual impact of containers	<ul style="list-style-type: none"> Visual impact on sense of place Obtrusive elements in an otherwise 'pristine' grassland environment 	<ul style="list-style-type: none"> Reduced visual impact of containers (*) Consider alternative placement Consider screening or camouflaging – 'toning down' of impact Consider more appropriate structures 	Desirable	Landowner, researchers		Ongoing
Toilets, abluition	<ul style="list-style-type: none"> Inadequate or improper sewage disposal could pollute groundwater Poor toilet facilities create a poor tourist impression Two pit toilets (no separate male/female toilet facilities) for all site users and visitors is inadequate on a World Heritage Site is inappropriate if tourism and field schools are taking place Unscreened, lack of privacy 	<ul style="list-style-type: none"> Appropriate sanitation installed (*) VIP or Environbo to be installed in time 	Necessary	Landowner (for farm workers), researcher, (for excavators and tourists)	<ul style="list-style-type: none"> Check type of toilet Check efficacy, odours, flies 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Waste management and disposal	<ul style="list-style-type: none"> Litter Cattle and wild animals die from ingesting plastic bags Water pollution 	Litter-free site (*) <ul style="list-style-type: none"> Provide litter bins, more when extra people are expected Collect and remove all litter regularly Best practice would require sorting and recycling litter 	necessary	All site users	<ul style="list-style-type: none"> Check for left litter Check that litter bins have been installed Check removal schedule Check that litter stored on site cannot be wind distributed Encourage recycling 	Ongoing
Pathways for site users and visitors	<ul style="list-style-type: none"> Pathways too close to excavations can cause excavation edges to collapse Visitors/children falling into excavations, avens or miners' excavations Pathways can cause erosion 	Safe level pathways (*) <ul style="list-style-type: none"> Capping with thin layer of cement Psychological barriers Use safe retaining area for visitors Provide anti-erosion measures at sensitive areas 	Done	Researchers	<ul style="list-style-type: none"> Check visitor pathways, boardwalks, viewing platforms for safety - of visitors and of site fabric Check pathways for wear and tear and channelling/erosion 	Ongoing
Site plaque recognizing World Heritage Site status and National Heritage Site Status	<ul style="list-style-type: none"> Required in terms of the WHC Act and NHRA. Enhances site status 	Site plaque denoting site status installed (*) <ul style="list-style-type: none"> Select appropriate position, agreed by researchers and landowner (Done) Ensure wording appropriate and agreed, checked by SAHRA Ensure that both SAHRA and WHS logos appear Acquire budget SAHRA to install 	Necessary	SAHRA	<ul style="list-style-type: none"> Check plaque condition and safety 	Ongoing
Signage: adequacy	<ul style="list-style-type: none"> Poor tourist experience if site not adequately interpreted 	Appropriate signage installed when necessary (*) <ul style="list-style-type: none"> Site not open to general public, specialist tour operator and permitted scientist provide site interpretation 	Attended	Researchers	<ul style="list-style-type: none"> Check quality of signage Check quality of site interpretation 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Visitor impacts	<ul style="list-style-type: none"> • Littering • Pollution • Erosion of pathways • Disturbance of excavations • Theft of fossils • Graffiti 	<p>Visitor impacts minimal (*)</p> <ul style="list-style-type: none"> • These potential impacts all adequately attended to at Drimolen • Toilet facilities still inadequate 	Attended	Researchers, tour operator	<ul style="list-style-type: none"> • Check for littering • Check for pollution of site • Check all walkways for wear and tear • Check for visitor disturbance of excavations or equipment • Check for tampering with and removal of stored fossils • Check for graffiti 	
Infrastructure : water	<ul style="list-style-type: none"> • Used to be supplied by 200 L drum • Inadequate water supply inhibits excavation • Inadequate water supply reduces quality of life for residents • Legal minimum must be supplied in terms of legislation for farm workers • Lack of water slows down breccia preparation • Water needed for ablutions • Water needed to control dust 	<p>Ultimate outcome: water on site (*)</p> <ul style="list-style-type: none"> • Buried pipeline from borehole 800 m away should be considered • Concealed/screened storage tank for pumped water 	Necessary	Researchers	<ul style="list-style-type: none"> • Buried pipeline • Concealed/screened storage tank 	
Infrastructure : Energy	<ul style="list-style-type: none"> • Lack of energy reduces excavation speed and efficiency • Nearest supply is at borehole 800 m away 	<ul style="list-style-type: none"> • If brought to site, bury cable underground 	Necessary	Landowner, researchers	<ul style="list-style-type: none"> • None 	

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Telecommunications	<ul style="list-style-type: none"> Telephone necessary for responsible tourism No landline 	<ul style="list-style-type: none"> Cellphone reception is adequate 	Necessary	COH WHS MA	<ul style="list-style-type: none"> None 	
RESEARCH ENVIRONMENT						
Alteration of surface topography, drainage	<ul style="list-style-type: none"> Excavation has created a sump, into which water is directed Collapse of the footwall is a risk. 	<ul style="list-style-type: none"> Excavation area safe from erosion (*) Create appropriate drainage in area peripheral to excavation area which directs runoff away from sump Situation appears to be in hand at the site 		Researcher	<ul style="list-style-type: none"> Monitor sump for floodwater and ponding (usually drains underground) 	Ongoing
Safety of heritage material, pathways	<ul style="list-style-type: none"> Trampling by visitors 	<ul style="list-style-type: none"> Site safe from trampling by human pedestrian traffic (*) Check a suitable route around Main Quarry for exposed fossils and provide a boardwalk that can be relocated as excavation develops 	Done	Researchers	<ul style="list-style-type: none"> Monitor site for trampling, particularly in pathway areas 	Ongoing
Excavation edges	<ul style="list-style-type: none"> Decalcifying braccia results in the excavation walls having friable edges Unstable edges collapse This poses a risk of physical danger as well as of information loss 	<ul style="list-style-type: none"> Safe and stable excavation edges (*) Bevel off edge, Provide physical barrier or psychological barrier to prevent visitors getting too close Do not place pathways too close to excavation edges Cap unstable edges with lime cement 	Necessary	Researcher, SAHRA	<ul style="list-style-type: none"> Monitor for fallen and slumped wall debris. Annual professional assessment 	Ongoing

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Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Excavation walls	<ul style="list-style-type: none"> • Unstable walls, particularly if decalcified tend to slump and collapse • Collapse poses a threat to site users below unstable areas • Collapse poses a threat to site significance because of mixing • Very high walls are difficult to stabilize when excavation is terminated or completed • Very high walls are susceptible to problems noted above 	<p>Stable excavation walls (*)</p> <ul style="list-style-type: none"> • Excavation walls at Drimolen are acceptable at present • Deep excavations should be "benched", quarry-style. • Unstable walls should be stabilised - geotextile or sandbagging with 10% cement 	Necessary	Researchers, SAHRA	<ul style="list-style-type: none"> • Check degree of calcification of breccia – hard breccia can take higher walls than decalcified material • Check unsupported wall height and recommend benching out if it appears unstable • Check wall for loose rocks and boulders and bar down (remove from wall with crowbar) if necessary • Bevel off friable excavation edges 	Ongoing
Access to bottom of excavation	<ul style="list-style-type: none"> • Steps, ladders, etc. must be safe and stable 	<p>Safe access to excavation base possible (*)</p> <ul style="list-style-type: none"> • Make benching shallow enough to use as steps • Create and cap steps with protective layer • Ensure ladders are safe 	Necessary	Researchers, SAHRA	<ul style="list-style-type: none"> • Check access routes to excavation base for safety and stability 	Ongoing
Compliance with terms and conditions of permit	<ul style="list-style-type: none"> • Loss of information and site significance 	<p>Full compliance with conditions (*)</p> <ul style="list-style-type: none"> • Check all permit terms and conditions 	necessary	SAHRA, researchers	Check all terms and conditions	At each site inspection

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Witness sections	<ul style="list-style-type: none"> Loss of information and site significance 	Selection of appropriate witness sections are a requirement <ul style="list-style-type: none"> Ensure that the researcher provides adequate criteria for the selection of witness sections Ensure that, as far as is reasonable, all significant features are covered by or included in witness sections proposed Ensure that witness sections are not prone to collapse and that they are stabilized on closure of excavation Ensure that witness section is committed to plan 	Necessary	Researcher, SAHRA	<ul style="list-style-type: none"> 	

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Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Breccia Dumps	<ul style="list-style-type: none"> • Loss of information concerning source and contents of dumped material (NB) • Footprint site of dumps not checked for significant plants • Position unacceptable to landowner • Position obscures significant part of deposit • Dump built over cave infill • No proper toe to dump or careless containment • Dump is cascading due to incorrect angle of repose • Dump origin not recorded • Dump contents not recorded • Duration of dump on site not recorded • Dump built over or too close to drainage line 	<p>Management plans for dumps to be supplied with permit applications (*)</p>	Necessary	SAHRA, researchers	<p>Refer to dump Guidelines in generic Document. This site does not have specific problems with regards to dumps at present.</p> <ul style="list-style-type: none"> • Check placement of dump on landscape • Ensure that positioning is acceptable to landowner • Check to ensure dump is not planned to be situated over cave fill • Check that dump has containment toe • Check footprint area in relation to planned height – cascading must not happen • Check that source of material is recorded and on plan • Check that contents of dump are recorded on plan • Check that dump does not slump or erode into drainage line 	

Issues	Threats or Risks	Desired outcomes (*); Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Security of breccia piles	<ul style="list-style-type: none"> Exposed fossiliferous breccia is at risk to scavenging by souvenir hunters, many small pieces lying about 	<ul style="list-style-type: none"> Portable blocks should be stored under lock and key Tourist groups should not free-range: provide site guide Keep groups to a size than can be properly supervised Importance of every fossil should be taught – signage that outlines appropriate behaviour Control access to excavation area strictly 	Necessary	Researchers, SAHRA	<ul style="list-style-type: none"> Monitor for security of fossiliferous breccia. Only non-portable blocks should be left in accessible places Monitor site for vulnerable pieces and remove for safe keeping 	Ongoing
Sieved residues, sterile	<ul style="list-style-type: none"> Could be placed where they will inconvenience landowner Placed where they will constitute a visual impediment Built in such a way that they will erode or become unstable See points recorded for dumps above 	<p>Appropriate disposal of sieved residues (*)</p> <ul style="list-style-type: none"> Avoiding unnecessary dump piles (*) Could be used for road and erosion repair if really sterile and in places suited to nature of sieved waste residues 	Necessary	SAHRA, researchers	<ul style="list-style-type: none"> Check location of sieved waste material Check for stability and erosion Apply same monitoring criteria as noted for dumped breccia above 	Ongoing
Repository	<ul style="list-style-type: none"> Poor repository policies can result in information loss Poor repository policy can result in problems of locating fossils 	<p>Desired outcome is long-term security of artefacts and fossils (*)</p> <ul style="list-style-type: none"> Monitor repositories according to 'Minimum Standards for Repositories' guideline as prepared by SAHRA 	Necessary	SAHRA	<ul style="list-style-type: none"> Monitor repositories according to 'Minimum Standards for Repositories' guideline as prepared by SAHRA 	Ongoing
Site safety, security and stability						

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Domestic cooking fires	<ul style="list-style-type: none"> Gas cylinders can explode Domestic cooking fires are a potential source of uncontrolled fire 	<p>Desired outcome is a site which is free from fire hazards (*)</p> <ul style="list-style-type: none"> Provide fire extinguishers, one for each container Train residents in their use - suppliers often provide free training Ensure extinguishers checked annually Brief residents on what to do in the event of fire Provide appropriate beaters in the event of a grass fire Burn suitable firebreaks around fossil site and infrastructure 	Necessary	Landowner, researchers	<ul style="list-style-type: none"> Check that extinguishers are installed and appropriately mounted Check that residents understand their use Ensure that equipment is inspected annually Check that there are sufficient beaters on site 	At each fossil site inspection
Signage, site safety and warnings	<ul style="list-style-type: none"> Lack of appropriate signage can expose visitors to unexpected hazards, e.g. that there is a bees' nest 	<p>Desired state is: appropriate interpretive signs installed</p> <ul style="list-style-type: none"> Install appropriate behavior modifiers and site safety signage as and when this becomes necessary Appropriate safety signage is a requirement of Public (Occupational) Health and Safety Act, Maropeng even warns against possible presence of snakes 	Necessary	Researchers, landowner, tour operators	<ul style="list-style-type: none"> Check for installation and appropriate wording Check for appropriate location of signs, design and durability 	Ongoing
Subterranean environments at Drimolen : Main Quarry and adjacent caves	<ul style="list-style-type: none"> Instability due to previous mining activities and blasting Natural instability 	<p>Subterranean environments off-limits or declared safe (*)</p> <ul style="list-style-type: none"> No-go areas for tourists: specialist caving groups only 	Necessary	Researchers, tour operators	<ul style="list-style-type: none"> Check that no-go instruction is being obeyed 	Ongoing

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Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Bees, "Kransblye", Wasps	<ul style="list-style-type: none"> The numerous cavities and hollows are home to several bee hives and wasps' nests. Many people are allergic to bee stings in particular. 	Compliance with site safety requirements (*) <ul style="list-style-type: none"> Ensure that the necessary antihistamines are on hand. Destroy or have hives removed if these are where people frequently work. Post warning signage Provide first aid post 	Necessary	Researcher, Tour Operator	<ul style="list-style-type: none"> Monitoring should include checking the route for insect problems. Monitor speed at which an emergency case could reach appropriate medical help 	Ongoing
Accidental falls	<ul style="list-style-type: none"> Tourists suing the operator 	Compliance with Public health and safety regulations, site safety (*) <ul style="list-style-type: none"> Ensure that walkways are as even as possible. Provide handrails and steps at vertical drops and changes of level. Keep group sizes small enough to control at all times 	Necessary if tourism is taking place on site	Tourist operator, researcher	<ul style="list-style-type: none"> Monitor route by walking it regularly to check for flaws in routing, infrastructure 	Ongoing
Theft, crime	<ul style="list-style-type: none"> The isolated situation makes the site particularly prone to petty theft of excavation and other equipment. 	Desired state is a site that is as safe and secure as possible (*) <ul style="list-style-type: none"> A safe has been installed (by the researchers) in the container for research equipment and survey books. Provide additional secure lock-up facilities on-site for researchers equipment – lock-up garage required Control on all persons entering the area Patrolling site monitors (including the Game Park) might be considered. Consider security fence around research-related infrastructure and storage 	Necessary	Researchers, landowner, site residents	<ul style="list-style-type: none"> Security checks 	Ongoing

GENERIC ISSUES RELATING TO FOSSIL SITE EXCAVATIONS – NOT NECESSARILY ISSUES AT THIS SITE

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Preparation of fossils – preparation techniques	<ul style="list-style-type: none"> Preparation of delicate fossils by inexperienced and poorly trained preparators causes loss of fossils (breakages go unreported, fragmented fossils are discarded) 	<ul style="list-style-type: none"> Formal guidelines are required (*) 	Necessary	Researchers	<ul style="list-style-type: none"> Guidelines required 	Ongoing
Backlog of excavated breccias	<ul style="list-style-type: none"> Loss of provenance in the long run. New researchers want to target in situ breccia Site significance is not realised Funding input has not been fulfilled by Information yield 	<ul style="list-style-type: none"> Formal guidelines are required (*) 	Necessary	SAHRA and researchers	<ul style="list-style-type: none"> Guidelines required 	Ongoing
Research Activity incomplete – all stops not covered	<ul style="list-style-type: none"> Incomplete coverage of research areas on account of minimal funding and lack of specialists. Macro- and Microfaunal classes sometimes neglected Loss of information, site significance 	<ul style="list-style-type: none"> Guidelines are indicated (*) 	Necessary	SAHRA, and the Recommended Research Management Committee	<ul style="list-style-type: none"> SAHRA to address issue of full coverage at time of permit application 	Ongoing

Issues	Threats or Risks	Desired outcomes (*), Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Housing of support staff	<ul style="list-style-type: none"> Inconvenient to landowner Strained relations between landowner and researcher Not possible for researcher to control and monitor behaviour of support staff all the time 	<ul style="list-style-type: none"> To be addressed in the Landowner-researcher memorandum of agreement 	Necessary	Researcher to be responsible for maintenance of support staff housing and maintenance	<ul style="list-style-type: none"> Monitor housing and environs 	Ongoing
Access to Landowner's property	<ul style="list-style-type: none"> Unannounced arrivals by researchers and his visitors cause inconvenience to landowner 	<ul style="list-style-type: none"> To be addressed in the Landowner-Scientist Agreement 	necessary	Researcher	<ul style="list-style-type: none"> Ensure that all official visitors are aware of the protocols 	Ongoing
Use of Landowner's resources - wood	<ul style="list-style-type: none"> Uncontrolled wood collection, Collecting wood where landowner disapproves 	<ul style="list-style-type: none"> To be addressed in the Landowner-researcher memorandum of agreement 	Necessary	Landowner, Researcher	<ul style="list-style-type: none"> Monitor wood use by support staff 	Ongoing
Use of Landowner's resources - water	<ul style="list-style-type: none"> Concerns regarding utilisation Water wastage 	<ul style="list-style-type: none"> To be addressed in the Landowner-researcher memorandum of agreement 	Necessary	Landowner, researcher	<ul style="list-style-type: none"> Monitor water use and conservation measures by support staff 	Ongoing
Use of landowner's resources - roads	<ul style="list-style-type: none"> Possible deterioration of access routes 	<ul style="list-style-type: none"> To be addressed in the Landowner-researcher memorandum of agreement 	Necessary	Landowner, researcher. If tourism, tourist concessionaire to contribute	<ul style="list-style-type: none"> Monitor against a starting baseline mutually agreed by researcher-landowner 	Ongoing
Use of Landowner's resources - electricity	<ul style="list-style-type: none"> Concerns regarding terms of use. Used by both by researchers and resident field staff 	<ul style="list-style-type: none"> To be addressed in the Landowner-researcher memorandum of agreement 	Necessary	Researcher, landowner	<ul style="list-style-type: none"> Difficult to monitor 	Ongoing

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