APPENDIX 2

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

1 Extent

The extent scale defines the physical extent or spatial scale of the impact.

Rating	Description
LOCAL	Extending only as far as the activity, limited to the site and its immediate surroundings. Specialist studies to specify extent.
REGIONAL	Northern Cape
NATIONAL	South Africa

2 Duration

The duration of an impact gives an indication of how long the impact would occur.

Rating	Description
SHORT TERM	0 - 5 years
MEDIUM TERM	5 - 15 years
LONG TERM	Where the impact will cease after the operational life of the activity, either because of natural processes or by human intervention.
PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.

3 Intensity

The intensity scale establishes whether the impact would be destructive or benign.

Rating	Description
LOW	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
MEDIUM	Where the affected environment is altered, but natural, cultural and social functions and processes continue, albeit in a modified way.
HIGH	Where natural, cultural and social functions or processes are altered to the extent that it will temporarily or permanently cease.

4 Significance

The significance scale is an attempt to evaluate the importance of a particular impact, and in doing so incorporates the above three scales (i.e. extent, duration and intensity).

Rating	Description
VERY HIGH	Impacts could be EITHER: of **high intensity** at a **regional level** and endure in the **long term**; OR of **high intensity** at a **national level** in the **medium term**; OR of **medium intensity** at a **national level** in the **long term.**
HIGH	Impacts could be EITHER: of **high intensity** at a **regional level** and endure in the **medium term**; OR of **high intensity** at a **national level** in the **short term**; OR of **medium intensity** at a **national level** in the **medium term**; OR of **low intensity** at a **national level** in the **long term**; OR of **high intensity** at a **local level** in the **long term**; OR of **medium intensity** at a **regional level** in the **long term.**
MEDIUM	Impacts could be EITHER: of **high intensity** at a **local level** and endure in the **medium term**; OR of **medium intensity** at a **regional level** in the **medium term**;

	OR of **high intensity** at a **regional level** in the **short term**; OR of **medium intensity** at a **national level** in the **short term**; OR of **medium intensity** at a **local level** in the **long term**; OR of **low intensity** at a **national level** in the **medium term**; OR of **low intensity** at a **regional level** in the **long term.**
LOW	Impacts could be EITHER of **low intensity** at a **regional level** and endure in the **medium term**; OR of **low intensity** at a **national level** in the **short term**; OR of **high intensity** at a **local level** and endure in the **short term**; OR of **medium intensity** at a **regional level** in the **short term**; OR of **low intensity** at a **local level** in the **long term**; OR of **medium intensity** at a **local level** and endure in the **medium term.**
VERY LOW	Impacts could be EITHER of **low intensity** at a **local level** and endure in the **medium term**; OR of **low intensity** at a **regional level** and endure in the **short term**; OR of **low to medium intensity** at a **local level** and endure in the **short term.**
NOT APPLICABLE	Impacts with: Zero intensity with any combination of extent and duration.
UNKNOWN	In certain cases it may not be possible to determine the significance of an impact.

5 Status of impact

The status of an impact is used to describe whether the impact would have a negative, positive or zero effect on the affected environment. An impact may therefore be negative, positive (or referred to as a benefit) or neutral.

6 Probability

The probability that an impact will take place differs, and for this reason it is necessary to describe the likelihood of the impact occurring.

Rating	Description
IMPROBABLE	Where the possibility of the impact to materialise is very low either because of design or historic experience.
PROBABLE	Where there is a distinct possibility that the impact will occur.
HIGHLY PROBABLE	Where it is most likely that the impact will occur.
DEFINITE	Where the impact will occur regardless of any prevention measures.

7 Degree of Confidence

This indicates the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge.

Rating	Description
HIGH	Greater than 70% sure of a particular fact.
MEDIUM	Between 35% and 70% sure of a particular fact.
LOW	Less than 35% sure of a particular fact.

APPENDIX 3

SPECIALIST REPORT: VEGETATION

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VEGETATION SENSITIVITY REPORT FOR EIGHT BORROW PITS IN THE COLESBERT DISTRICT OF THE UPPER KAROO

Prepared for CCA Environmental (Pty) Ltd

12 January 2009

Contents

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1. INTRODUCTION AND TERMS OF REFERENCE

The terms of reference can be summarized as follows:

- to execute a vegetation sensitivity study at four borrow pits as well as an area where a proposed new intersection is to be constructed;
- identification of the vegetation types, according to Mucina & Rutherford (2006), at the proposed borrow pits and intersection;
- description of the current condition of the natural vegetation;
- identification of possible impacts by the proposed activities on the natural vegetation as well as judging the weights of these impacts;
- practicable and reasonable suggestions for mitigation of possible negative impacts and to enhance any positive impacts;
- suggestions for the rehabilitation of the borrow pits and other disturbed areas

The areas under discussion in this document were visited on the 19th of March 2008. The team consisted of an Archeologist, a Botanist, two Engineers, and an Environmentalist. Approximately one and a half hours were spent at the proposed intersection and, on average, 45 minutes at each of the four borrow pits. At each location the proposed areas to be mined and disturbed were indicated to us by the Engineer. During the time spent at each location a plant species list was compiled while thoroughly exploring the indicated areas. Current veld condition, vigor and species composition were focused on. Any other notable information regarding ecologically sensitive areas or rare and endangered plant species was noted if discovered.

Impacts were rated according to the: "Convention for assigning significance ratings to impacts". These results are included at the description and discussion of each borrow pit.

2. GENERAL DESCRIPTION OF THE AREA

The area under investigation is situated in the False Upper Karoo (Acocks, 1988). Low & Rebelo (1996) later described this area as the Eastern Mixed Nama Karoo. More recently Mucina and Rutherford (2006) described it as the Eastern Upper Karoo. A few dolerite rocky outcrops (the town of Colesberg is surrounded by such koppies) are also present in this area and described by Mucina and Rutherford (2006) as Besemkaree Koppies Shrubland. Borrow pit 2 is situated in these rocky outcrops. According to Mucina and Rutherford (2006) the Eastern Upper Karoo has the largest mapped area of all vegetation units. Therefore the vegetation is known for its diverse number of different species.

Climate

Rainfall, occurring mostly in late summer and autumn, varies between 300 and 400 mm per year. Frost is very common during the colder months from as early as late March until as late as the beginning of October.

Geology and soils

The landscape is known for its flats and gently sloping plains, dominated by Beaufort Group sandstones and shales.

Vegetation

A mixture of grass and shrub vegetation is found here. A few common shrubs include *Pentzia incana*, *Eriocephalus ericoides*, *E. spinescens* and *Hermannia* spp. and grasses, such as various *Aristida* and *Eragrostis* species (Low & Rebelo, 1996).

Mucina and Rutherford (2006) highlights the following endemic taxa:

* Succulent shrubs – *Chasmatophyllum rouxii*, *Hertia cluytiifolia*, *Rabiea albinota* and *Salsola tetrandra*.

* Tall shrubs – *Phymosparmum scoparium*

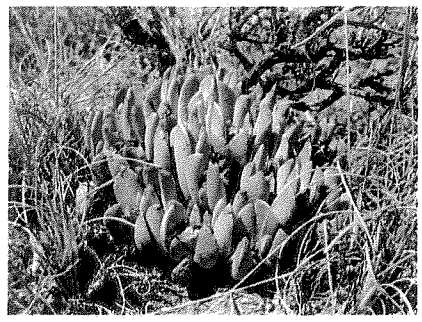
* Low shrubs – *Aspalathus acicularis* subsp. *Planifolia*, *selago persimilis* and *S. walpersii.*

3. BORROW PITS

3.1 BORROW PIT 1 [Co-ordinates: 30°42.379' S 25°07.689' E]

Description of site

This is a koppie that is not very high and was utilized for quarrying in the past. It is planned to further utilize the south eastern portion of this koppie. The area to be mined has a steepish slope from northwest to southeast. The steepness of the slope, together with the poor vegetation cover causes high runoff of rainfall water which makes this a very dry slope. The soil is also very shallow. The site is currently unfenced and partially utilized by grazing animals. The veld can be described as dry apron veld. The most dominating species are *Eriocephalus ericoides* (kapokbos) and *Tragus koelerioides* (carrot seed grass). The veld is generally in a poor condition.



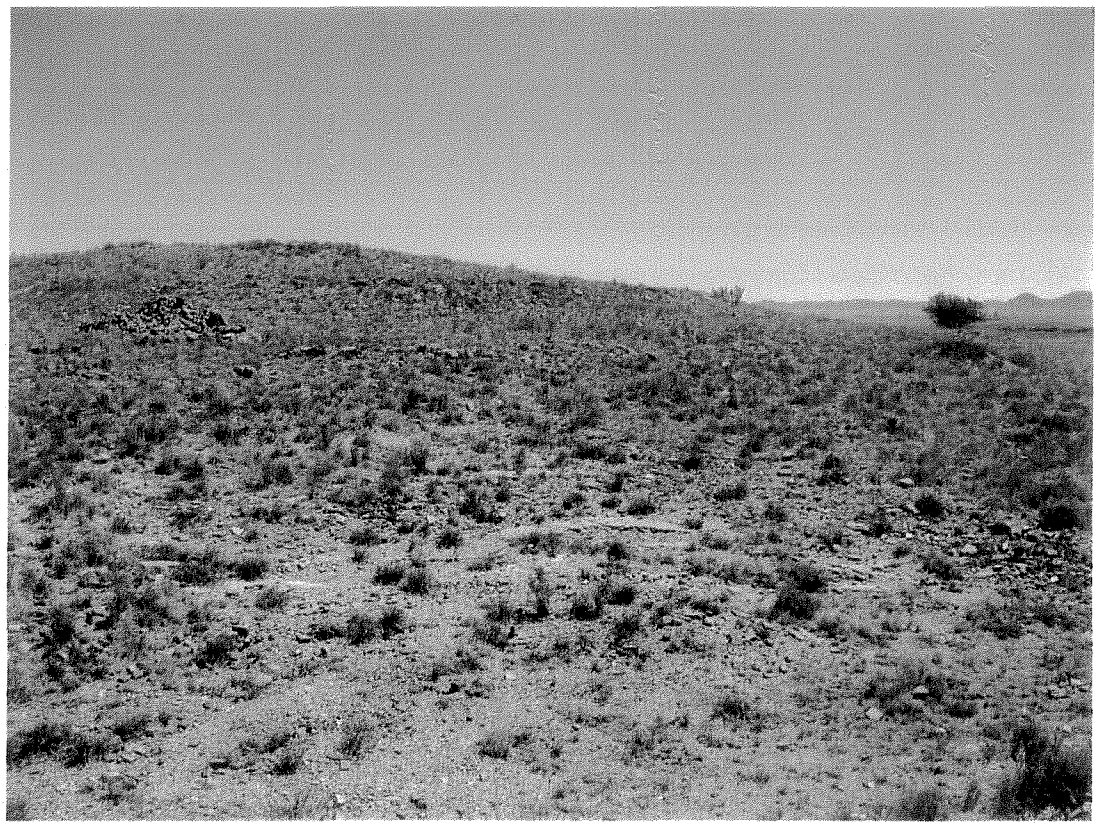


FIGURE 1: Borrow pit 1 with *Eriocephalus ericoides*, as the dominating species.

Plant species list

TABLE 1: Plant species list of Borrow pit number 1

BORROW PIT 1				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Amphiglossa triflora				
Aptosimum procumbens	*Aristida congesta*	*Diospyros austro-africana*	*Opuntia ficus-indica*	
Chrysocoma ciliata	*Aristida diffusa*	var. *microphylla*		
Dianthus micropetalus	*Eragrostis lehmanniana*	*Rhus burchelli*		

Bushes (Karoo bossies)	Grasses	Shrubs and trees	Weeds and aliens (invaders)	Red Data species
Eberlanzia ferox *Eriocephalus ericoides* *Helichrysum dregeanum* *Hermannia cunifolia* var. *glabrescens* *Helichrysum zeyheri* *Lightfootia nodosa* *Melolobium candicans* *Nenax microphylla* *Pentzia globosa* *Pentzia quinquefida* *Walafrida saxatilis* **Succulents** *Rabiea albinota* *Rushia grisea*	*Sporobolus fimbriatus* *Themeda triandra* *Tragus koelerioides*	*Rhus pendulina*		

No rare or endangered plant species were found.

Impact assessment

TABLE 2: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Low	Low
4 - Significance	Low	Very Low
5 - Status of impact	Negative	Positive
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

The soil on this site is very shallow. As much as possible of the top soil, together with the existing plant material should be removed and stored in wind rows, not higher than two meters. It is suggested that this area should be rested (withdrawn from grazing by fencing it) for as long a period as possible before starting with mining activities. This will allow seed production which might be useful for future restoration. After exploration the unused material can be placed back in the deepest areas of the quarry. The saved top soil can be worked back onto the disturbed areas. As this site has a very steep slope, the dangers of erosion should be taken into consideration while repairing the site. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Eriocephalus ericoides* (kapokbos) should also be considered.

3.2 BORROW PIT 2 [Co-ordinates: 30°42.464' S 25°05.491' E]

Description of site

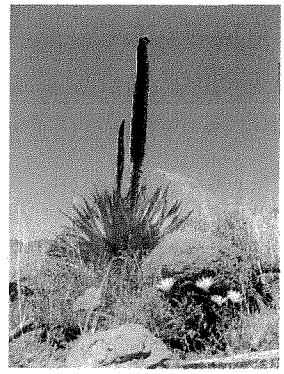


FIGURE 2: Borrow pit 2 with *Aristida diffusa* as one of the dominating species.

This is an existing borrow pit which is going to be further expanded towards the western and southwestern sides. The vegetation is grown out tall and in a very good condition, on the

undisturbed banks of the excavated areas. A large number of different plant species are present. This site is situated within dolerite rocky outcrops (the town of Colesberg is surrounded by such koppies) and described by Mucina and Rutherford (2006) as Besemkaree Koppies Shrubland. One of these smaller copies will be taken out during the intended mining process. The topsoil might carry a lot of seed due to high seed production of the current vegetation. The dominating species include the following: *Lightfootia nodosa* (muistepel), *Felicia muricata* (bloublommetjie), *Aristida diffusa* (iron grass) and *Eragrostis lehmanniana* (Lehmann's love grass).

Plant species list

TABLE 3: Plant species list of Borrow pit number 2

BORROW PIT 2				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Amphiglossa triflora	*Aristida congesta*	*Asparagus suaveolens*	*Datura stramonium*	
Aptosimum spinescens	*Aristida diffusa*	*Diospyros austroafricana*		
Chrysocoma ciliata	*Cymbopogon pospischilii*	*var. microphylla*		
Eriocephalus ericoides	*Digitaria eriantha*	*Diospyros lycioides*		
Felicia filifolia	*Eragrostis lehmanniana*	*var. lycioides*		
Felicia muricata	*Eragrostis obtusa*	*Euclea crispa*		
Helichrysum zeyheri	*Heteropogon contortus*	*Olea europaea*		
Helichrysum lucilioides	*Themeda triandra*	*Protasparagus africanus*		
Indigastrum argyraea	*Tragus koelerioides*	*Rhus burchelli*		
Lightfootia nodosa		*Rhus erosa*		
Melolobium candicans				
Nenax microphylla		**Aloe's**		
Pegolittia retrofracta		*Aloe broomii*		
Pelargonium abrotanifolium				
Stachys spathulata				
Sutera virgulosa				
Walafrida saxatilis				
Forbs				
Ceterach cordatum				

No rare or endangered plant species were found.

Impact assessment

TABLE 4: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Medium	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

There is enough topsoil to be used for the rehabilitation process, except if the currently excavated areas are also to be rehabilitated. The topsoil might carry a lot of seed due to high seed production of the current vegetation. There is more than 20 mountain aloe (*Aloe broomii*) growing in the area that is going to be excavated. Even though it not an endangered species, it is advised to carefully remove and replant at least 50% of these plants. Some of them are old and big and almost lying flat on the ground. These plants will be difficult to remove and handle without damaging them. There is however enough younger and smaller plants that should be much easier to handle and transplant. Try to transplant the plants on the eastern to southern side of bigger shrubs and trees to ensure that they grow in the shade of the bigger plants to protect them from severe radiation. If this is done during cooler months like autumn or spring this is not essential.

It is further recommended that the top soil should be removed and stored in wind rows not higher than two meters. After exploration the unused boulders can be placed back in the deepest areas of the quarry. The saved top soil can be worked back onto the disturbed areas. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass), and *Digitaria eriantha* (finger grass) and *Eriocephalus ericoides* (kapokbos) should also be considered. *Digitaria eriantha* should be sown in the lower areas of the repaired landscape. Water accumulation will take place in these lower lying areas which will provide in the water need of this species.

3.3 BORROW PIT 3 [Co-ordinates: 30°43.804' S 25°04.212' E]

Description of site

This site is situated in a plain with gentle slope from west to east. It is also an existing borrow pit which will be further expanded to the west rather than going deeper. The area to be excavated can be divided into a southern and a northern portion. The southern portion has a deeper topsoil

and a denser cover with *Sporobolus fimbriatus* (dropseed grass) and *Eriocephalus spinescens* (doringkapok) as the dominating species. The northern portion has sparse cover in a shallow, stony topsoil with *Aristida diffusa* (iron grass) and *Euryops spp.* (harpuis). The current condition of the veld is acceptable.

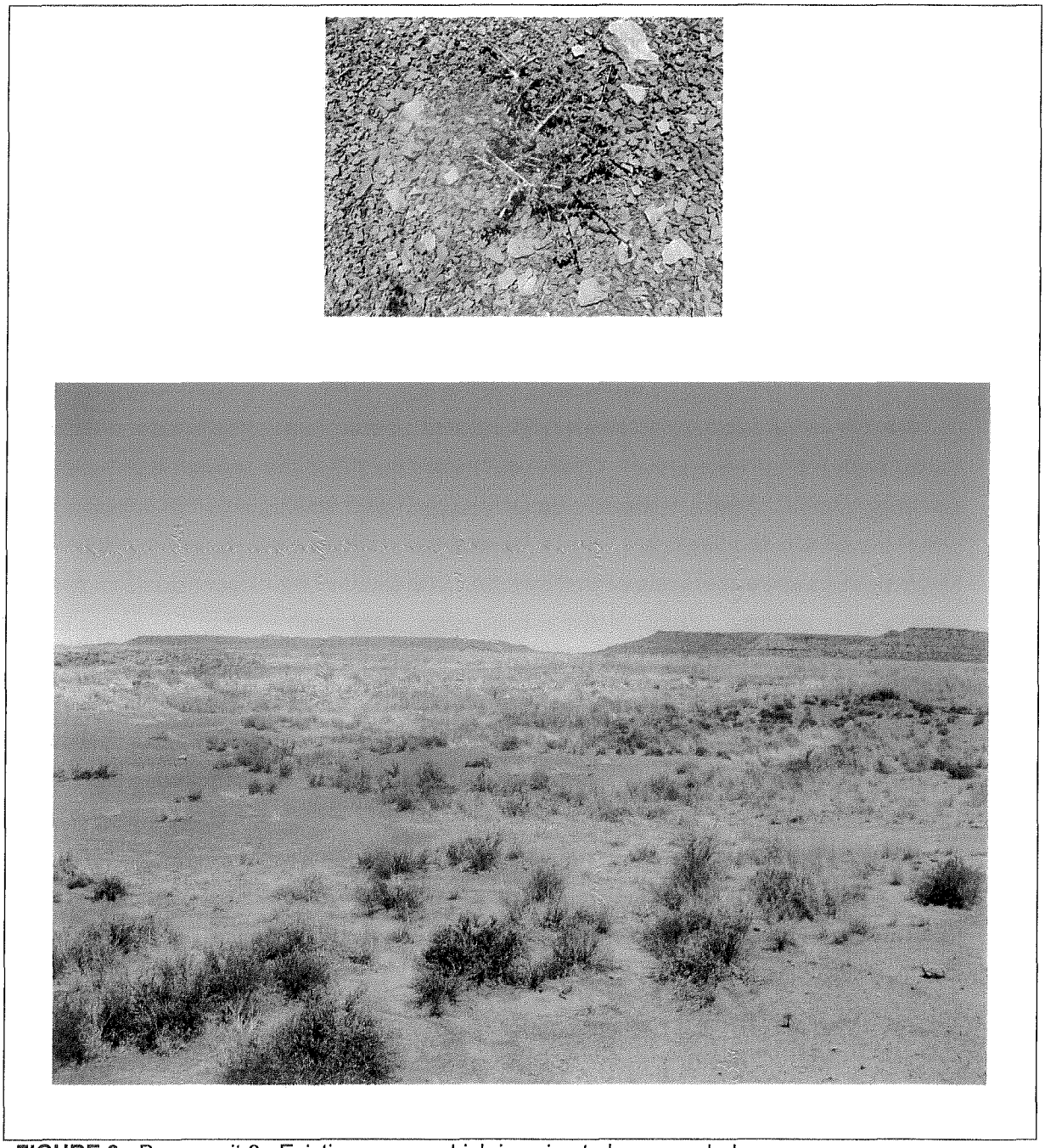


FIGURE 3: Borrow pit 3. Existing quarry which is going to be expanded.

Plant species list

TABLE 5: Plant species list of Borrow pit number 3

BORROW PIT 3				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Eriocephalus ericoides	*Aristida congesta*		*Argemone ochroleuca*	
Eriocephalus spinescens	*Aristida diffusa*		*Tagetes minuta*	
Euryops empetrifolius	*Chloris virgata*			
Euryops subcarnosus subsp. *Vulgaris*	*Enneapogon desvauxii*			
	Eragrostis lehmanniana			
Helichrysum zeyheri	*Sporobolus fimbriatus*			
Limeum aethiopicum	*Tragus koelerioides*			
Nenax microphylla				
Pentzia globosa				
Pteronia tricephala				
Succulents				
Rushia rigens				
Trichodiadema pomeridianum				

No rare or endangered plant species were found.

Impact assessment

TABLE 6: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium
3 - Intensity	Medium	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

The northern portion of the area to be excavated has a deep topsoil. There should be an acceptable seedbank in the topsoil. It is recommended that the top soil should be removed and stored in wind rows not higher than two meters. After excavation the saved top soil can be worked back onto the disturbed areas. The already excavated area which is covered with a mudstone layer that should be ripped, after which it can be covered by a layer of topsoil. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Pentzia incana* (ankerkaroo) should also be considered. *Sporobolus fimbriatus* should be sown in the

lower areas of the repaired landscape. Water accumulation will take place in these lower lying areas and *Sporobolus fimbriatus* will very effectively utilize this extra water.

3.4 BORROW PIT 4 [Co-ordinates: 30°45.224' S 25°05.471' E]

Description of site

FIGURE 4: Borrow pit 4 with *Euryops empetrifolius* as one of dominating species.

This is an existing borrow pit, fairly large and situated high in the landscape with a gentle slope from east to west. This borrow pit will be further expanded to the southern side. The vegetation cover is acceptable and the veld is generally in a good condition. The depth of the topsoil varies as there are a few rocky patches with almost no topsoil. There is however enough topsoil available for rehabilitation. The dominating species are: *Eriocephalus ericoides* (kapokbos), *Euryops spp.* (harpuis) and *Eragrostis lehmanniana* (Lehmann's love grass).

Plant species list

TABLE 7: Plant species list of Borrow pit number 4

BORROW PIT 4				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Amphiglossa triflora *Eberlanzia ferox* *Eriocephalus ericoides* *Eriocephalus spinescens* *Euryops empetrifolius* *Euryops subcarnosus* subsp. *Vulgaris* *Felicia fascicularus* *Felicia muricata* *Lightfootia nodosa* *Nolletia ciliaris* *Nenax microphylla* *Stachys spathulata* *Walafrida geniculata* *Walafrida saxatilis* **Succulents** *Trichodiadema pomeridianum*	*Aristida diffusa* *Digitaria eriantha* *Eragrostis lehmanniana* *Sporobolus fimbriatus* *Themeda triandra* *Tragus koelerioides*	*Euclea crispa* *Rhus burchelli* *Rhus ciliata* *Rhus erosa*		

No rare or endangered plant species were found.

Impact assessment

Table 8: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	**Without Mitigation**	**With Mitigation**
1 - Extent	Local	Local
2 - Duration	Long term	Medium
3 - Intensity	Low	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

There will be enough topsoil available for rehabilitation. It might also carry a lot of seed due to the high seed production of the current vegetation, if not grazed in the mean while. It is recommended that the top soil should be removed and stored in wind rows not higher than two meters. After exploration the unused boulders can be placed back in the deepest areas of the quarry. The saved top soil can be worked back onto the disturbed areas. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Eriocephalus ericoides* (kapokbos) should also be considered. *Sporobolus fimbriatus* should be sown in the lower areas of the repaired landscape. Water accumulation will take place in these lower lying areas which will enhance the growth of this species.

3.5 BORROW PIT 5 [Co-ordinates: 30°49.866' S 25°04.473' E]

Description of site

The site is currently unfenced and partially utilized by grazing animals. It is an old borrow pit which will be further mined by cutting up to two meters into the apron of the koppie, rather than digging deeper in the existing quarry. The site is situated high in the landscape, almost in a koppie (Figure 5). The slope is steep and slopes from northwest to southeast. The veld can be described as typically apron veld. The most dominating species are *Eriocephalus ericoides* (kapokbos) and *Eragrostis lehmanniana* (Lehmann's love grass). The veld is generally in a good condition.

Restoration guidelines

The soil on this site is very shallow. As much as possible of the top soil, together with the existing plant material should be removed and stored in wind rows, not higher than two meters. The vegetation is grown out and an acceptable seed bank might be present in the top soil. This can however be enhanced by resting this area for as long a period as possible before starting with mining activities. This will allow seed production which might be useful for future restoration. After exploration the unused boulders can be placed back in the deepest areas of the quarry. The saved top soil can be worked back onto the disturbed areas. As this site has a very steep slope, the dangers of erosion should be taken into consideration while repairing the site. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Eriocephalus ericoides* (kapokbos) should also be considered.

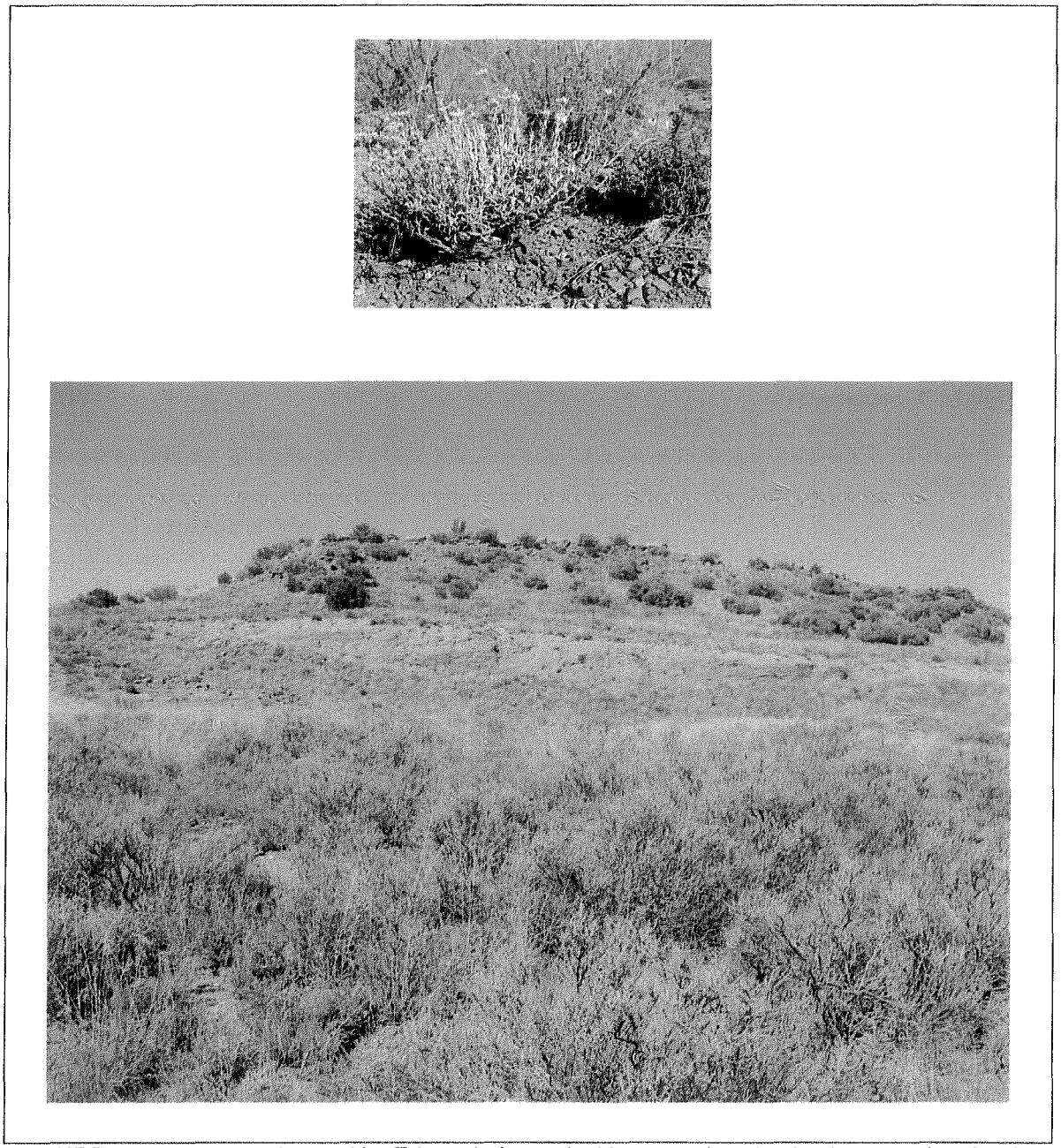


FIGURE 5: Borrow pit 5 with *Eriocephalus ericoides*, as the dominating species in the foreground.

Plant species list

TABLE 9: Plant species list of Borrow pit number 5

BORROW PIT 5				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Chrysocoma ciliata	*Aristida congesta*	*Diospyros austro-africana* var. *microphylla*	*Argemone ochroleuca*	
Eriocephalus ericoides	*Aristida diffusa*			
Eriocephalus spinescens	*Digitaria eriantha*	*Rhus burchelli*		

Helichrysum dregeanum	*Enneapogon scoparius*	*Rhus erosa*		
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Helichrysum zeyheri *Lightfootia nodosa* *Nenax microphylla* *Stachys spathulata* *Walafrida saxatilis*	*Eragrostis lehmanniana* *Heteropogon contortus* *Sporobolus fimbriatus* *Stipagrostis ciliata* *Themeda triandra*			

No rare or endangered plant species were found.

Impact assessment

TABLE 10: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Low	Low
4 - Significance	Low	Very Low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

3.6 BORROW PIT 6 [Co-ordinates: 30°54.765' S 25°02.726' E]

Description of site

This is also an existing borrow pit which is going to be further expanded towards the sides as well as deeper in some areas. The site is fenced off since it was last excavated. Therefore it was not utilized by grazing animals. The vegetation is grown out tall and in a very good condition, especially in the undisturbed areas. The site is situated on a plain and therefore flat with almost no slope. The topsoil is deep and might carry a lot of seed due to high seed production of the current vegetation. The dominating species include the following: *Walafrida saxatilis* (Wit-aar), *Helichrysum zeyheri* (vaalbergkaroo), *Eriocephalus spinescens* (doringkapok), *Aristida diffusa* (iron grass), *Eragrostis lehmanniana* (Lehmann's love grass) and *Sporobolus fimbriatus* (dropseed grass).

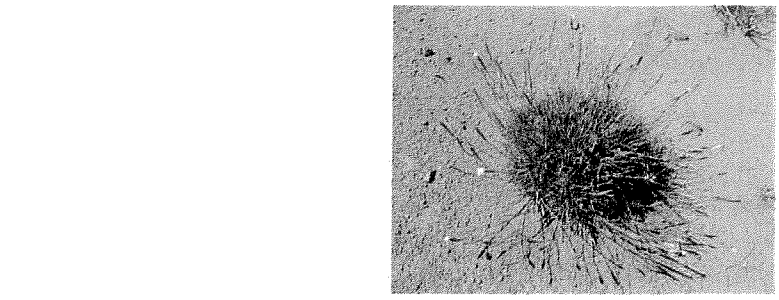


FIGURE 6: Borrow pit 6 with *Aristida diffusa* and *Eragrostis lehmanniana* as the dominating species in the foreground.

Plant species list

TABLE 11: Plant species list of Borrow pit number 6

BORROW PIT 6				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Amphiglossa triflora	*Aristida congesta*			
Dianthus thunbergii	*Aristida diffusa*			
Eriocephalus ericoides	*Eragrostis curvula* var. *conferta*			
Eriocephalus spinescens	*Eragrostis lehmanniana*			
Felicia muricata	*Panicum stapfianum*	**Ephemerals**		
Galenia sarcophylla	*Sporobolus fimbriatus*	*Cucumis africanus*		
Helichrysum zeyheri	*Tragus koelerioides*			
Salsola cali	*Tragus racemosa*			
Sutera virgulosa				
Walafrida saxatilis				

No rare or endangered plant species were found.

Impact assessment

TABLE 12: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Medium	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

The topsoil is deep and might carry a lot of seed due to high seed production of the current vegetation. It is recommended that the top soil should be removed and stored in wind rows not higher than two meters. After exploration the unused boulders can be placed back in the deepest areas of the quarry. The saved top soil can be worked back onto the disturbed areas. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Digitaria eriantha* (finger grass) should also be considered. *Digitaria eriantha* should be sown in the lower areas of the repaired landscape. Water accumulation will take place in these lower lying areas which will provide in the water need of this species.

3.7 BORROW PIT 7 [Co-ordinates: 30°57.439' S 25°01.958' E]

Description of site

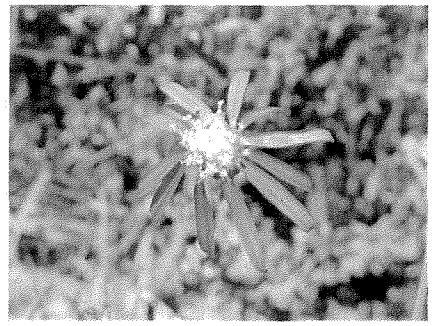


FIGURE 7: Borrow pit 7. Existing quarry which is going to be expanded.

This site is situated in an undulating landscape with a gentle slope from northwest to southeast. It is also an existing borrow pit which will be further expanded to the sides rather than going deeper. The veld is a bit short due to the fact that it is frequently grazed by livestock. The condition of the veld is however acceptable as a result of the high species diversity. The

dominating species are: *Walafrida saxatilis* (wit-aar), *Eriocephalus ericoides* (kapokbos), *Phymaspermum parvifolium* (witblommetjie) and *Cynodon incompletus* (kweek).

Plant species list

TABLE 5: Plant species list of Borrow pit number 7

BORROW PIT 7				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Aptosimum indivisum	*Aristida congesta*	*Lycium spp.*	*Argemone ochroleuca*	
Asparagus suaveolens	*Aristida diffusa*		*Xanthium spinosum*	
Chrysocoma ciliata	*Chloris virgata*			
Eberlanzia ferox	*Cynodon incompletus*			
Eriocephalus ericoides	*Digitaria eriantha*			
Eriocephalus spinescens	*Eragrostis lehmanniana*			
Felicia filifolia subsp. *flifolia*	*Eragrostis obtusa*			
Helichrysum zeyheri	*Eragrostis truncata*			
Pentzia globosa	*Melica decumbens*			
Pentzia incana	*Panicum stapfianum*			
Phymaspermum parvifolium	*Sporobolus fimbriatus*			
Pteronia glauca	*Tragus koelerioides*			
Rosenia humilis	*Tragus racemosa*			
Salsola calluna				
Sutera virgulosa				
Walafrida geniculata				
Walafrida saxatilis				

No rare or endangered plant species were found.

Impact assessment

TABLE 6: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	Without Mitigation	With Mitigation
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Medium	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Negative
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

Restoration guidelines

The topsoil is not deep and due to frequent grazing the seed bank might be a bit limited. This can however be enhanced by resting (not allowing any grazing animals by fencing off the area)

this area for as long a period as possible before starting with mining activities. It is recommended that the top soil should be removed and stored in wind rows not higher than two meters. After excavation the saved top soil can be worked back onto the disturbed areas. Introduction of seed of species such as *Sporobolus fimbriatus* (dropseed grass) and *Pentzia incana* (ankerkaroo) should also be considered. *Sporobolus fimbriatus* should be sown in the lower areas of the repaired landscape. Water accumulation will take place in these lower lying areas and *Sporobolus fimbriatus* will very effectively utilize this extra water.

3.8 BORROW PIT 8 [Co-ordinates: 30°57.439' S 25°01.958' E]

Description of site

This is a very small abandoned borrow pit and the intention is to cut off the top of this ridge without going lower than the lowest point in the landscape. This site is situated on top of a ridge. There is almost no topsoil and the current vegetation grows in gravel rather than soil. The cover is very sparse and the species diversity is also low. The veld is not in a good condition due to the lack of growth medium (soil). The location in the landscape also resembles the driest area, with run-off taking place in all directions, lowering infiltration of rainwater into the soil. The dominating species are: *Eriocephalus ericoides* (kapokbos) *Eriocephalus spinescens* (doringkapok), *Aristida diffusa* (iron grass) and *Tragus koelerioides* (carrot seed grass).

Restoration guidelines

The topsoil is not deep or almost non-existent. The seed bank will therefore, together with the low species diversity, be limited. It is recommended that the "topsoil" (or the present vegetation) should be removed and stored in wind rows not higher than two meters. After excavation additional topsoil should be obtained and mixed with the saved top soil and worked back onto the disturbed areas. Introduction of seed of species such as *Eragrostis lehmanniana* (Lehmann's love grass) and *Pentzia incana* (ankerkaroo) should also be considered. If any slope is present after the mitigation actions, erosion control measures should be applied. Access should be restricted to the existing track. A new track from the existing track to the quarry area should also be rehabilitated after completion of the mining activities.

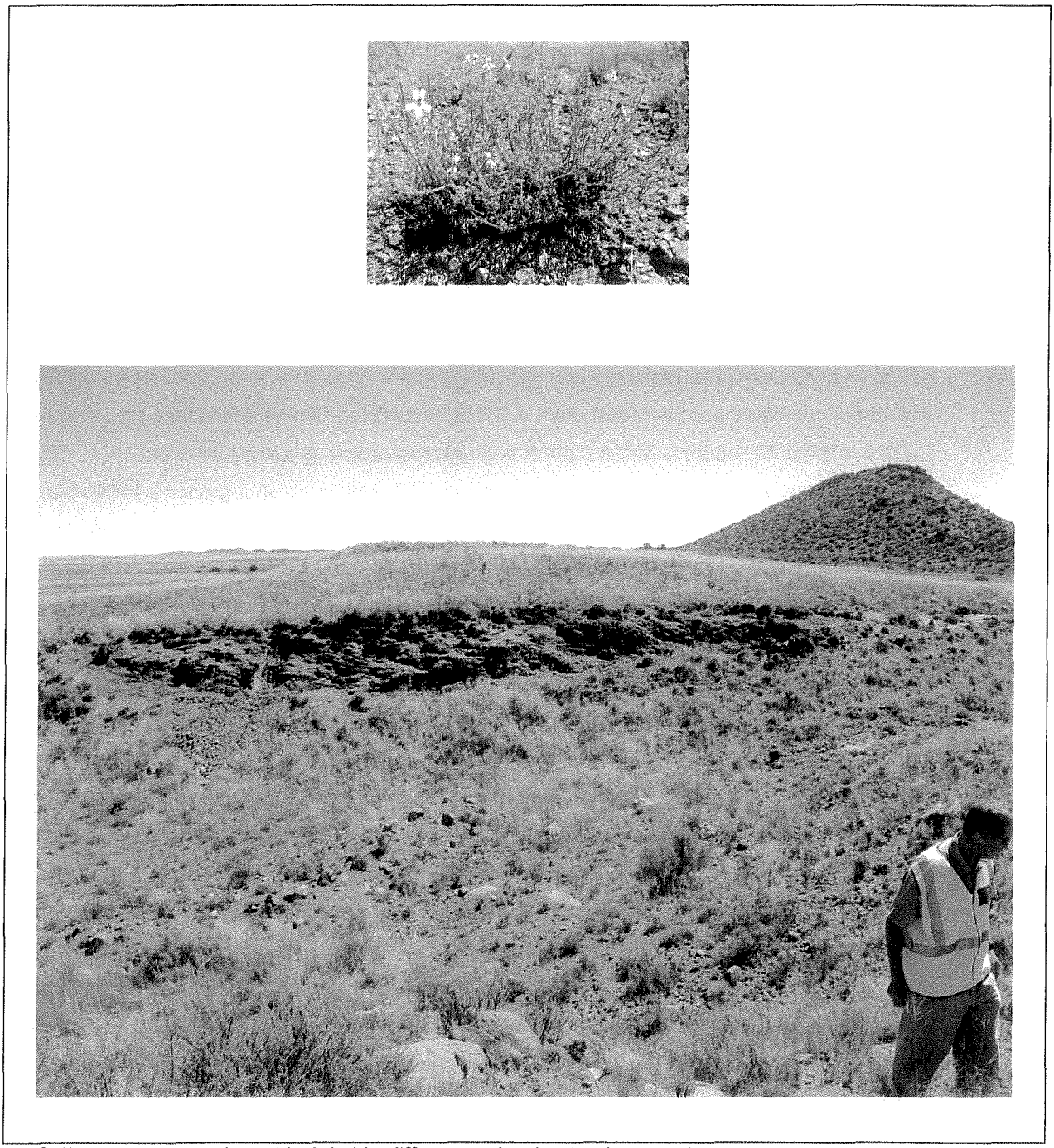


FIGURE 8: Borrow pit 8 with *Aristida diffusa*, as the dominating species.

Plant species list

TABLE 7: Plant species list of Borrow pit number 8

BORROW PIT 8				
Bushes (Karoo bossies)	**Grasses**	**Shrubs and trees**	**Weeds and aliens (invaders)**	**Red Data species**
Amphiglossa triflora	*Aristida diffusa*	*Lycium* spp.		
Eberlanzia ferox	*Enneapogon desvauxi*	*Rhus erosa*		
Eriocephalus ericoides	*Tragus koelerioides*			
Eriocephalus spinescens				
Gnidia deserticola				
Helichrysum zeyheri				
Lightfootia nodosa				
Nenax microphylla				
Pentzia globosa				
Pentzia quinquefida				
Stachys spathulata				
Sutera virgulosa				

No rare or endangered plant species were found.

Impact assessment

Table 8: Ratings of impacts according to the Convention for assigning significance ratings to impacts

Impact	**Without Mitigation**	**With Mitigation**
1 - Extent	Local	Local
2 - Duration	Long term	Medium term
3 - Intensity	Low	Low
4 - Significance	Low	Very low
5 - Status of impact	Negative	Positive
6 - Probability	Highly probable	Probable
7 - Degree of confidence	Medium	Medium

5. CONCLUSION

No rare, endangered or Red Data listed plant species were found on any of the sites during the investigation.

Rehabilitation

It is recommended that all proposed areas are fenced off as soon as possible to exclude these areas from grazing. This will allow seed production of all the present plant species which might help with future rehabilitation of the different sites.

When top soil and vegetation is removed it should be at least a layer of 40 to 50 cm, which should be stored in wind rows, not more than two meters in height. This will enhance seed survival. The top soil should be stored for as short a period as possible. This saved material should be evenly redistributed over the disturbed areas. Branches or any other coarse organic matter, even rocks, can be scattered or packed over this area, to create favorable microclimates for seed germination and seedling establishment. Such rehabilitated areas should be protected from grazing for at least 12 to 18 months to allow proper re-vegetation.

Reseeding should take place during autumn or spring while temperatures are not too high and the probability for rainfall is high.

Seed for rehabilitation purposes can be obtained from the following people:

Hans van Rooyen 051-9337000 Species: *Digitaria eriantha* and *Sporobolus fimbriatus*

Hannes Botha 023-3471121 Species: *Eriocephalus ericoides* and other Karoo shrubs

Sue Milton 023-5411828 Species: Karoo shrub species

North West University – Potchefstroom Campus Species: *Eragrostis lehmanniana* and other grass species

Picnic areas

For the upgrading of the picnic areas along the N9 it is proposed to make use of a combination of trees and "shade ports". Trees to be planted are: *Rhus pendulina* and/or *Olea europaea*. These trees should be planted in holes of one meter by one meter which are filled with compost and a fertile top soil. Thereafter it should be watered frequently until well established.

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APPENDIX 4

SPECIALIST REPORT: ARCHAEOLOGY/HERITAGE

ARCHAEOLOGICAL INVESTIGATION OF EIGHT PROPOSED BORROW PITS FOR THE PROPOSED REHABILITATION OF THE N9 FROM WOLWEFONTEIN TO COLESBERG NORTHERN PROVINCE

Prepared for

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FEBRUARY 2009

Executive summary

An archaeological investigation of eight borrow pits located around the town of Colesberg in the Northern Cape Province has identified no significant impacts to pre-colonial archaeological heritage remains that will need to be mitigated prior to the proposed development activities.

The proposed borrow pits have been identified as material sources for the proposed rehabilitation and maintenance of Section 7 of National Route 9 (N9) between Wolwefontein and Colesberg and the proposed construction of a new grade separated interchange between the N1 and N9 at Colesberg.

The following findings were made:

Stone Age artefacts were documented at each of the proposed eight borrow pits, but the material are spread very thinly and unevenly over the surrounding landscape.

The archaeological remains have been rated as having low local significance.

Table of Contents

1. INTRODUCTION

1.1 Background and brief

CCA Environmental (Pty) Ltd, on behalf of South African National Roads Agency Limited (SANRAL) requested the Agency for Cultural Resource Management to undertake an archaeological investigation of eight borrow pits located alongside the National Route 9 (N9), between Colesberg and Wolwefontein and around the town of Colesberg in the Northern Cape Province.

The proposed borrow pits have been identified as possible material sources for the rehabilitation of the N9 Section 7, between Wolwefontein (km 63.63) and Colesberg (km 94.84) and the proposed construction of a new grade separated interchange between the N1 and N9 at Colesberg.

The aim of the study is to locate, identify and map archaeological heritage remains that may be negatively impacted by the implementation of the proposed project, and to propose measures to mitigate against the impact.

Dr John Almond has been appointed to undertake a Palaeontological Impact Assessment of the proposed project.

2. TERMS OF REFERENCE

The terms of reference for the archaeological study were:

- to determine whether there are likely to be any archaeological sites of significance within the proposed borrow pits;
- to identify and map any sites of archaeological significance within the proposed borrow pits;
- to assess the sensitivity and conservation significance of archaeological sites located within the proposed borrow pits;
- to assess the status and significance of any impacts resulting from the proposed development, and
- to identify mitigatory measures to protect and maintain any valuable archaeological sites that may exist within the proposed borrow pits.

3. THE STUDY AREA

Locality maps indicating the approximate location of the eight borrow pits are illustrated in Figures 1 to 3. Colesberg is situated about 280 kms south of Bloemfontein on the N1.

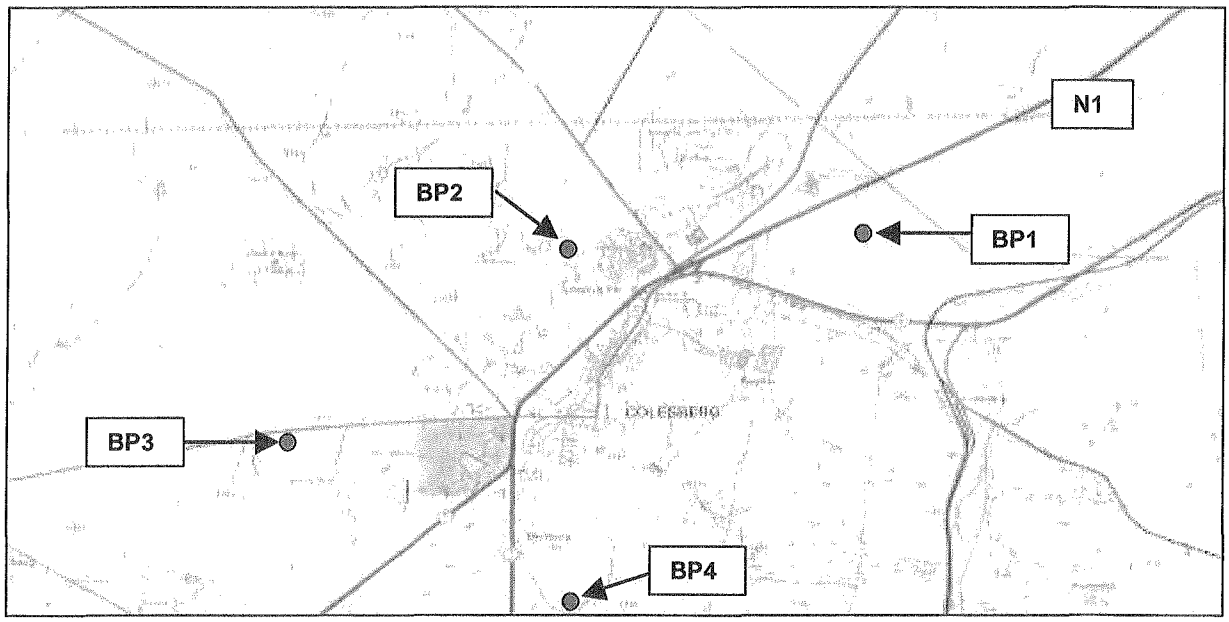


Figure 1. Locality map (3025CA Colesberg)

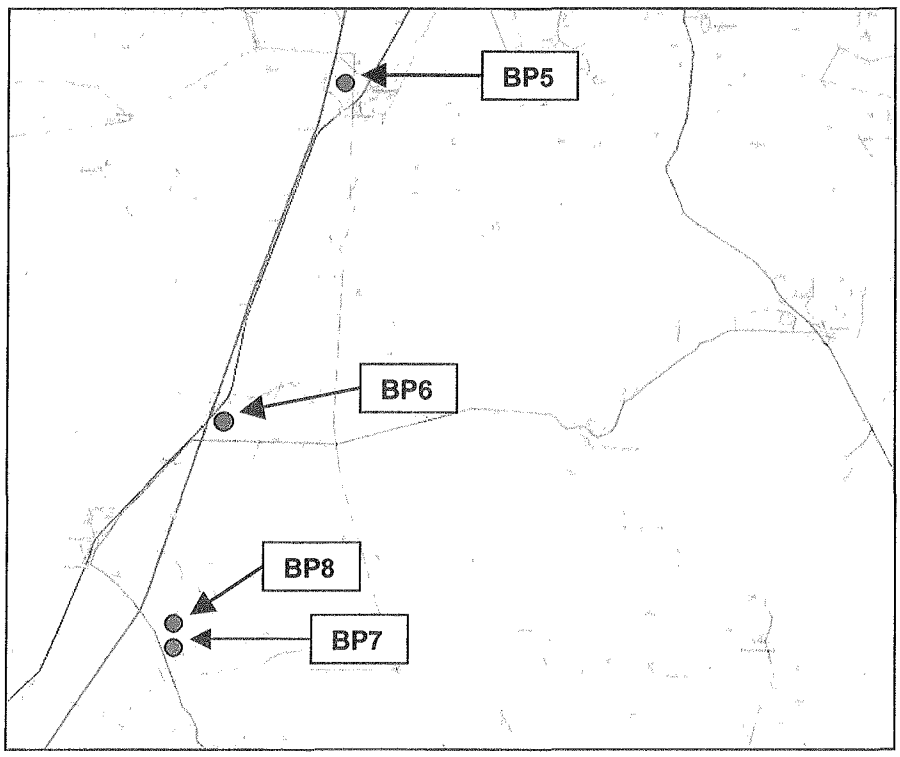


Figure 2. Locality Map (3025 CC Arundel)

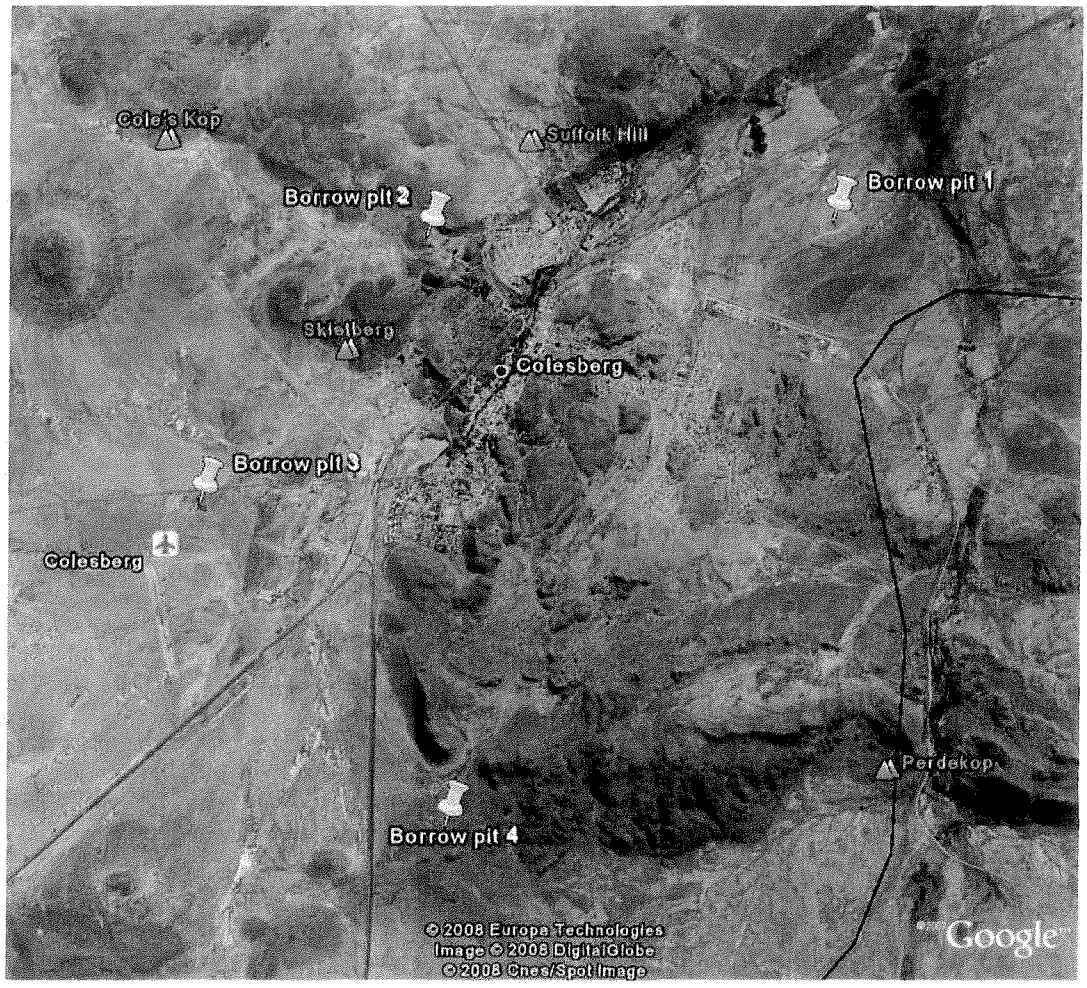


Figure 3. Aerial photograph indicating location of the 4 borrow pits around the town of Colesberg.

4. APPROACH TO THE STUDY

4.1 Method of survey

The approach followed in the archaeological study entailed a site inspection of each of the eight proposed borrow pits.

Archaeological heritage remains were recorded using a Garmin Geko GPS unit set on map datum wgs 84.

Borrow pits 5 to 8 were visited on 19 March 2008 and borrow pits 1 to 4 on 17 November 2008.

4.2. Constraints and limitations

There were no constraints or limitations associated with the study.

4.3 Identification of potential risks

There are no potential (archaeological) risks associated with the proposed project.

5. LEGISLATIVE REQUIREMENTS

The following section provides a brief overview of the relevant legislation.

5.1 The National Heritage Resources Act (Act No. 25 of 1999)

The National Heritage Resources (NHR) Act requires that "...any development or other activity which will change the character of a site exceeding 5 000m², or the rezoning or change of land use of a site exceeding 10 000 m², requires an archaeological impact assessment"

The relevant sections of the Act are briefly outlined below.

5.2 Structures (Section 34 (1))

No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the South African Heritage Resources Agency (SAHRA), or Heritage Western Cape.

5.3 Archaeology (Section 35 (4))

Section 35 (4) of the NHR stipulates that no person may, without a permit issued by HWC, destroy, damage, excavate, alter or remove from its original position, or collect, any archaeological material or object.

5.4 Burial grounds and graves (Section 36 (3))

Section 36 (3) of the HHR stipulates that no person may, without a permit issued by the South African Heritage Resources Agency (SAHRA), destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years, which is situated outside a formal cemetery administered by a local authority.

6. FINDINGS

6.1 Borrow Pit 1 (S 30° 42 22.8' E 25° 07 43.2')

The proposed site – an existing borrow pit - is located south of the N1 National Road, on municipal land (Remainder Erf 675) alongside a large, new municipal housing development (Figure 1). Access to the proposed site is via the R58 to Burgersdorp. The

proposed borrow pit comprises a prominent kopje in an otherwise flat and degraded landscape (Figure 2). The existing borrow pit has been terraced and the sides of the kopje have been extensively worked. Large piles of fill material from the new development have been tipped alongside its southern edge (Figures 3-5). If utilised, selected fill material (and the existing fill material from the development) will be excavated from the southern side of the kopje, thus minimising any visual impact from the N1.

Findings:

One weathered chunk, one broken, partially retouched and weathered Middle Stone Age (MSA) flake and one flat weathered MSA flake was documented on the proposed site. All the tools are in dolerite.

The archaeological remains have been rated as having low local significance.

Figure 1. Aerial photograph indicating Borrow Pit 1

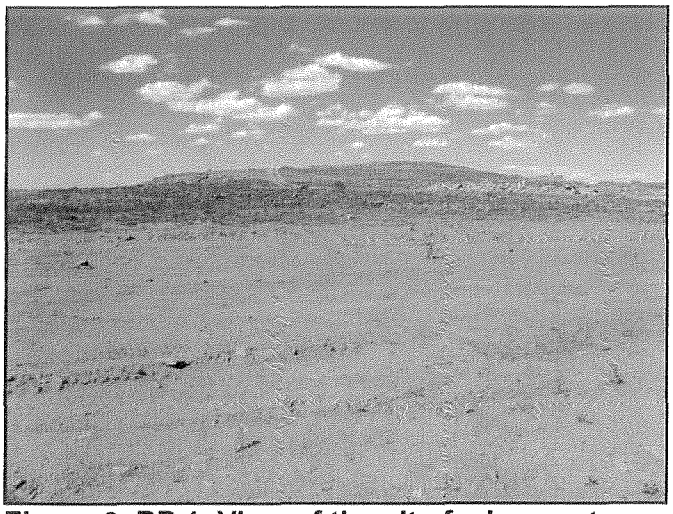


Figure 2. BP 1. View of the site facing east

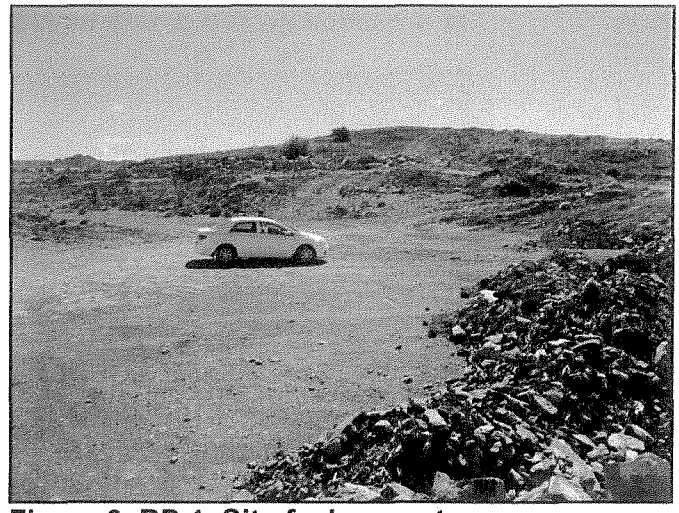


Figure 3. BP 1. Site facing west

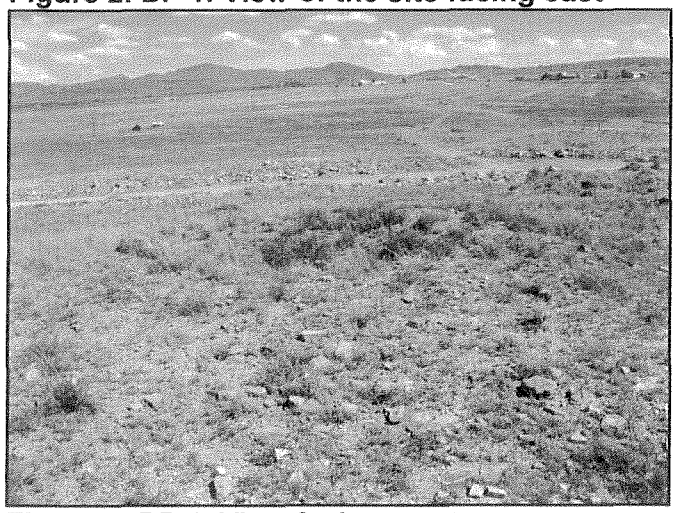


Figure 4. BP 1. View facing west

Figure 5. BP 1. View facing south

6.2 Borrow Pit 2 (S 30° 42 31.2' E 25° 05 29.6')

The proposed site – an existing borrow pit - is located in Colesburg, on municipal land (Remainder Erf 675). Access to the site is via the R369 to Petrusville. The proposed borrow pit is located alongside the town cemetery (Figure 6). The surrounding environment is severely degraded. The existing borrow pit has been extensively exploited (Figures 7-10). Several test pits have already been excavated on the proposed site. A small dolerite kopje and dolerite covered slopes occur immediately behind the proposed new site. Selected sub-base material from existing deposit will be exploited from the degraded south east facing slopes of the borrow pit.

Findings:

Three large, very weathered partially retouched dolerite MSA flakes and one broken, weathered flake were found on the proposed site.

No rock engravings were found among any of the boulders and the small kopje.

The archaeological remains have been rated as having low local significance.

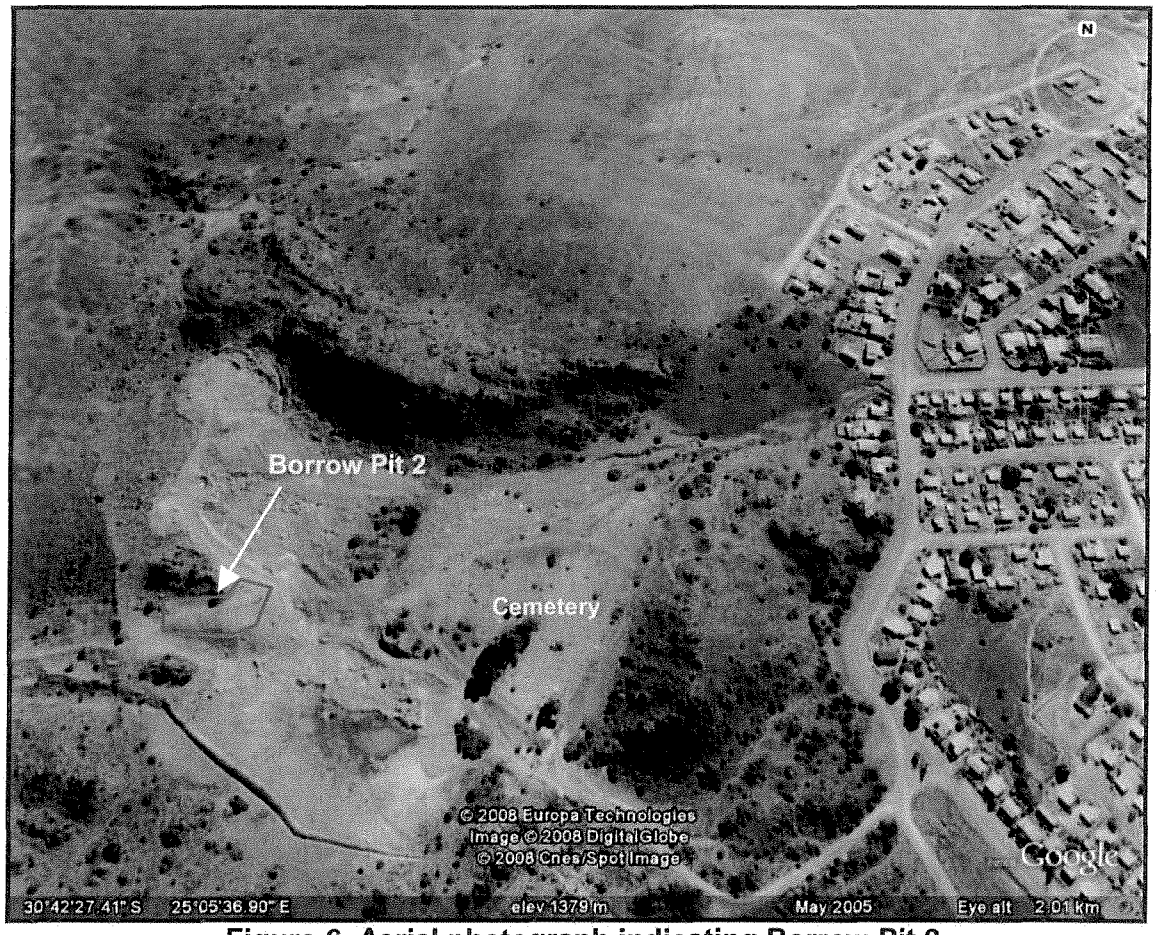


Figure 6. Aerial photograph indicating Borrow Pit 2

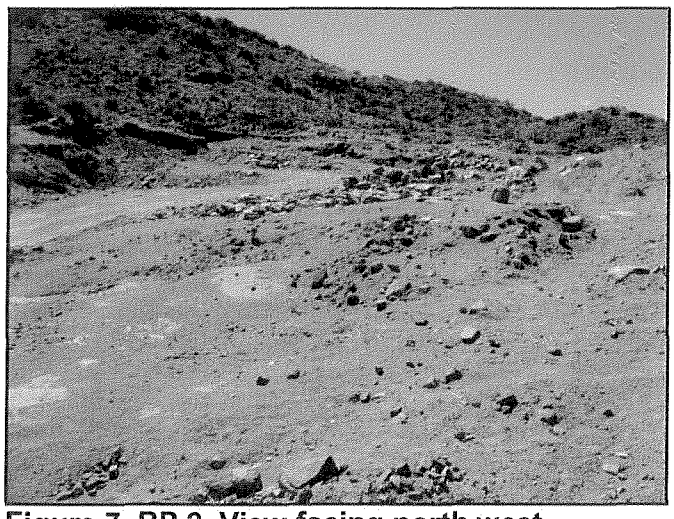


Figure 7. BP 2. View facing north west

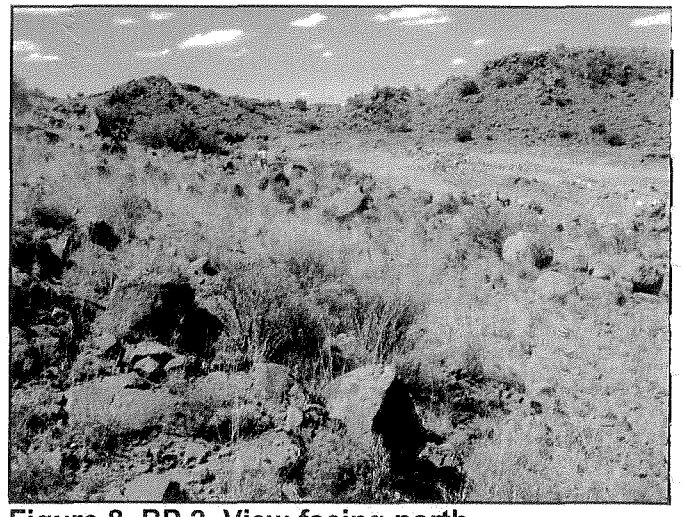


Figure 8. BP 2. View facing north

Figure 9. BP 2. View facing south

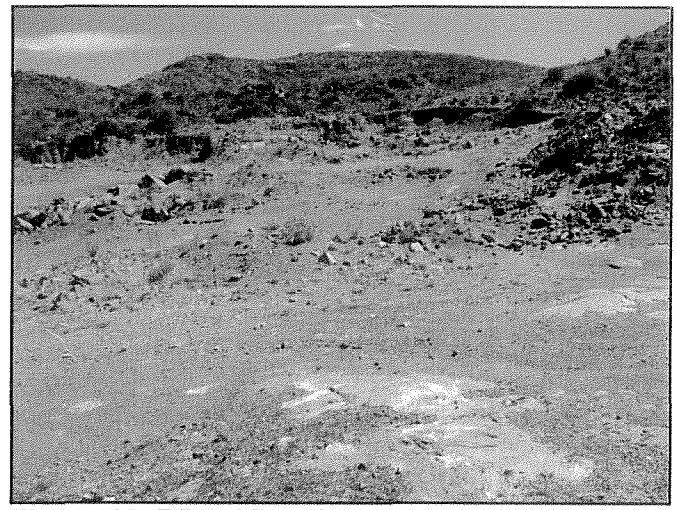


Figure 10. BP 2. View facing west

6.3 Borrow Pit 3 (S 30° 43 40.5' E 25° 04 07.8')

The proposed site – an existing borrow pit - is located north of the N1, on municipal land (Remainder Erf 675). Access to the proposed site is via a gravel road to Terewa, from the Engen Garage in Colesburg. The borrow pit is located directly alongside (i.e. west of) the gravel road (Figures 11-15) Very little surface stone occurs on the site, which is covered in dry winter grass and some sporadic bush. The site is moderately flat, sloping gently from north to south. There are no significant landscape features on the site. Several test pits have been excavated in the surrounding area. Selected base material (dolerite and mudstone) will be utilised from the proposed site.

Findings:

Three weathered MSA flakes, one weathered MSA chunk, one weathered MSA core and one flat Later Stone Age (LSA) flake were found on the proposed site. All the tools are in dolerite.

The archaeological remains have been rated as having low local significance.

Figure 11. Aerial photograph indicating Borrow Pit 3

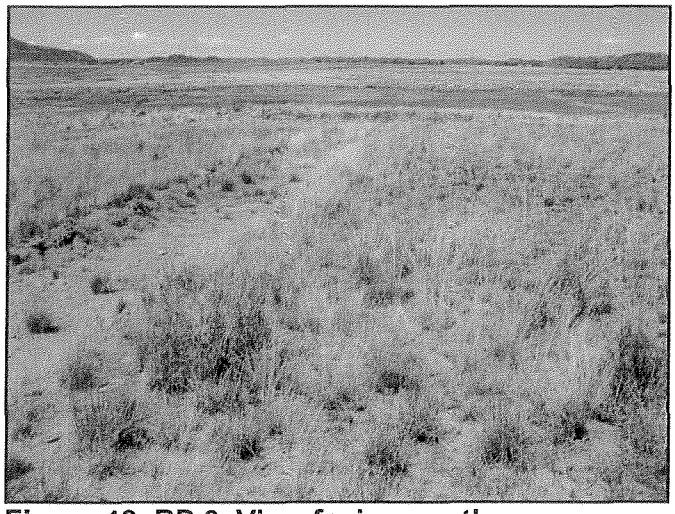


Figure 12. BP 3. View facing south

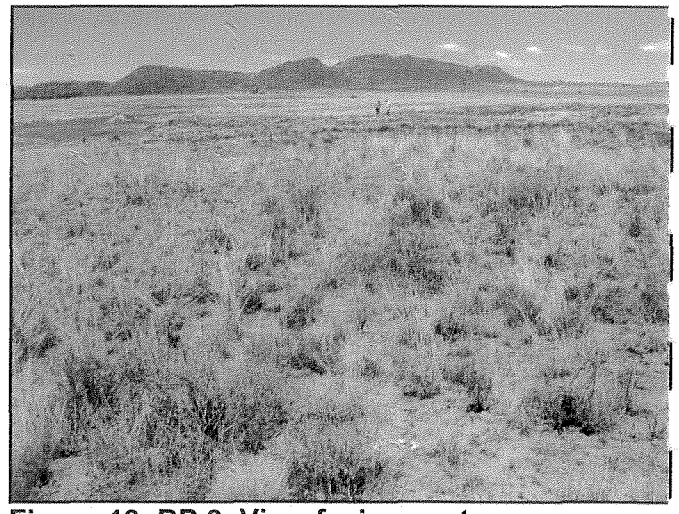


Figure 13. BP 3. View facing east

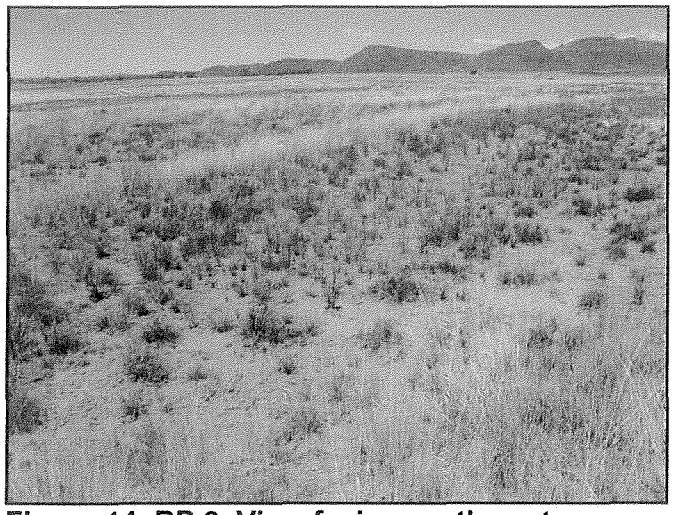


Figure 14. BP 3. View facing north east

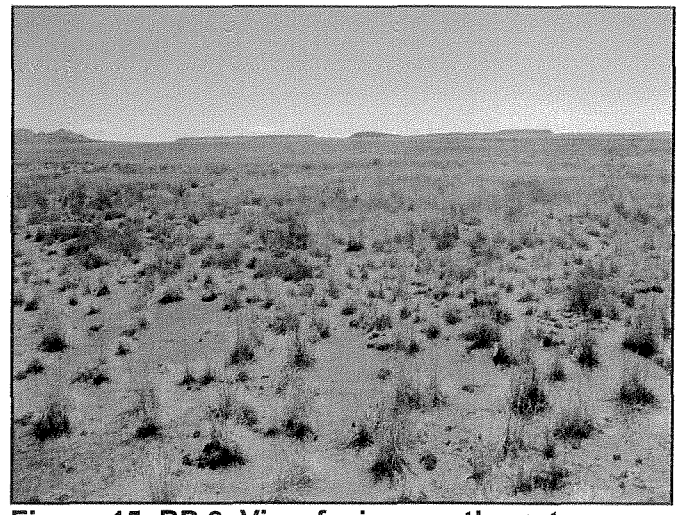


Figure 15. BP 3. View facing south east

6.4 Borrow Pit 4 (S 30° 45 16.8' E 25° 05 24.1')

The proposed site – an existing borrow pit - is located on the Farm Taaiboslaagte about 700 m east of the N9 (Figures 16-19) and about three kms south of Colesburg. The proposed borrow pit is obscured from the N9 by a low ridge. Fill or selected base material (dolerite and mudstone) will be sourced from the proposed site. Material will only be exploited from the southern edge of the existing borrow pit. The receiving environment is fairly flat but slopes gently from east to west and is covered with thick indigenous grasses and some sporadic bush. There are no significant landscape features on the proposed site, although there are prominent dolerite kopjes about 500 m south of the proposed borrow pit.

Findings:

Moderately large numbers of stone tools were documented on the site, but these occur in a disturbed context. Most of the tools were documented on a gravel patch near the south western edge of the existing borrow pit (refer to Figure 20), while some tools are spread unevenly in the surrounding landscape, mostly to the south east and near the edge of the existing borrow pit.

It is clear that this archaeological site has been disturbed/damaged by previous borrow pit activities. All the tools comprise highly weathered MSA flakes, chunks and a several rounded (prepared) cores. Some of the flakes are partially retouched, but no formal tools were found. The tools are identical to those that were documented in the 2008 study (Kaplan 2008). All the tools are in dolerite.

A collection of tools is illustrated in Figure 21.

The archaeological remains have been rated as having low local significance.

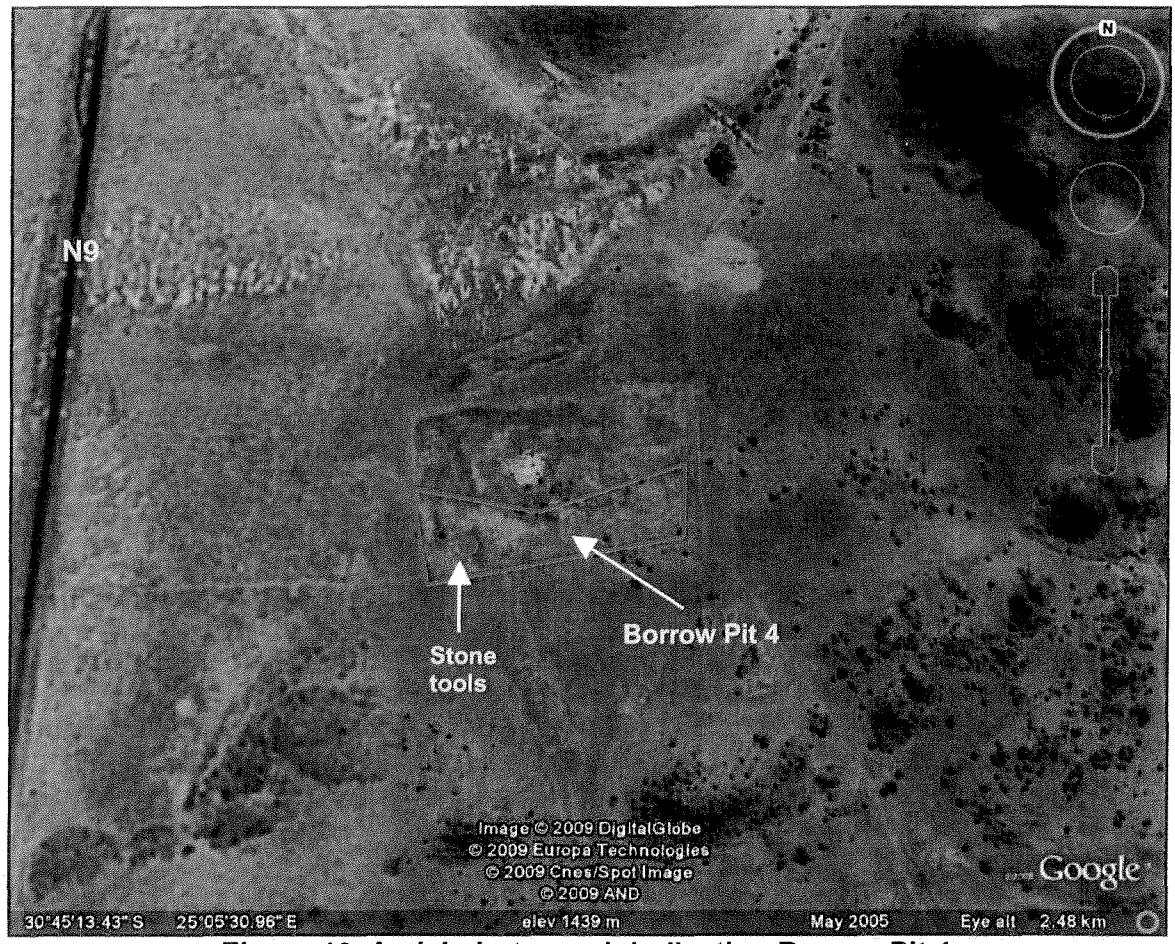


Figure 16. Aerial photograph indicating Borrow Pit 4

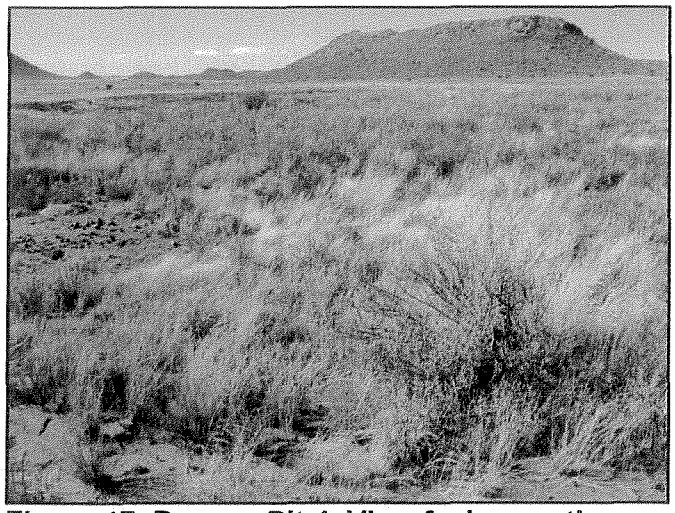


Figure 17. Borrow Pit 4. View facing north

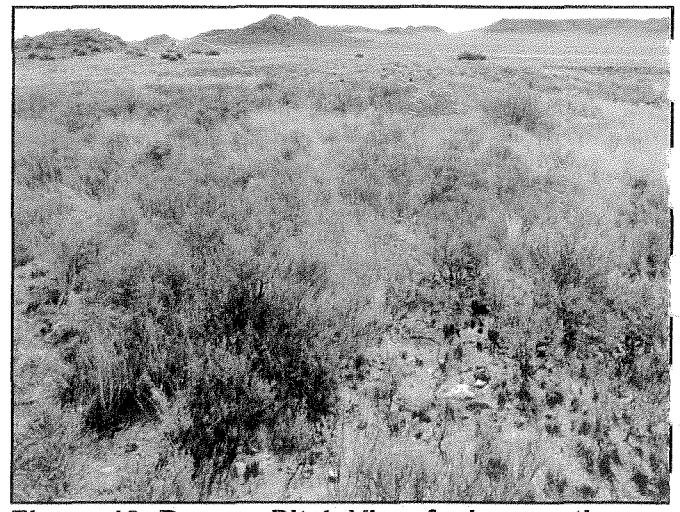


Figure 18. Borrow Pit 4. View facing south west

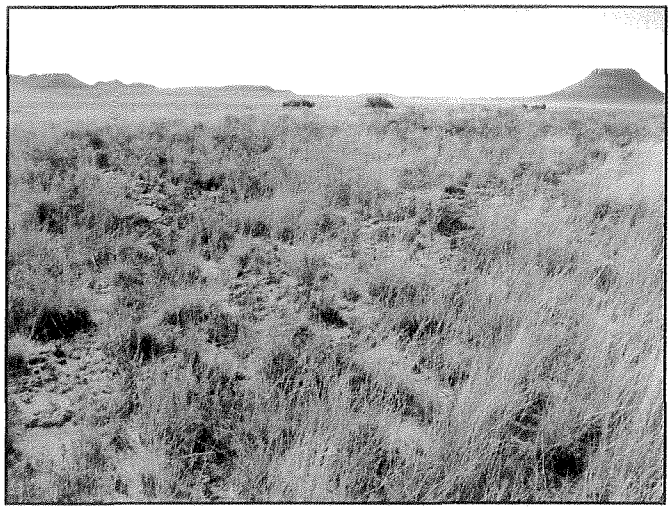


Figure 19. Borrow Pit 4. View facing south west

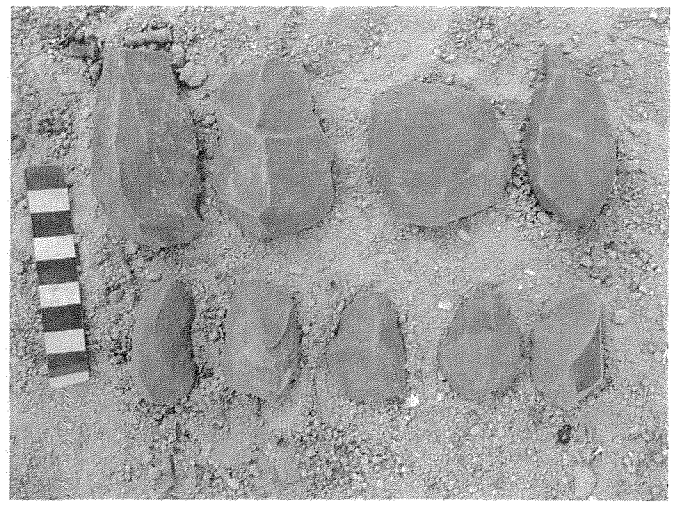


Figure 20. Stone tools. Scale is in cm

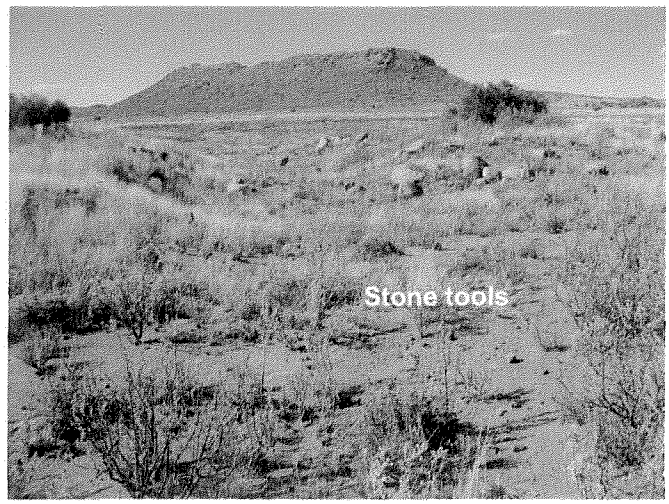


Figure 21. Borrow Pit 4. View facing north

6.5 Borrow Pit 5 (S 30° 49 934' E 25° 04 403')

The proposed site – an existing borrow pit up against a Koppie - is located on the Farm Taaiboslaagte alongside the eastern edge of the N9 (Figure 22-24). The proposed borrow pit is hidden from the N9 by a ridge. The borrow pit is about 3 m deep in places. Fill or selected base material will be sourced for the proposed rehabilitation of the road. The receiving environment slopes fairly gently from north to south and is covered with thick indigenous grasses and some sporadic bush. Several large dumps of stockpile material still occur on the site.

Findings:

A very thin and dispersed scatter of a few thin, Later Stone Age (LSA) dolerite flakes, chunks and an utilised flake, and two weathered and patinated thick, chunky Middle Stone Age (MSA) dolerite flakes were documented on the proposed site.

The archaeological remains have been rated as having low local significance.

Figure 22. Aerial photograph showing the location of Borrow Pit 5

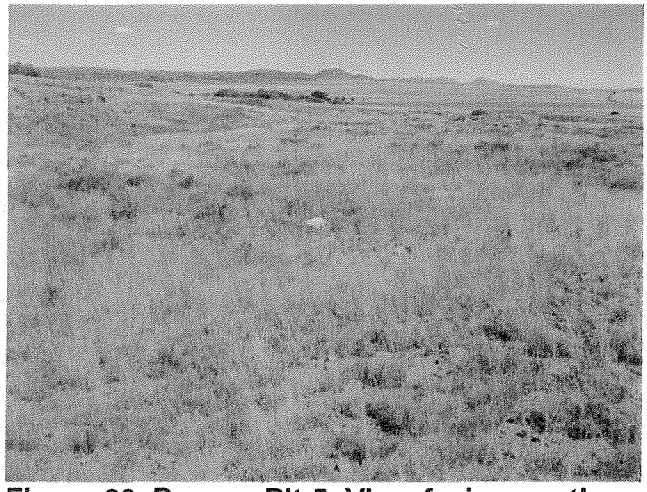


Figure 23. Borrow Pit 5. View facing south

Figure 24. Borrow Pit 5. View facing nort

6.6 Borrow Pit 6 (S 30° 54 763' E 25° 02 702')

The proposed site – a large, existing borrow pit - is located on the Farm Rietfontein, alongside the eastern edge of the N9, next to a railway crossing (Figures 25-27). The borrow pit is enclosed within a fence measuring ± 300 m x ±120 m. The current borrow pit depth varies between 2 m and 4 m. Fill or selected base material will be sourced for the proposed rehabilitation of the road. The receiving environment is flat and in an already, highly disturbed and degraded state. Large areas have already been scraped, while large patches once containing stockpile material were also noted.

Findings:

Scatters of thin, LSA dolerite flakes, including a few bladelets and some chunks and two small round cores were counted on the site, but these occur in a very disturbed and degraded context. A few flakes were also noted in the access road leading down into the existing borrow pit. Several weathered and patinated, MSA flakes were also noted lying about.

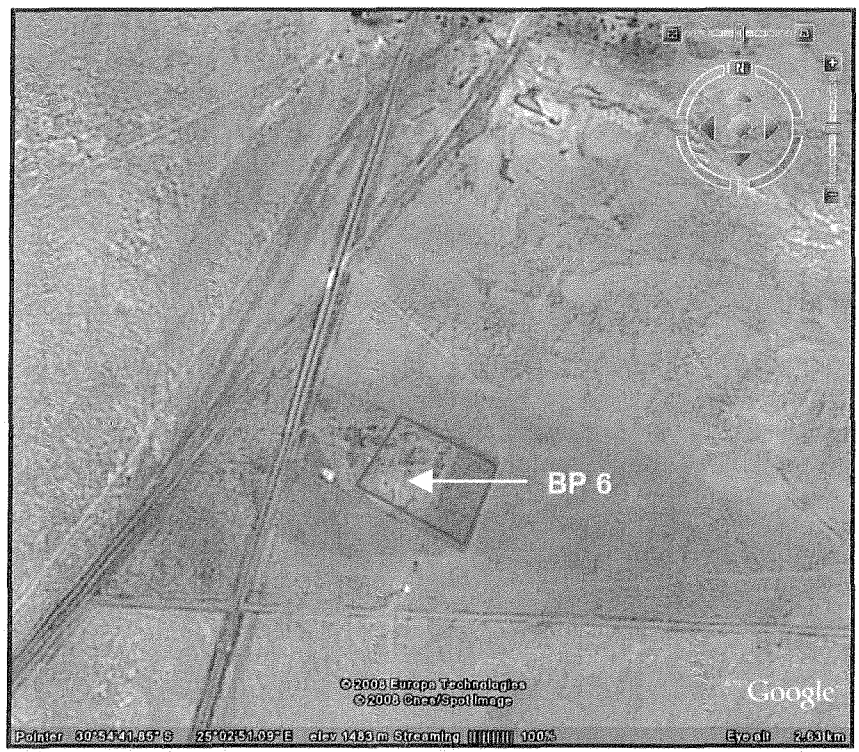


Figure 25. Aerial photograph showing the location of Borrow Pit 6

Figure 26. Borrow Pit 6. View facing east

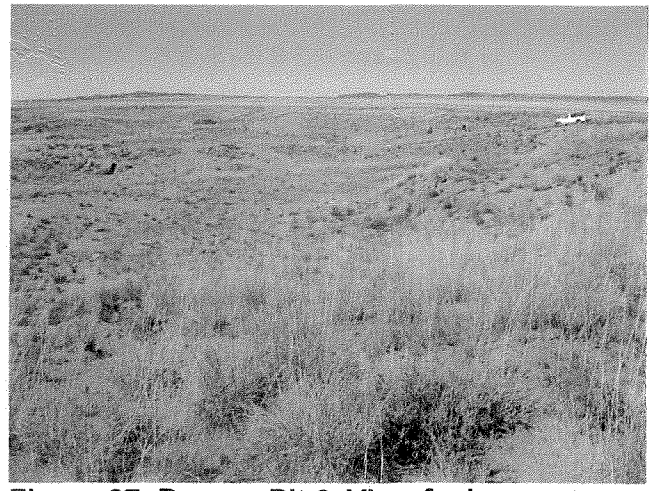


Figure 27. Borrow Pit 6. View facing east

6.7 Borrow Pit 7 (S 30° 57 516' E 25° 02 012')

The proposed site – a fairly small, existing borrow pit - is located alongside the Bosberg Road on the Farm Arundel and about 450 m east of the N9 (Figures 28 & 29). The borrow pit is about 2.5 m deep. The site is fairly flat, but slopes gently toward the south east. Fill or selected base material will be sourced for the proposed rehabilitation of the road. Except for the existing borrow pit, the receiving environment is undisturbed and covered with thick indigenous grass. Very little surface stone is present. The north western edge of the extent of the proposed borrow pit is defined by a small stone littered, hill-washed slope, with a remnant dolerite dyke.

Findings:

A few weathered and patinated MSA quartzite and dolerite flakes were found at the bottom of the hill-washed slope in the north western portion of the site. One partially retouched LSA flake on a reworked MSA flake was also found. A few more flake tools were counted on the slopes, but these fall outside the proposed extent of the borrow pit.

Figure 28. Borrow Pit 7. View facing north west

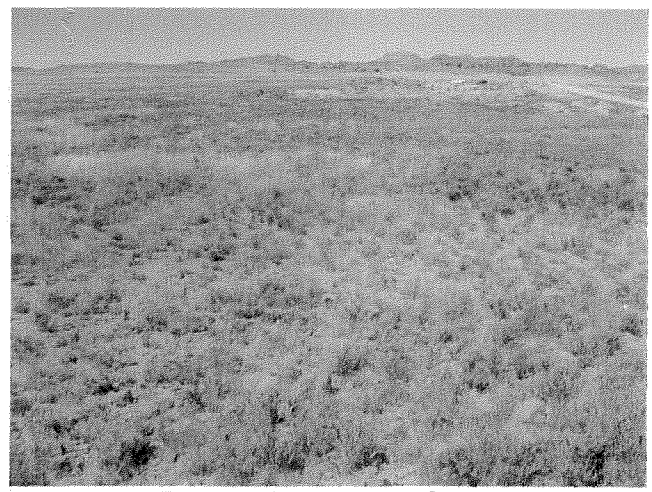


Figure 29. Borrow Pit 7. View facing north west

6.8 Borrow Pit 8 (S 30° 57 230' E 25° 02 040')

The proposed (existing) borrow pit is located about 300 m north west of Borrow Pit 8 and about 300 m east from the N9, on the Farm Arundel (Figures 30-32). The borrow pit is not visible from the road as it is hidden behind a stone covered Koppie. The existing borrow pit is about 5 m deep. The borrow pit would be extended by removing the Koppie adjacent to it, for fill or selected base material. The natural contour of the hill will be followed in order to minimise any visual impact.

Findings:

A low density scatter of weathered and patinated MSA and LSA dolerite flakes were documented on the approach to the proposed borrow pit. No stone flakes were found within the area of the proposed new borrow pit area.

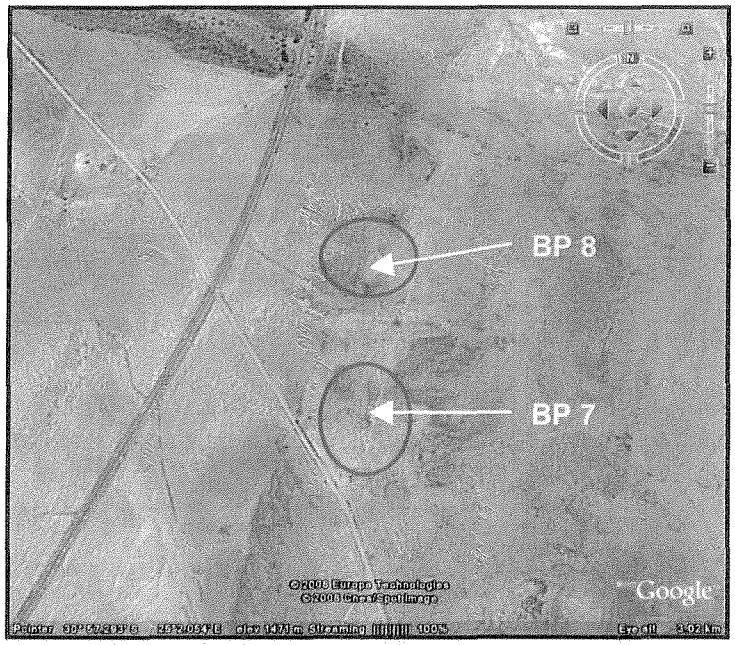


Figure 30. Aerial photograph showing the location of Borrow Pits 7 and 8

Figure 31. Borrow Pit 8. View facing south

Figure 32. Borrow Pit 8. View facing east

7. IMPACT STATEMENT

The archaeological investigation of eight borrow pits alongside the N9 near Colesberg, and around the town of Colesberg, has identified no significant impacts to pre-colonial archaeological remains that will need to be mitigated prior to construction activities commencing.

The proposed project will not have any negative impact on the heritage qualities of the receiving environment. Visual impacts will be minimised and the cultural landscape qualities of the study site and affected environment will not be compromised, either.

Table 1 presents an assessment of the archaeological impacts of the proposed project.

Table 1. Assessment of the archaeological impacts of the proposed project.

Borrow Pit (BP)	Extent	Duration	Intensity	Probability	Confidence	Significance Without Mitigation	Significance With mitigation
BP 1	Local	Short term	Low	Improbable	High	Very Low	N/A
BP 2	Local	Short term	Low	Improbable	High	Very Low	N/A
BP 3	Local	Short term	Low	Improbable	High	Low	Low
BP 4	Local	Short term	Low	Improbable	High	Low	Low
BP 5	Local	Short term	Low	Improbable	High	Very Low	N/A
BP 6	Local	Short term	Low	Improbable	High	Very Low	N/A
BP 7	Local	Short term	Low	Improbable	High	Very Low	N/A
BP 8	Local	Short term	Low	Improbable	High	Very Low	N/A

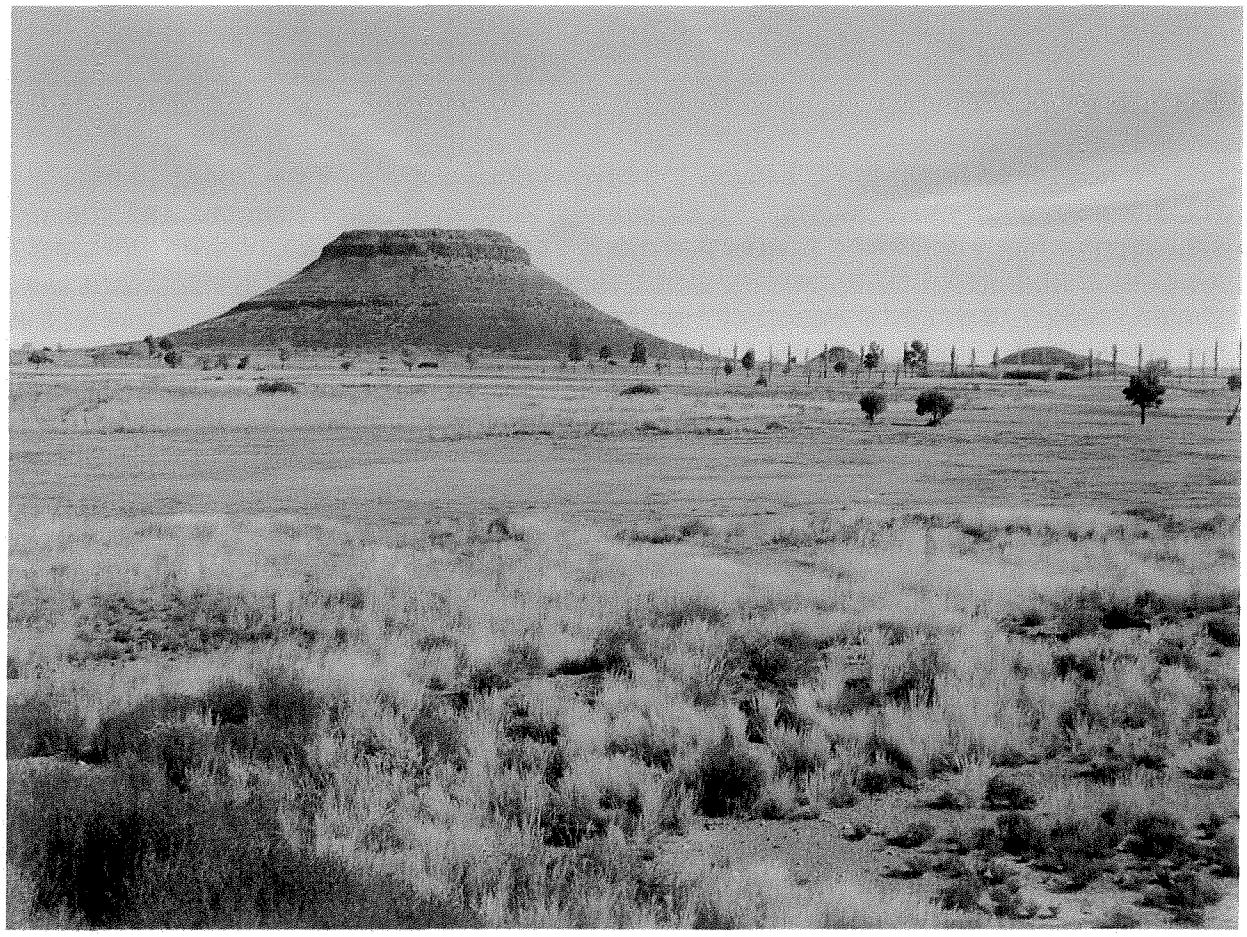
8. RECOMMENDATIONS

With regard to the proposed project, no archaeological mitigation is required, and the project should be allowed to proceed.

APPENDIX 5

SPECIALIST REPORT: PALAEONTOLOGY

COLESBERG ROAD UPGRADE PROJECT: PALAEONTOLOGICAL IMPACT ASSESSMENT



Colesberg Kop viewed from the south (N1 / N9 interchange construction site) showing lenticular channel sandstone halfway up slope and thick dolerite sill towards the crest

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May 2008

COLESBERG ROAD UPGRADE PROJECT (N. CAPE): PALAEONTOLOGICAL IMPACT ASSESSMENT

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1. SUMMARY

The proposed road upgrade will involve the construction of a new interchange at the N1 / N9 intersection on the outskirts of Colesberg, Northern Cape Province, and the re-excavation of four abandoned borrow pits along the N9 to the south of town. Potentially fossiliferous bedrock of the lower Beaufort Group at the interchange development site is almost entirely obscured by deep drift and no fossils were observed here. Three of the four borrow pits involved (Numbers 5,6 and 8) are excavated into deeply weathered dolerite and are therefore of no palaeontological interest. Borrow Pit 7 is excavated into distal floodplain sediments of the Beaufort Group and might yield fossil tetrapods, but the chances of useful fossils emerging here are low.

There are no objections on palaeontological grounds to the proposed development.

However, palaeontologically significant specimens of fossil tetrapods, vascular plants and trace fossils are quite likely to be exposed during excavations into fresh Beaufort Group bedrock (especially mudrocks) during construction of the N1/N9 interchange and, less so, at Borrow Pit No. 7. Before development starts, the responsible ECO should therefore inspect the local palaeontological material in the Colesberg Museum to gain experience in recognising Karoo fossils. The position of any obvious finds of fossil material found during development should be accurately recorded by the ECO on a 1: 250 000 map / aerial photo or with a GPS. Where practicable, fossil specimens, together with the surrounding rocky matrix, should be carefully collected, labled and handed over to a professional palaeontologist for examination. Should substantial skeletal material be discovered (*eg* the articulated skeleton of a Karoo "reptile"), the ECO should inform Heritage Western Cape so that it can be inspected and, if necessary collected, by a professional palaeontologist. Fossil specimens that are not of research interest could be usefully donated to the Colesberg Museum for educational purposes.

2. INTRODUCTION

The proposed upgrading of the N9 Section 7 from Wolwefontein to Colesberg in the Northern Cape by SANRAL will involve the construction of a new interchange at the N1 / N9 intersection at Colesberg and the re-opening of four abandoned borrow pits to the south of town (**Figure 1**). All proposed construction south of Colesberg would take place within the existing road reserve. A palaeontological scoping study of the interchange site, borrow pits and nearby roadcuts was commissioned by CCA Environmental on behalf of SANRAL as part of a NEMA Basic Assessment. All four borrow pits concerned as well as the interchange area were visited by the author on 16 April 2008. A small fossil collection at the Colesberg Museum was also inspected to obtain a better understanding of the palaeontological potential of the area as a whole.

3. GEOLOGICAL & PALAEONTOLOGICAL BACKGROUND

The characteristic Karoo koppie landscape of the Colesberg area is underlain by Late Permian sediments of the **Lower Beaufort Group** (**Adelaide Subgroup**) which have been extensively intruded by dolerite sills and dykes of the Early Jurassic (182 Ma) **Karoo Dolerite Suite** (Le Roux, 1993). The outcrop distribution of these two major geological units in the Colesberg area is clearly shown on the geological map 1: 250 000 sheet 3024 Colesberg (Council for Geoscience, Pretoria 1997). The peculiar, intersecting ring-shaped outcrop pattern of the Karoo dolerites in this part of the Great Karoo is due to the dish-shaped 3d configuration of the intrusions (Chevallier & Woodford 1999, Cole *et al.* 2004).

According to le Roux (1993) the lithostratigraphic subdivision of the Adelaide Subgroup into constituent formations in the Colesberg sheet area is still unresolved. A prominent pale-weathering sandstone around halfway up the Adelaide succession is tentatively correlated with the Oudeberg Member at the base of the Balfour Formation in the southern Karoo (*ibid.*, p. 5). If correct, this would allow the differentiation of the Adelaide succession in the Colesberg area of an underlying Middleton Formation and an overlying Balfour Formation. However, several pale-weathering sandstones occur within the Beaufort Group succession in this portion of the basin - see, for example, the middle slopes of Colesberg Kop shown on the title page. Therefore further biostratigraphic data – such as the demonstration of *Cistecephalus* Assemblage Zone fossils within the aforementioned pale-weathering sandstone - is required to test this model. Current biozonation maps for the Main Karoo Basin (Rubidge 1995, Fig. 1) show Colesberg as situated within the latest Permian *Dicynodon* Assemblage Zone (AZ), close to its northern boundary with the slightly older *Cistecephalus* AZ. Early Triassic sediments of the *Lystrosaurus* AZ crop out much further to the south, *en route* to Middelburg.

The *Dicynodon* Assemblage Zone is very latest Permian in age, *ie.* 253.8 - 251.4 Ma (Changhsingian / Late Tartarian; Rubidge 2005) It represents the end-Palaeozoic continental biota of Gondwana, dominated by therapsid "mammal-like reptiles" and the *Glossopteris* Flora, that was largely wiped out by the catastrophic end-Permian Mass Extinction Event (Ward *et al.* 2005). Detailed lists of fossils from this biozone are provided by Keyser & Smith (1979) and updated by Kitching (*in* Rubidge 1995). Popular illustrated accounts are also given by Cluver (1978), MacRae (1999) and McCarthy & Rubidge (2005). The diverse vertebrate fauna comprises palaeoniscoid fish (**Figures 11-12**),

crocodile-like temnospondyl amphibians, reptiles such as large herbivorous pareiasaurs and lizard-like younginids, as well as a large spectrum of therapsids or "mammal-like reptiles". These last include numerous small- to large-bodied herbivorous dicynodonts (**Figure 13**), several carnivorous gorgonopsians and cynodonts, and a range of therocephalians, among others. Invertebrates are represented by freshwater bivalves and insects, and vascular plants by petrified wood ("*Dadoxylon*", **Figure 16**) and leaves, stems and other debris of the characteristic Gondwanan *Glossopteris* Flora (Anderson & Anderson 1985, Bamford 1999). Trace fossil assemblages are generally low in diversity and include a variety of tetrapod trackways, fish swimming trails, invertebrate burrows and coprolites (Smith 1993b, Smith & Almond 1998).

The Lower Beaufort sediments were deposited by large-scale meandering river systems flowing northwards from the youthful Cape Fold belt across the extensive floodplains of the ancient Karoo Basin (Smith 1980, Johnson *et al.* 2006). They mainly comprise bluish-grey, grey-green and rarer purplish overbank mudrocks with subordinate lenticular channel sandstones. These last commonly have a basal conglomeratic lag of rolled mudflake pellets and calcrete nodules. Small, often transient playa lakes were also present on the floodplain and may be associated with disarticulated amphibian bones and a range of trace fossils. Well-preserved tetrapod fossils, from isolated skulls and post-cranial bones to fully articulated skeletons, are mainly found in overbank mudrocks, often in association with pedogenic calcretes (palaeosol horizons). Disarticulated, water-worn bones occur in the channel lag conglomerates (Smith 1980, 1993a). Fossils embedded within metamorphosed sediments (quartzites, hornfels) adjacent to dolerite intrusions may be well-preserved, but are very difficult to prepare out from the matrix and therefore usually of limited scientific value.

Various types of **superficial deposits** ("drift") of Late Caenozoic (Miocene / Pliocene to Recent) age occur in the Colesberg area of the central Karoo. They include pedocretes (*eg* calcretes), colluvial slope deposits (dolerite scree *etc*), river alluvium, as well as spring and pan sediments (Keyser 1993, with more extensive discussion in Holmes & Marker 1995, Cole *et al.* 2004, Partridge *et al.* 2006). These central Karoo drift deposits have been comparatively neglected in palaeontological terms for the most part. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (*eg* Pleistocene mammal faunas at Florisbad, Cornelia and Erfkroon, Free State and elsewhere; Wells & Cooke 1942, Cooke 1974, Skead 1980, Klein 1984, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al.* 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al.* 2000 Partridge & Scott 2000). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalbes, gastropods), ostrich egg shells, trace fossils (*eg* calcretised termitaria, coprolites), and plant remains such as palynomorphs in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments.

4. RESULTS OF PALAEONTOLOGICAL SCOPING STUDY

A map of the showing the location of the proposed road developments in the Colesberg area is given in **Figure 1** (kindly provided by CCA Environmental).

4.1. N1/N9 interchange area, Colesberg

The area of the proposed new N1/N9 interchange on the southwestern outskirts of Colesberg is largely covered with thick alluvial soil and grassy Karoo bossieveld (**Figure 2**). A few, very limited exposures of Beaufort Group bedrock were seen – for example, near the concrete wall north of the dam (30° 43' 52.5" S, 25° 04' 47.9" E), and on the northern edge of property, south of the Colesberg Country Club golf course (30° 43' 43.2" S, 25° 04' 56.2" E). Here small *in situ* outcrops and dumps of excavated rock rubble include buff to greenish-buff sandstone, crumbly grey-green mudrock, pale calcrete and ferruginous concretions ("koffieklip"), but no fossils were seen. Locally the sandstones (with vugs) and hornfelsed mudrocks reflect thermal alteration by dolerite intrusions. Alluvium exposures in deeper gullies and the margins of the shallow dam were also inspected for fossils without success.

4.2. Borrow Pit 5 (km 84.0)

This abandoned borrow pit (30° 49' 54.9" S, 25° 04' 30.1" E) is excavated into deeply weathered dolerite, and hence unfossiliferous (**Figure 3**). Good exposures of weathered dolerite, including onion-skin weathered corestones and narrow, resistant-weathering, late stage basaltic dykes are seen in nearby roadcuts along the N9 (**Figure 4**). Bedded mudrocks are exposed at the northern end of the roadcuts, but these have been thermally altered, are brittle in consequence, and unlikely to yield scientifically useful fossil material.

4.3. Borrow Pit 6 (km 74.3)

This abandoned borrow pit (**Figure 5**; 30° 54' 48.1" S, 25° 02' 48.6" E) is excavated into weathered dolerite, intruded by narrow basaltic or perhaps felsitic dykes (**Figure 7**), and is therefore unfossiliferous. Excellent examples of dolerite onion-skin weathering (**Figure 6**) and are seen here.

4.4. Borrow Pit 7 (km 69.6)

This borrow pit (30° 57' 29.4" S, 25° 02' 01.9" E) is excavated in crumbly, thin-bedded to laminated sediments of the lower Beaufort Group, overlain by *c.*1m of colluvial soils with a thin calcrete hard pan (**Figure 8**). Close up the sediments at the margins of the pit are seen to consist of stacked thin fining-upwards cycles, with pale greyish fine sandstone at the base and buff, shaley siltstone to claystone at the top (**Figure 9**). Thin, laterally persistent distal crevasse splay sandstones with current ripple cross lamination are also seen. No fossils were found here during this scoping study. These rocks are probably distal floodplain deposits within which vertebrate fossils – predominantly scattered post-cranial bones with rare, usually compressed skulls - are typically scarce and poorly

preserved (Smith 1993a). Lacustrine (playa lake) facies can be expected within such successions, showing small scale wave ripples, *Scoyenia* Ichnofacies burrows (*eg* fish trails, arthropod scratch burrows) and disarticulated but associated amphibian remains. Finely laminated, darker brown (?ferruginised) sandstones exposed in the SW corner of the pit may have a lacustrine association.

4.5. Borrow Pit 8

This abandoned borrow pit (30° 57' 15.7" S, 25° 02' 01.1" E) is excavated into dolerite and therefore unfossiliferous (**Figure 10**).

5. BEAUFORT GROUP FOSSILS IN COLESBERG MUSEUM

A small collection of fossils, most collected locally by the Colesberg amateur naturalist L. Kemper, is housed at the Colesberg Museum. A few specimens are illustrated here because they should give some idea of the sort of fossil material that might well be encountered during road development in the region.

Beaufort Group fossils in the Kemper collection include:

- well-preserved, albeit incomplete specimens **palaeoniscoid fish**.from Suffolk Hill on the northern outskirts of Colesberg (**Figures 11, 12**). This *might* be related to the well-known Late Permian genus *Atherstonia*, type material of which (*A. scutata*) was collected from the Dicynodon Assemblage Zone at "the Fish River site of the Colesberg District" (Woodward 1889, Bender 2004)

- skulls and postcranial remains of **Karoo "reptiles"**, the majority of which are attributable to small **therapsids** or "mammal-like reptiles". Examples are the distorted dicynodont skull with large canine tusks shown in **Figure 13** and the limb bones, girdle, vertebrae and ribs seen in **Figures 14** and **15**.

- **petrified wood**. Several small pieces of silicified wood are present in the Colesberg museum collections (**Figure 16**), and a more substantial log is on display at The Barracks guesthouse, 15-17 D'Urban Row, Colesberg. Petrified wood is often shoehorned into the basket-genus *Dadoxylon* in older literature, but a small range of gymnospermous wood genera, including podocarps, has now been identified from the Beaufort Group (*eg* Bamford 1999, 2004).

- **pseudofossils** – *ie* non-biological structures with a fortuitous and superficial resemblance to organic remains. A good example is the ferruginous diagentic concretion in **Figure 17** that looks very like the petrified hoof of a horse or zebra.

5. RECOMMENDATIONS

There are no objections to the proposed development on palaeontological grounds.

Fresh exposures of Beaufort Group sediments excavated during development at the Colesberg N1/N9 interchange and Borrow Pit No. 7 may well be of palaeontological interest, however, and should be inspected at intervals by the responsible Environmental Control Officer (ECO) before they are infilled or sealed. The ECO for this development should briefly inspect the Karoo fossils on display at the Colesberg Museum at the start of operations so that (s)he acquire some familiarity with the appearance of typical Beaufort Group fossil material.

Should loose fossils be encountered during excavations, they should be carefully collected, with adherent matrix where necessary, given a provisional reference number (*e.g.* marked on masking tape) and carefully wrapped in newspaper. It is *essential* that the locality where the fossil is found be accurately marked on a 1: 50 000 map or recorded by GPS; specimens without locality information are of limited scientific value. Fossils should be checked over by a professional palaeontologist at a later date. Some of this material may be of scientific interest - in which case it should be deposited ultimately in an approved repository (*e.g.* Iziko: South African Museum, Cape Town) – while other specimens may be of educational value and might be donated for display at the Colesberg Museum.

If well-articulated skeletons are encountered during construction, they should *not* be informally excavated since this will almost invariably lead to damage and loss of useful contextual information (*e.g.* taphonomy – data on mode of death and burial of animals). If feasible, the skeleton should be photographed (with scale), covered with a protective layer of loose gravel, and the site marked and carefully recorded (GPS / 1: 50 000 map / aerial photograph). The Environmental Control Officer should inform Heritage Western Cape so that the specimen can be examined and, if necessary, properly excavated by a palaeontologist.

6. ACKNOWLEDGEMENTS

Louise Costandius of CCA Environmental, Cape Town is thanked for commissioning this study and for providing necessary contextual information, including maps and locality details. Landowners in the Colesberg area kindly allowed access to their land. David Lardner of The Barracks guesthouse, Colesberg generously took time to introduce me to the Colesberg Museum collections and also showed me the fossil log on display at the guesthouse. The curator of the Colesberg Museum is thanked for allowing me to photograph fossil specimens under her care.

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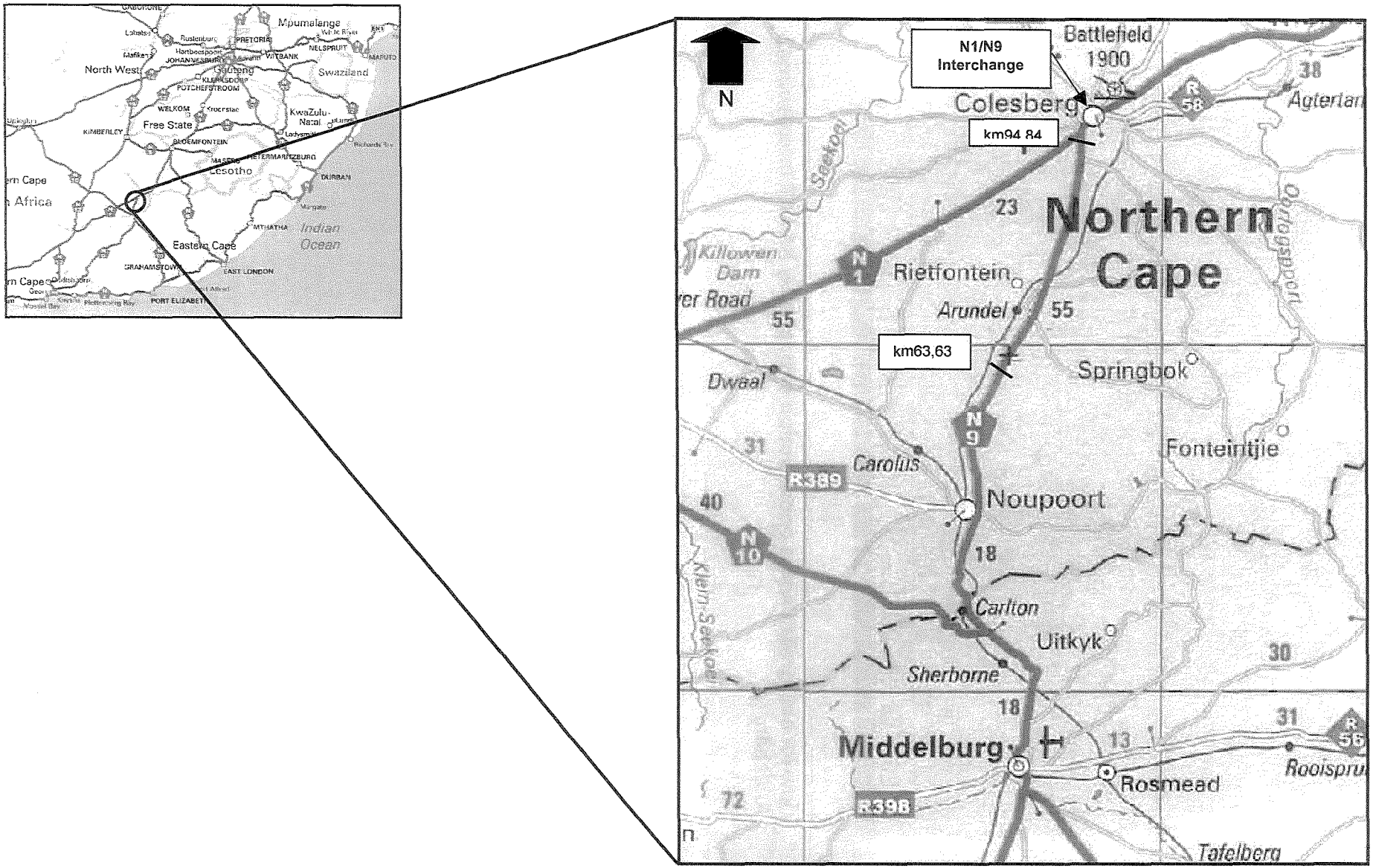

Figure 1. Proposed rehabilitation of National Route 9 Section 7 from Wolwefontein (km63.63) to Colesberg (km94.84).

Figure 2. View looking west across construction site for new N1 / N9 intersection, Colesberg

Figure 3. General view towards east of Borrow Pit 5 excavated into weathered dolerite

Figure 4. **Roadcut along N9 adjacent to Borrow Pit No 5 showing typical dolerite weathering (*eg* rounded corestones)**

Figure 5. **Borrow Pit No. 6 excavated into deeply weathered dolerite**

Figure 6. Classic onionskin weathering in dolerite, Borrow Pit 6

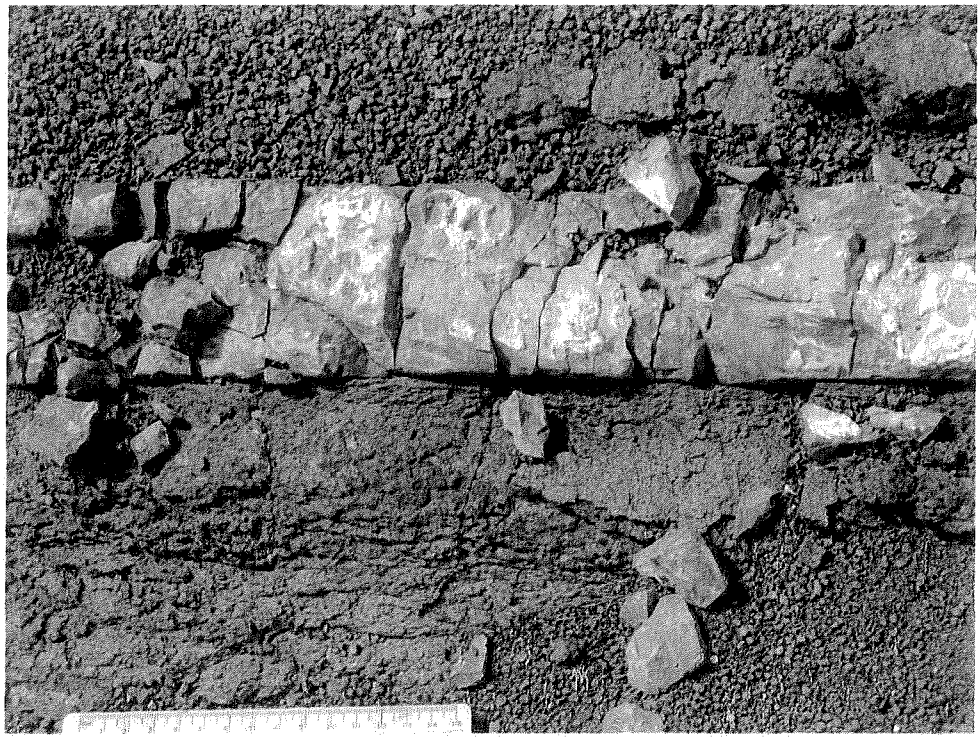

Figure 7. Narrow dyke of fine-grained ?felsite intruding dolerite in Borrow Pit 6

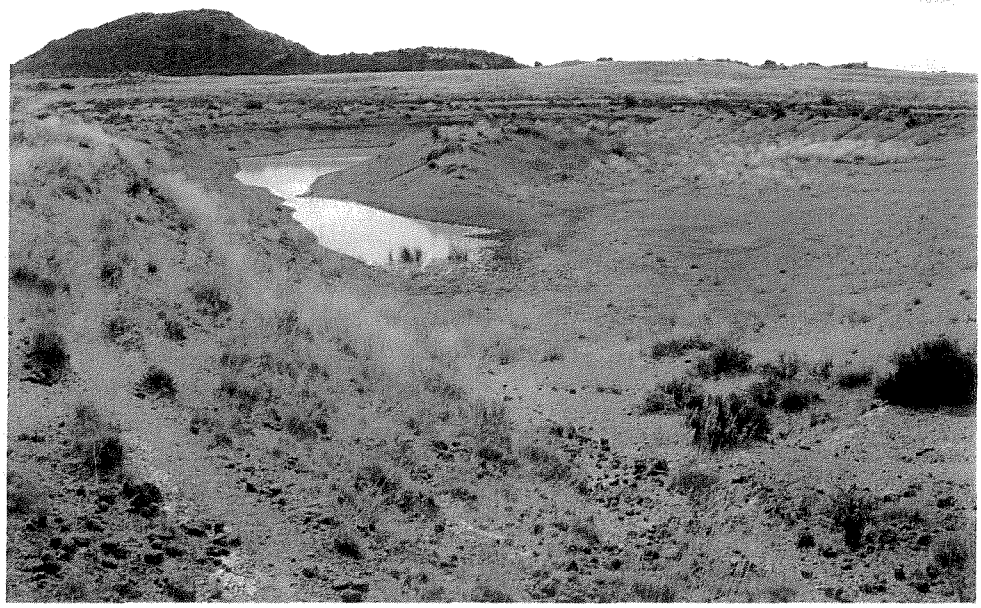

Figure 8. Borrow Pit 7, excavated into Beaufort Group sediments, looking souhwest

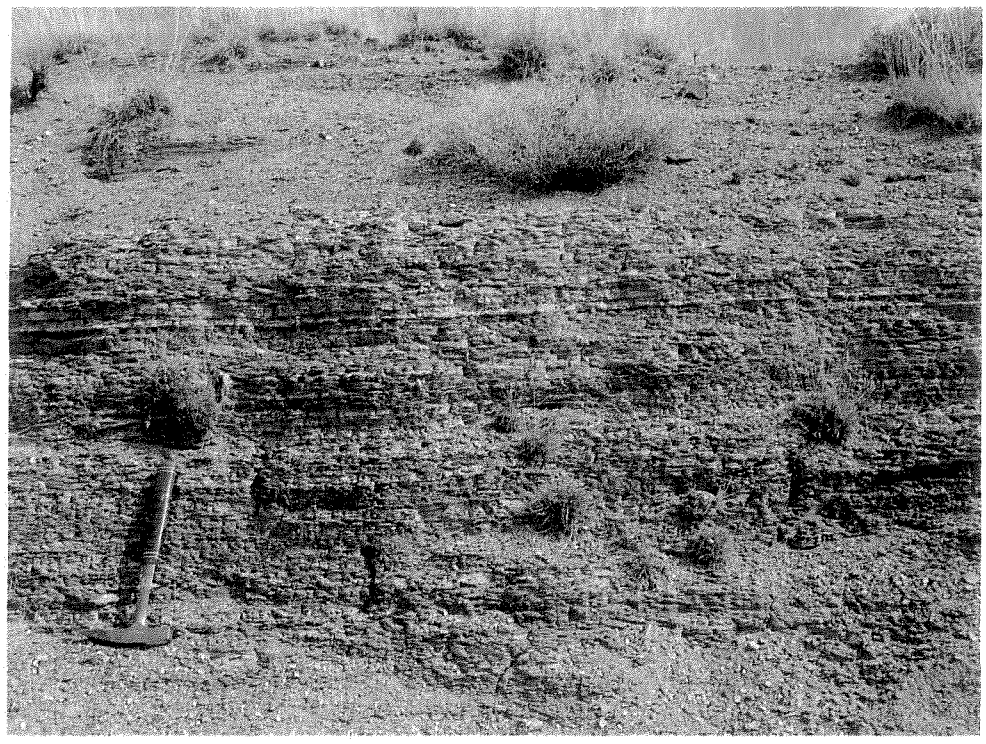

Figure 9. Thin-bedded to laminated sediments of Beaufort Group, Borrow Pit 7 – probably distal floodplain facies

Figure 10. General view of Borrow Pit 8, excavated into dolerite, looking northwest

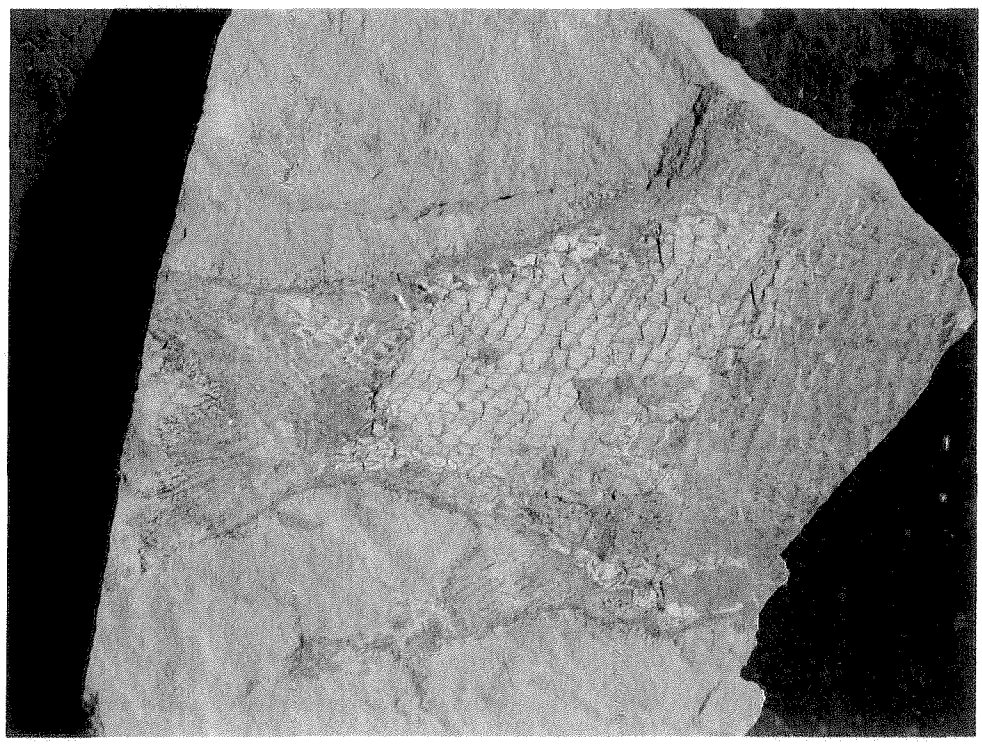

Figure 11. Palaeoniscoid fish from Beaufort Group at Suffolk Hill, Colesberg (Colesberg Museum, X 0.9)

Figure 12. Palaeoniscoid fish from Beaufort Group at Suffolk Hill, Colesberg (Colesberg Museum, X1)

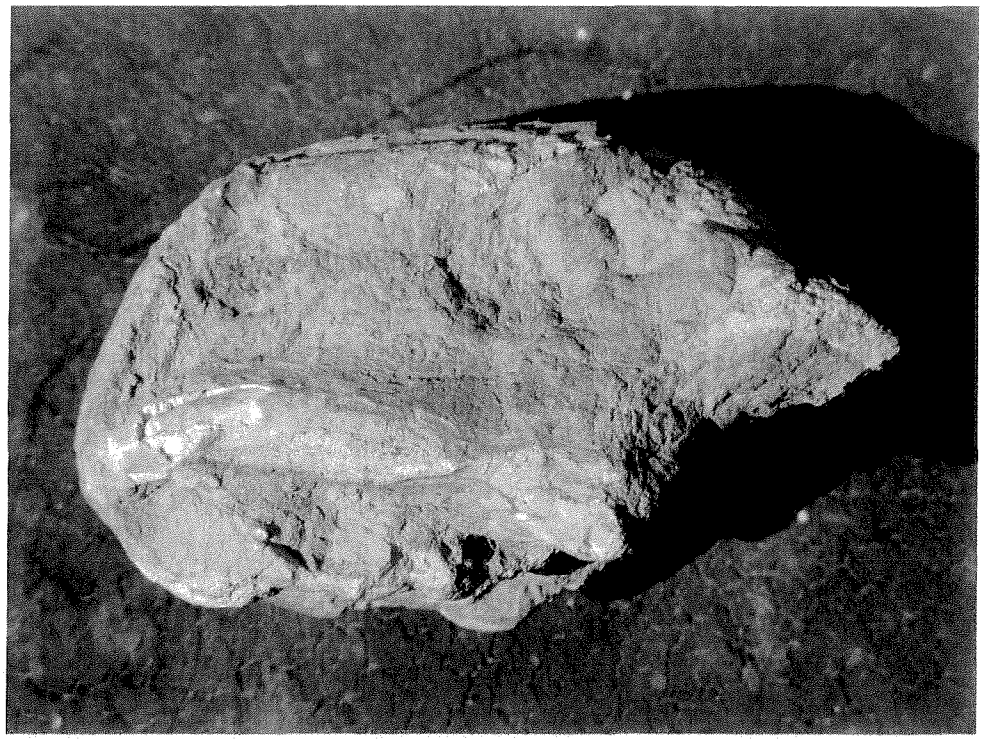

Figure 13. Dicynodont skull from Beaufort Group, Colesberg area (Colesberg Museum), showing large canine tusk (X1.2)

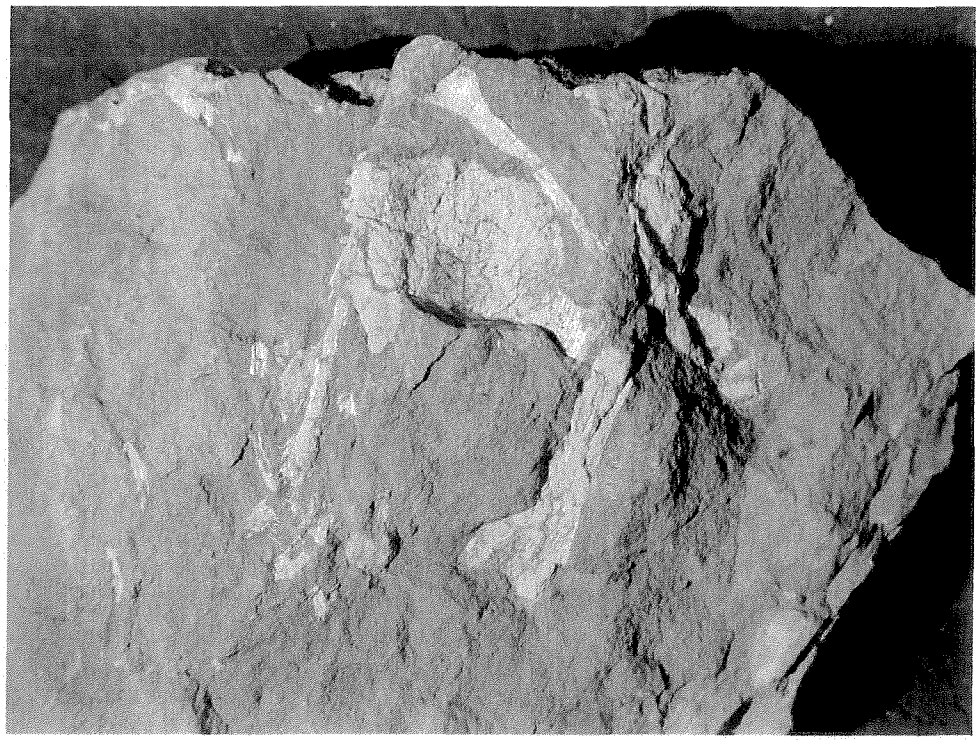

Figure 14. Postcranial remains of a small therapsid, Beaufort Group near Colesberg (Colesberg Museum, X1.2)

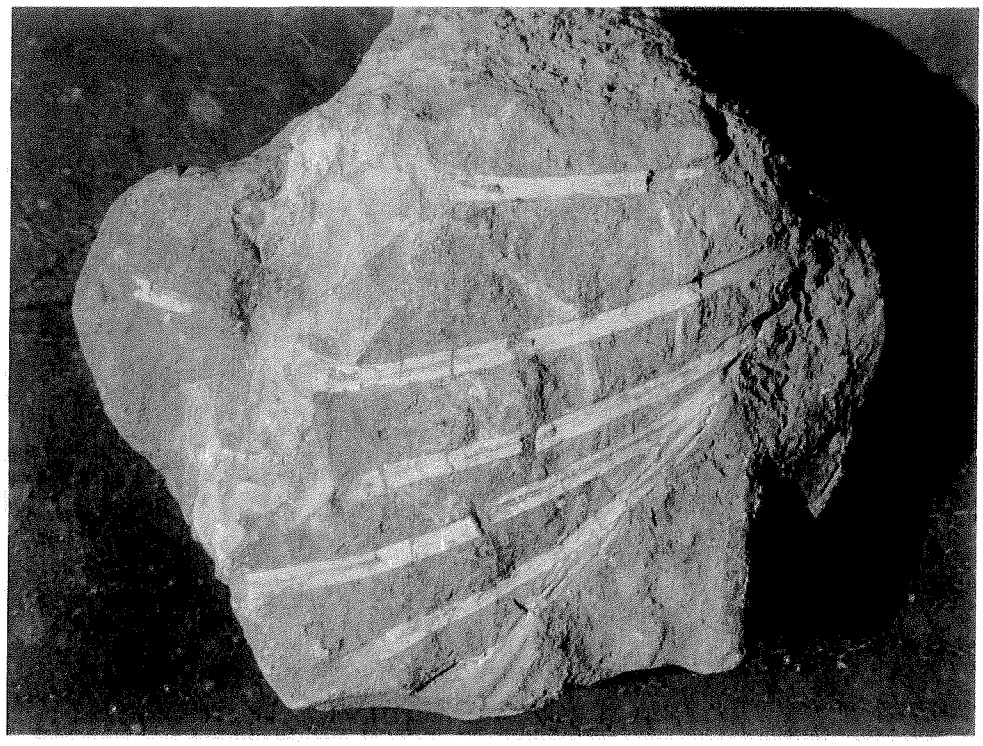

Figure 15. Backbone and ribcage of small therapsid from the Beaufort Group near Colesberg (Colesberg Museum, X0.75)

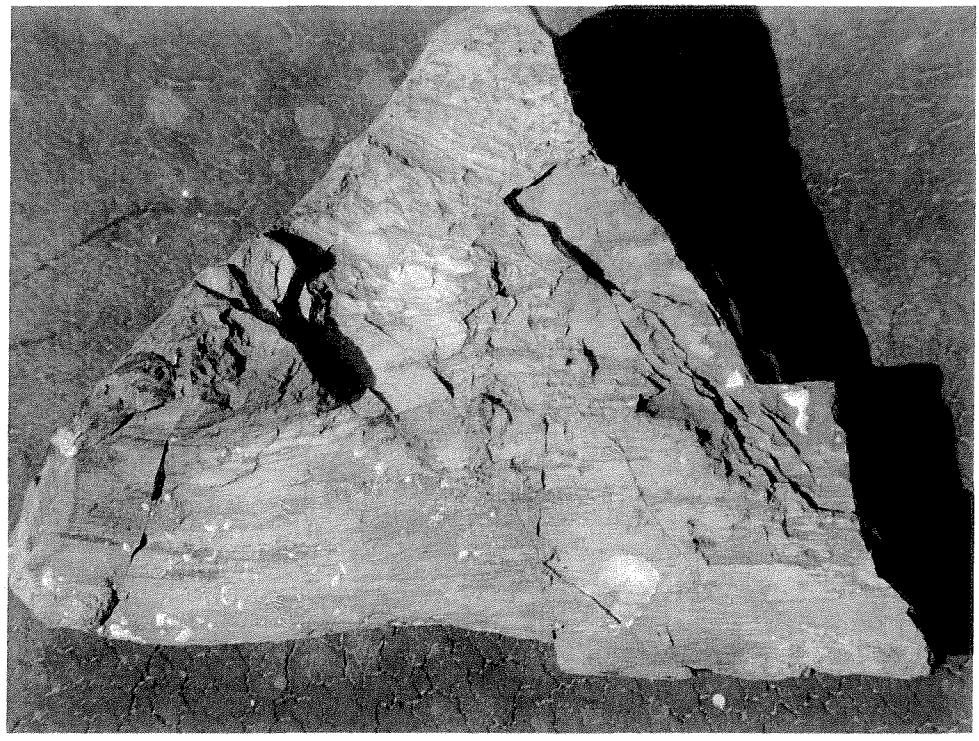

Figure 16. Silicified wood from the Beaufort Group near Colesberg (Colesberg Museum, X0.9)

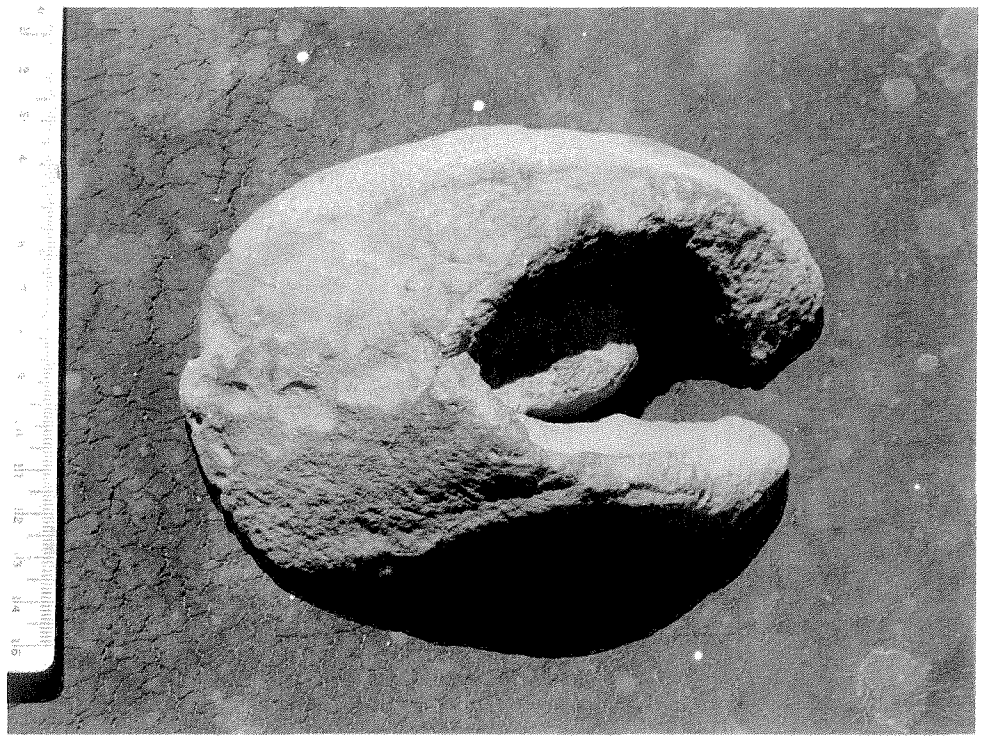

Figure 17. Horse's hoof-like pseudofossil formed by a ferruginous concretion, Beaufort Group in the Colesberg area (Colesberg Museum)