SOIL SCAN AND PROTECTED SPECIES SURVEY OF THE PROPOSED BORROW PIT SITES FOR THE WATERBERG JOINT VENTURE, LIMPOPO, SOUTH AFRICA.

Commissioned by

Bateleur Environmental

Compiled by

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&
EkoInfo$_{CC}$ & Associates

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Quality Control	Reviewer
Draft V01	LD van Essen & W. de Frey

1. EXECUTIVE SUMMARY

Bateleur Environmental appointed Nyengere Wildlife & Environmental Solutions to conduct an assessment of the proposed WJV burrow pit sites. The assessment focus is the verification of the presence or absence of wetland soils and national protected trees as well as protected faunal species within five proposed burrow pit areas associated the Waterberg Project of Platinum Group Metals Ltd.

The SRTM 1arc DEM was used to generate a wetness index on which three plots were placed within each burrow pit area to verify the presence or absence of soils associated with wetland conditions. The same plots were used to observe and count national protected trees. Due to the low density of protected trees in general, a pilotless method was used to determine the density of the national protected trees observed. A walk through biodiversity survey to determine the presence of fauna through tracks, signs, scat etc. was conducted.

No wetland soils were encountered within the burrow pits, in spite of the wetness index model indicating the potential for wetland to develop. This is mainly due to the fact that the study area is located in a semi-arid area with a mean annual rainfall of between 400 mm to 600 mm. The soils is overall coarse textured favouring infiltration rather than runoff, therefore limiting the potential for water to accumulate in the low lying areas (depressions) in the landscape. Most of the signs of wetness are associated with 4th order watercourses.

The following national protected species had been recorded: *Balanites maughamii, Boscia albitrunca, Combretum imberbe, Elaeodendron transvaalense, Sclerocarya birrea* and *Vachellia erioloba*. Only *Elaeodendron transvaalense* is near threatened, the rest of the species are all least concern in terms of the national Red Data list for plants *Vachellia erioloba* and *Boscia albitrunca* was the most abundant.
Based on the densities calculated up to 955 *Vachellia erioloba* and 33 *Boscia albitrunca* individuals will be destroyed once the burrow pits are developed. In the order of 20 individuals of the other national protected trees will be lost.

Faunal species presence was limited to porcupine *Hystrix africaeaustralis*, black-backed jackal *Canis mesomelas*, yellow mongoose *Cynictis penicillata*, scrub hare *Lepus axatalis* and Smith's bush squirrel *Paraxerus cepapi*.

It is recommended that:
1. The topsoil is effectively management to ensure the return of the species once the areas had been rehabilitated. If the topsoil is managed well, limited expenditure will be required to stabilise and rehabilitate the burrow pit areas, and they will be able to return to grazing within a few years.
2. Fencing off the rehabilitated areas using natural fences consisting of encroacher thorny species is critical to ensure the successful rehabilitation of the areas and to ensure the return of the national protected tree species.
3. Seed of the near-threatened *Elaeodendron transvaalense* is collected and propagated to assist with the re-introduction of this species into the rehabilitated areas and the landscape in general. The population of this species is under pressure and could benefit from a population boost.
4. It is recommended that a vegetation scientist/ ecologist and a plant reproductive biologist assist with these aspects.
Based on the observation during the surveys, that the majority of juvenile *Vachellia erioloba* individuals were recorded in a fenced off area, a network of steppingstone areas is suggested throughout the landscape in the persistent primary natural areas to assist with the germination and recruitment of the national protected trees in the area.

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4. INTRODUCTION

NYENGERE SOLUTIONS (NS) was commissioned to undertake a specialist assessment within five proposed burrow pit areas that will form part of the proposed Waterberg Joint Venture (WJV) Platinum mine project in the Limpopo province of South Africa (Figure 1 & 2).

NS assisted by EkoInfo CC conducted the assessment to verify the absence or presence of:

- Wetland soils
- National Protected Trees
- Endangered Faunal Species

5. SCOPE OF WORK/ TERMS OF REFERENCE

The scope of work required that within the five proposed burrow pits:

- The presence or absence of wetland soils be assessed;
- The presence and absence of national protected trees be confirmed, and their density calculated;
- The presence and absence of endangered faunal species be recorded through tracks, signs, scat and vocalizations.

6. STUDY AREA

The five burrow pits are located across two regional vegetation units and two regional soil types. Both the regional vegetation units are least concern in terms of their conservation status, the two units are:

a. Makhado Sweet Bushveld;
b. Roodeberg Bushveld (Mucina & Rutherford 2006)

The two regional soil types are land type unit Ae335 and Fc731. Soils from the Ae soil pattern are associated with soil conditions where red and yellow soils without water tables are dominant.
The Ae soil pattern specifically refers to red soils with a high base status, which is more than 300 mm deep, with no dunes (Land Type Survey Staff 1985).
The Fc soil pattern belongs to a group of Pedological young soils, where the development of A-horizons had occurred, as well as clay illuviation, resulting in Lithocutanic horizons. Glenrosa and Mispah soils are typical present. Fc associated soils refer to landscapes where lime occurs regularly, in both upland and bottom valley soils, not necessarily in high quantities.

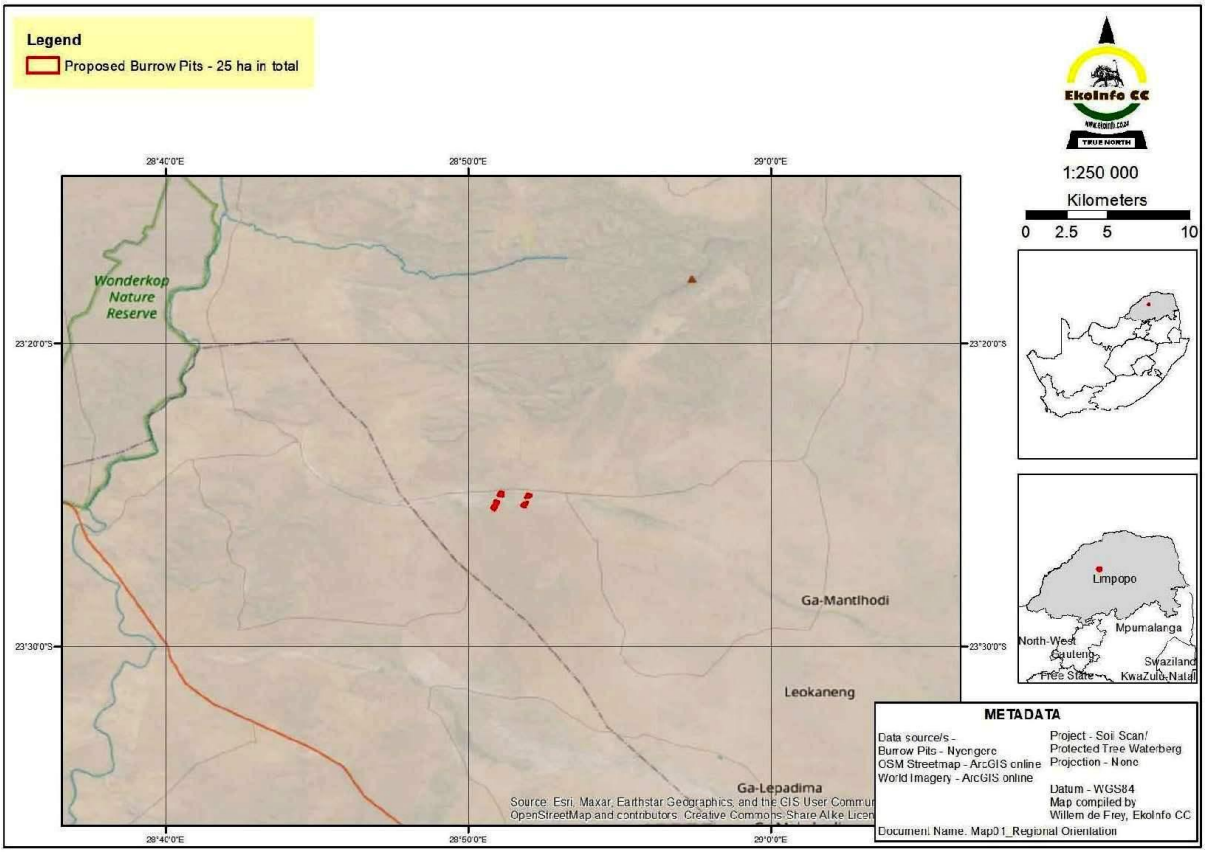

Figure 1: Regional orientation of the five proposed burrow pits in the Limpopo province, South Africa

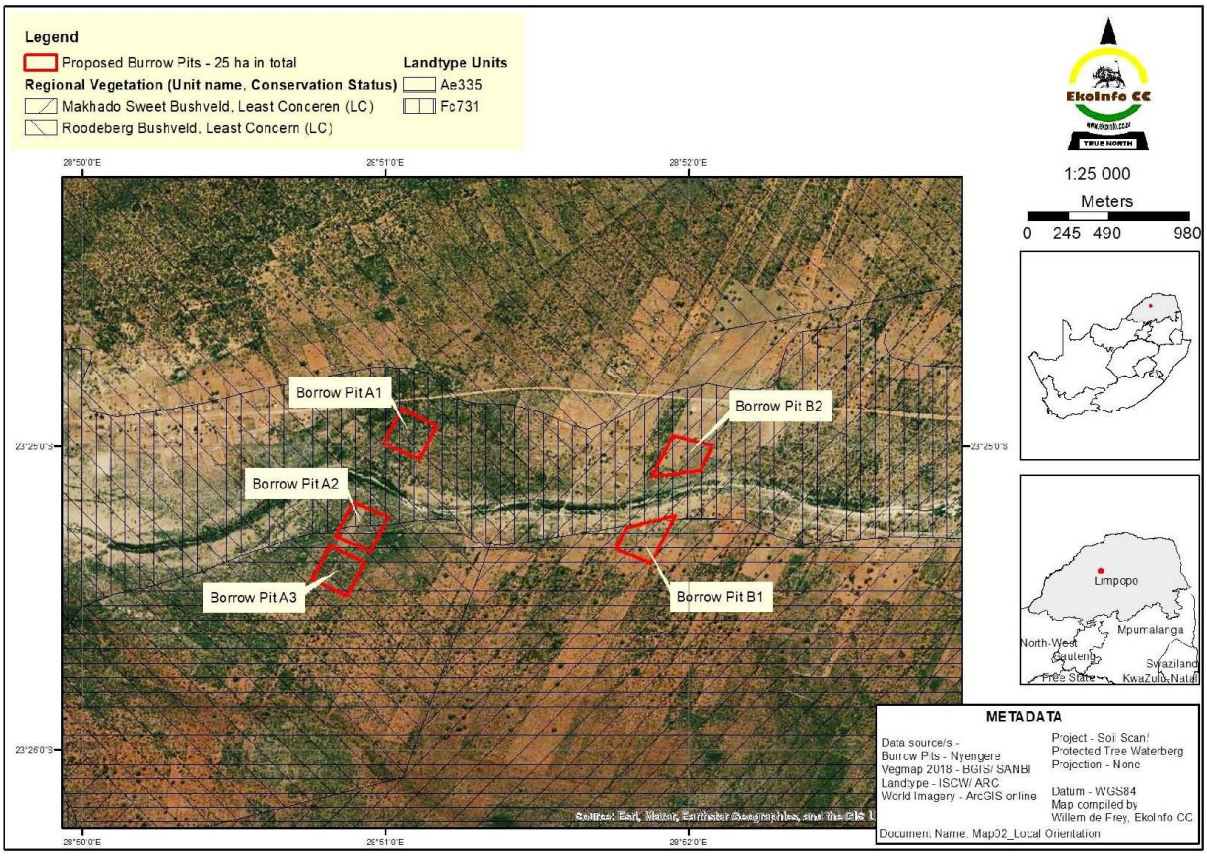

Figure 2: Local orientation of the study area within the regional soil and vegetation units.

7. METHOD STATEMENT

7.1. Wetland Soils

The potential for wetlands were modeled based on the available SRTM Digital Elevation Model (DEM)[1] 1 Arc (30 m x 30 m pixel resolution). The DEM was used as input for the SAGA GIS Topographic Wetness Index Model[2] (Figure 3).

Plots were placed within the wetland categories present within the proposed burrow pit areas. At the plot location, the soil was augured and classified according to the South African soil classification system (Soil Classification Workgroup 1991). The soils observed where then compared against the national wetland guideline document (DWAF 2005). According to the guideline document, the following soils qualify as wetland soils:

1. Permanent wet areas – Champagne, Katspruit, Willowbrook or Rensburg soil forms
2. Seasonal and temporary wet areas:–
    a. Form level: Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu
    b. Family level: Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee

7.1.1. Limitations And Assumptions

- The soil assessment was not a detailed assessment, but only aimed to assess the presence or absence of wetland soils based on the wetness index results. A detailed soil assessment (100 m x 100 m grid) was beyond the scope of this document;
- The model only shows the potential for water to accumulate within certain areas of the landscape, and does not account for annual rainfall or soil conditions, that is why it needs to be verified;
- Only three plots were surveyed within the burrow pits.

7.2. National Protected Trees

The sample plots for the wetland verification were used to assess the presence of national protected trees on terms of the National Forest Act 1998 (Act No. 84 of 1998) (Appendix A). The area in the vicinity of the plot was scanned for the presence of any of the species on the list, if a species were observed a plot less method[3] was used to document the species presence on a relational database namely MS Access. The density was calculated according to formula provided for:

1. Point Centered Quarter
2. Closest Individual

For the point centered quarter method, the plot was orientated North, with quadrants numbered clockwise from 1 to 4. Four geo-referenced images were taken at the plot centre towards the four major wind directions: North, East, South and West.

[1] https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-1
[2] https://saga-gis.sourceforge.io/saga_tool_doc/7.0.0/ta_hydrology_20.html
[3] https://www.webpages.uidaho.edu/veg_measure/Modules/Lessons/Module%205(Density)/5_3_Plotless_Techniques.htm

7.2.1.Limitations and Assumptions

- Severe bush encroachment hampered movement; therefore distance measurements are not absolute. Therefore, more than one calculation method was applied to provide a range of values;
- Tree densities calculated is not absolute but represent estimates, the more the sample the more representative the results will be.

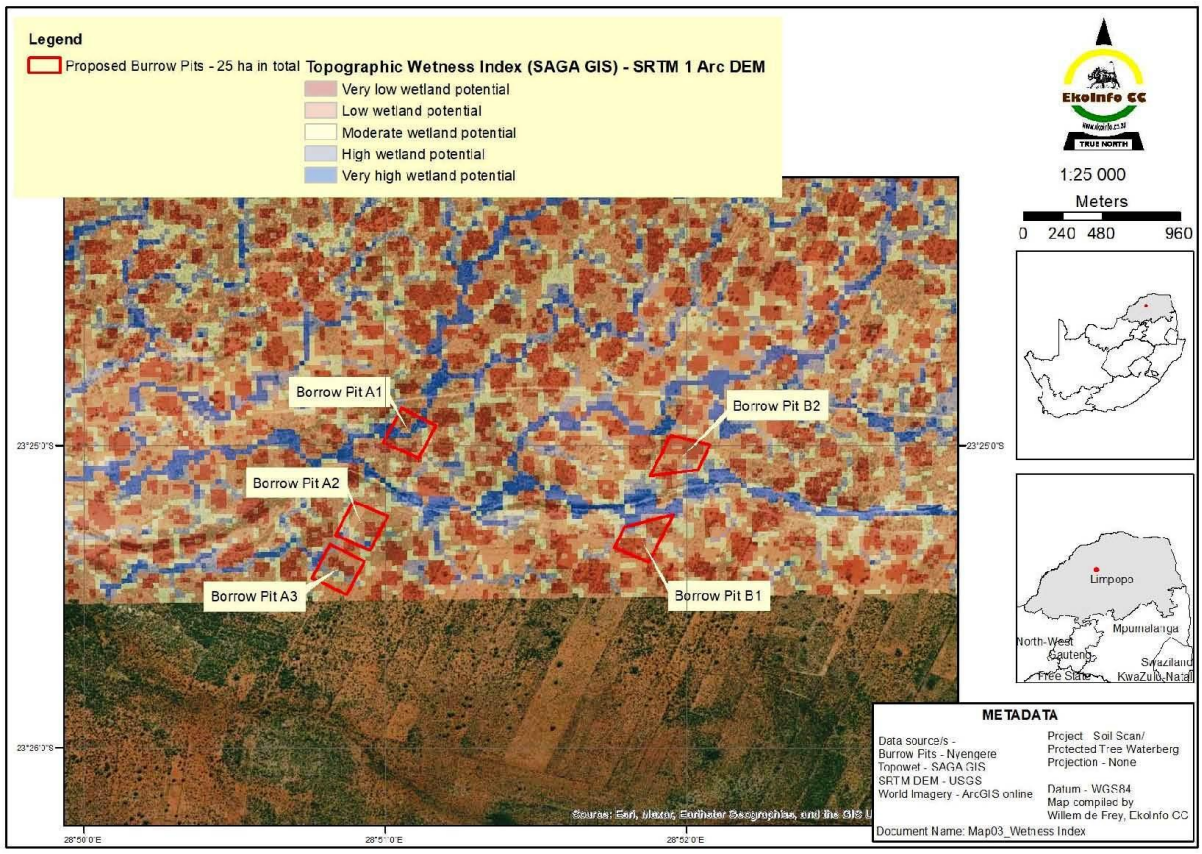

Figure 3: Topographic wetness index model based on the SRTM DEM 1 Arc.

8. RESULTS

Fifteen (15) sites were surveyed over a two-day period on the 19th and 20th of September 2022 across the five proposed burrow pit areas.

8.1. Burrow Pit A1

8.1.1. Wetland Soils

Based on the wetness index, plot 2 within this site had a very high probability to be wetland (Figure 4), however the soil profile was classified as Askam, which is not one of the soil forms associated with wetland conditions (Figure 5). Plot 1 had a very low probability, and plot 3 a moderate probability to represent wetland, neither of the soils recorded at these plots were associated with wetland soils, namely Askam (Plot 1) and Clovelly (Plot 3) (Table 1). The overall soil depth ranged from 500 mm to 1 200 mm, with the mean soil depth being 816 mm (Table 1). Therefore, it is concluded that no wetland conditions are present within this site.

8.1.2. National Protected Trees

Two national protected tree species were recorded within the three plots surveyed, namely *Vachellia erioloba* (previously *Acacia erioloba*) and *Boscia albitrunca* (Table 2). From this table, it is evident the *Vachellia erioloba* was the most abundant. Due to the low density of the trees in general, it was not possible to apply the point-centered quarter method, and only the closest individual method was applied. Based on the closest individual method calculation the total mean number of individuals per ha for *Vachellia erioloba* is 216/ha and for *Boscia albitrunca* is 7/ha (Table 3). Other national protected trees observed in this site are: *Elaeodendron transvaalensis* (one individual) and *Balanites maughamii* (Figure 4). These trees obviously occur at lower densities than the two species recorded within the survey plots of the site.

8.2. Burrow Pit A2

8.2.1. Wetland Soils

Based on the wetness index, both plot 4 and 6 within this site had a very high probability to be wetland (Figure 6), however the soil profiles were classified as Coega, which is not one of the soil forms associated with wetland conditions (Figure 7). Plot 5 had a very low probability to be wetland, and the Coega soil form was also recorded at this plot (Table 1). The overall soil depth ranged from 50 mm to 200 mm, with the mean soil depth being 117 mm (Table 1). Therefore, it is concluded that no wetland conditions are present within this site.

8.2.2. National Protected Trees

Two national protected tree species were recorded within only one of the three plots surveyed (Plot 4) surveyed, namely *Boscia albitrunca* and *Sclerocarya birrea* (Table 4). Due to the low density of the trees in general, it was not possible to apply the point-centered quarter method, and only the closest individual method was applied. Based on the closest individual method calculation the total mean number of individuals per ha for *Boscia albitrunca* is 5/ha and for *Sclerocarya birrea* is 4/ha (Table 5). Other national protected trees observed in this site are: *Vachellia erioloba* (one individual) (Figure 6). These trees obviously occur at lower densities than the two species recorded within the survey plot of the site.

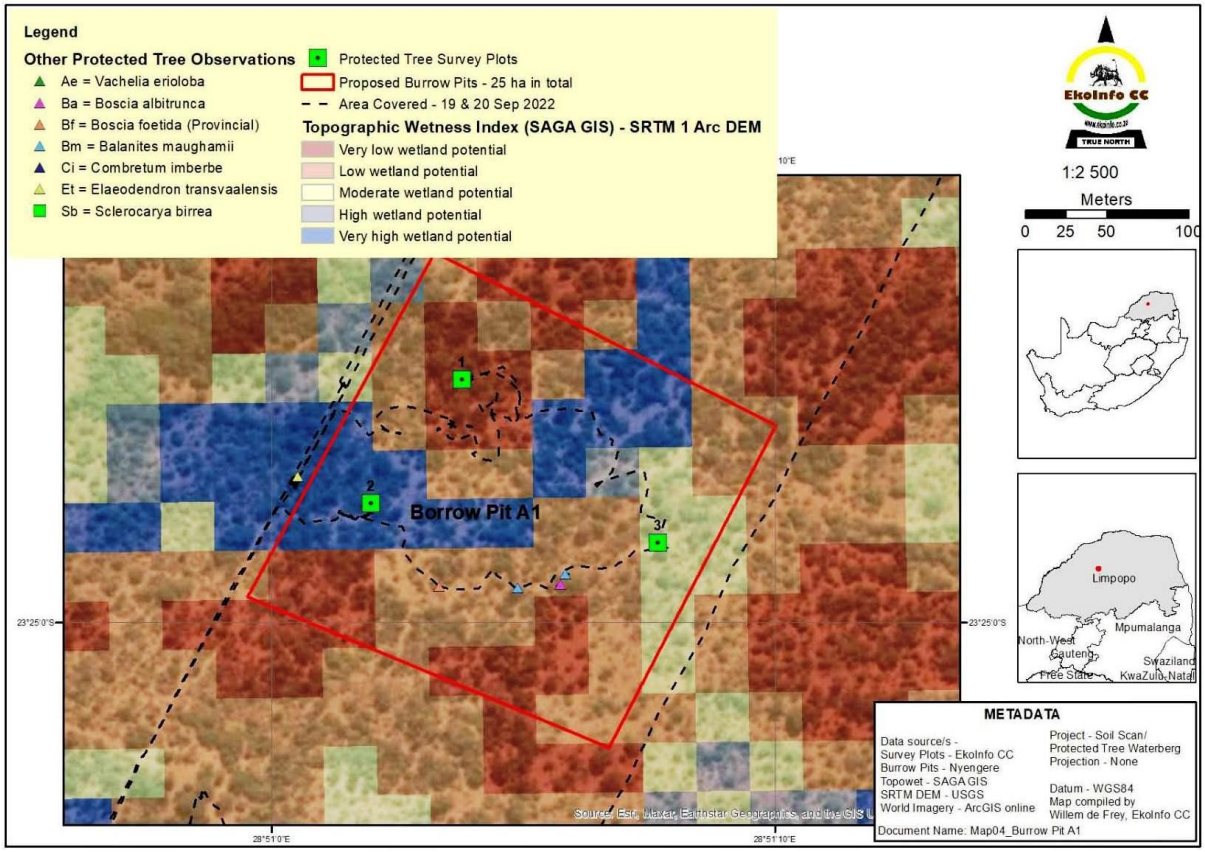

Figure 4: Distribution of survey plots and protected tree observations within the area of burrow pit A1.

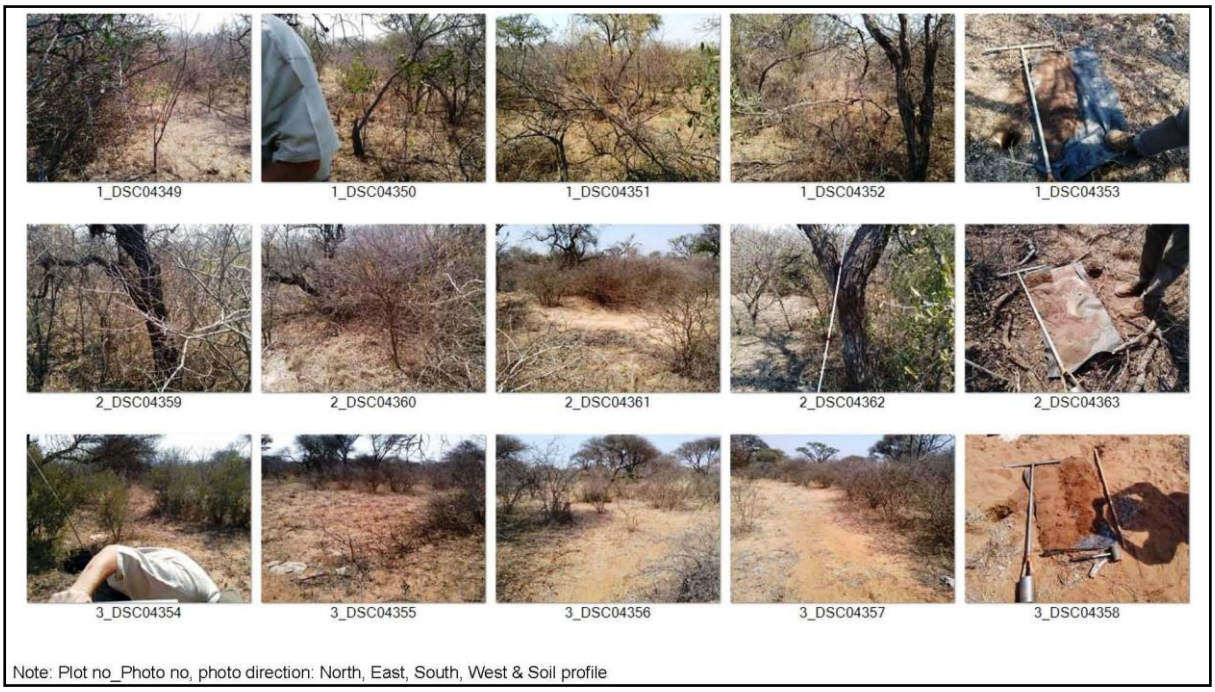

Figure 5: Geo-referenced images of the vegetation and soil profiles for the three plots within the area of burrow pit A1

Table 1: Overview of the soil forms and soil depths recorded on the 15 plots surveyed across the five burrow pit areas.

Plot no	Soil form	Soil depth (mm)
1	Askam	500
2	Askam	750
3	Clovelly	1200
4	Coega	200
5	Coega	50
6	Coega	100
7	Coega	100
8	Coega	200
9	Clovelly	1200
10	Coega	50
11	Coega	200
12	Coega	100
13	Coega	400
14	Coega	100
15	Askam	600

Table 2: Overview of the national protected tree species recorded in the survey plots of burrow pit A1.

Plot no	Time	Quadrant	Species	Height/ Age class	Distance to nearest target plants (m)
1	09:42:52	3	Vachellia erioloba	3 - 6 m	22
1	09:44:12	3	Vachellia erioloba	6 m +	20
3	10:02:33	1	Boscia albitrunca	3 - 6 m	15
3	10:04:16	1	Vachellia erioloba	6 m +	30
3	10:07:05	4	Vachellia erioloba	3 - 6 m	29.5
3	10:07:52	4	Vachellia erioloba	6 m +	30
2	10:29:51	2	Vachellia erioloba	3 - 6 m	12
2	10:30:07	3	Vachellia erioloba	3 - 6 m	19
2	10:30:29	3	Vachellia erioloba	6 m +	30.5
2	10:30:45	4	Vachellia erioloba	3 - 6 m	2
2	10:31:12	4	Vachellia erioloba	6 m +	21.5
2	10:31:24	4	Boscia albitrunca	3 - 6 m	28

Table 3: Mean tree density of protected tree species recorded within burrow pit A1

Plot no	Time	Quadrant No.	Species	Height/ Age class	Distance to nearest (m)	Closest individual – individuals/ha			
						0 - 3m	3 - 6m	>6m	Total mean value
1	09:42:52	3	Vachellia erioloba	3 - 6 m	22		5		
1	09:44:12	3	Vachellia erioloba	6 m +	20			6	
2	10:30:45	4	Vachellia erioloba	3 - 6 m	2		625		
2	10:29:51	2	Vachellia erioloba	3 - 6 m	12				
2	10:30:07	3	Vachellia erioloba	3 - 6 m	19				
2	10:31:12	4	Vachellia erioloba	6 m +	21.5			5	
2	10:30:29	3	Vachellia erioloba	6 m +	30.5				
3	10:07:05	4	Vachellia erioloba	3 - 6 m	29.5		3		
3	10:04:16	1	Vachellia erioloba	6 m +	30			3	
3	10:07:52	4	Vachellia erioloba	6 m +	30				
					Mean value		**211**	**5**	**216**
2	10:31:24	4	Boscia albitrunca	3 - 6 m	28		3		
3	10:02:33	1	Boscia albitrunca	3 - 6 m	15		11		
					Mean value		**7**		**7**

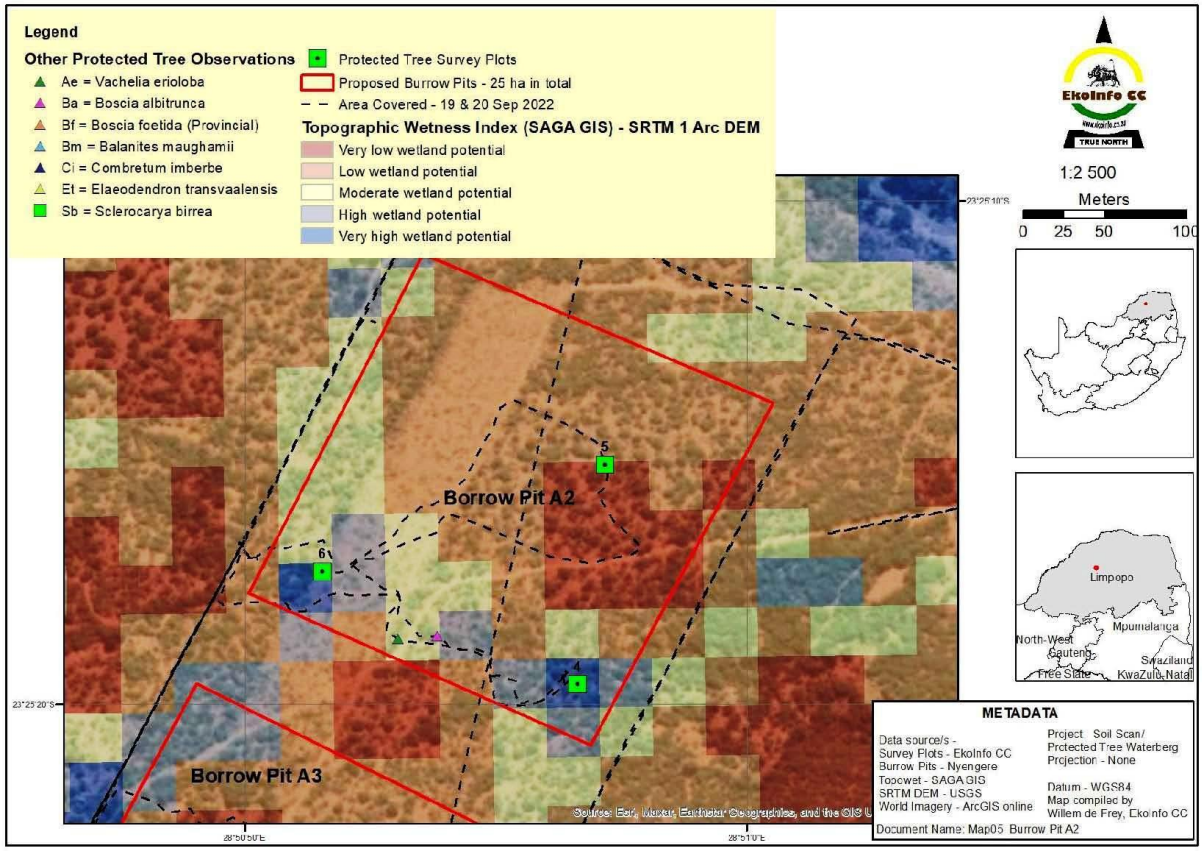

Figure 6: Distribution of survey plots and protected tree species observations within the burrow pit A2 area.

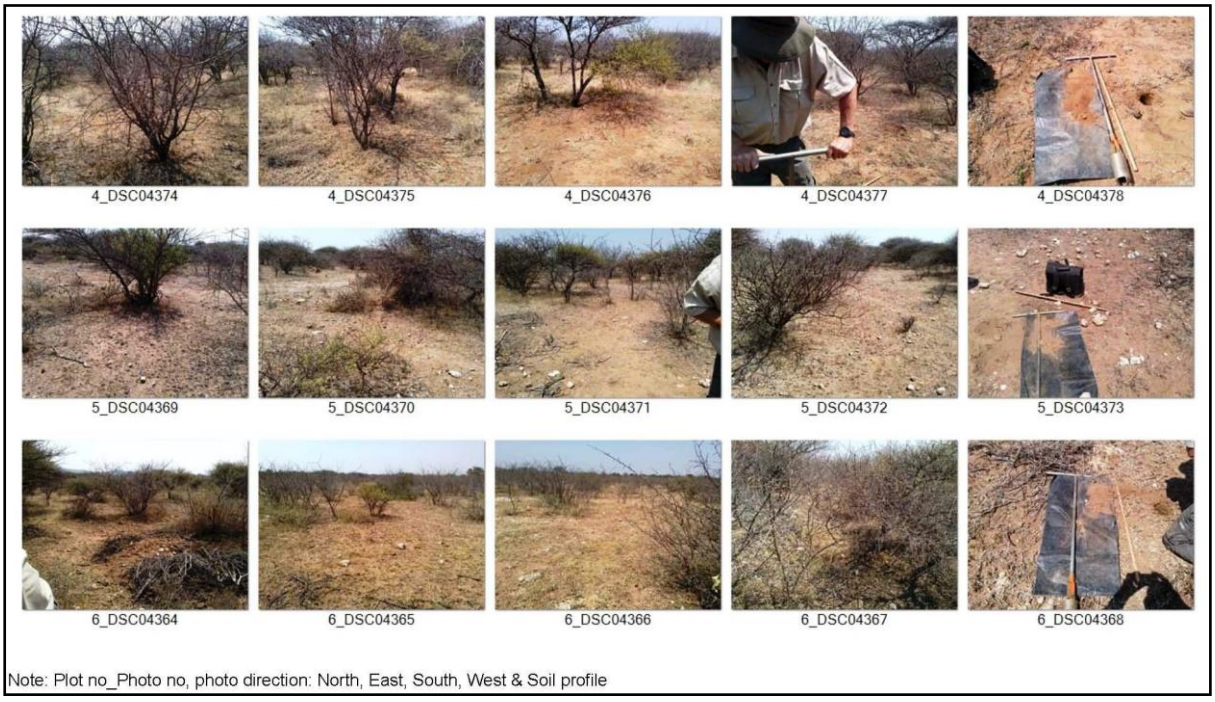

Figure 7: Geo-referenced images of the vegetation and soil profile for the three plots within the burrow pit A2 area.

Table 4: Overview of the national protected tree species recorded in burrow pit A2 survey plots.

Plot no	Time	Quadrant	Species	Height/Age class	Distance to nearest
4	11:38:56	1	Boscia albitrunca	3 - 6 m	22
4	11:42:45	4	Sclerocarya birrea	3 - 6 m	25

Table 5: Mean tree density of protected tree species recorded within the area of burrow pit A2.

Plot no	Time	Quadrant no.	Species	Height/ Age class	Distance to nearest plant (m)	Closest individual - individuals/ha			
						0 - 3m	3 - 6m	>6m	Total mean value
4	11:38:56	1	Boscia albitrunca	3 - 6 m	22		5		5
4	11:42:45	4	Sclerocarya birrea	3 - 6 m	25		4		4

8.3. Burrow Pit A3

8.3.1. Wetland Soils

Based on the wetness index, plot 8 within this site had a very high probability to be wetland (Figure 8), however the soil profile was classified as Coega, which is not one of the soil forms associated with wetland conditions (Figure 9). Plot 7 had a very low probability, and plot 9 a low probability to represent wetland, neither of the soils recorded at these plots were associated with wetland soils, namely Coega (Plot 7) and Clovelly (Plot 9) (Table 1). The overall soil depth ranged from 100 mm to 1 200 mm, with the mean soil depth being 500 mm (Table 1). Therefore, it is concluded that no wetland conditions are present within this site.

8.3.2. National Protected Trees

Two national protected tree species were recorded within the three plots surveyed, namely *Vachellia erioloba* (previously *Acacia erioloba*) and *Boscia albitrunca* (Table 6, Table 2). From this table, it is evident the *Vachellia erioloba* was the most abundant. Due to the low density of the trees in general, it was not possible to apply the point-centered quarter method, and only the closest individual method was applied. Based on the closest individual method calculation the total mean number of individuals per ha for *Vachellia erioloba* is 75/ha and for *Boscia albitrunca* is 8/ha (Table 7). No other national protected trees were observed in this site (Figure 6).

8.4. Burrow Pit B1

8.4.1. Wetland Soils

Based on the wetness index, plot 10 within this site had a high probability to be wetland (Figure 10), however the soil profile was classified as Coega, which is not one of the soil forms associated with wetland conditions (Figure 11). The other two plots, plot 11 and 12, were both located with very low wetland probability areas, and were also classified as Coega soils (Table 1). The overall soil depth

ranged from 50 mm to 200 mm, with the mean soil depth being 117 mm (Table 1). Therefore, it is concluded that no wetland conditions are present within this site.

8.4.2.National Protected Trees

No national protected trees were recorded in the three survey plots, however the provincial protected tree *Boscia foetida* was observed within the site (Figure 7), as well as a very large specimen of the national protected tree *Vachellia erioloba* (Figure 12). This is the only *Vachellia erioloba* of more than 6 m height within the 5 ha site, which translates to 0.2 individuals per ha.

8.5. Burrow Pit B2

8.5.1.Wetland Soils

Based on the wetness index, plot 14 within this site had a high probability to be wetland (Figure 13), however the soil profile was classified as Coega, which is not one of the soil forms associated with wetland conditions (Figure 14). Plot 13 was in a low wetland probability area, and Plot 15 in a very low probability area, the soil form at Plot 13 was also Coega, but Plot 15 was Askam (Table 1). The overall soil depth ranged from 100 mm to 600 mm, with the mean soil depth being 367 mm (Table 1). Therefore, it is concluded that no wetland conditions are present within this site.

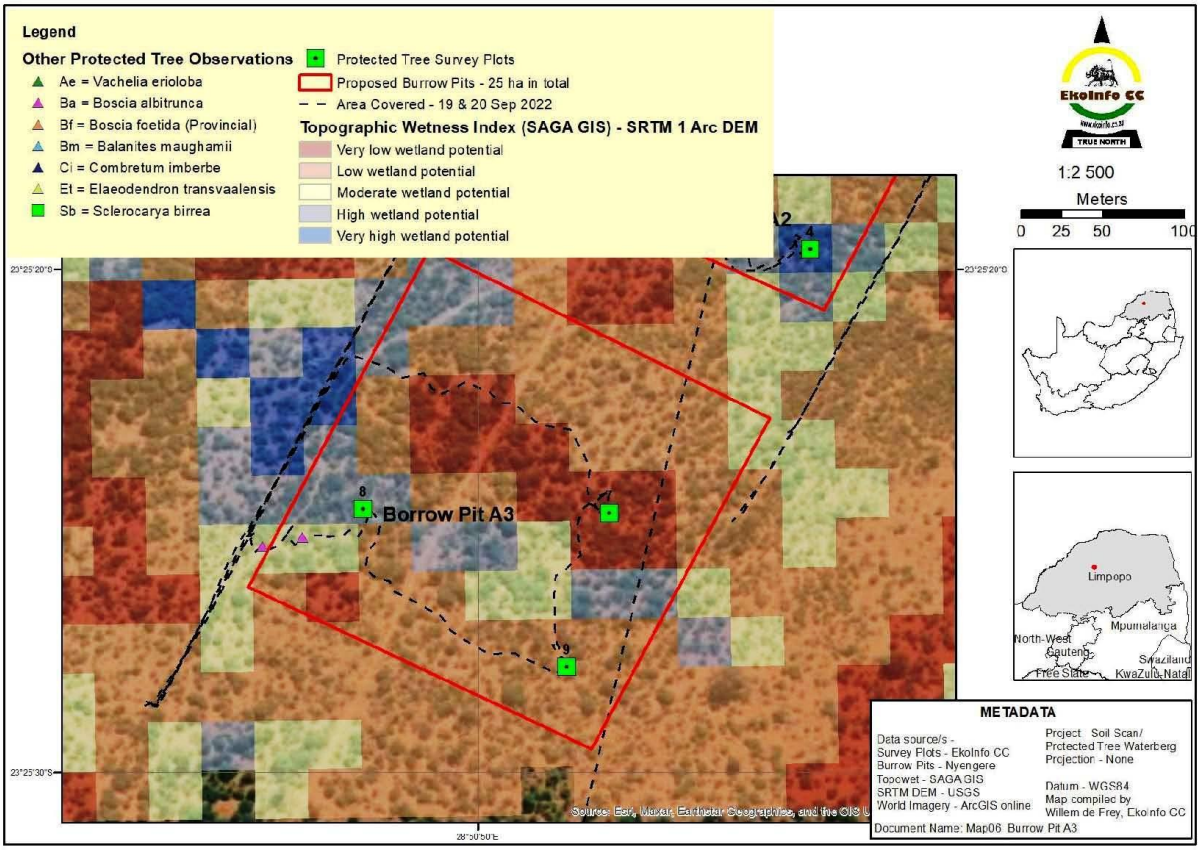

Figure 8: Distribution of survey plots and protected tree species observations within the area of burrow pit A3.

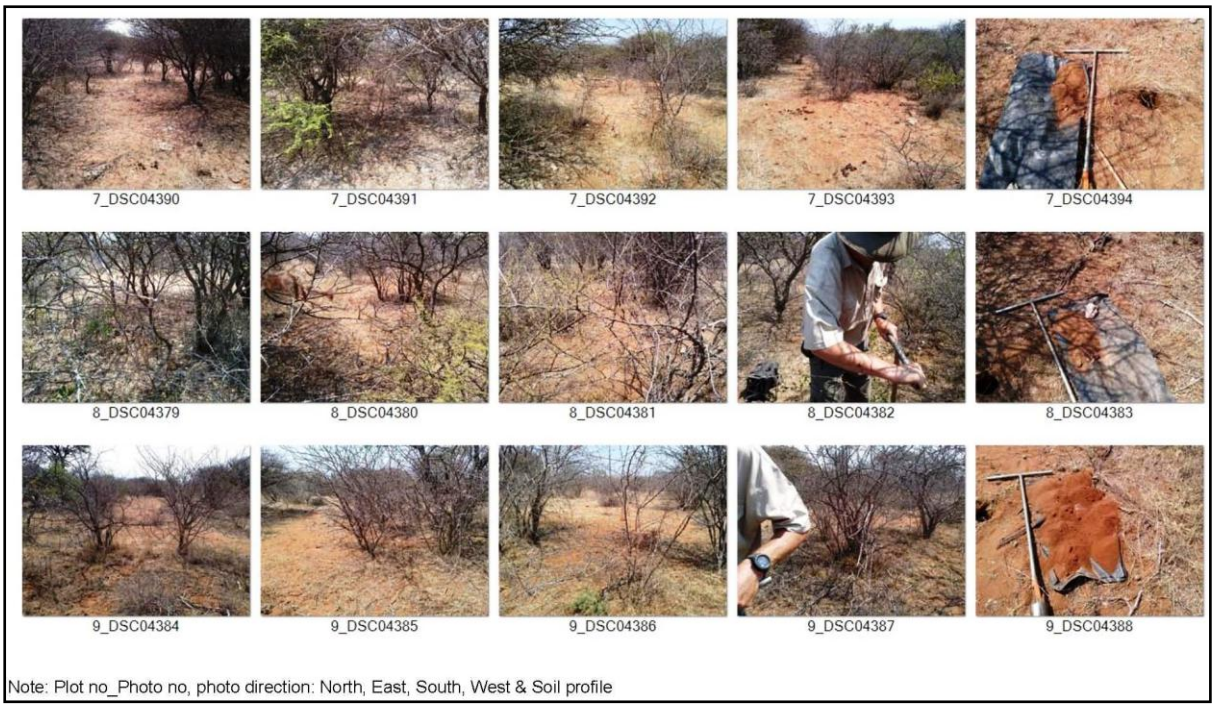

Figure 9: Geo-referenced images of the vegetation and soil profiles for the three plots within the burrow pit A3 area.

Table 6: Overview of the national protected tree species recorded in the burrow pit A3 survey plots.

Plot no	Time	Quadrant no.	Species	Height/ Age class	Distance to nearest target plants (m)
7	12:41:01	3	Vachellia erioloba	3 - 6 m	16
8	12:14:03	3	Boscia albitrunca	0 - 3 m	26
8	12:13:18	1	Vachellia erioloba	3 - 6 m	18
9	12:29:27	1	Vachellia erioloba	0 - 3 m	19
9	12:29:57	1	Vachellia erioloba	6 m +	24
9	12:30:32	2	Vachellia erioloba	3 - 6 m	23
9	12:30:58	2	Vachellia erioloba	6 m +	30
9	12:31:20	4	Vachellia erioloba	0 - 3 m	7
9	12:31:37	4	Vachellia erioloba	6 m +	22
9	12:32:13	4	Boscia albitrunca	3 - 6 m	25
9	12:28:59	1	Vachellia erioloba	3 - 6 m	8

Table 7: Mean tree density of protected trees species recorded within the burrow pit A3 area.

Plot no	Time	Quadrant no.	Species	Height / Age class	Distance to nearest plant (m)	Closest individual – individuals/ha			
						0 – 3 m	3 – 6 m	>6 m	Total mean value
7	12:41:01	3	Vachellia erioloba	3 - 6 m	16		10		
8	12:13:18	1	Vachellia erioloba	3 - 6 m	18		8		
9	12:31:20	4	Vachellia erioloba	0 - 3 m	7	51			
9	12:29:27	1	Vachellia erioloba	0 - 3 m	19				
9	12:28:59	1	Vachellia erioloba	3 - 6 m	8		39		
9	12:30:32	2	Vachellia erioloba	3 - 6 m	23				
9	12:31:37	4	Vachellia erioloba	6 m +	22			5	
9	12:29:57	1	Vachellia erioloba	6 m +	24				
9	12:30:58	2	Vachellia erioloba	6 m +	30				
					Mean value	**51**	**19**	**5**	**75**
8	12:14:03	3	Boscia albitrunca	0 - 3 m	26	4			
9	12:32:13	4	Boscia albitrunca	3 - 6 m	25		4		
					Mean value	**4**	**4**		**8**

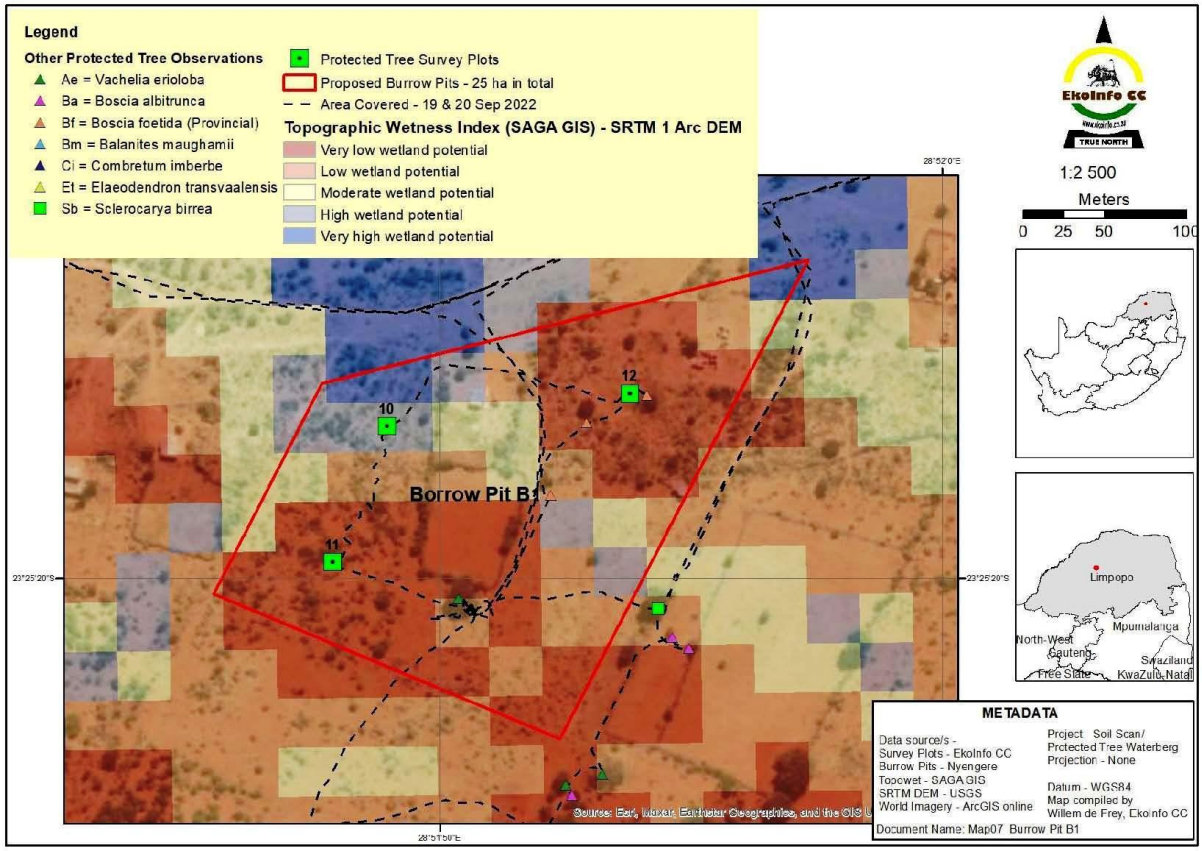

Figure 10: Distribution of survey plots and protected tree species observations within the area of burrow pit B1.

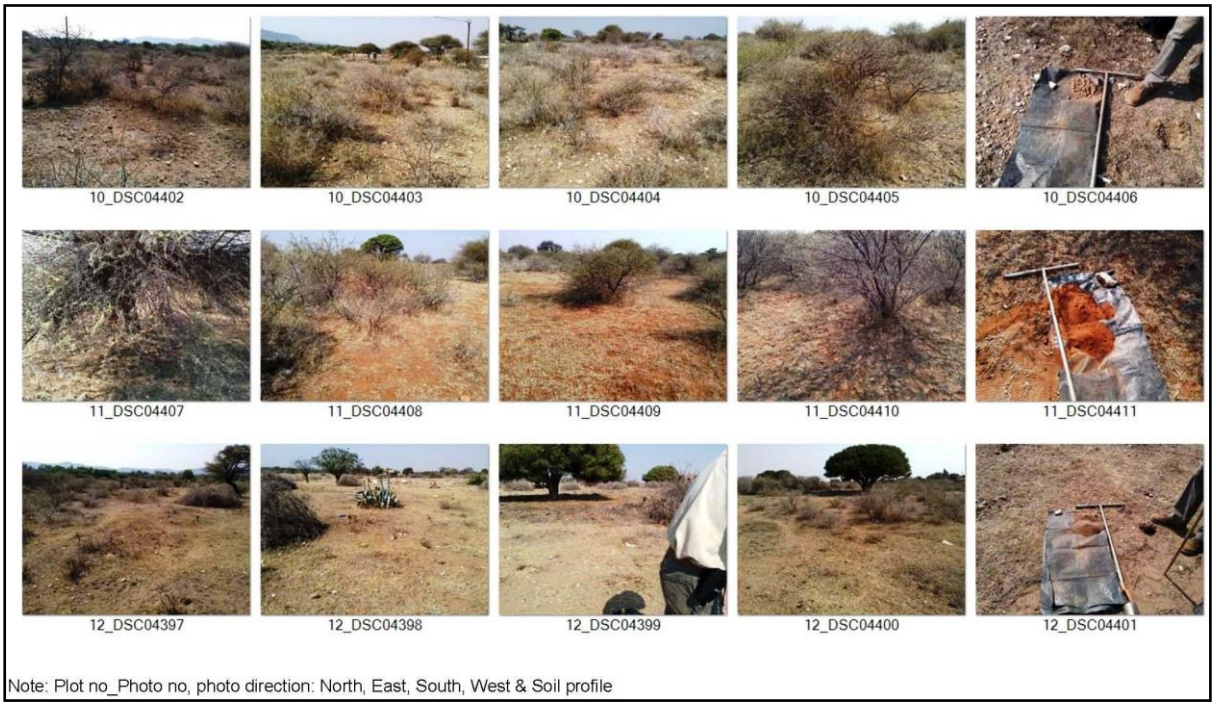

Figure 11: Geo-referenced images of the vegetation and soil profiles of the three plots within burrow pit B1.

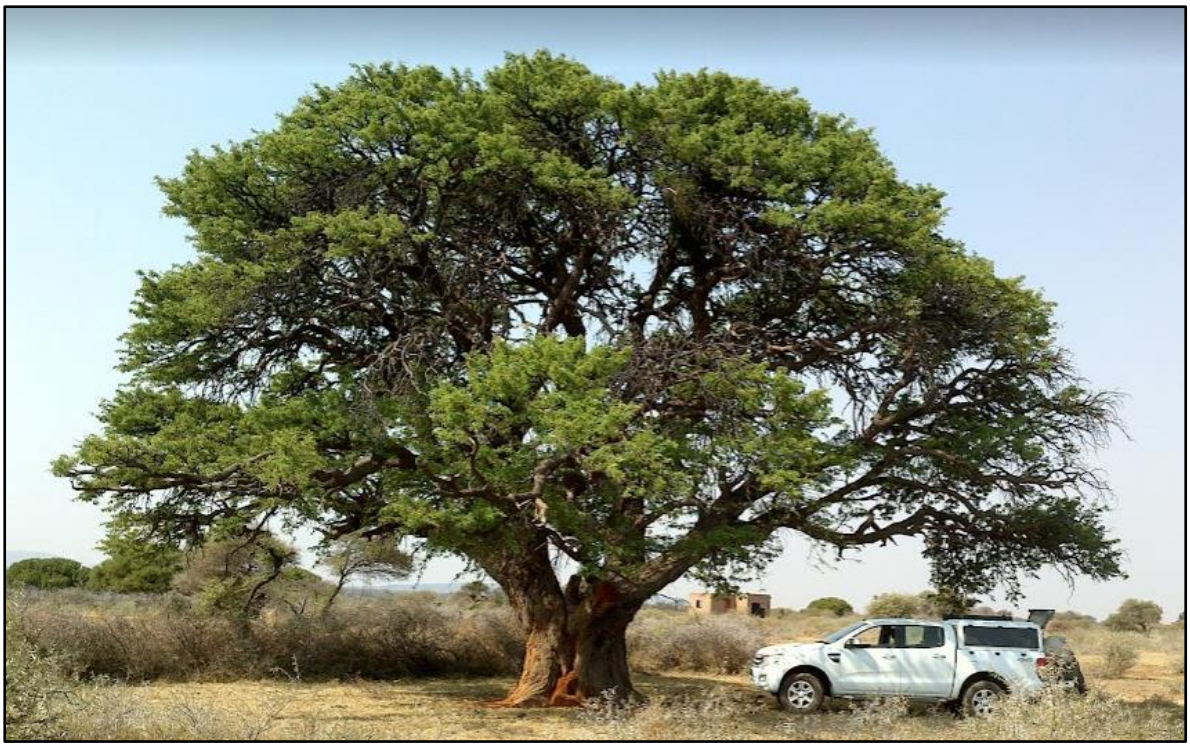

Figure 12: Large specimen of *Vachellia erioloba* present within Burrow Pit B1 area.

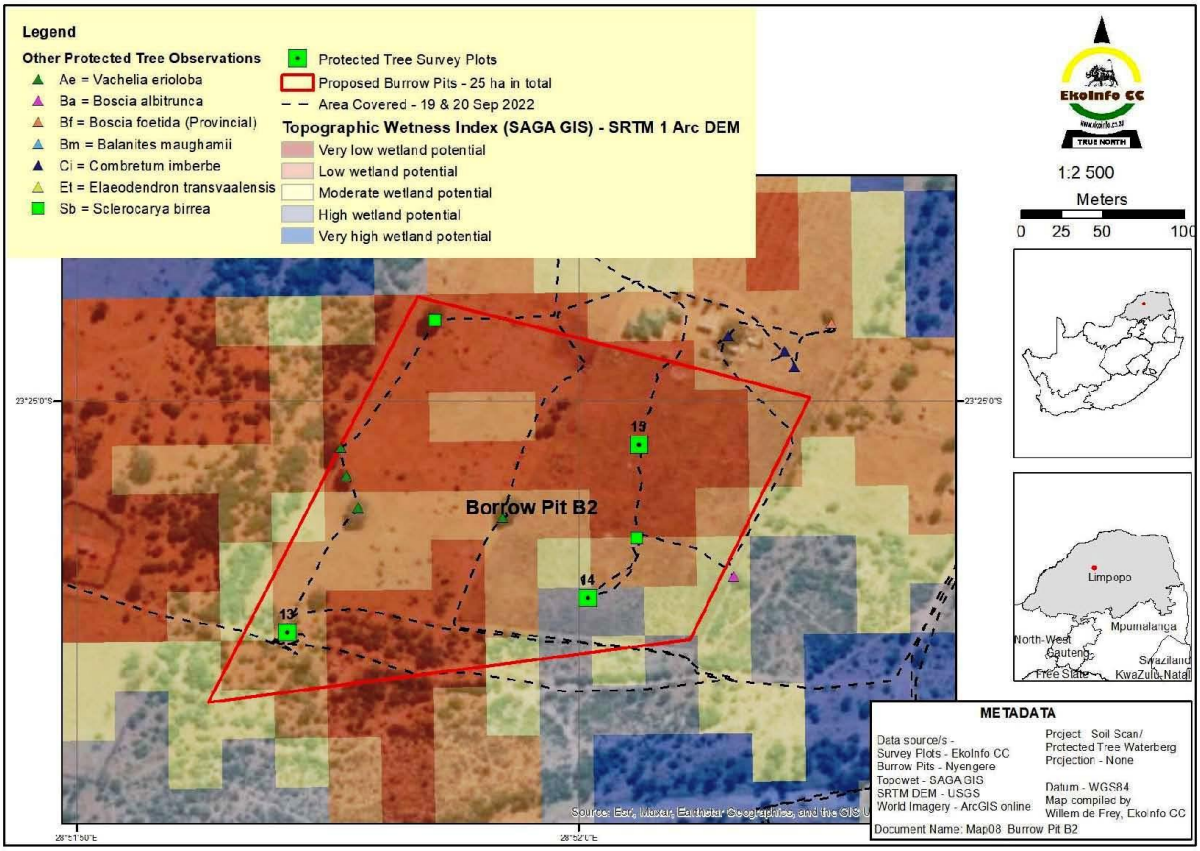

Figure 13: Distribution of survey plots and protected tree species observations within the burrow pit B2 area.

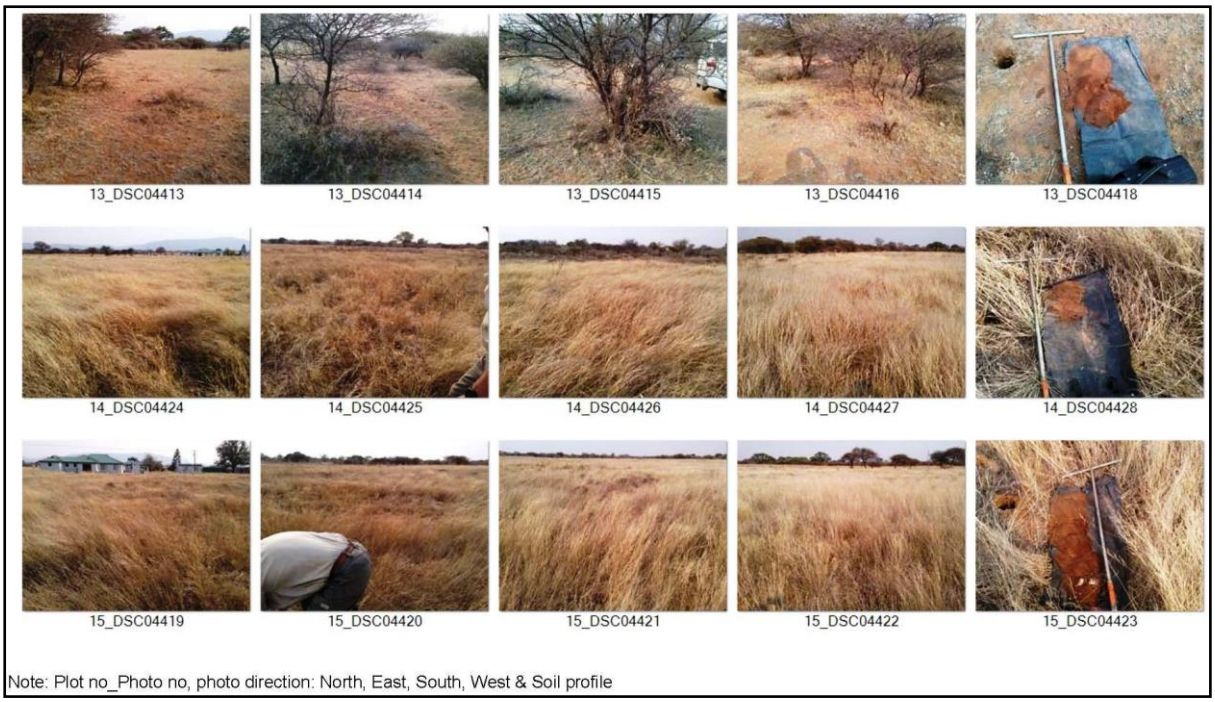

Figure 14: Geo-referenced images of the vegetation and soil profiles for the three plots within burrow pit B2 area.

8.5.2. National Protected Trees

Two national protected trees were recorded within this site namely *Vachellia erioloba* and *Sclerocarya birrea* (Table 8). Of the two species *Vachellia erioloba* is the most abundant in the area. The mean density of this species is 282 individuals per ha, while the mean density for *Sclerocarya birrea* is 4/ha (Table 9).

Two other national protected tree species were observed within the vicinity of the site, but was not within the footprint of the site, namely *Combretum imberbe* and *Boscia albitrunca*.

8.6.Faunal composition

The proposed burrow pit areas are located in a Microphyllous Woodland habitat dominated by *Vachellia* spp*, Senegalia* spp and *Dichrostachys cinerea* dense shrubland/woodland. Each of the proposed sites is too small to consider faunal assemblages on an individual basis.

8.6.1.Avifauna.

Dominant species: The bird composition consists primarily of typical "thornveld" species such as Marico flycatcher *Melaenornis mariquensis*, black-chested prinia *Prinia flavicans*, chestnut-vented warbler *Sylvia subcoerulea*, crimson-breasted shrike *Laniarius atrococcineus*, scaly-feathered finch *Sporopipes squamifrons*, green-winged pytilia *Pytilia melba*, white-browed sparrow weaver *Plocepasser mahali*, laughing dove *Spilopelia senegalensis*, blue waxbill *Uraeginthus angolensis* and Acacia pied barbet *Tricholaema leucomelas*.

Indicator species (species largely restricted to this habitat) include: Kalahari scrub-robin *Cercotrichas paena*, ashy tit *Melaniparus cinerascens*, burned-necked eremomela *Eremomela usticollis*, Sabota lark *Calendulauda sabota*, great sparrow *Passer motitensis*, violet-eared waxbill *Uraeginthus*

granatina, rattling cisticola *Cisticola cheniana*, barred wren-warbler *Calamonastes fasciolatus* and Gabar goshawk *Micronisus gabar*.

8.6.2. Invertebrates

A walk through survey is insufficient to get adequate data on the invertebrate assemblage of the area. The timing of the survey, in the dry season, also contributes to low numbers of invertebrates present. Prominent Orders seen were represented by the Coleoptera (beetles) and Hymenoptera (bees and wasps), while prominent families included the Scarabaeidae (scarab beetles such as dung beetles and miniature dung chafers represented by the Aphodinae) and Tenebrionidae (darkling beetles) as well as Muscid flies (various species). Active scorpion burrows were observed. As *Uroplectes planimanus* is know to be the most abundant scorpion in the area is it accepted that the majority of burrows belong to this species. No sign of Theraphosid spiders (Baboon Spiders) were observed, however, there are four theraphosid spider taxa that are likely to occur on the study area. These include:

- *Augacephalus junodi* (Junodi's golden baboon spider);
- *Brachionopus pretoriae*;
- *Ceratogyrus darlingi* (South African horned baboon spider); and
- *Idiothele nigrofulva*.

8.6.3. Herpetofauna

Previous biodiversity surveys recorded 30 species, 20 lizards & 10 snake species, in the area during the dry season. Several gecko species including *Chondrodactylus turneri* (Turber's gecko), *Hemidactylus mabouia* (common tropical house gecko) and *Lygodactylus c. capensis* (common dwarf gecko) were positively identified as well as the common desert lizard *Meroles squamulosus* and the spotted sand lizard *Pedioplanis l. lineoocellata.*

8.6.4. Mammals

Tracks, sign and faeces of the following species were recorded on all of the proposed burrow pit sites - the yellow mongoose *Cynictis penicillata,* banded mongoose *Mungos mungos,* scrub hare *Lepus saxatilis* as well as small rodent species.
The presence of carnivorous meso-predators such as the black-backed jackal *Canis mesomelas*, brown hyena *Parahyaena brunnea* and small-spotted genet *Genetta genetta* is confirmed on burrow pits A1 and B2. Tracks and quills of the ubiquitous porcupine *Hystrix africaeaustralis* were observed on burrow pit sites A1 and A3.

9. DISCUSSION

9.1. Wetland Soils

The data point towards that although the wetness index model indicates the potential for wetlands to develop in the area; the rainfall and soil conditions are not optimal for the development of wetlands. The area falls in a semi-arid climate type with a mean annual rainfall of 400 to 600 mm (De Frey 2019). The overall soil texture in the A-horizon is sandy (very coarse textured < 10% clay) (De Frey 2019), which implies that infiltration exceed runoff, which lowers the potential for water to accumulate in the lower laying areas.

It is further evident that the signs of wetness (DWAF 2005) are better developed along the higher stream orders (Figure 15), as these systems are fed from much larger catchments. It is most probable that subsurface flow occurs within the 1st to 3rd order streams, with surface flow evident in the 4th order streams on a seasonal or permanent level. A detail soil survey will most probably reveal that there is a slight increase in the clay content in these areas in the subsoil, which is reflected by the high density of an encroachment species such as *Senegalia melifera*, which was common throughout the sites. The increase of clay mineral would be due to the movement of finer material both horizontal and vertical within the soil profile on a local and regional scale.

9.2. National Protected Trees

The data manifest that *Vachellia erioloba* and *Boscia albitrunca* is the most abundant national protected trees species in the burrow pit areas, as they occurred in 60% of the sites surveyed (Table 10). *Sclerocarya birrea* only occurred in 40% of the sites surveyed. None of these three species are threatened and is classified as Least Concern in term of the South African Red List of Plants[4]. Therefore, the rational for their protection on the national list is unsure, except to possibly regulate commercial exploitation on a local scale. However, the fact that these species are present within this rural landscape, and especially larger individuals, clearly indicates that they are valued by the local community and not specifically targeted for utilisation in terms of wood harvesting. The absence of younger individuals (0 – 3 m height class) is of a concern, especially with regards to *Boscia albitrunca* and *Sclerocarya birrea* (Table 10).

If the density of these species is considered without the height classes (Table 11) and compared to the density derived including the height classes (Table 10), it would appear that the mean density of *Vachellia erioloba* is lower at 123 individuals per ha, compared to 191 individuals per ha (Table 10). This implies that more than 2 000 individuals would theoretically be lost, should all five burrow pits be developed. However, from Figure 2 and the data collected, it should be evident that the protected species do not have a significant presence in Burrow Pits B1 and B2, except for a few large individuals (Figure 16). The only unit with intact natural vegetation is Burrow Pit A1, and therefore with the highest risk that up to 955 *Vachellia erioloba* or 33 *Boscia albitrunca* could be lost. Although the highest potential exist that the burrow pits will impact on the *Vachellia erioloba* population, it is the only species with significant numbers of individuals in the 0 – 3 m height/ age class, representing juveniles and therefore recruitment potential. The same cannot be said for the other species.

It should be evident that significant lower number of individuals of the other national protected trees will be lost, namely *Sclerocarya birrea, Balanites maughamii* (Least concern) and *Elaeodendron transvaalensis* (Near-threatened – medicinal use: bark exploitation). Due to the low numbers of

[4] http://redlist.sanbi.org/stats.php

these species in the landscape, there conservation or protection should be given priority, especially with regards to *Elaeodendron transvaalens.*

Table 8: Overview of the national protected trees species recorded in the burrow pit B2 survey plots.

Plot no	Time	Quadrant no.	Species	Height/ Age class	Distance to nearest target plant (m)
13	07:29:52	1	Vachellia erioloba	3 - 6 m	24.5
13	07:30:19	2	Sclerocarya birrea	6 m +	25
14	08:09:38	4	Vachellia erioloba	0 - 3 m	18
14	08:08:02	1	Vachellia erioloba	0 - 3 m	8
14	08:08:16	2	Vachellia erioloba	0 - 3 m	4.5
14	08:08:35	2	Vachellia erioloba	0 - 3 m	3

Table 9: Mean tree density of protected trees species recorded within the burrow pit B2 area.

Plot no	Time	Quadrant no.	Species	Height/ Age class	Distance to nearest target plants (m):	Closest individual – individual/ha			
						0 - 3m	3 - 6m	>6m	Total mean value
13	07:29:52	1	Vachellia erioloba	3 - 6 m	24.5		4		
14	08:08:35	2	Vachellia erioloba	0 - 3 m	3	278			
14	08:08:16	2	Vachellia erioloba	0 - 3 m	4.5				
14	08:08:02	1	Vachellia erioloba	0 - 3 m	8				
14	08:09:38	4	Vachellia erioloba	0 - 3 m	18				
					Mean value	**278**	**4**		**282**
13	07:30:19	2	Sclerocarya birrea	6 m +	25			4	
					Mean value			**4**	**4**

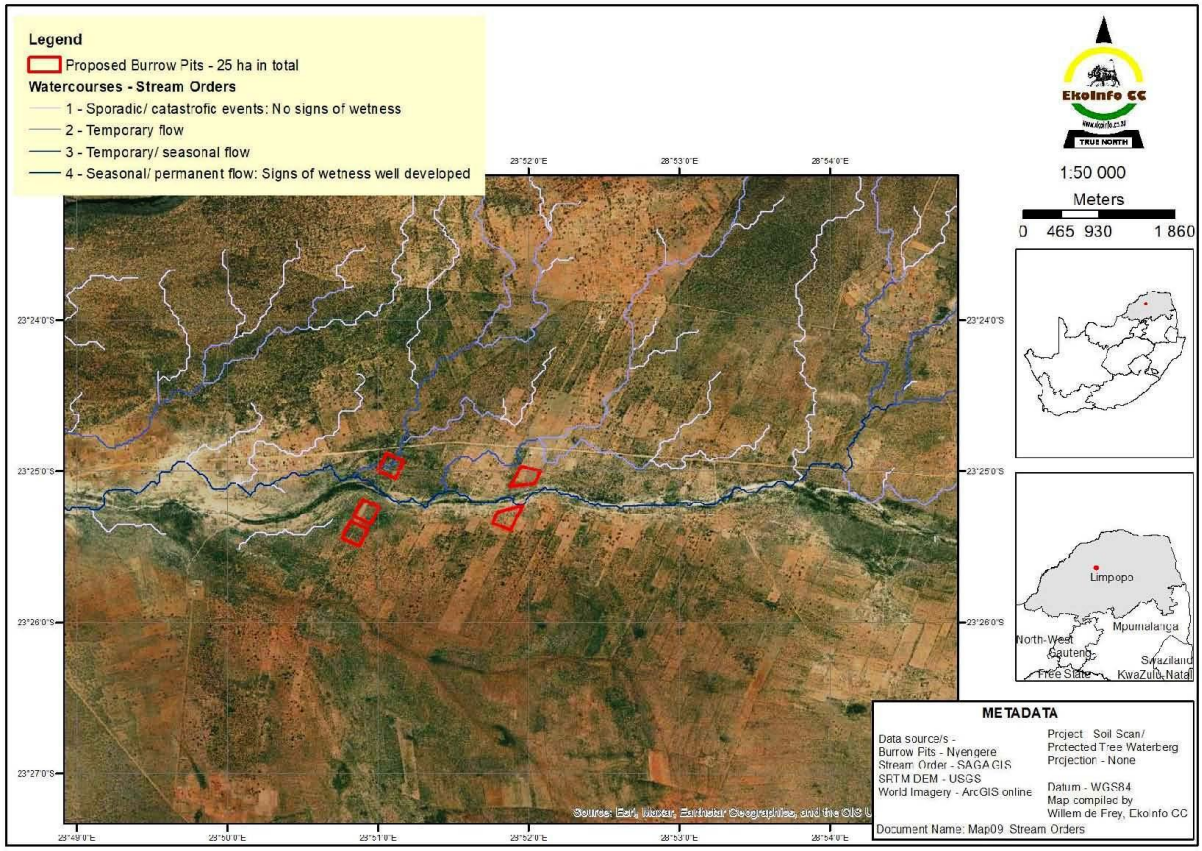

Figure 15: Stream orders associated with the watercourses present within the landscape associated with the burrow pits.

Table 10: Overview of the occurrence of national protected trees species within the proposed burrow pit areas based on the plots surveyed and their overall density.

Burrow Pit	Species	Mean number of individuals per height class (individuals / ha)				Mean density per species	Burrow Pit Area (ha)	Maximum no of individuals to be removed
		0 - 3m	3 - 6m	>6m	Total mean			
A1	Boscia albitrunca	0	7	0	7			
A2	Boscia albitrunca	0	5	0	5			
A3	Boscia albitrunca	4	4	0	8	7	25	167
B1	No National Protected Tree species in survey plots	0	0	0	0			
A2	Sclerocarya birrea	0	4	0	4			
B2	Sclerocarya birrea	0	0	4	4	4	25	100
A1	Vachellia erioloba	0	211	5	216			
A3	Vachellia erioloba	51	19	5	75			
B2	Vachellia erioloba	278	4		282	191	25	4775

Table 11: Mean density per national protected tree species irrespective of size/ age class.

Plot no	Species	Closest individual (m)	Closest individual – No/ha	Mean individuals per hectare
1	Vachellia erioloba	20	6	
2	Vachellia erioloba	2	625	
3	Vachellia erioloba	29.5	3	
7	Vachellia erioloba	16	10	
8	Vachellia erioloba	18	8	
9	Vachellia erioloba	7	51	
13	Vachellia erioloba	24.5	4	
14	Vachellia erioloba	3	278	123
2	Boscia albitrunca	28	3	
3	Boscia albitrunca	15	11	
4	Boscia albitrunca	22	5	
8	Boscia albitrunca	26	4	
9	Boscia albitrunca	25	4	5
4	Sclerocarya birrea	25	4	
13	Sclerocarya birrea	25	4	4

Figure 16: Example of large *Vachellia erioloba* individuals present in the burrow pit B2 area.

9.3. Faunal component

The Microphyllous Woodland habitat, dominated by *Vachellia* spp, *Senegalia* spp and *Dichrostachys cinerea* dense shrubland/woodland, has low mammal diversity. This relatively disturbed habitat with high agricultural and anthropogenic activities precludes many natural wildlife species from this habitat. This situation is further exacerbated by persistent hunting pressure for game species. High cattle densities and livestock activity as well as the intensity of anthropogenic disturbances also contribute to low habitat sensitivity and the resultant low presence of any natural wildlife species.

10. RECOMMENDATION

It is understood that the burrow pits will be developed to access the calcrete below, therefore the topsoil will have to be removed. Due to the presence of the seed bank of these national protected trees, it is critical that the topsoil needs to be managed very effectively, to be used in the rehabilitation of the burrow pits once the burrowing has ended.

Ideally the top 30 cm should be stored separately from the remaining subsoil, as it contains the majority of the seed bank, organic carbon and micro-organism required for the plants to re-establish. This high-quality topsoil should not be stored to high or for to long, ideally rehabilitation should take place within six months of the topsoil being removed. It is critical that no fertiliser be added to the areas, once the topsoil had been returned, as most of the regional indigenous species are not used to high nitrogen concentration in the soil, and the high nitrogen content will attract livestock, as well as stimulate weed growth. It is critical that the area be fenced off to protect the germinating plants from livestock. It might be sensible to use the woody component, which will be removed to access the calcrete to form a natural fence (Figure 17). The woody component consists mainly of thorny species such as *Senegalia melifera*, *Dichrostachys cinerea* and *Vachellia tortilis* which will deter livestock and wildlife. These thorny species can also be used for brush packing once the topsoil had been returned. Ideally a roll over approach should be applied to the burrowing activities. If the topsoil is managed well, the cost of rehabilitation will be very low (Figure 18). The key is the topsoil management. It is recommended that a vegetation scientist/ ecologist is appointed to assist with the rehabilitation and the monitoring thereof.
It is highly likely that once the area had been rehabilitated with the topsoil and fenced off/ protected from intensive grazing and browsing by livestock, whether domestic or wildlife, these trees will return.

In fact, it is believed that a simple management intervention such as fencing of a network of steppingstone corridors throughout the landscape will contribute significantly to the recruitment of all of the national protected trees within the area. This statement is based on the observation that the majority of juvenile individuals (0 – 3 m height class) was recorded within the fenced of area of burrow pit B2 associated with plot 14 (Figure 13 & 19). These steppingstone areas should be at least equivalent in size to the burrow pit areas, but need not be permanent, they only needed to be managed until the germinated individuals of national protected trees had reached maturity (> 3 m in height). The objective would be to keep cattle and goats out of the area for a minimum of three years. The network of steppingstone corridors should be spaced through areas of persistent primary vegetation within the landscape. Once again, the thorny encroaching species present in the landscape can be used to create these fenced of areas, thereby reducing the level of encroachment in the landscape, while creating job opportunities for the local communities. The local communities know how to create these natural fences, and therefore limited training or equipment would be required. After a minimum of three years, the natural fence can be allowed to deteriorate and grazing and browsing can resume, while new areas are targeted for similar intervention.

It would be prudent to harvest seed[5] from the *Elaeodendron transvaalensis* individual recorded (burrow pit A1 - Figure 4) and propagate a number of individuals to be re-introduced into the rehabilitated areas, as this species is classified as near threatened, and therefore could benefit from a boost of its population. The fruit is highly likely to be present during November[6]. A plant reproductive biologist could assist with the propagation of this species.

Figure 17: Example of thorny woody species used to create a natural fence which could protect the germinating species from livestock.

Dragline walkway – Natural grassland with topsoil removed (EkoInfo CC 2019)

Dragline walkway – Natural grassland with topsoil returned, no fertiliser (EkoInfo CC - Feb 2021

Figure 18: Example of rehabilitation success through effective topsoil management.

[5] http://pza.sanbi.org/elaeodendron-transvaalense

[6] https://treesa.org/elaeodendron-transvaalense/

Figure 19: Fenced off area (yellow block) in burrow pit B2 in which the majority of *Vachellia erioloba* juvenile individuals were recorded.

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12. APPENDIX B – NATIONAL PROTECTED TREE SPECIESLIST AS FROM 25 MARCH 2022.

Adansonia digitata
Afzelia quanzensis
Balanites maughamii
Barringtonia racemosa
Berchemia zeyheri
Boscia albitrunca
Brachystegia spiciformis
Breonadia salicina
Bruguiera gymnorrhiza
Cassipourea swaziensis
Catha edulis
Ceriops tagal
Cleistanthus schlechteri
Colubrina nicholsonii
Combretum imberbe
Curtisia dentata
Diospyros mespiliformis
Elaeodendron transvaalensis
Erythrophysa transvaalensis
Euclea pseudebenus
Ficus trichopoda
Leucadendron argenteum
Lumnitzera racemosa
Lydenburgia abottii
Lydenburgia cassinoides
Mimusops caffra
Newtonia hildebrandtii
Ocotea bullata
Ozoroa namaensis
Philenoptera violacea
Pittosporum viridiflorum
Podocarpus elongatus
Podocarpus falcatus
Podocarpus henkelii
Podocarpus latifolius
Protea comptonii
Protea curvata
Prunus africana
Pterocarpus angolensis
Rhizophora mucronata
Schinziophyton rautanenii
Sclerocarya birrea
Securidaca longepedunculata
Sideroxylon inerme
Tephrosia pondoensis
Umtiza listeriana
Vachellia erioloba
Vachellia haematoxylon
Warburgia salutaris
Widdringtonia cedarbergensis
Widdringtonia schwarzii