APPENDIX 5

PALAEONTOLOGICAL IMPACT ASSESSMENT

Palaeontological Impact Assessment for a Prospecting Right Application on Gappepin Reserve 670, between Olifantshoek and Kathu, Northern Cape Province

Desktop Study (Phase 1)

For

Prime Resources (Pty) Ltd

03 March 2024

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 35 years research and lecturing in Palaeontology
27 years PIA studies and over 350 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Prime Resources (Pty) Ltd, Johannesburg, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for a Prospecting Right Application on Farm Gappepin Reserve 670, between Olifantshoek and Kathu, on the margin of the Maremane dome, Northern Cape Province.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the highly sensitive Tertiary to Quaternary surface limestone that might have trapped fossils, although no such fossils have been reported from here. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations or drilling activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	High	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

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1. Background

A Prospecting Right (PR) Application in the Northern Cape Province, triggers the requirement for a palaeontological impact assessment (Figures 1-2).

Monnapula Mining is applying for a PR on the Farm Gappepin Reserve 670. The PR application includes non-invasive and invasive activities. The prospecting activities are expected to be undertaken over a period of three years.

Prospecting activities proposed include:

- Desktop research and literature reviews
- Surface geological mapping
- Geophysical surveys (ground magnetic and ground gravity techniques)
- Development of geological models
- Diamond drilled exploration boreholes, 20 sites are proposed. Boreholes will likely be 50 - 100 m deep. The grid for this drilling will be confirmed once the non-invasive validation studies are complete.

A 10 m x 10 m drill pad will be required per drill site for the drilling rig and sump. Drill pads will be cordoned off with danger tape or fences if required.

A Palaeontological Impact Assessment was requested for the prospecting right application (PRA) on Farm Gappepin Reserve 670. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

Figure 1: Google Earth map of the general area to show the relative land marks. The prospecting right area is shown by the yellow rectangle.

Figure 2: Google Earth Map of the proposed prospecting right area on Farm Gappepin Reserve 670 shown by the green polygon.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases; eg https://sahris.sahra.org.za/map/palaeo
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representativity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

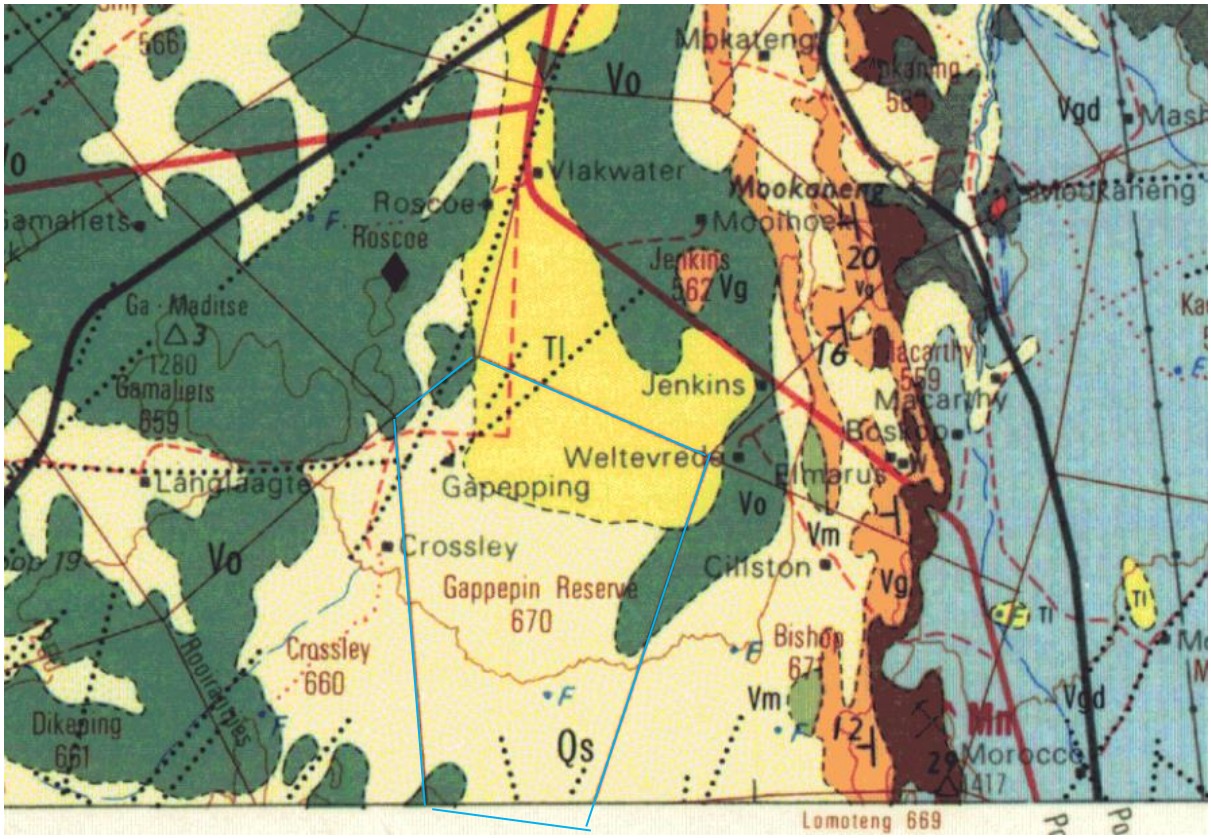

Figure 3: Geological map of the area around the PRA on Farm Gappepin Reserve 670 indicated within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2722 Kuruman.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Schier et al., 2018;). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Gordonia Fm, Kalahari Group	Alluvium, sand, calcrete	Quaternary, ca 1.0 Ma to present
Ql	Quaternary limestone	Surficial limestone	Quaternary, ca 1.0 Ma to present
Vg	Gamagara (Mapedi) Fm, Elim Group, Keis SG	Shale, conglomerate	<1966 Ma
Vo	Ongeluk Fm, Postmasburg Group, Transvaal SG	Mafic volcanic rocks	Palaeoproterozoic Ca 2436 Ma
Vm	Makganyene Fm, Postmasburg Group, Transvaal SG	Conglomerate and diamictites, quartzites, sandstone	Palaeoproterozoic Ca 2450 Ma
Vad	Griquatown/Danielskuil Fm; Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Brown jaspilite and crocidolite, (Banded iron formation and manganese formation)	Palaeoproterozoic Ca 2489 Ma
Vak	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Banded iron formation with bands of amphibolite; conglomerate layers	Palaeoproterozoic Ca 2460 Ma
Vgd	Ghaap Plateau Subgroup, Campbell Rand Group, Transvaal SG	Fine and coarse-grained dolomite, chert, dolomitic limestone, banded chert	Palaeoproterozoic Ca 2541 Ma

The project lies in the Griqualand West Basin where the rocks of the Transvaal Supergroup are exposed. Unconformably overlying the ancient rocks are much younger transported sediments of Quaternary age (Figure 3).

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

In the Griqualand West Basin, the Ghaap Group of the Transvaal Supergroup, is divided into four subgroups, from the oldest, Schmidtsdrift, Campbell Rand, Asbestos Hills and

Koegas Subgroups (Eriksson et al., 2006, p. 244). The Koegas Subgroup is overlain by the Postmasburg Group and the latter is divided into the lower Makganyene Formation and the Ongeluk Formation (ibid).

There are two Formations in the Schmidtsdrift with the lower Boomplaas Formation composed of stromatolitic and oolitic platform carbonates. The upper Clearwater Formation comprises shales, tuffites and BIF-like cherts and is interpreted as a transgressive deposit over the Boomplaas Formation (ibid; Eriksson et al., 2006). The Campbell Rand Subgroup has nine Formations (Eriksson et al., 2006; Beukes et al., 2016) and they form a stromatolitic carbonate platform. The Campbell Rand Subgroup occurs around the basin margin on the craton. Platform margin and lagoonal dolomites are manganese-rich, whereas basinal dolomites are iron-rich, and intertidal to supratidal deposits are virtually free of iron and manganese (Beukes, 1987). There are three formations in the Asbestos Hills Subgroup, from the base, the Kliphuis, **Kuruman and Danielskuil (or Griquatown) Formations,** with all three composed of iron-formation. The Asbestos Hills Subgroup is dated at about 2460 - 2489 Ma (Schier et al., 2018).

Tertiary calcretes cover large parts of the Northern Cape but they are difficult to date and there are several schools of thought (see Partridge et al., 2006). Nonetheless, it is accepted that calcretes form under alternating cycles humid and arid climatic conditions in strata that have calcium carbonate (Netterberg, 1969). More recent research using geophysical techniques to measure uplift of the continent during the Cretaceous and tertiary, combined with the fossil record (Braun et al., 2014) suggest that there were two predominant humid periods during the Tertiary. The whole of the Eocene (56-33 Ma) and a short period during the early Miocene (ca 20-19 Ma) were humid according to their estimation. It is possible that the Northern Cape calcretes formed during one of these periods.

Overlying many of these rocks are loose sands and sand dunes of the **Gordonia Formation**, Kalahari Group of Neogene Age. The Gordonia Formation is the youngest of six formations and is the most extensive, stretching from the northern Karoo, Botswana, Namibia to the Congo River (Partridge et al., 2006). It is considered to be the biggest palaeo-erg in the world (ibid). The sands have been derived from local sources with some additional material transported into the basin (Partridge et al., 2006). Much of the Gordonia Formation comprises linear dunes that were reworked a number of times before being stabilised by vegetation (ibid).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 4-5. The site for prospecting is covered by Quaternary sands and limestone (highly sensitive, orange) but the target rocks for prospecting are most likely the below-ground iron and or manganese ores.

Although banded iron was formed by the seasonal oxidation of iron in solution by the oxygen released by the ancient algal colonies, converting ferrous iron to haematite, there are no fossil microbes preserved in the banded iron. Therefore, it is not considered to contain any trace fossils or fossils.

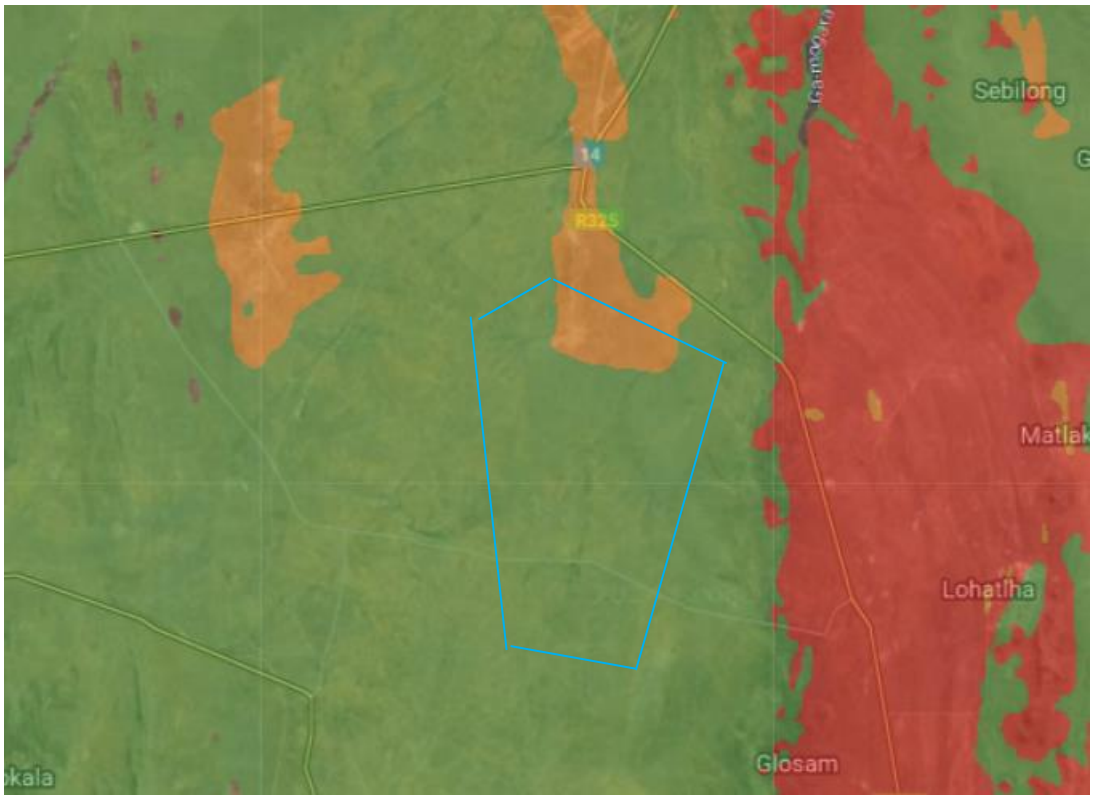

Figure 4: SAHRIS palaeosensitivity map for the site for the prospecting right application of Farm Gappepin Reserve 670 shown within the blue outline. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

KALAHARI GROUP

Aeolian sands and alluvium are fairly mobile and very porous so they do not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, is there any chance of fossilisation. For example, roots can be encased in calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

The **Tertiary calcretes** can trap fossils and artefacts when associated with palaeo-pans or palaeo-springs (Partridge et al., 2006). Where deflation has occurred, for example along the west coast of South Africa, any trapped materials in the different levels can be concentrated in the depo-centre of the pan or dune and thus it can be challenging to interpret the deposit (Felix-Henningsen et al., 2003).

The Aeolian sands of the **Gordonia Formation** do not preserve fossils because they have been transported and reworked. Conditions required for the preservation of organic material and formation of fossils are burial in a low energy, anoxic environment such as overbank deposits, lake muds or clays (Briggs and McMahon, 2016). Aeolian sands are

high energy, well oxygenated environments. In some regions the sands may have covered pan or spring deposits and these can trap fossils, and more frequently archaeological artefacts. Usually, these geomorphological features can be detected using satellite imagery. No such features are visible.

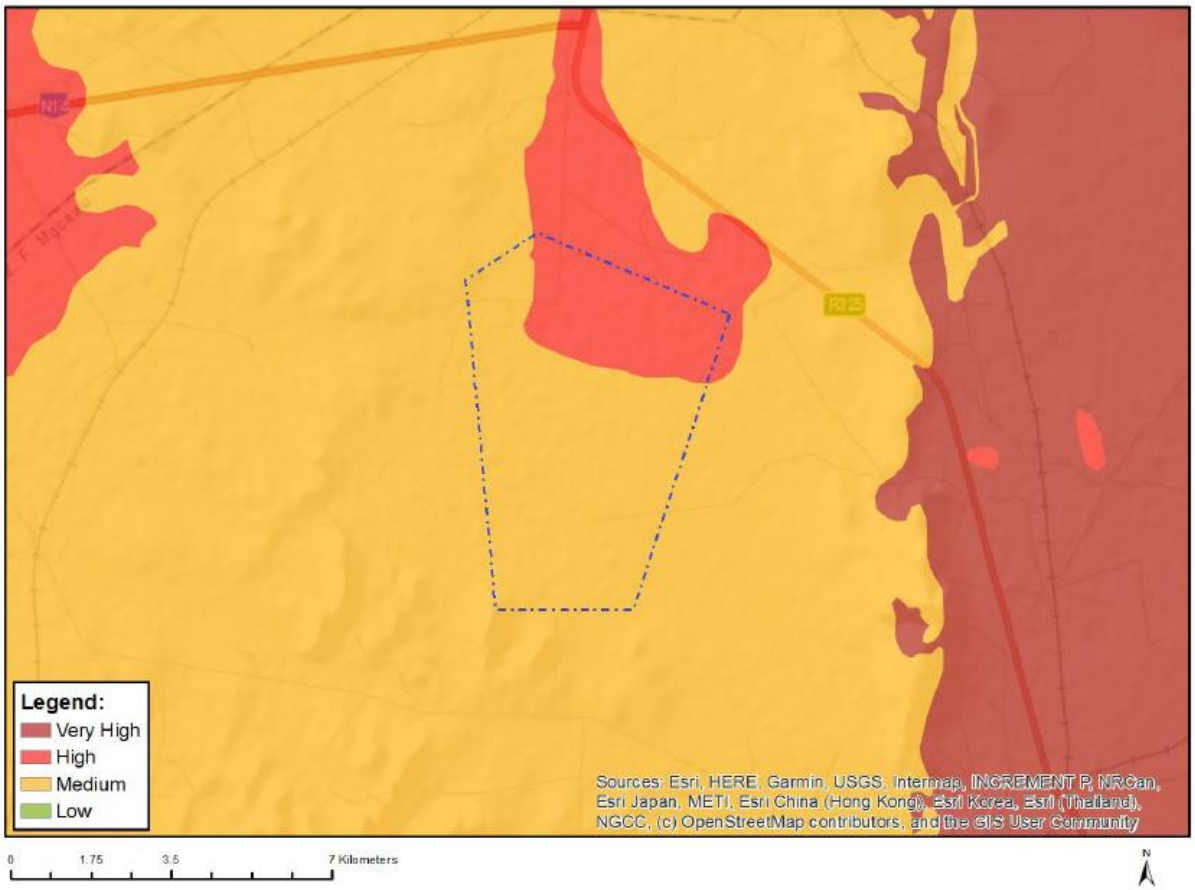

Figure 5: DFFE Screening map for palaeosensitivity for Farm Gappepin Reserve 670. Note that although the colours differ the meaning of the colours is the same as for the SAHRIS map (Figure 5).

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

Table 3a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 3b: Impact Assessment for Gappepin Reserve 670

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Soils and sands do not preserve fossils; so far there are no records from the Tertiary-Quaternary limestone of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.

PART B: Assessment		
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trapped fossils in the limestone, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the surficial limestone, or the iron or manganese ores below ground that will be drilled. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain fossils or are the wrong kind. Furthermore, the material to be targeted does not preserve fossils. Since there is an extremely small chance that fossils from the surficial limestone may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and only some might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils of the Quaternary. There is a very small chance that fossils may occur in the surficial limestone but none has been recorded from this region. Nonetheless, a Fossil Chance Find Protocol (as outlined in Section 8) should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations or drilling have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, so as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	High	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

7. References

Almond, J.E., Pether, J. 2009. Palaeontological Heritage of the Northern Cape; Palaeotechnical Report for SAHRA. 115pp.

Beukes, N.J., Swindell, E.W.P., Wabo, H., 2016. Manganese Deposits of Africa. Episodes, 39(3), 1-33. DOI: 10.18814/epiiugs/2016/v39i2/95779

Briggs, D.E.G., McMahon, S., 2016. The role of experiments in the taphonomy of exceptional preservation. Palaeontology 59, 1-11.

Button, A., 1976. Iron formation as an end member in carbonate sedimentary cycles in the Transvaal Supergroup, South Africa. Economic Geology 71, 193-201.

Cramer, M.D., Hawkins, H.-J., 2009. A physiological mechanism for the formation of root casts. Palaeogeography, Palaeoclimatology, Palaeoecology 274, 125-133.

Cowan, R., 1995. History of Life. 2nd Edition. Blackwell Scientific Publications, Boston. 462pp.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Felix-Henningsen, P., Kandel, A.W., Conard, N.J., 2003. The significance of calcretes and paleosols on ancient dunes of the Western Cape, South Africa, as stratigraphic markers and paleoenvironments. In: G. Füleky (Ed.) Papers of the 1st International Conference on Archaeology and Soils. BAR International S1163, pp. 45-52.

Klappa, C.F., 1980. Rhizoliths in terrestrial carbonates: classification, recognition, genesis and significance. Sedimentology 27, 613-629.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Netterberg, F., 1969. The interpretation of some basic calcrete types. South African Archaeology Bulletin 24, 117-122.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 585-604.

Peters, C.R., Bamford, M.K., Shields, J.P., 2022. Ch 33. Lower Bed II Olduvai Basin, Tanzania: Wetland Sedge Taphonomy, Seasonal Pasture, and Implications for Hominin Scavenging. In Reynolds, SC., Bobe, R., (Eds). African Paleoecology and Human Evolution, Cambridge University Press & Assessment. 413-434.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Schier, K., Bau, M., Münker, C., Beukes, N., Viehmann, S., 2018. Trace element and Nd isotope composition of shallow seawater prior to the Great Oxidation Event: Evidence from stromatolitic bioherms in the Paleoproterozoic Rooinekke and Nelani Formations, South Africa. Precambrian Research 315, 92-102.

Zeh, A., Wilson, A.H., Gerdes, A., 2020. Zircon U-Pb-Hf isotope systematics of Transvaal Supergroup – Constraints for the geodynamic evolution of the Kaapvaal Craton and its hinterland between 2.65 and 2.06 Ga. Precambrian Research 345, 105760. https://doi.org/10.1016/j.precamres.2020.105760

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the trace fossils such as stromatolites in the dolomites or the Quaternary bones, rhizoliths, traces (for example see Figures 6-7). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project,

should visit the site to inspect the selected material and check the dumps where feasible.

6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. Appendix A – Examples of fossils from the Tertiary and Quaternary sands and calcretes.

Figure 6: Photographs of fragmentary but robust fossils recovered from Quaternary alluvium, sands and calcrete.

Figure 7: Photographs of rhizoliths or rhizocretions from stabilised dunes associated with a palaeo-pan.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2024

Present employment: Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
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ii) **Academic qualifications**
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) **Professional qualifications**
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) **Membership of professional bodies/associations**
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12 - 20 students per year.

vii**) Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020

Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
27 years' experience in PIA site and desktop projects
Selected from recent projects only – list not complete:

- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage
- Adara 2 SEF 2023 for CTS Heritage
- Buffalo & Lyra SEFs 2023 for Nextec
- Camel Thorn Group Prospecting Rights 2023 for AHSA
- Dalmanutha SEFs 2023 for Beyond Heritage
- Elandsfontein Residential 2023 for Beyond Heritage
- Waterkloof Samancor 2023 for Elemental Sustainability
- Zonnebloem WTP 2023 for WSP
- Elders Irrigation 2023 for SRK
- Leghoya WEFS 2023 for Red Cap & SLR

ix) **Research Output**
Publications by M K Bamford up to January 2024 peer-reviewed journals or scholarly books: over 175 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 32; Google Scholar h-index = 40; -i10-index = 121 based on 7261 citations.
Conferences: numerous presentations at local and international conferences.

APPENDIX 6

AGRICULTURAL COMPLIANCE STATEMENT

COMPLIANCE STATEMENT FOR PROSPECTING RIGHTS AT FARM GAPPEPIN RESERVE 670, NEAR KATHU

PREPARED FOR

PRIME RESOURCES (PTY) LTD

APRIL 2024

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Digital Soils Africa

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darren@dsafrica.co.za

Kemsley Street

Port Elizabeth

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BACKGROUND TO THE STUDY

Digital Soils Africa (Pty) LTD (DSA) were tasked by Prime Resources Ltd to undertake an Agricultural Compliance Statement for the Environmental Authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA"), Environmental Impact Assessment ("EIA") Regulations, 2014. As per GN960 of 2019, read with Section 24(5)(a) of the NEMA. An Environmental Screening Report (ESR) was generated for the application using the National Web-based Screening Tool. The ESR classifies the area as being of medium sensitivity for the *Agricultural* theme.

Monnapula Mining is applying for a prospecting right (PR) on the Farm Gappepin Reserve 670. The PR application includes non-invasive and invasive activities. The prospecting activities are expected to be undertaken over a period of three years.

Prospecting activities proposed include:

- Desktop research and literature reviews
- Surface geological mapping
- Geophysical surveys (ground magnetic and ground gravity techniques)
- Development of geological models
- Diamond drilled exploration boreholes; 20 sites are proposed. Boreholes will likely be 50 - 100 m deep. The grid for this drilling will be confirmed once the non-invasive validation studies are complete.

A 10 m x 10 m drill pad will be required per drill site for the drilling rig and sump. Drill pads will be cordoned off with danger tape or fences if required.

SITE LOCATION

The town of Kathu is situated in the Northern Cape Province, approximately 275 km from Kimberley. The study area, where prospecting would like to take place, is a farm called Gappepin Reserve 670, situated near Kathu (Figure 1).

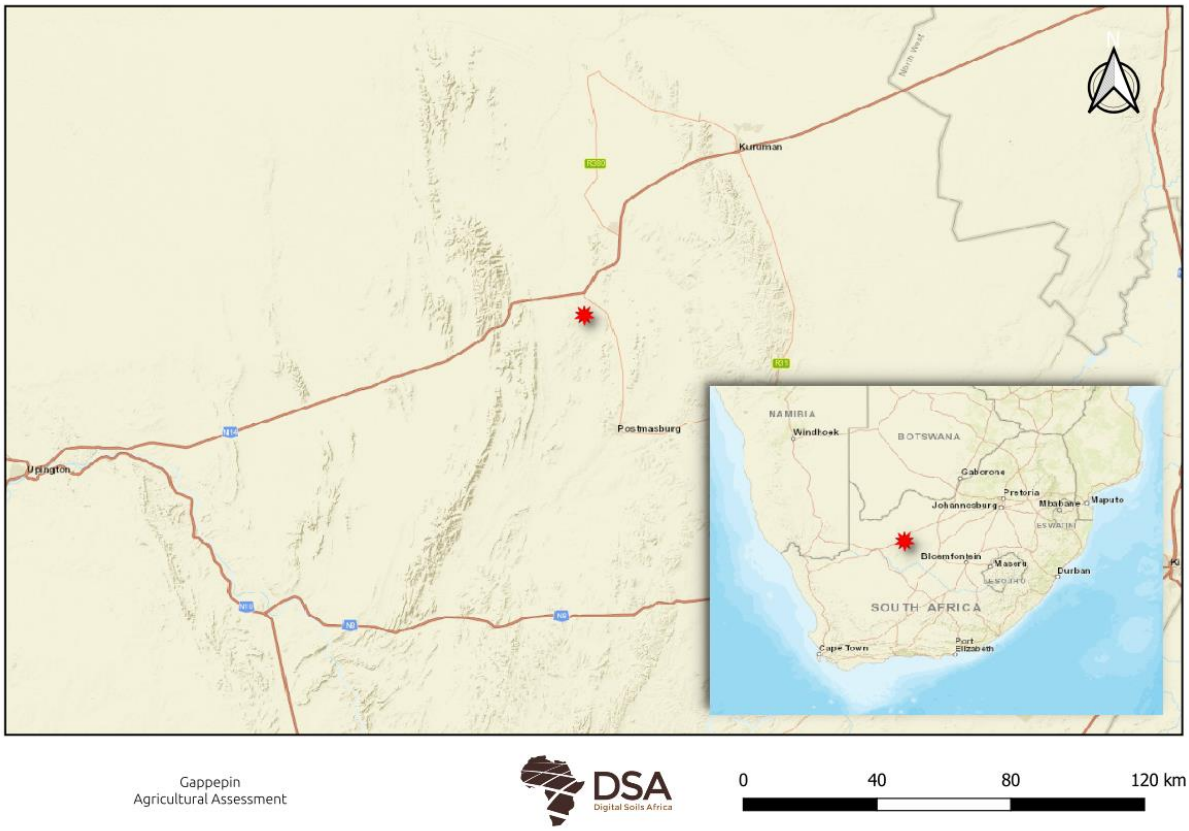


FIGURE 1: LOCATION OF THE STUDY AREA IN THE NORTHERN CAPE PROVINCE.

The layout of the study area is presented in. The total area of the study area is approximately 2 600 ha. As seen from Figure 2, a 500 m wetland buffer was also created to present the areas where prospecting is unauthorised to take place and a 'no-go' areas for invasive prospecting.

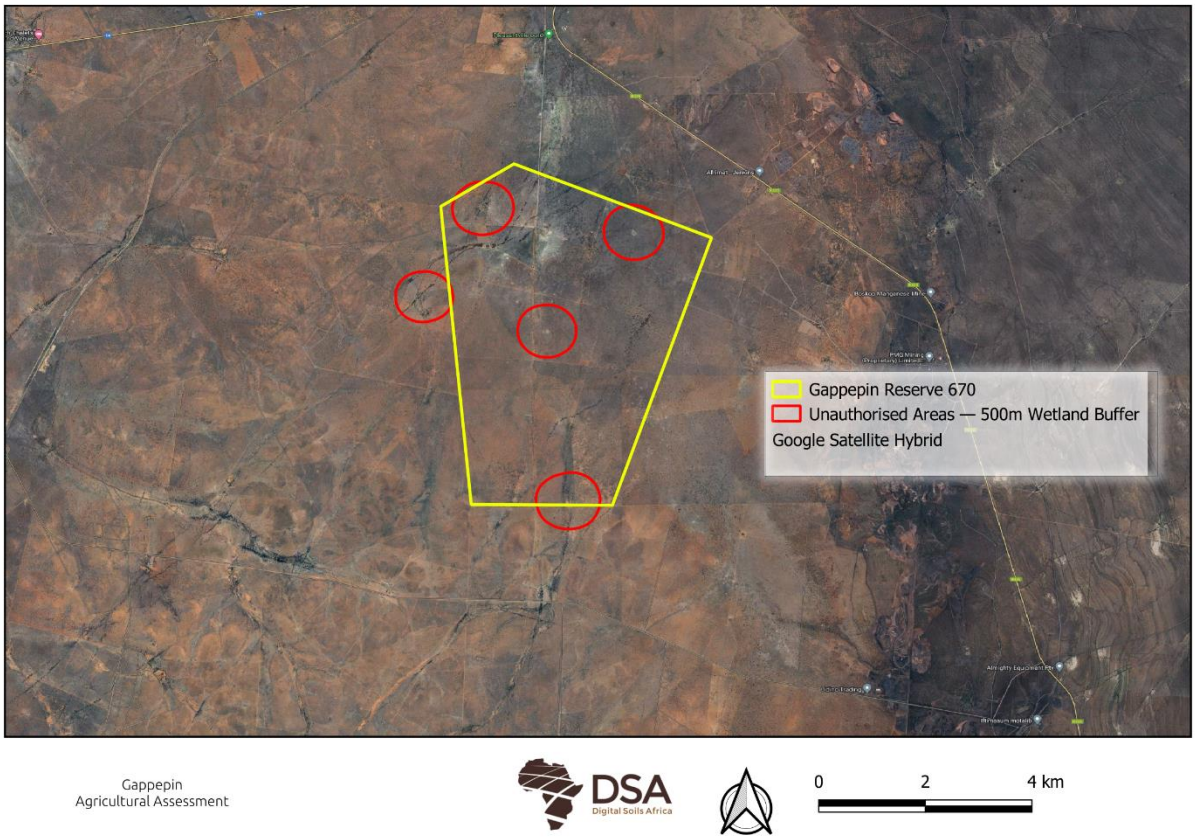


FIGURE 2: THE PROPOSED LAYOUT OF THE STUDY AREA.

ENVIRONMENTAL SCREENING TOOL

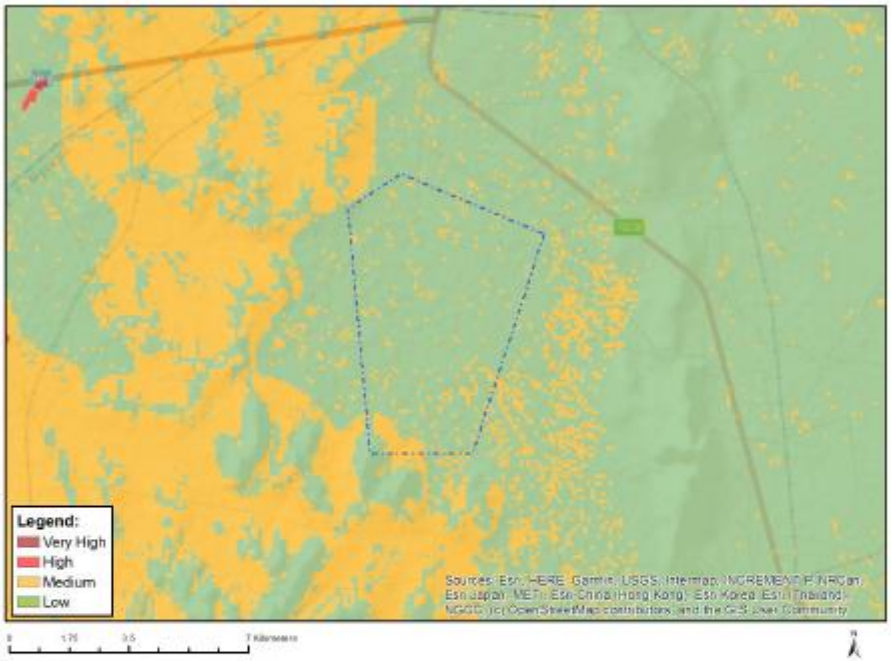
Agricultural sensitivity, as reported in the screening tool, is based upon the land use (SANLC, 2014) and land capability (Department of Agriculture, Forestry and Fisheries, 2017, also referred to as DAFF, 2017).

All cultivated land is considered a high sensitivity, while irrigation and unique crops, are considered very high sensitivity, irrespective of the land capability. The land use in the screening tool is based on the South African Nation Land Cover (SANLC, 2014). Meanwhile, there have been two more updated versions of the land use (2018 and 2020).

According to the Department of Agriculture, Forestry and Fisheries (2017), land capability is defined as the most intensive long-term use of land for purposes of rainfed farming determined by the interaction of climate, soil, and terrain. The following weight was given to each attribute when calculating the Land Capability:

Land capability = Climate (40%) + Terrain (30%) + Soil (30%)

According to the National Web based Environmental Screening Tool, the agricultural sensitivity is classified as medium agricultural sensitivity (Figure 3), this is due to the land use being predominantly low shrubland and natural grassland (Figure 4). There are no field crop boundaries located within the study area as seen in Figure 4. The land capability (DAFF, 2017) classifies the soils as having a land capability of predominantly low sensitivity (Figure 5).



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Land capability;01. Very low/02. Very low/03. Low-Very low/04. Low-Very low/05. Low
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

FIGURE 3: RESULTS FROM THE ENVIRONMENTAL SCREENING TOOL.

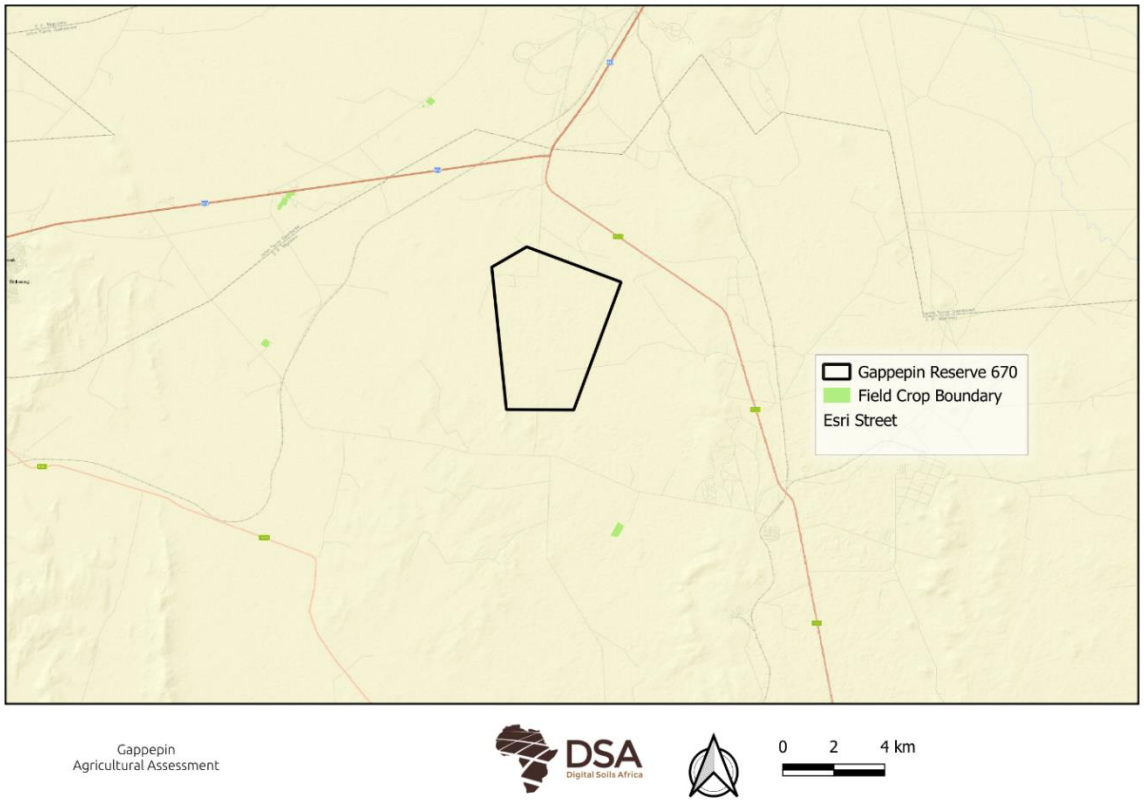


FIGURE 4: THE FIELD CROP BOUNDARIES AS USED IN THE SCREENING TOOL.

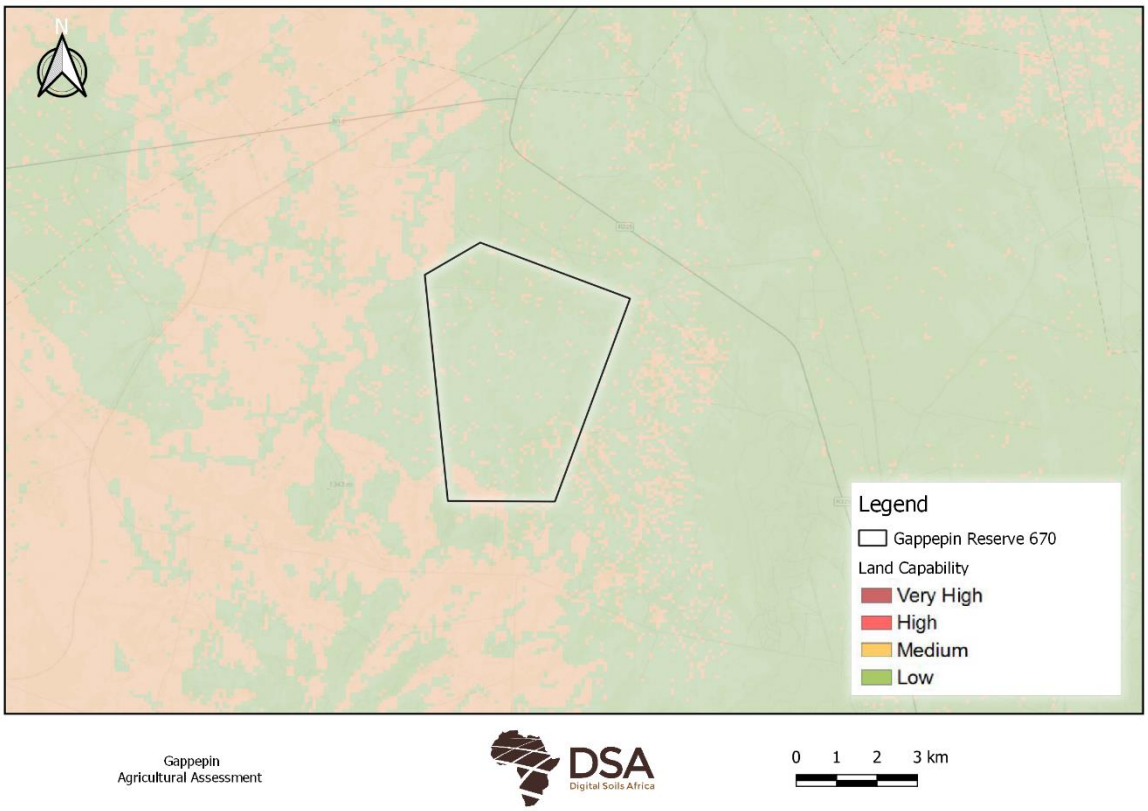


FIGURE 5:THE LAND CAPABILITY OF THE STUDY AS USED IN THE SCREENING TOOL.

Preservation and Development of Agricultural Land Framework Act (PD-ALF) is in the process of being published. The new statutory framework will replace the Subdivision of Agricultural Land Act, Act 70 of 1970.

Protected Agricultural Area, as in the draft framework, is defined as *"an agricultural land use zone, protected for purposes of food production and ensuring that high potential and best available agricultural land are protected against non-agricultural land uses in order to promote long-term agricultural production and food security."*

The study area is not situated within a Protected Agricultural Area (Figure 6).

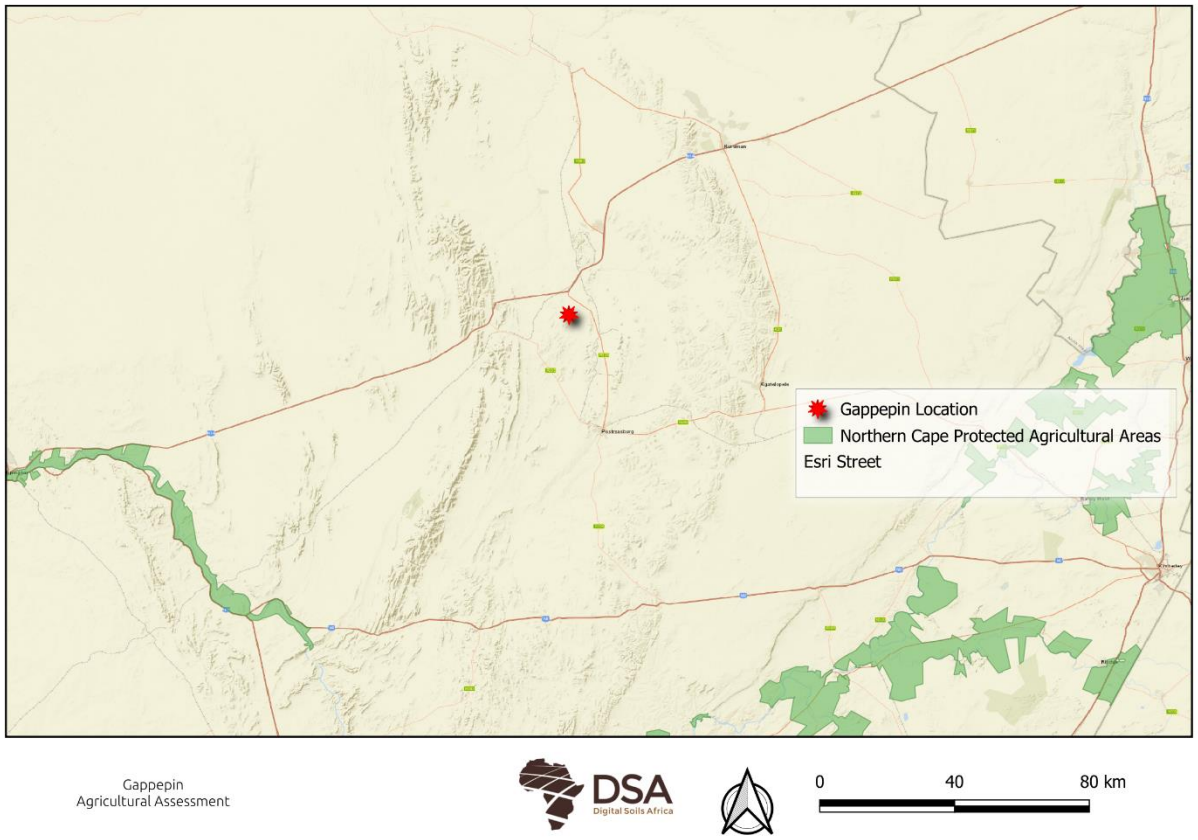


FIGURE 6: THE PROTECTED AGRICULTURAL AREAS FOR THE STUDY AREA.

As per the protocol, Terms of Reference applicable to an "Agricultural Compliance Statement" is as follows:

- The compliance statement must be prepared by a soil scientist or agricultural specialist registered with the SACNASP. (pg26)
- The compliance statement must:
- be applicable to the preferred site and proposed development footprint (pg6);
- confirm that the site is of "low" or "medium" sensitivity for agriculture(pg25);

- indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site (pg25).
- The compliance statement must contain, as a minimum, the following information:
- contact details and relevant experience as well as the SACNASP registration number of the soil scientist or agricultural specialist preparing the assessment including a curriculum vitae (pg25);
- a map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope, overlaid on the agricultural sensitivity map generated by the screening tool (pg7);
- confirmation from the specialist that all reasonable measures have been taken through micro-siting to avoid or minimise fragmentation and disturbance of agricultural activities (pg25);
- a substantiated statement from the soil scientist or agricultural specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development (pg25);
- any conditions to which the statement is subjected (pg25);
- in the case of a linear activity, confirmation from the agricultural specialist or soil scientist, that in their opinion, based on the mitigation and remedial measures proposed, the land can be returned to the current state within two years of completion of the construction phase (not applicable).
- where required, proposed impact management outcomes or any monitoring requirements for inclusion in the EMPr (not applicable);
- and a description of the assumptions made and any uncertainties or gaps in knowledge or data (pg 4).

ASSUMPTIONS, UNCERTAINTIES OR GAPS

- Desktop data assumed to be correct.

RESULTS

CLIMATE CAPABILITY

The climate is considered a local steppe climate. The Köppen-Geiger climate classification is BSh. The average annual temperature is 18.8 °C. During the year, there is virtually no rainfall, with an annual precipitation of about 374 mm. The site has an arid climate (Figure 7). Therefore, cultivation of dry land crops will prove to be very difficult.

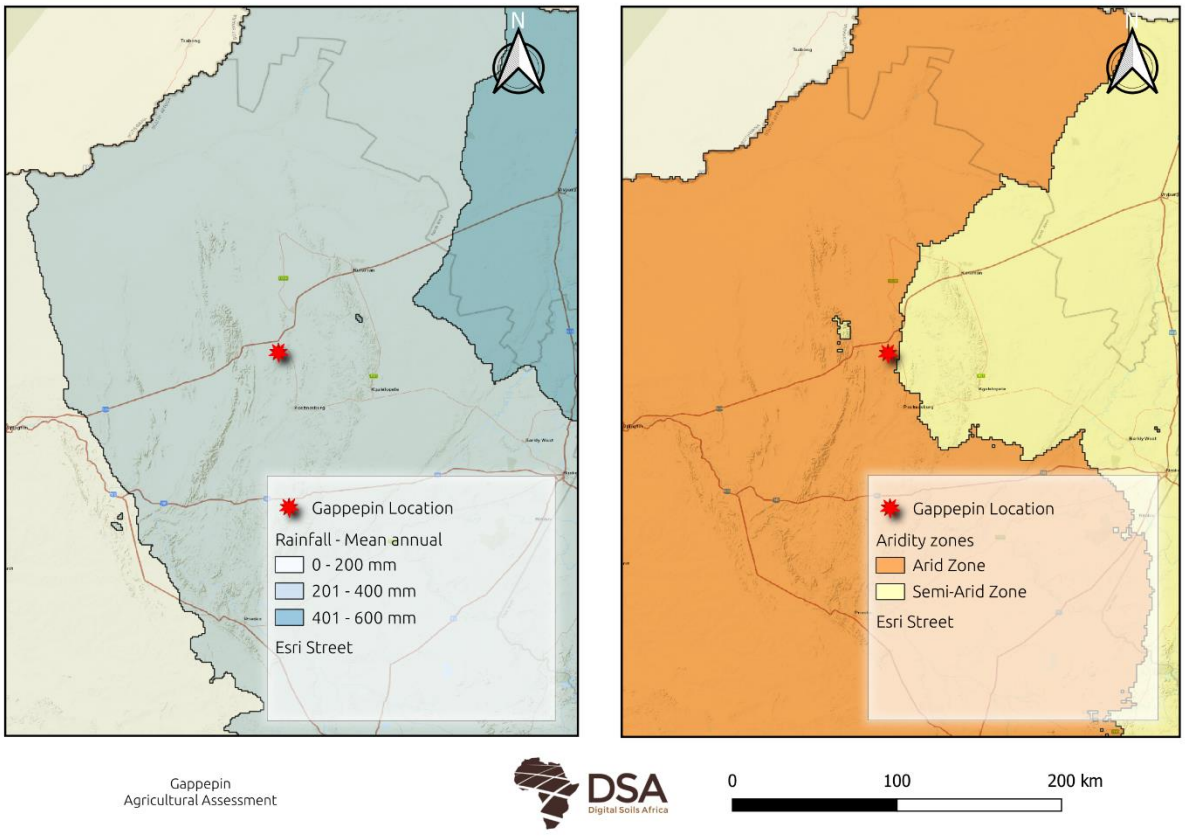


FIGURE 7: CLIMATE OF THE SITE AND THE SURROUNDING AREA (SCHULZE, 2007).

TABLE 1: CLIMATIC PROPERTIES OF KATHU, NORTHERN CAPE PROVINCE (CLIMATE-DATA.ORG).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature	25 °C	24.2 °C	22.2 °C	18 °C	14.4 °C	10.7 °C	10.5 °C	13.5 °C	17.6 °C	21.3 °C	23.3 °C	24.8 °C
Min. Temperature	17.4 °C	17.2 °C	15.3 °C	11 °C	6.8 °C	3.1 °C	2.5 °C	4.6 °C	8.2 °C	12.2 °C	14.2 °C	16.4 °C
Max. Temperature	31.8 °C	31 °C	29.1 °C	25 °C	22.2 °C	18.8 °C	18.8 °C	22 °C	26.3 °C	29.5 °C	31.1 °C	32.2 °C
Rainfall mm	75	60	53	35	12	11	4	5	11	21	31	56
Humidity	39%	44%	47%	50%	46%	47%	42%	33%	26%	25%	26%	33%
Rainy days	8	7	6	4	2	1	1	1	1	3	4	6
avg. Sun hours	11.6	11.1	10.4	9.6	9.3	9.0	9.2	9.8	10.5	11.2	11.8	12.0

Climate capability is highest weighted factor (40%) in the calculation of the Land capability (DAFF, 2017) which is used in the Screening Tool to determine the agricultural sensitivity. Soil capability (30%) and Terrain capability (30%) contribute the remaining considerations. The climate capability consists of 9 values, with 1 being the lowest value and 9 being the highest value (There is however no evaluation value of 1 & 2).

The Climate capability determined by the following factors:

- Moisture supply capacity (50%)
- Physiological capacity (20%)
- Climatic constraints (30%)

The climate capability according to the Department of Agriculture, Forestry and Fisheries, 2017, is a value of 4 (Figure 8Figure 8). This is considered a low to moderate climate capability.

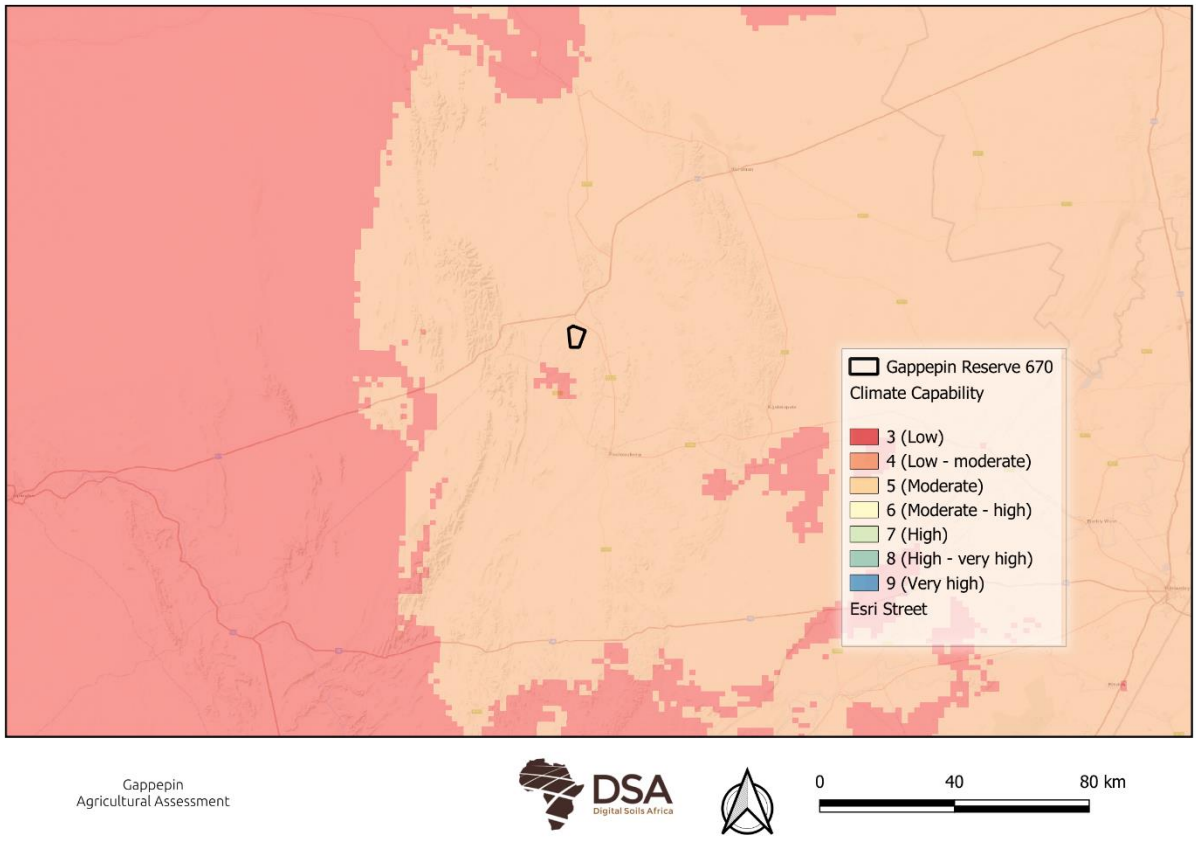


FIGURE 8: THE CLIMATE CAPABILITY OF THE SITE AND SURROUNDING AREA (DAFF, 2017).

SOIL

LANDTYPE

A land type is an area which can be demarcated at a scale of 1:250 000 with similar soil forming factors and therefore soil distribution patterns. A land type does therefore not represent uniform soil polygons, but rather information regarding the occurrence of different soils on different terrain units can be obtained from the land type inventory. Land type data was used in calculating the soil capability (DAFF, 2017), and therefore, indirectly used in the Screening tool for estimating the agricultural sensitivity.

The study area is mainly comprised of two broad land types, namely Ag and Ae (Land Type Survey Staff, 1972 – 2002) (Figure 9). The Ag (110) land type is distributed in the central and northern part of the study area, while the Ag (109) land type only comprises a small part of the southwestern tip of the study area. The Ae (12) land type is distributed in the southern part of the study area. The Ag and Ae broad land types are both described as freely-drained, apedal soils, with the main difference being that the Ae broad land type being predominantly deep, while the Ag broad land type being predominantly shallow (< 300 mm deep) (Land Type Survey Staff, 1972 – 2002). In terms of soil potential, the Ae broad land type provides a higher potential, as the deeper soil allows for roots to penetrate deeper for nutrients and water compared to the shallow soils of the Ag broad land type.

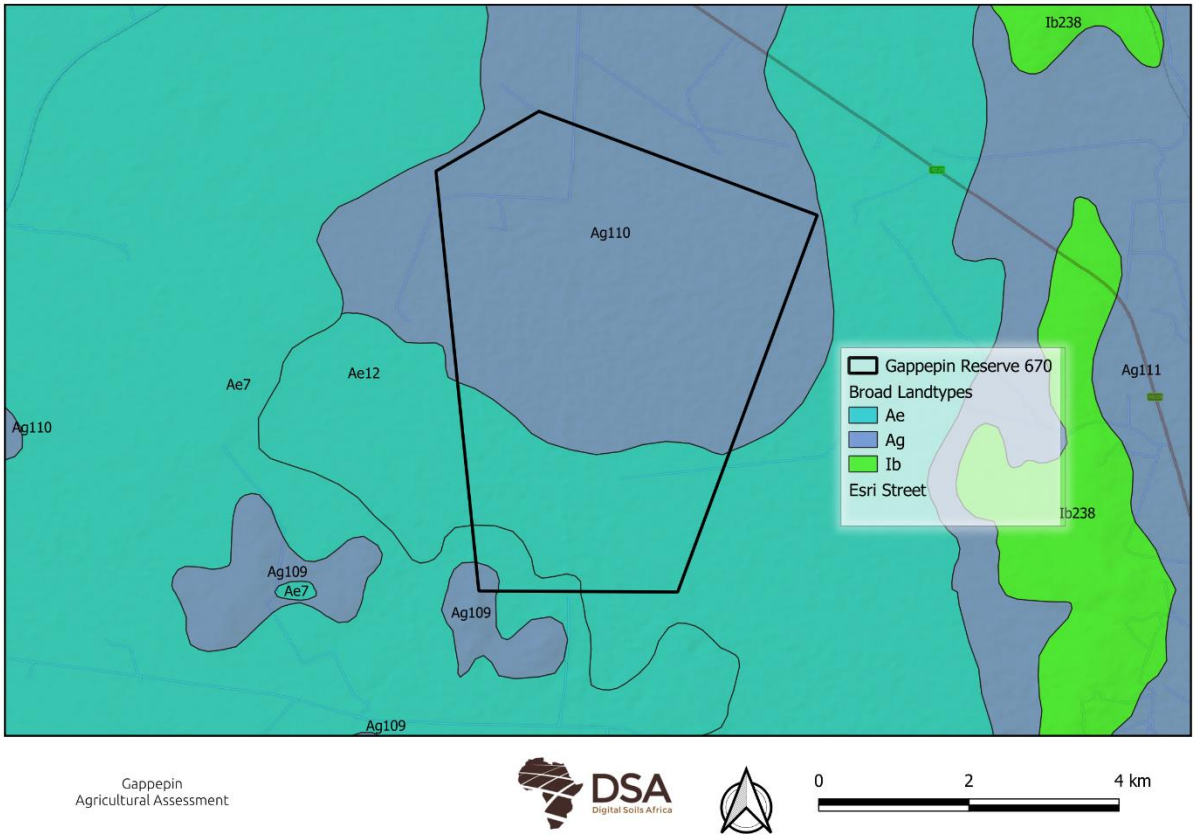


FIGURE 9: LANDTYPES FOUND IN THE STUDY AREA AND THE SURROUNDING AREA (LAND TYPE SURVEY STAFF, 1972 – 2002).

SOIL CAPABILITY

The Soil capability consists of 9 values, with 1 being the lowest value and 9 being the highest value. The main factors contributing to the Soil capability consist of:

- Plan available water (80%)
- Soil sensitivity (17%)
- Soil fertility (3%)

The soil capability of the study area, according to the DAFF (2017), has a range from 2 (Low-Very low) to 5 (Moderate) (Figure 10). The majority of the study area has a soil capability of 3 (Low), with small areas within the study area having a soil capability of 2 (Low-Very low). Only the southwestern part of the study area has a soil capability of 4 (Low-Moderate) and 5 (Moderate). Overall, the study area has a low soil capability.

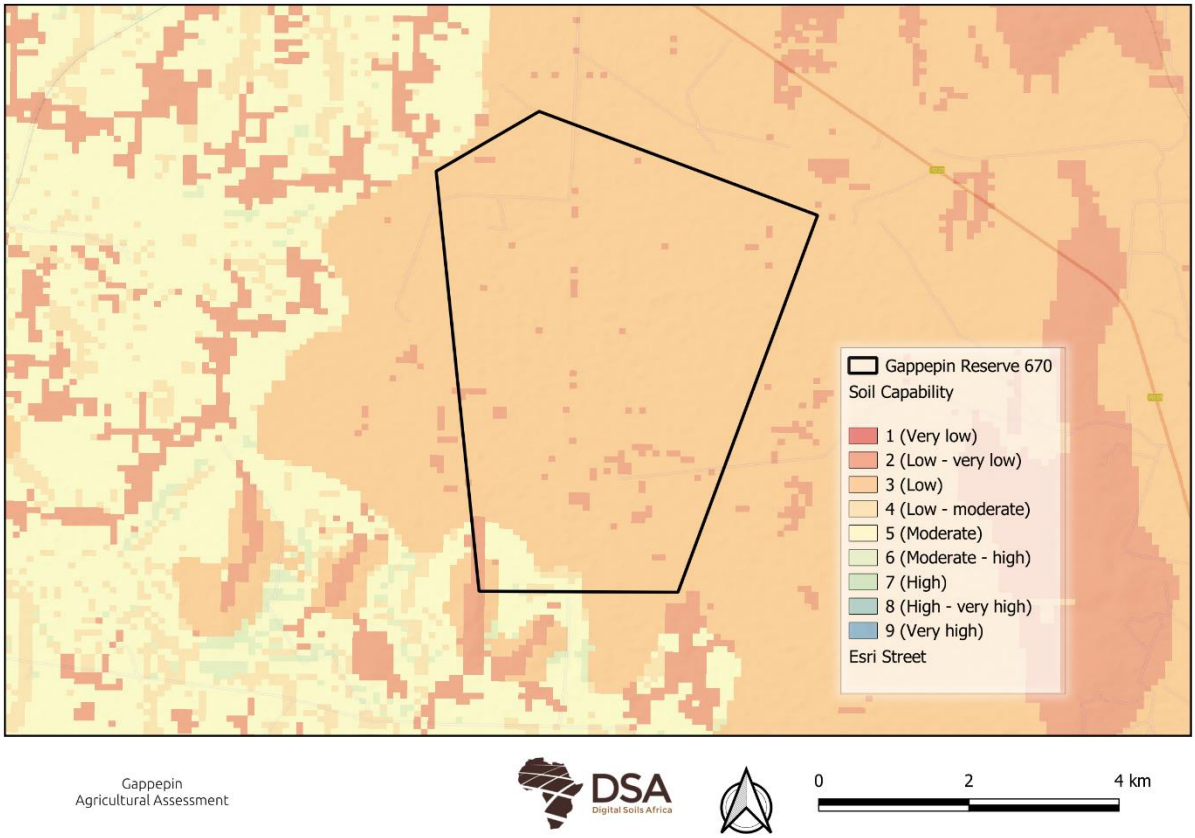


FIGURE 10: THE SOIL CAPABILITY OF THE SITE AND SURROUNDING AREA (DAFF, 2017).

TERRAIN CAPABILITY

Terrain plays an important role in a plants' physiological growth requirements, and from a sensitivity and accessibility perspective, Therefore, the two terrain modelling concerns included in the terrain capability modelling exercise were plant physiology and terrain sensitivity. The Terrain capability consists of 9 values, with 1 being the lowest value and 9 being the highest value.

The terrain capability of the study area, according to the DAFF (2017), has a range from 4 (Low-Moderate) to 8 (High-Very High) (Figure 11). The study area has a terrain capability predominantly of 7 (High), with a very small area in the northern part having a terrain capability of 8 (High-Very High). Also, a very small region in the southwestern part of the study area has a terrain capability in the range of 4 (Low-Moderate) to 6 (Moderate-High). Overall, the study area has a high terrain capability.

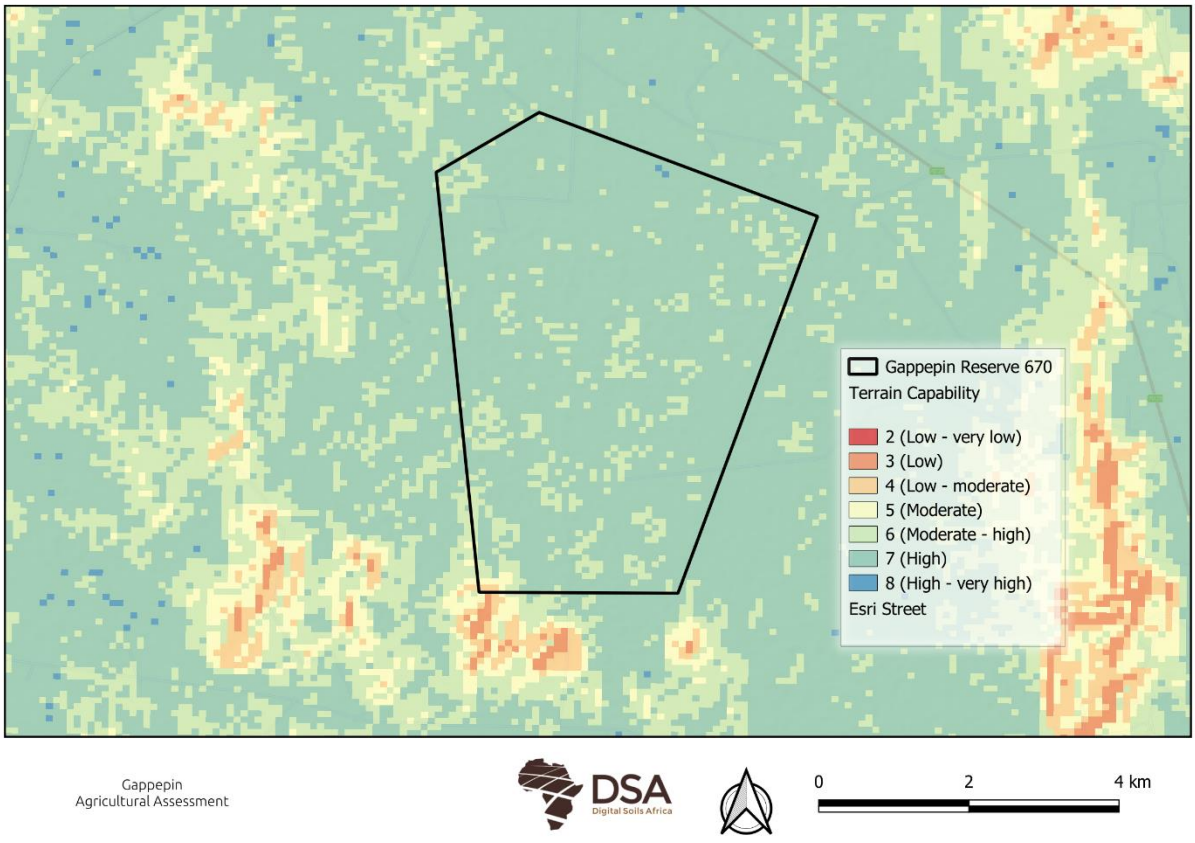


FIGURE 11: THE TERRAIN CAPABILITY OF THE SITE AND SURROUNDING AREA (DAFF, 2017).

LAND CAPABILITY

The new Land capability (Department of Agriculture, Forestry and Fisheries, 2017) has fifteen classes, as opposed to the eight classes described by Schoeman et al. (2002). The data is usable on a scale of 1:50 000 – 1: 100 000, therefore, not suitable for farm scale recommendations. Classes 1 to 7 are of low land capability and only suitable for wilderness or grazing. Classes 8 to 15 are considered to have arable land capability with the potential for high yields increasing with the land capability class number.

TABLE 2: LAND CAPABILITY CLASS AND THE DESCRIPTION OF THE CLASS

Land Capability Class	Description	
1-2	Very Low	Not arable
3-4	Very Low to Low	
5	Low	
6-7	Low to Moderate	
8	Moderate	Arable
9-10	Moderate to High	
11	High	
12-13	High to Very High	
14-15	Very High	

The Land capability values of the study area are between 4 (Very low to Low) and 7 (Low to moderate), which is in the range of non-arable soils (1-7), with low land capability (Figure 12Figure 12).

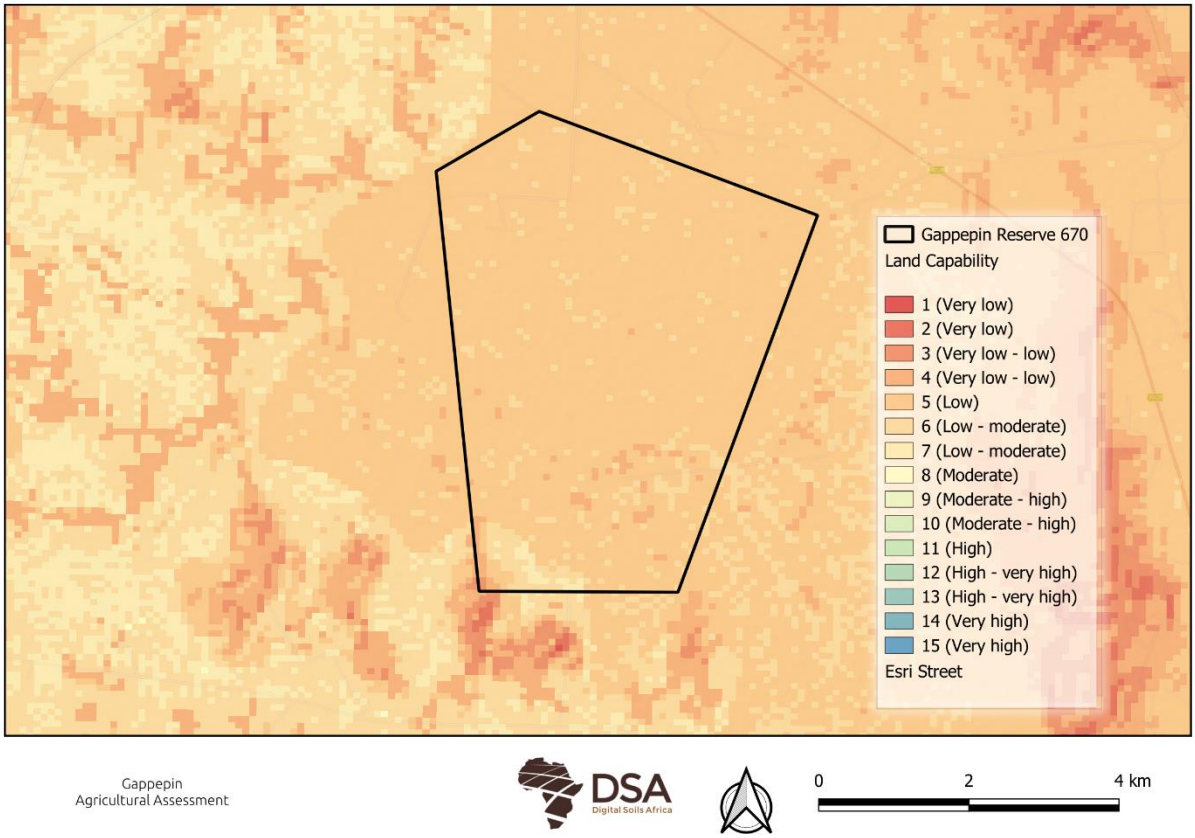


FIGURE 12: LAND CAPABILITY CLASS MAP OF THE STUDY AREA (DAFF, 2017).

GRAZING CAPACITY

The unit used in the grazing capacity is hectares per large stock unit (ha/LSU). The site has a low to moderate grazing capacity of 14 ha/LSU (Figure 13Figure 13). A homogeneous unit of vegetation expressed as the area of land required (in hectares) to maintain a single animal unit (LSU) over an extended number of years without deterioration to vegetation or soil. Where an LSU = An animal with a mass of 450 kg and which gains 0.5 kg per day on forage with a digestible energy of 55%. (Trollope et. Al., 1990).

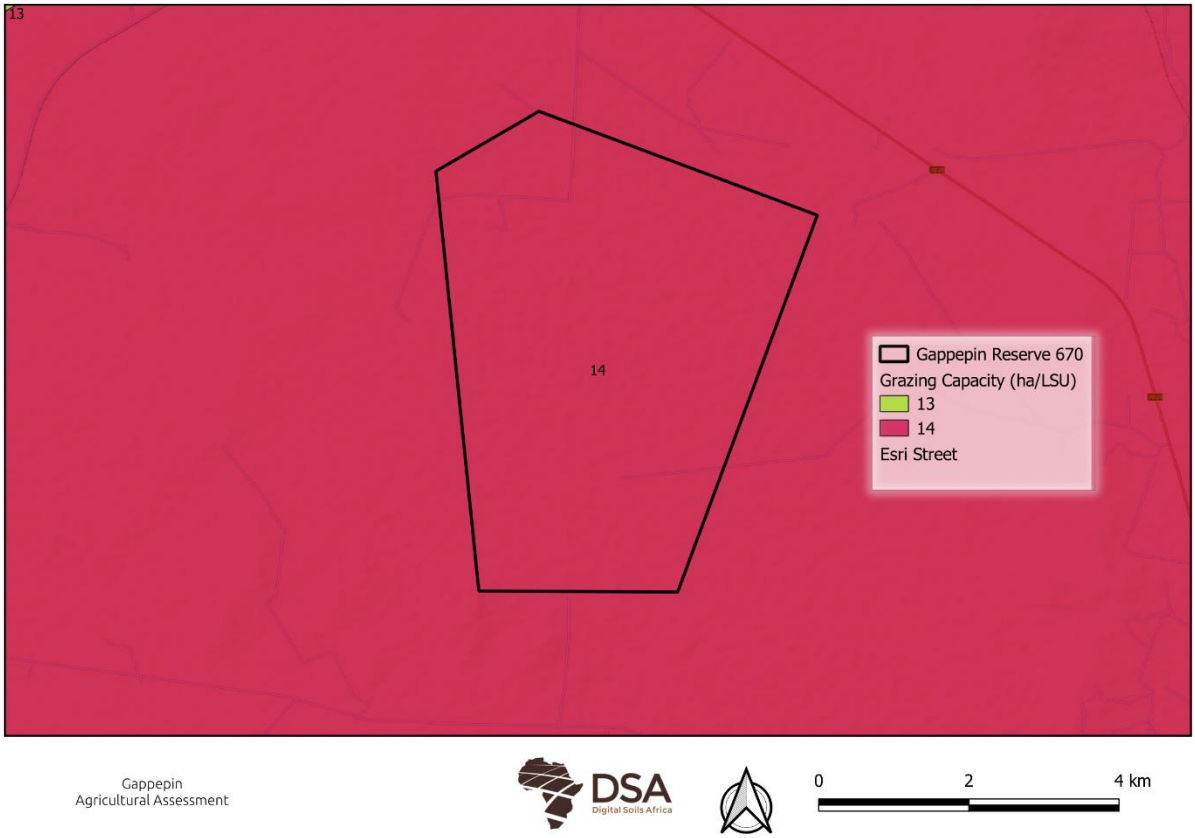


FIGURE 13: GRAZING CAPACITY FOR THE SITE AND THE SURROUNDING AREA (DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES, 2016).

LAND USE

South African National Land-Cover 2020 (SANLC 2020) (GeoTerraImage, 2020) was compared to the 2014 Land Cover to determine if there was a land use change since 2014, and there was very little conflicting classification in the study area. SANLC 2020 classifies the area as predominantly low shrubland (Fynbos) (8), together with natural grassland (13) (Figure 14). There are indications of dry pans (26) in the northwestern, central and southern part of the study area (Figure 14). Smaller areas within the study area also indicate the presence of dense forests (4) and the northwestern part of the study area indicate a small village community (55 and 56), as well as the presence of a natural inland pan (18) (Figure 14).

TABLE 3: LEGEND TO FIGURE 14

No.	Class Name	Class Definition
4	Contiguous & Dense Planted Forest	Dense to contiguous cover, planted tree forests, consisting primarily of exotic timber species, with canopy cover exceeding 35%, and canopy heights exceeding 2.5 metres. Typically represented by mature commercial plantation tree stands. This class also includes smaller woodlots and windbreaks, where they have been identified by the same spectral-based image modelling procedures used to detect the plantation forests.
8	Low Shrubland (Fynbos)	Natural, low woody shrubland communities, where the total plant canopy cover is typically both dominant over any adjacent bare ground exposure, and the canopy height ranges between 0.2 – 2 metres. Note: this definition differs slightly from the equivalent gazetted class definition (i.e. total plant canopy cover ranges between 10 - 100%) in order to provide a more comparable content to the 1990 and 2013-14 SANLC datasets. If a tree or tall bush woody cover is evident it is typically < 0.1 % of total canopy cover. Typically representative of low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially outside the SANBI defined boundaries for Fynbos, Succulent and Nama-Karoo vegetation communities. This is the same approach as used in the 1990 and 2013-14 SANLC datasets and has been replicated for consistency and comparability.
13	Natural Grassland	Natural and/or semi-natural indigenous grasslands, typically devoid of any significant tree or bush cover, and where the grassland component is typically dominant over any adjacent bare ground exposure. Typically representative of low, grass-dominated vegetation communities in the Grassland and Savanna Biomes.
18	Natural Pans (flooded)	Naturally occurring inland waterbodies within pans, where the water extent is both spatially and temporally sufficient to be image-detectable. The spatial extent of classified water is the cumulative extent of all image-detectable open water surfaces from all available images used in the production of the NLC dataset; which is comparable to the annual maximum extent. Note that the occurrence of rooted or floating emerge.
26	Barren Land (dry pans)	Area is comprised of consolidated pans that dried out.
55	Village Scattered	Built-up areas primarily associated with scattered rural settlements and associated utilities. It may include some adjacent areas of subsistence farming, especially if the village structures and fields are inter-mixed. This

		class is also associated with both structures on individual (commercial or smallholding) farming units, depending on clustering and size. Scattered villages are defined as those represented by contiguous / adjacent village-classified cells which collectively do not form the majority cover in a surrounding 1 ha window. Note that the class extent includes both bare / non-vegetated and low vegetation covered areas within the village boundary. Woody cover is excluded from this class and represented separately (i.e. classes 2 – 4).
56	Village Dense	Built-up areas primarily associated with scattered rural settlements and associated utilities. It may include some adjacent areas of subsistence farming, especially if the village structures and fields are inter-mixed. This class is also associated with both structures on individual (commercial or smallholding) farming units, depending on clustering and size. Dense villages are identified as those represented by contiguous / adjacent village- cells which collectively do form the majority cover in a surrounding 1 ha window. Woody cover is excluded from this class and represented separately (i.e., classes 2-4).

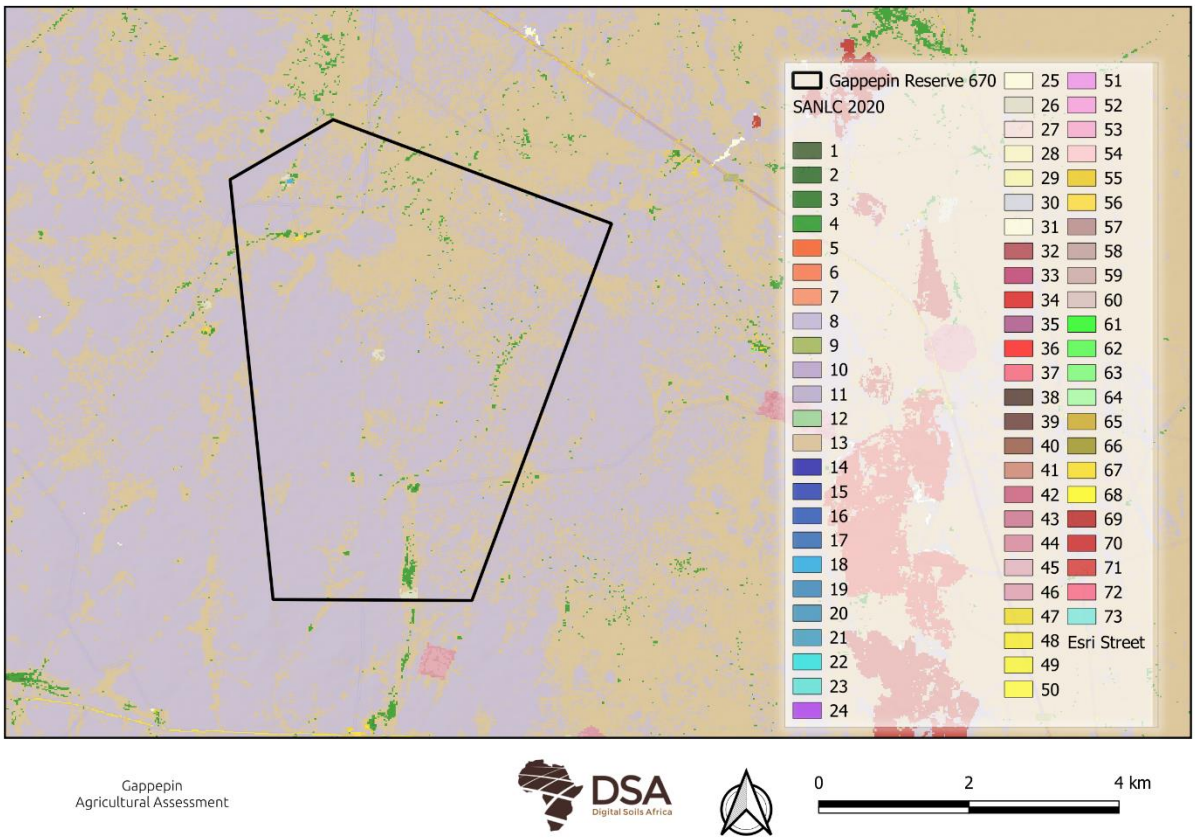


FIGURE 14: SOUTH AFRICAN NATIONAL LAND-COVER 2020 (SANLC 2020).

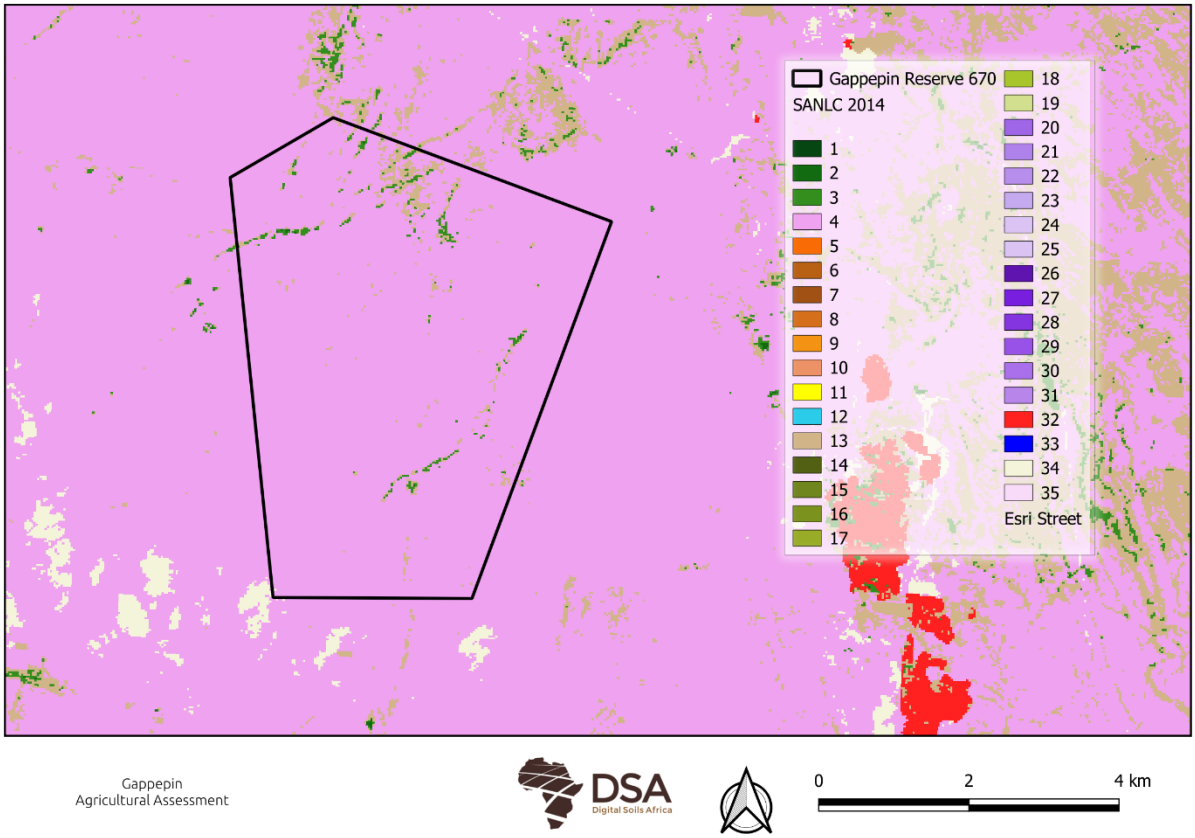


FIGURE 15: SOUTH AFRICAN NATIONAL LAND-COVER 2014 (SANLC 2014).

From Figures 16-18, the land-use did not change, being predominantly low shrubland and natural grassland throughout the study area.

FIGURE 16: GOOGLE EARTH IMAGE (2013) OF GAPPEPIN.

FIGURE 17: GOOGLE EARTH IMAGE (2018) OF GAPPEPIN.

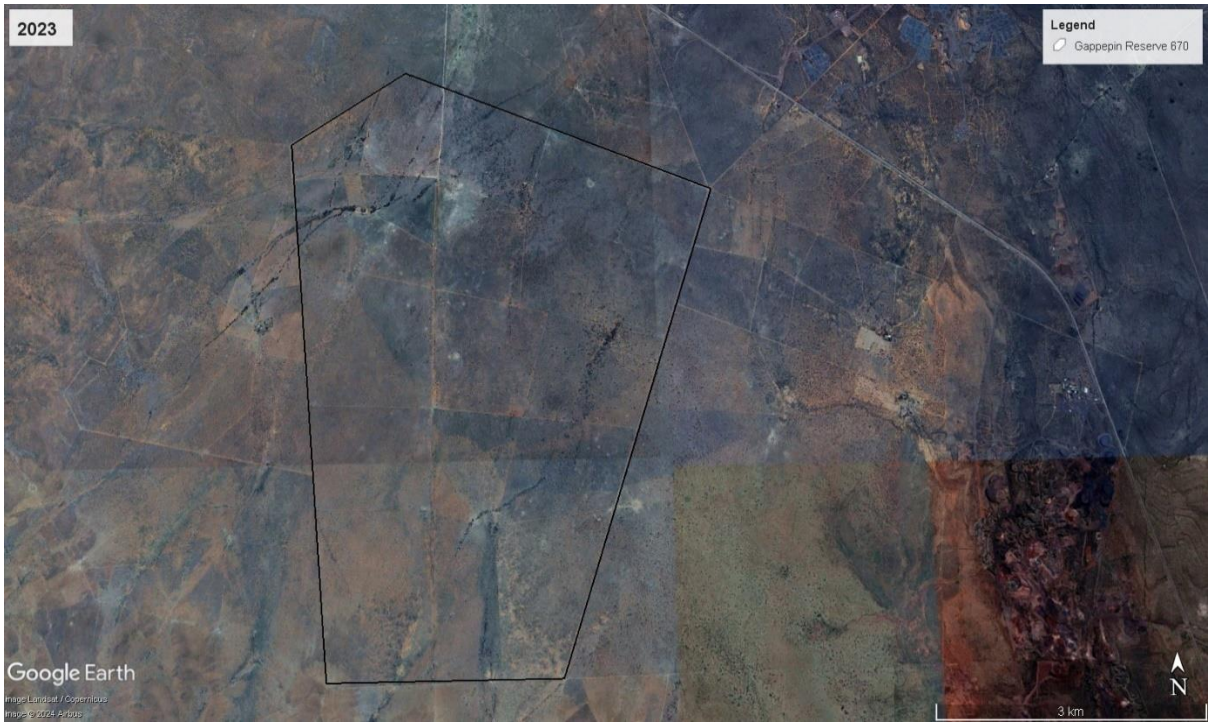


FIGURE 18: LATEST GOOGLE EARTH IMAGE (2023) OF GAPPEPIN.

COMPLIANCE STATEMENT

This Agricultural Compliance Statement conforms with the Environmental Authorization requirements stipulated by the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA"). The Environmental Screening Report (ESR) generated through the National Web-based Screening Tool identifies the study area as having a medium sensitive according to the Agricultural theme.

Findings from the desktop assessment:

- The study area is not situated within a Northern Cape Protected Agricultural Area.
- No field crop boundaries are recorded in the study area.
- The climate capability of the area was classified as low to moderate due to the very low mean annual rainfall and arid environment.
- The Ae and Ag broad land types dominate the study area, which indicate the northern part of the study area is comprised of shallower soils (< 300 mm deep), while the southern part of the study area is comprised of deeper soils.
- Area had a high terrain capability.
- The overall land capability was concluded as low.
- The grazing capacity of the study area was moderate (14 ha/LSU).

Therefore, the desktop assessment aligns with the screening tool of medium agricultural sensitivity. Due to the small footprint and low impact on existing agricultural activities, it is the specialist's opinion that the development continues. The development will not have a significant impact on agricultural activities in the area and poses no threat to food security. In terms of agricultural sensitivity, the development should thus be allowed to proceed.

APPENDIX 1: SPECIALIST CV

DR DARREN BOUWER

EDUCATION

PhD Soil Science	University of the Free State	2018
M.Sc. Soil Science	University of the Free State	2013
B.Sc. Soil Science (Hon)	University of the Free State	2009
B.Sc. Soil Science	University of the Free State	2008
Matric certificate	Queens College	2005

PROFESSIONAL AFFILIATIONS

- SACNASP- Pri Nat Sci 400081/16
- Member of the Soil Science Society of South Africa
- Member of the Soil Classification Work Group
- Member of South African Soil Surveyors Organisation

WORK EXPERIENCE

- **Digital Soils Africa** / Soil Scientist - May 2012 – Present
- **Ghent University** / Researcher- January 2016 - December 2016
- **University of the Free State**/ Assistant Researcher- January 2011- December 2015

PUBLICATIONS

Total consultancy reports: >120 **Total Publications: 6**

Most relevant:

Bouwer, D., Le Roux, P. A., van Tol, J. J., & van Huyssteen, C. W. (2015). Using ancient and recent soil properties to design a conceptual hydrological response model. Geoderma, 241, 1–11.

Van Zijl, G. M., Bouwer, D., van Tol, J. J., & le Roux, P.A.L. (2014). Functional digital soil mapping: A case study from Namarroi, Mozambique. Geoderma, 219-220, 155–161.

SPECIALIST DECLARATION

I, Darren Bouwer, declare that –

- I act as the independent specialist in this application;
- I regard the information contained in this report to be true and correct;
- I do not have a conflict of interest in this project;
- I will conduct the work relating to the project in an objective manner.

Dr Darren Bouwer
PhD Soil Science
Pri Nat Sci 400081/16

APPENDIX 7

TERRESTRIAL BIODIVERSITY ASSESSMENT

Desktop Terrestrial Biodiversity Assessment for the Proposed Prospecting Right Application on the Farm Gappepin Reserve 670

Tsantsabane Local Municipality, Kathu, Northern Cape Province, South Africa

25/03/2024

Prepared by:

The Biodiversity Company

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Report Name	**Desktop Terrestrial Biodiversity Assessment for the Proposed Prospecting Right Application on the Farm Gappepin Reserve 670**	
Specialist Theme	Terrestrial Biodiversity Theme	
Project Reference	Gappepin Prospecting Right Application	
Report Version	Draft 1 / 25/03/2024	
Environmental Assessment Practitioner	prime | resources	
Report Writer	Byron Goris	
Reviewer	Martinus Erasmus (SACNASP 118630)	
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.	

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1 Introduction

1.1 Background

The Biodiversity Company was appointed to undertake a Desktop Terrestrial Scoping Report for the prospecting right application near Kathu, within the Tsantsabane Local Municipality, Northern Cape Province. The proposed project is for the planned prospecting activities located on Portion 0 of the Farm Gappepin Reserve 670. A map presenting the regional context of the Project Area can be seen in Figure 1-1 and a map presenting the Project Footprint can be seen in Figure 1-2. The Project Area of Influence (PAOI) is defined as the project area combined with a buffer of a specified distance (500 m, 5 km, or 10 km – depending on the ecological factor considered) placed around the project area where relevant ecological impacts are expected to occur.

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations (2014) (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices (GN) 320 (20 March 2020) and GN 1150 (30 October 2020) in terms of NEMA, dated 20 March and 30 October 2020: “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation” (Reporting Criteria).

This report, after taking into consideration the findings and recommendation provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making with regards to the ecological viability of the proposed development and related activities.

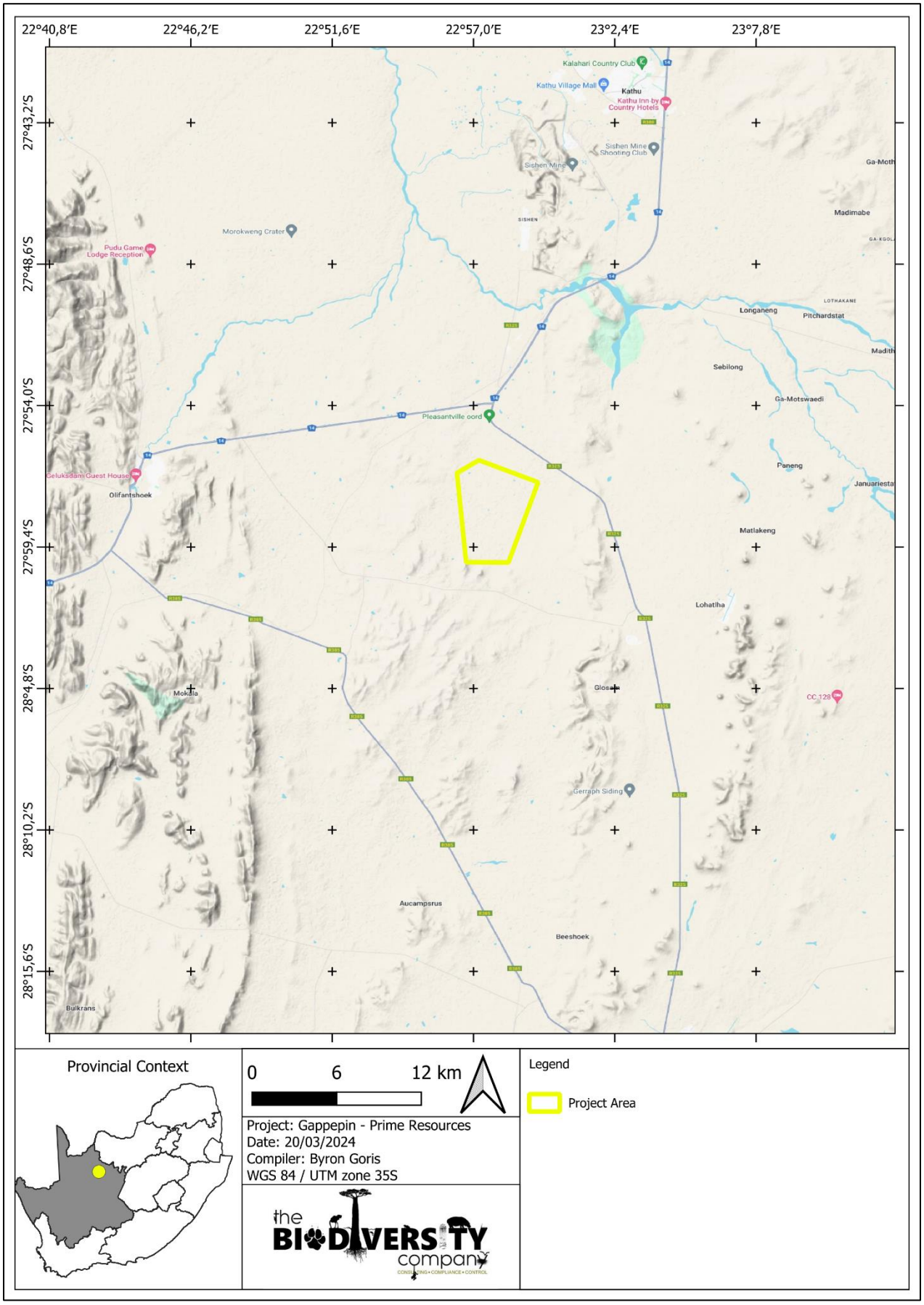


Figure 1-1 Location of the proposed project

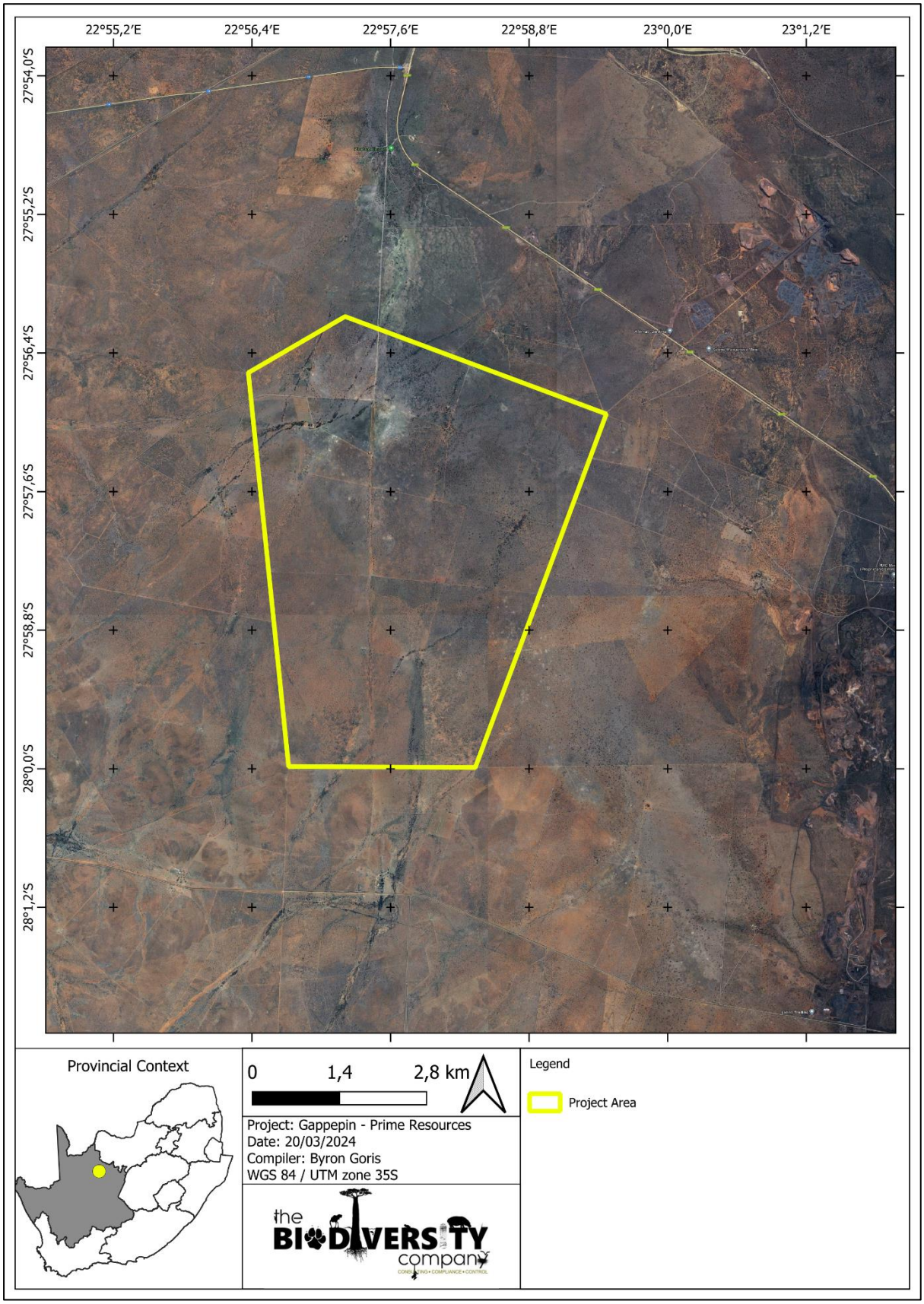


Figure 1-2 Map illustrating the project layout

1.2 Scope of Work

The principle aim of the scoping assessment was to identify any constraints for the development of the area. This was achieved through the following:

- Desktop assessment to identify the relevant ecologically important geographical features within the project area;
- Desktop assessment to compile an expected species list and identify possible threatened flora and fauna species that occur within the project area;
- Desktop assessment to identify the relevant land types within the project area;
- Completion of an initial impact assessment based on based on the desktop findings; and
- The prescription of mitigation measures and recommendations for identified risks.

According to Prime Resources (2024), the prospecting right application includes non-invasive and invasive activities. Furthermore, the prospecting activities are expected to be undertaken over a period of three years.

The prospecting activities proposed include:

- Desktop research and literature reviews;
- Surface geological mapping;
- Geophysical surveys (ground magnetic and ground gravity techniques);
- Development of geological models; and
- Diamond drilled exploration boreholes.

In addition, further considerations for the invasive activities (exploration boreholes) include:

- If the outcomes of the above validation studies reveal the need for additional exploration drilling, up to 20 boreholes may be drilled across the site. Boreholes will likely be drilled to a depth of 50 – 100 m.
- The positions of exploration boreholes (i.e., the drilling grid) will be confirmed once the initial, non-invasive desktop studies (geological mapping) and geophysical surveys have been completed. In addition to the underlying geology, drillhole locations will take into account any environmental features (such as the presence of pans/wetlands) and proximity to existing access tracks. Areas identified as no-go areas include the 500 m regulated areas around the pans, pending confirmation of presence by specialist.
- Access tracks to the drill sites will be determined in consultation with the landowner. Where possible available access roads and tracks will be used. Potentially new access tracks may be required. Any new access roads developed must be less than 4 m wide and less than 1 km long.
- A 10 m x 10 m drill pad will be required per drill site for the drilling rig and sump. Drill pads will be cordoned off with danger tape or fences if required.

- Small volumes of consumables required for drilling will be stored at the drill pad. This may include biodegradable drilling fluid, portable diesel bowser and any required lubricants. Storage and handling of dangerous goods with a combined capacity of less than 30 m^3 i.e. hydrocarbon storage (including diesel storage).
- Water and diesel required for borehole drilling activities will be sourced off-site.
- Cores will be taken to a temporary storage yard for logging, sampling and storage.
- Portable chemical toilets will be used for the management of sewage waste generated on site.
- Drill pads will be rehabilitated following the completion of exploration drilling at that position.

1.3 Assumptions and Limitations

The following aspects were considered as limitations:

- It has been assumed that the extent of the project area provided to the specialist is accurate;
- For this desktop report, the Project Footprint was considered together with a wider Project Area of Influence (PAOI) which will inform the field survey and subsequent impact assessments, according to required protocols based on regulated areas and legislation. The PAOI is necessary because prospecting of this nature has the potential for primary and secondary impacts on the surrounding habitats of the Project Footprint which must therefore be taken into account, especially from a wetlands/aquatic perspective;
- The impact assessment was based only on the desktop information available – no preliminary on-site inspection was carried out at the time of writing this report;
- Planned drilling descriptions were provided however greater detail to prospecting activities is provided in the Basic Assessment Report (BAR); and
- Apart from the project site polygon, no spatial information was provided in relation to the layout of the proposed drill pads at the time of report preparation, therefore the impacts and their significance ratings should be revisited upon finalisation of a full project layout.

1.4 Key Legislative Requirements

The legislation, policies and guidelines listed below in Table 1-1 are applicable to the current project. The list below, although extensive, may not be complete and other legislation, policies and guidelines may apply in addition to those listed below.

Table 1-1 A list of key legislative requirements relevant to biodiversity and conservation in the Northern Cape Province

Region	Legislation / Guideline
National	Constitution of the Republic of South Africa (Act No. 108 of 1996)
	The National Environmental Management Act (Act No. 107 of 1998) (NEMA)
	The National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
	The National Environmental Management: Biodiversity Act (Act No. 10 of 2004), Threatened or Protected Species Regulations
	Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 320 of Government Gazette 43310 (March 2020)
	Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 1150 of Government Gazette 43855 (October 2020)
	The National Environmental Management: Waste Act (Act 59 of 2008)
	The Environment Conservation Act (Act No. 73 of 1989)
	Natural Scientific Professions Act (Act No. 27 of 2003)
	National Biodiversity Framework (NBF, 2009)
	National Forest Act (Act No. 84 of 1998)
	National Veld and Forest Fire Act (Act No. 101 of 1998)
	National Water Act) (Act No. 36 of 1998) (NWA
	World Heritage Convention Act (Act No. 49 of 1999)
	Municipal Systems Act (Act No. 32 of 2000)
	Alien and Invasive Species Regulations and, Alien and Invasive Species List 20142020, published under NEMBA
	Conservation of Agricultural Resources Ac, (Act No. 43 of 1983) (CARA)
Provincial	Northern Cape Planning and Development Act (Act No. 7 of 1998)
	Northern Cape Nature Conservation Act (Act No. 9 of 2009)

2 Desktop Assessment

The desktop assessment was principally undertaken using a Geographic Information System (GIS) to access the latest available spatial datasets to develop digital cartographs and species lists. These datasets and their date of publishing are provided below.

2.1 Ecologically Important Landscape Features

Existing ecologically relevant data layers were incorporated into a GIS to establish how the proposed project might interact with any ecologically important entities. Emphasis was placed around the following spatial datasets:

2.1.1 Conservation/Biodiversity Sector Plan

The Northern Cape Department of Environment and Nature Conservation has developed the Northern Cape CBA Map which identifies biodiversity priority areas for the province, called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs). These biodiversity priority areas, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape as a whole.

The identification of Critical Biodiversity Areas for the Northern Cape was undertaken using a Systematic Conservation Planning approach. Available data on biodiversity features (incorporating both

pattern and process, and covering terrestrial and inland aquatic realms), their condition, current Protected Areas and Conservation Areas, and opportunities and constraints for effective conservation were collated.

2.1.2 National Biodiversity Assessment 2018

The purpose of the National Biodiversity Assessment 2018 (NBA) (Skowno et al, 2019) is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA deals with all three components of biodiversity: genes, species and ecosystems; and assesses biodiversity and ecosystems across terrestrial, freshwater, estuarine and marine environments. The three headline indicators assessed in the NBA are:

- **Red List of Ecosystems (RLE) 2021** – The list was first published in 2011 and has since been substantially revised by authors Dr Andrew Skowno and Mrs Maphale Monyeki (SANBI, 2022). This list is based on assessments that followed the International Union for Conservation of Nature (IUCN) Red List of Ecosystems Framework (version 1.1) and covers all 456 terrestrial ecosystem types described in South Africa by Mucina and Rutherford (2006). A total of 120 of the 456 terrestrial ecosystem types assessed are categorised as threatened and together make up approximately 10% of the remaining natural habitat in the country. Of these 120 ecosystem types, 55 are Critically Endangered (CR), 51 Endangered (EN) and 14 are Vulnerable (VU). The remainder are categorised as Least Concern (LC) (SANBI, 2022; Skowno & Monyeki, 2021).

- **Ecosystem Threat Status (ETS)** – indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition. The revised red list of threatened ecosystems was developed between 2016 and 2021 incorporating the best available information on terrestrial ecosystem extent and condition, pressures and drivers of change. The revised list (known as the Red List of Ecosystems (RLE) 2022) is based on assessments that followed the International Union for Conservation of Nature (IUCN) Red List of Ecosystems Framework (version 1.1) and covers all 456 terrestrial ecosystem types described in South Africa (Mucina and Rutherford 2006; with updates described in Dayaram et al., 2019). The revised list identifies 120 threatened terrestrial ecosystem types (55 Critically Endangered, 51 Endangered and 14 Vulnerable types). The revised list was published in the Government Gazette (Gazette Number 47526, Notice Number 2747) and came into effect on 18 November 2022.

- **Ecosystem Protection Level (EPL)** – indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas (PA). NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems.

2.1.3 South Africa's Red List of Terrestrial Ecosystems

Skowno & Monyeki (2021) applied a systematic Red List of Ecosystems (RLE) assessment to 456 terrestrial ecosystems in South Africa between 2017 and 2021, in order to support the replacement of the existing list of threatened ecosystems (2011) with the RLE (2021). The revision is based on the best available data and used the IUCN RLE risk assessment framework version 1.1. Ecosystems are categorised into one of four classes representing their risk of collapse; in descending order of risk: Critically Endangered, Endangered, Vulnerable, Least Concern. The revised list identifies 120

threatened terrestrial ecosystem types (55 Critically Endangered, 51 Endangered and 14 Vulnerable types).

The RLE is an important input into spatial planning and decision making in South Africa. The list and the spatial data underpinning it is referred to in national regulations relating to environmental impact assessment (EIA); specifically – Critically Endangered and Endangered ecosystem types trigger additional steps and processes during environmental authorisation processes (SANBI & DFFE, 2021). The 2021 RLE has been legislated by the publication of the Revised National List of Ecosystems that are Threatened and in need of Protection, under the National Environmental Management: Biodiversity Act, 2004 – published in Government Gazette No. 47526, 18th of November 2022.

For reference purposes this database is used in conjunction with the NBA 2018 database as discussed above, however it is noted that the 2021 RLE database is regarded as the most recent and relevant database that is actively legislated and managed by provincial and national authorities.

2.1.4 South Africa Protected and Conservation Areas

South Africa Protected Areas Database (SAPAD) (Department of Environmental Affairs (DEA), 2020) – The (SAPAD) Database contains spatial data for the conservation of South Africa. It includes spatial and attribute information for both formally protected areas and areas that have less formal protection. SAPAD is updated on a continuous basis and forms the basis for the Register of Protected Areas, which is a legislative requirement under the National Environmental Management: Protected Areas Act, Act 57 of 2003 (NEMPAA).

Formally protected areas are categorised according to several different types, and each type is subject to specific legislative restrictions and management guidelines, many of which restrict development to some degree. Generally, these areas are assigned a buffer of influence of between 5 and 10 km (the latter pertaining to National Parks and World Heritage Sites), within which certain laws and management actions may apply. Many of the protected area types are further classified into sub-types as well. Formally protected area types include:

- National Parks;
- Nature Reserves;
- Special Nature Reserves;
- Mountain Catchment Areas;
- World Heritage Sites;
- Protected Environments;
- Forest Nature Reserves and Forest Wilderness Areas;
- Specially Protected Forest Areas; and
- Marine Protected Areas.

The Department of Forestry, Fisheries and the Environment (DFFE) maintains a spatial database on PAs and Conservation Areas. The Protected Areas and Conservation Areas (PACA) Database scheme is used for classifying protected areas (South Africa Protected Areas Database-SAPAD) and conservation areas (South Africa Conservation Areas Database-(SACAD)) into types and sub-types in South Africa.

2.1.4.1 National Protected Areas Expansion Strategy

National Protected Areas Expansion Strategy (NPAES) (SANBI, 2018) – The Department of Environmental Affairs (now the Department of Forestry, Fisheries and the Environment) led the development of the National Protected Areas Expansion Strategy (NPAES) in consultation with the protected area agencies and other key private and public sector stakeholders. The need for the development of the NPAES was established in the National Biodiversity Framework in 2009. The NPAES is a 20-year strategy with 5-year implementation targets aligned with a 5-year revision cycle. (DEA, 2016).

South Africa's protected area network currently falls far short of representing all ecosystems and maintaining healthy functioning ecological processes. In this context, the goal of the NPAES is to achieve cost effective protected area expansion thus enabling better ecosystem representation, ecological sustainability, and resilience to climate change. A comprehensive set of priority areas was compiled based on the priorities identified by provincial and other agencies in their respective protected area expansion strategies. These focus areas are generally large, intact and unfragmented and are therefore of high importance for biodiversity, climate resilience and freshwater protection (DEA, 2016).

2.1.5 Important Bird and Biodiversity Areas

Important Bird and Biodiversity Areas (IBAs) are sites of international significance for the conservation of the world's birds, and other conservation significant species, as identified through multi-stakeholder processes using globally standardised, quantitative, and scientifically agreed criteria. These sites are also Key Biodiversity Areas; sites that contribute significantly to the global persistence and health of biodiversity (Birdlife, 2020).

The selection of IBAs is achieved through the application of quantitative ornithological criteria, grounded in up-to-date knowledge on the sizes and trends of bird populations. The criteria ensures that sites selected as IBAs have true significance for the international conservation of bird populations, and it also ensures classification consistency among sites at all geographic levels.

IBAs constitute a global network of over 13 500 sites, of which 112 sites are found in South Africa. Approximately 60% of the IBA network is unprotected, leaving these sites vulnerable to habitat transformation and mismanagement. Additionally, habitats within many IBAs are poorly managed, leading to habitat degradation, especially in unprotected sites. (BirdLife SA, 2022)

2.2 Desktop Flora Assessment

The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006) and SANBI (2019) were used to identify the vegetation type that would have occurred under natural or pre-anthropogenically altered conditions. Furthermore, the Plants of Southern Africa (POSA) database was accessed to compile a list of expected flora species within the project area (Figure 2-1). The Red List of South African Plants (Raimondo *et al.,* 2009; SANBI, 2020) was utilised to provide the most current national conservation status of flora species.

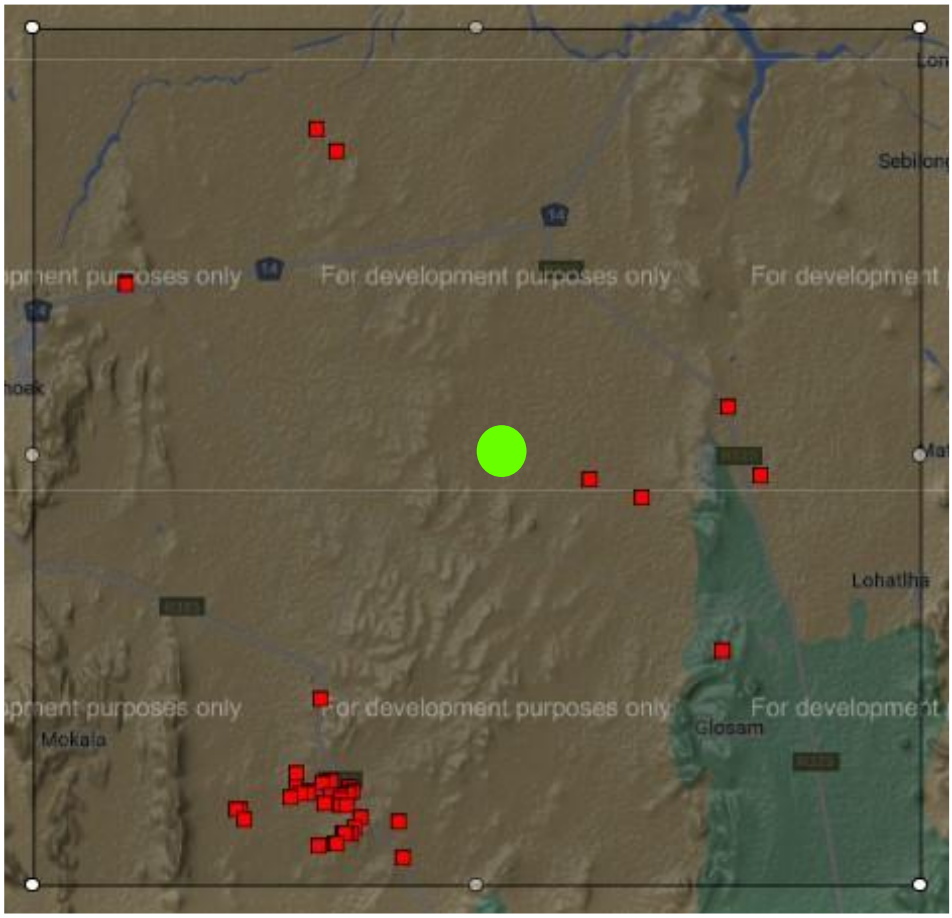


Figure 2-1 ***Map illustrating extent of area used to obtain the expected flora species list from the Plants of South Africa (POSA) database. The green icon is the approximate location of the project***

The latest information regarding provincially, and nationally protected flora was obtained from the following published legislative sources:

- Northern Cape Nature Conservation act no. 9 of 2009
- List of Nationally Protected Tree Species (DEFF, 2022); and
- Nationally Protected plant species (The 2022 lists of Threatened or Protected Species (TOPS), published in terms of Section 56(1) of the NEM:BA).

2.3 Desktop Faunal Assessment

The faunal desktop assessment comprised of the following, compiling an expected:

- Amphibian list, generated from the FrogMap database (Fitzpatrick Institute of African Ornithology, 2023c), using the 2722DD quarter degree square;
- Reptile list, generated from the ReptileMap database (Fitzpatrick Institute of African Ornithology, 2023b), using the 2722DD quarter degree square;
- Avifauna list, generated from the SABAP2 dataset by looking at pentads surrounding the project area; and
- Mammal list from the MammalMap database (Fitzpatrick Institute of African Ornithology, 2023a), using the 2722DD quarter degree square.

The latest information regarding provincially, and nationally protected fauna was obtained from the following published legislative lists:

- Northern Cape Nature Conservation act no. 9 of 2009; and
- Nationally Protected Wildlife species (The 2007 lists of Threatened or Protected Species (TOPS), published in terms of Section 56(1) of the NEM:BA, Act No. 10 of 2004).

3 Results & Discussion

3.1 Ecologically Important Landscape Features

The GIS analysis pertaining to the relevance of the proposed project to ecologically important landscape features is summarised in Table 3-1.

Table 3-1 Summary of relevance of the proposed project to ecologically important landscape features.

Desktop Information Considered	Relevant/Irrelevant	Section
Ecosystem Threat Status	Irrelevant – Overlaps with 'Least Concern' Ecosystems.	3.1.1
Ecosystem Protection Level	Relevant – Overlaps with a 'Poorly Protected' and some 'Not Protected Ecosystems.	3.1.2
Provincial Conservation Plan	Relevant – Overlaps with some isolated freshwater ESAs but is otherwise classified as "Other Natural Areas" (ONAs).	3.1.3
Protected Areas	Relevant – The nearest protected area is the 'Brooks Nature Reserve' and 'Bredenkamp Nature Reserve' situated approximately 12 km north-west of the project area.	3.1.4
National Protected Areas Expansion Strategy	Irrelevant – The project area does not overlap with NPAES areas.	3.1.5
Important Bird and Biodiversity Areas	Irrelevant – not located within 100 km of any IBAs.	3.1.6
Land cover	Relevant - dominant land use type in the project area was Low Shrubland (64.626%), followed by Natural grassland (34.056%).	3.1.7

3.1.1 Ecosystem Threat Status

The Ecosystem Threat Status is an indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition. According to the spatial dataset the proposed project overlaps with LC ecosystems (Figure 3-1Figure 3-1).

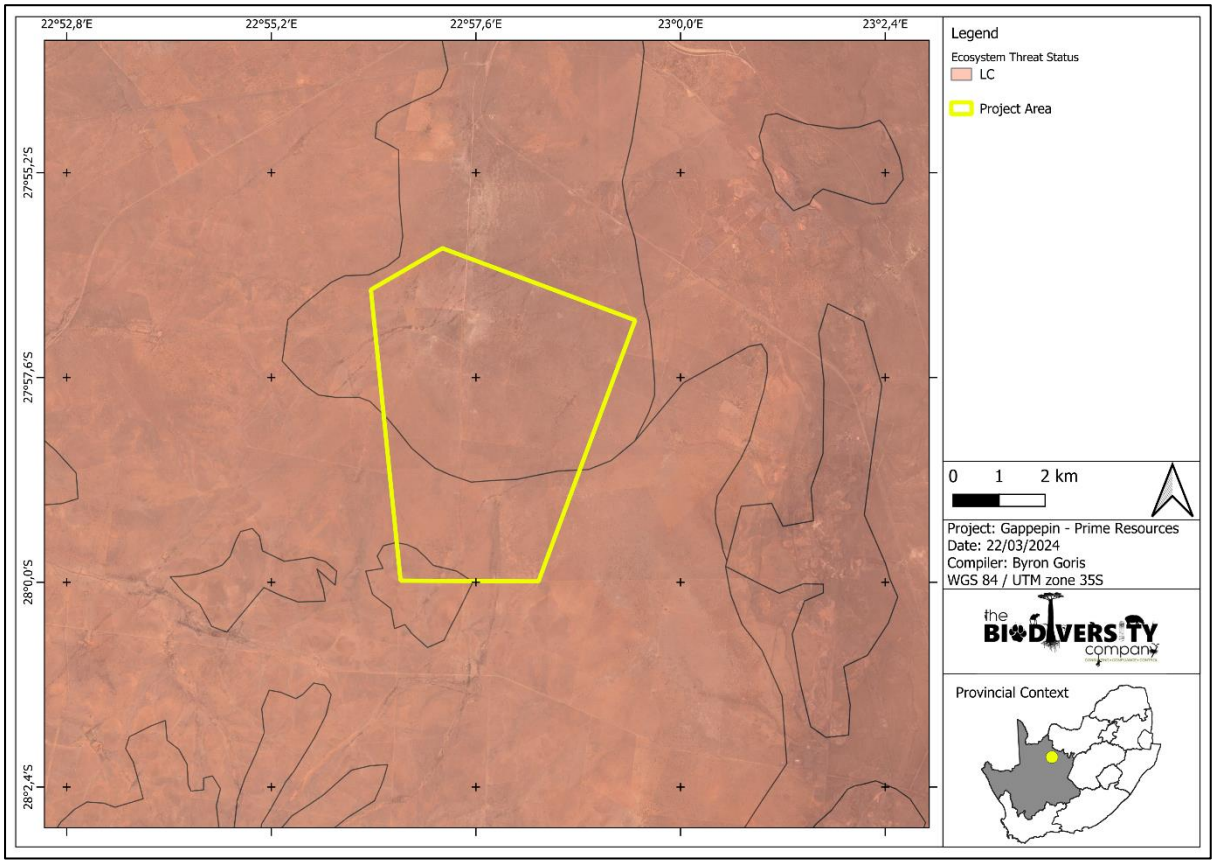


Figure 3-1 Map illustrating the ecosystem threat status associated with the project area

3.1.2 Ecosystem Protection Level

This is an indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems. The proposed project overlaps with a PP and NP ecosystem (Figure 3-2).

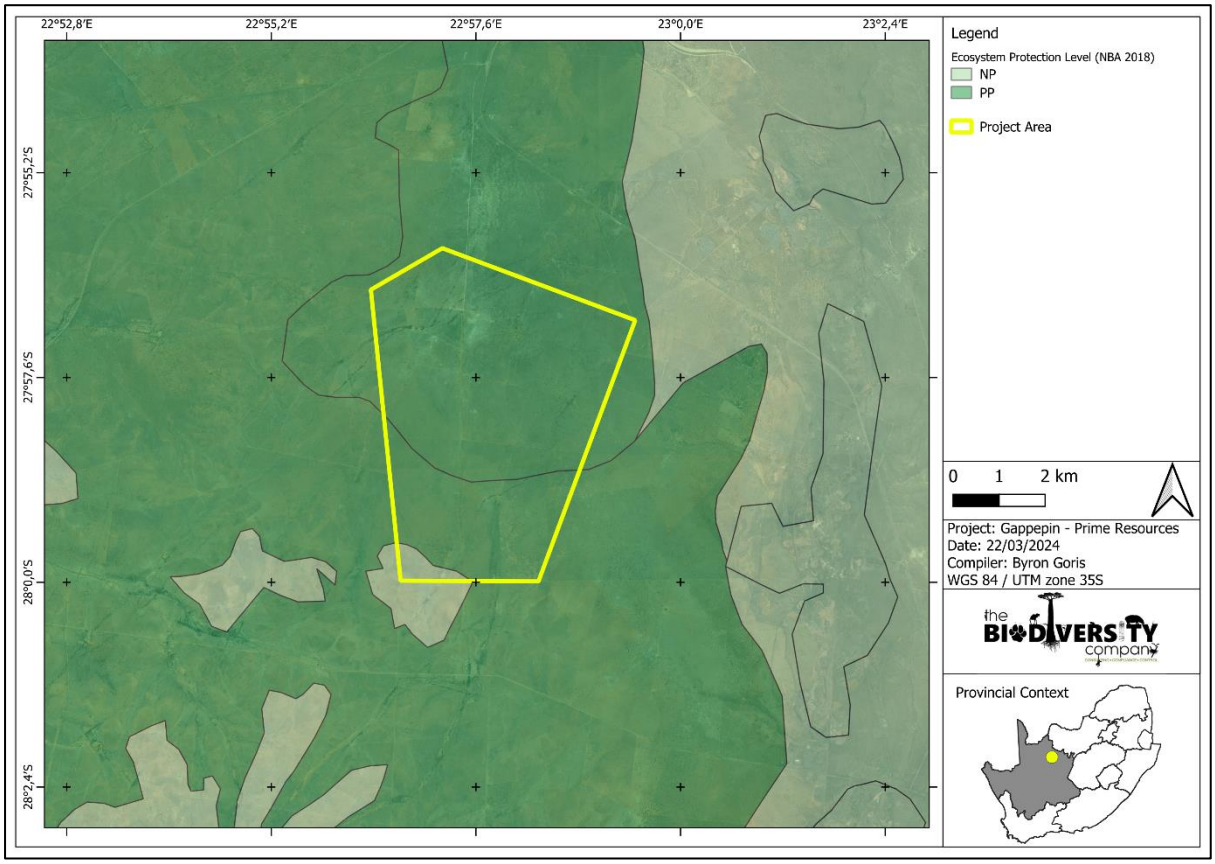


Figure 3-2 Map illustrating the ecosystem protection level associated with the project area

3.1.3 Critical Biodiversity Areas and Ecological Support Areas

The key output of a systematic biodiversity plan is a map of biodiversity priority areas. The CBA map delineates CBAs, Ecological Support Areas ESAs, ONAs, Pas, and areas that have been irreversibly modified from their natural state.

Figure 3-3 shows the project area superimposed on the Terrestrial CBA map. The project area overlaps with small wetland ESAs and otherwise is classified as “Other Natural Areas” (ONAs) by the Northern Cape Critical Biodiversity Areas Map. The majority of the project area overlaps with ONAs (Figure 3-3).

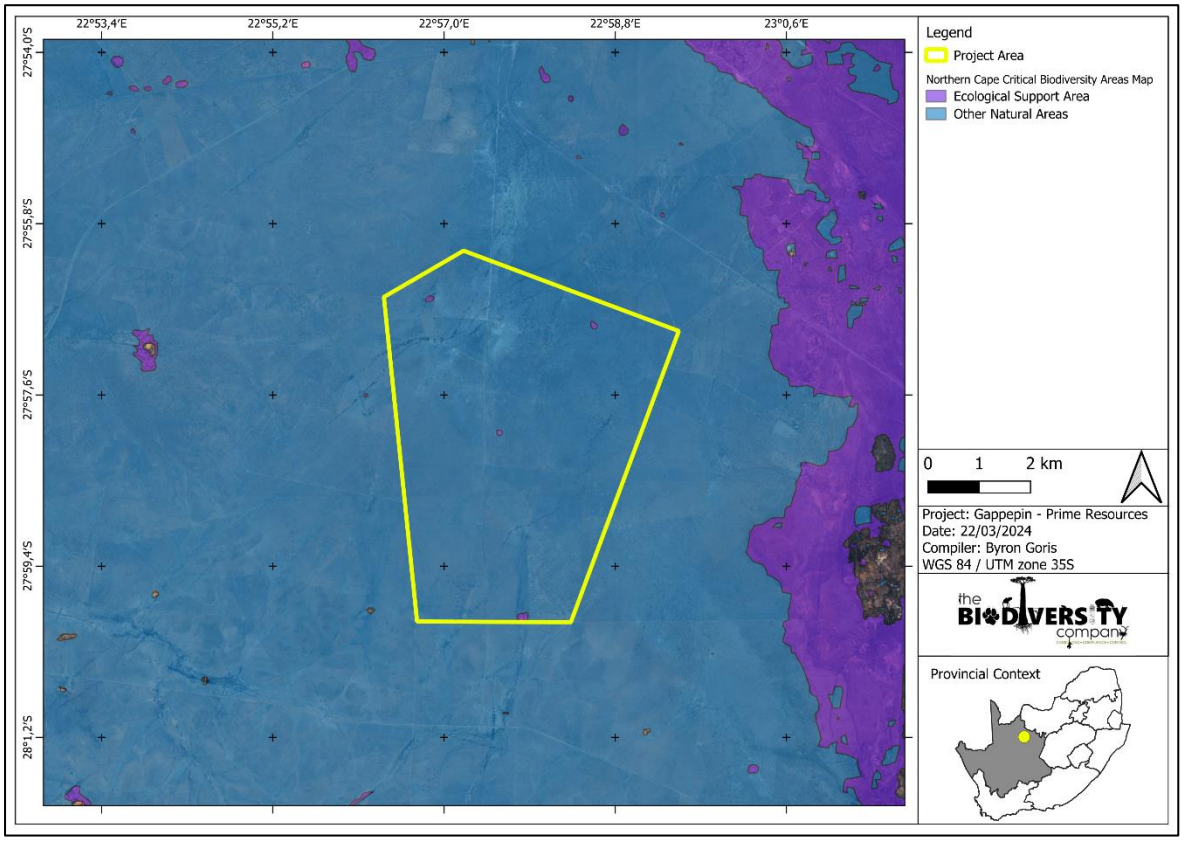


Figure 3-3 Map illustrating the project area in relation to the Northern Cape Conservation Plan

3.1.4 Protected Areas

According to the protected area spatial datasets from SAPAD (DFFE, 2021a), 'Brooks Nature Reserve' and 'Bredenkamp Nature Reserve' are situated approximately 12 km north-west of the project area. (Figure 3-4).

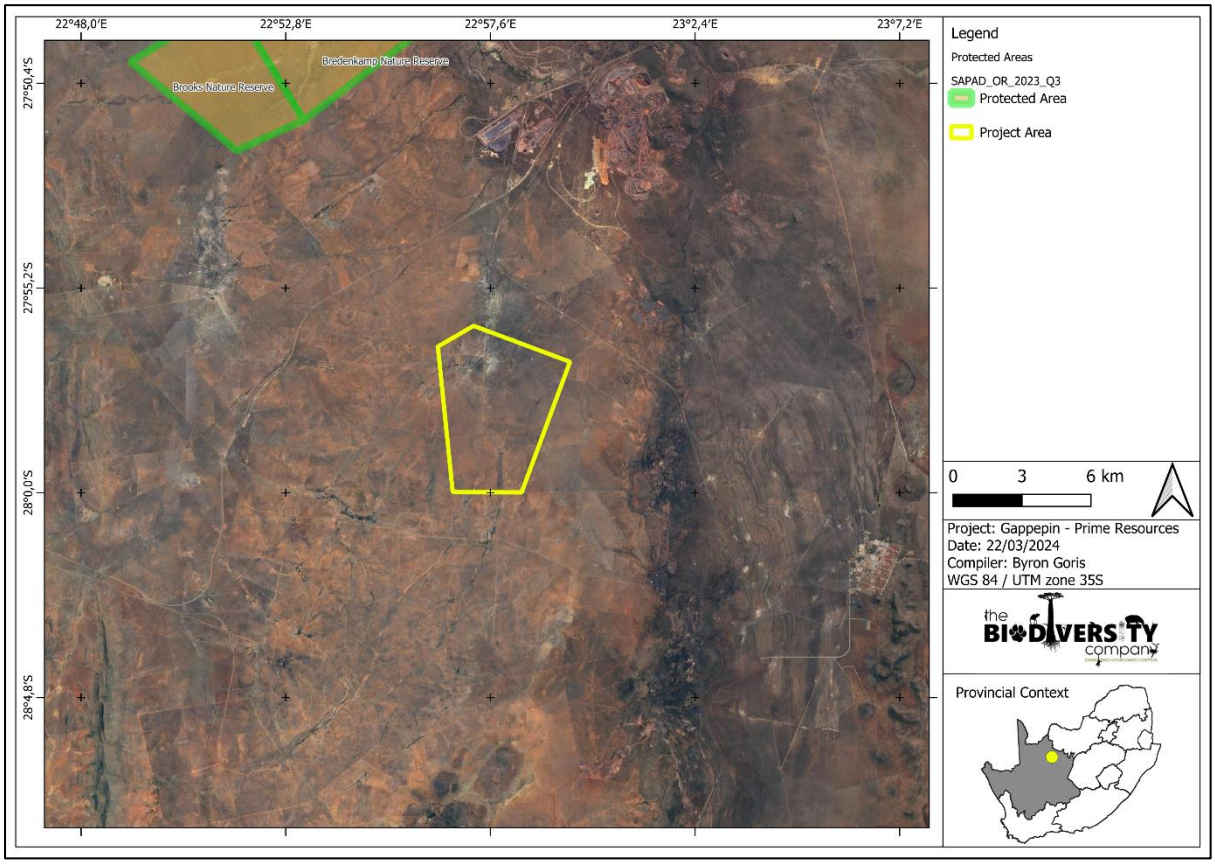


Figure 3-4 Map illustrating the Protected Areas in relation to the project area

3.1.5 National Protected Areas Expansion Strategy

The project area, as illustrated in Figure 3-5, does not overlap with NPAES priority focus areas. These areas are typically important for regional conservation due to their status as important habitat or biodiversity areas and their proximity to formally protected areas or CBA's. Priority focus areas are often large portions of undeveloped natural land occurring within important ecosystem types (Figure 3-5).

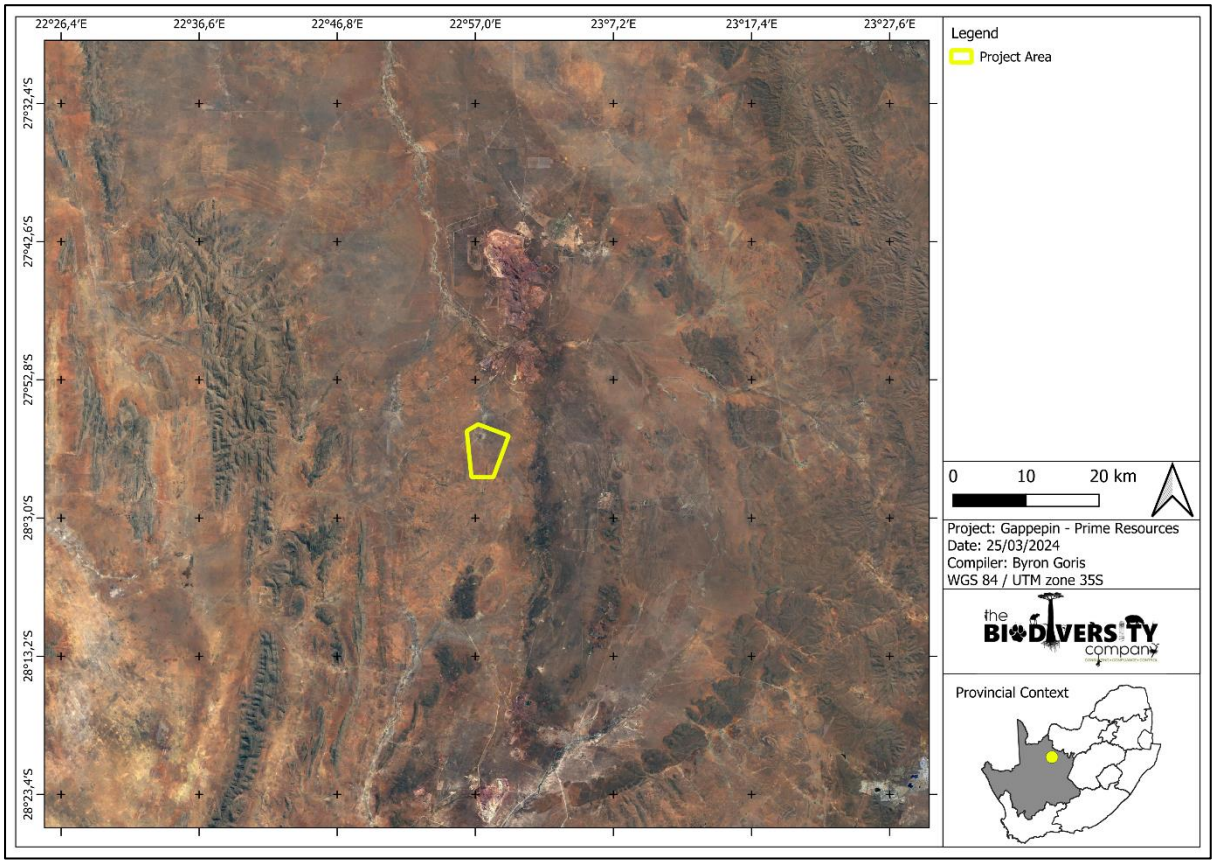


Figure 3-5 Map illustrating the NPAES dataset in relation to the project area

3.1.6 Important Bird and Biodiversity Areas

Important Bird & Biodiversity Areas (IBAs) are the sites of international significance for the conservation of the world's birds and other conservation significant species as identified by BirdLife International. These sites are also all Key Biodiversity Areas; sites that contribute significantly to the global persistence of biodiversity (Birdlife South Africa, 2017).

According to Birdlife South Africa (2017), the selection of IBAs is achieved through the application of quantitative ornithological criteria, grounded in up-to-date knowledge of the sizes and trends of bird populations. The criteria ensure that the sites selected as IBAs have true significance for the international conservation of bird populations and provide a common currency that all IBAs adhere to, thus creating consistency among, and enabling comparability between, sites at national, continental and global levels.

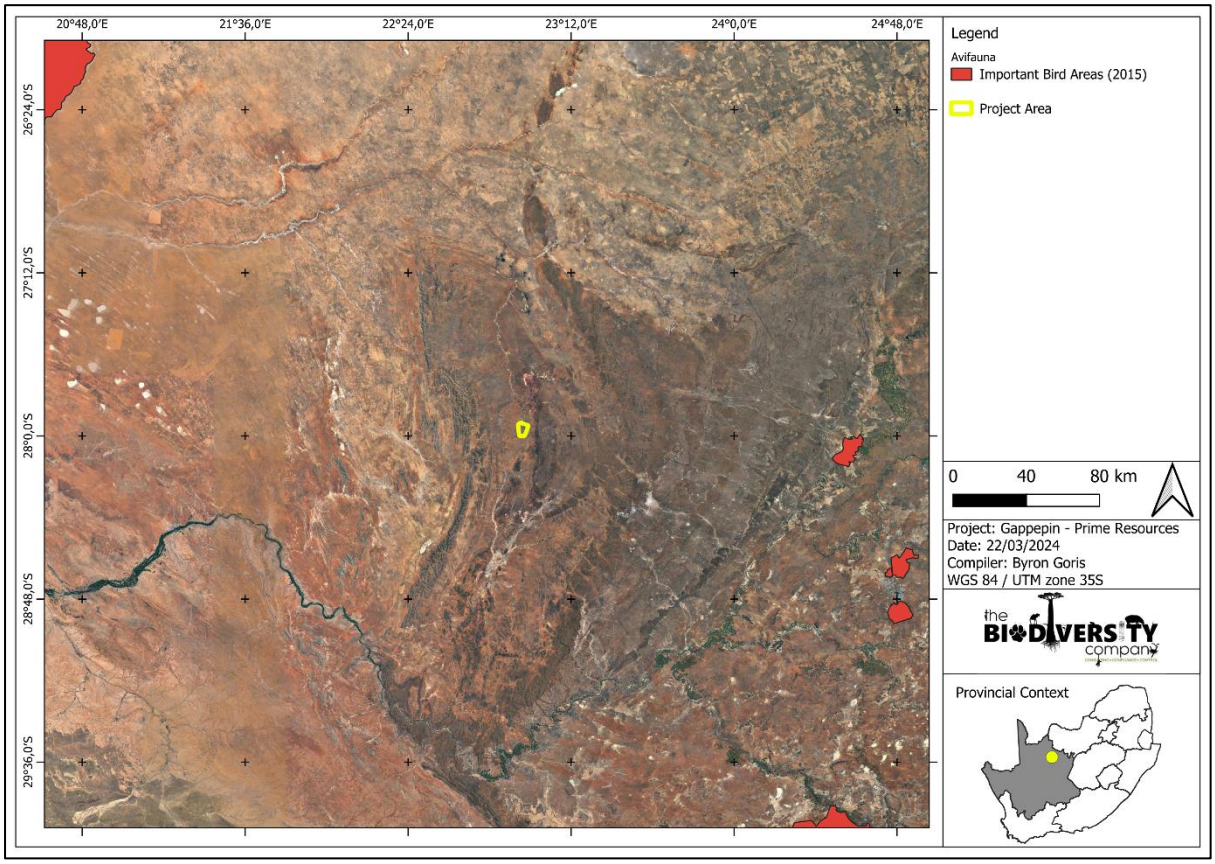


Figure 3-6 Map illustrating the IBAs in relation to the project area

3.1.7 Landcover

A total of 8 of the 73 land cover classes were derived for the project area (Thompson, 2019). These were then grouped into appropriate classes for simplification as well as according to land use types. The dominant land use type in the project area was Low Shrubland (64.626%), located throughout the project area. The second most dominant land cover type was derived to be Natural grassland (34.056%), with Open woodland making up 1.020% of the land cover. From a freshwater perspective, Dry and Natural pans collectively make up 0.238 % of the landcover. The land use types and percent coverage is represented in Table 3-2 and Figure 3-7.

Table 3-2 Project area land-use by area and percentage

Land Cover Class	Approximate Area in Hectares	Percentage Cover (%)
Dense forest & woodland	0.2916	0.0121
Open woodland	24.4944	1.020
Low shrubland	1551.1824	64.626
Natural grassland	817.4196	34.056
Natural pans	0.3564	0.0148
Dry pans	5.346	0.223
Village (scattered)	0.7452	0.0310
Village (dense)	0.4212	0.0175
Total	2400.2568	100

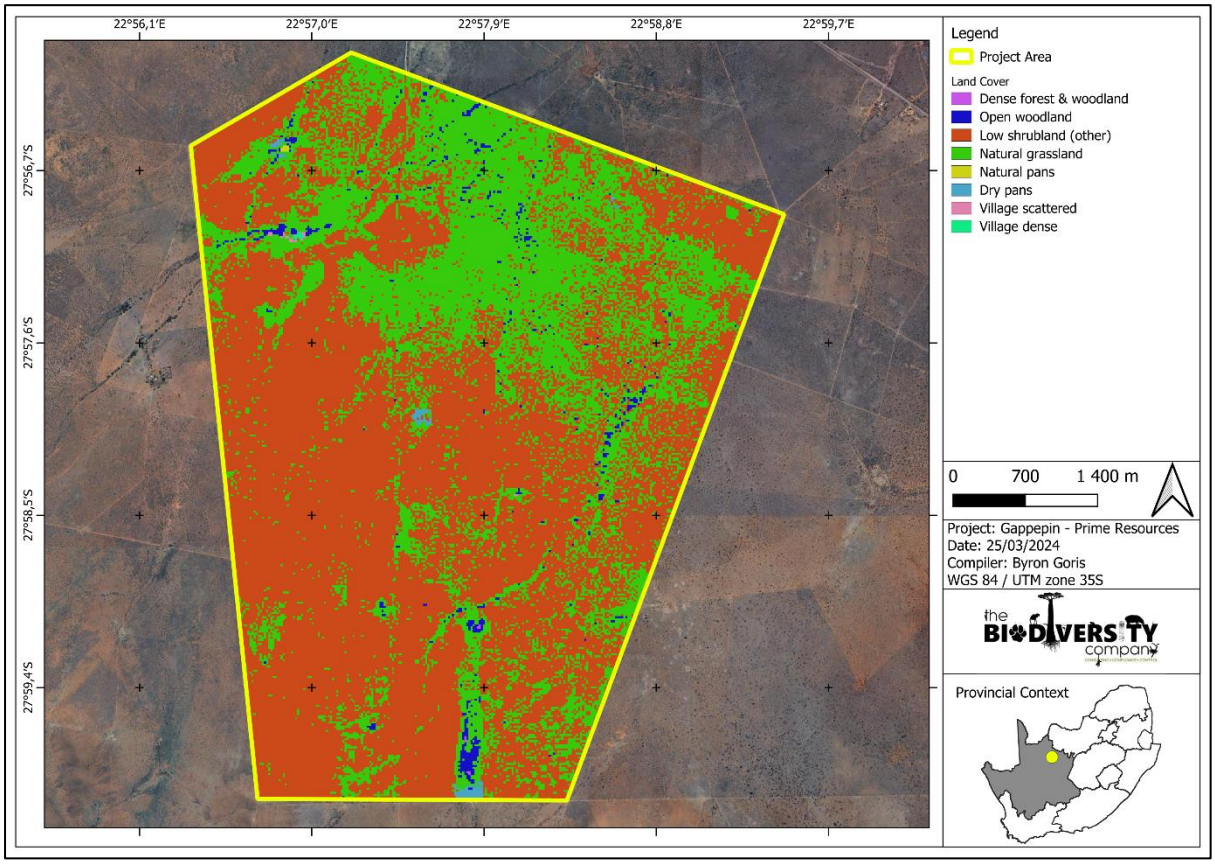


Figure 3-7 Land cover of the PAOI

3.1.8 Flora Assessment

This section is divided into a description of the vegetation type and flora species expected to occur under natural conditions.

3.1.8.1 Vegetation Type

The Project Footprint is situated in the Savanna biome. The savanna vegetation of South Africa represents the southernmost extension of the most widespread biome in Africa (Mucina & Rutherford, 2006).

On a fine-scale vegetation type, the Project Footprint overlaps predominantly with the Kathu Bushveld and Olifantshoek Plains Thornveld vegetation types. Furthermore, a small portion (southwest corner) of the footprint traverse the Kuruman Thornveld vegetation type (Figure 3-8). The following information pertaining to the Kathu Bushveld, Olifantshoek Plains Thornveld and Kuruman Thornveld is noted as per Mucina and Rutherford (2006):

3.1.8.1.1 Kathu Bushveld

The Project Footprint is predominantly located within the Kathu Bushveld (SVk 12) vegetation type. This vegetation type is located in the Northern Cape Province, specifically throughout the plains of Kathu and Dibeng in the south, the vicinity of the Frylinckspan, through Hotazel and towards the Botswana border (Mucina and Rutherford, 2006). This vegetation type is characterised by a medium tall tree layer with *Acacia erioloba* in places and predominantly includes the *Boscia albitrunca* as tree species. The dominant shrubs within this vegetation type are *A. mellifera*, *Lycium hirsutum* and *Diospyros lycioides* (Mucina and Rutherford, 2006).

The conservation status of the SVk 12 vegetation type is least threatened with a target percentage of 16. This vegetation type is not conserved in any conservation areas and is characterised by a loss of 1% due to mining activities (Mucina and Rutherford, 2006).

3.1.8.1.2 Olifantshoek Plains Thornveld

The Project Footprint also is predominantly located within the Olifantshoek Plains Thornveld (SVk 13) vegetation type. This vegetation type is located in the Northern Cape Province, specifically through the pediment areas of Korannaberg, Langeberg and Asbestos Mountains as well as some of those ridges to the west of the Langeberg. In addition, from the vicinity of Sonstraal in the north past Olifantshoek to the areas north of Niekerkshoop between Volop and Griekwastad in the south. Furthermore, from Griekwastad, this vegetation type stretches northwards to the flats west of the Lime Acres area (Mucina & Rutherford, 2006).

This vegetation type is characterised as a very wide and diverse unit on plains with usually open tree and shrub layers with, for example, *Acacia luederitzii*, *Boscia albitrunca* and *Rhus tenuinervis* and with a usually sparse grass layer (Mucina & Rutherford, 2006).

The conservation status of the SVk 13 vegetation type is least threatened with a target percentage of 16. Only 0.3% is conserved in the Witsand Nature Reserve while only approximately 1% of the area has been transformed and erosion is very low (Mucina & Rutherford, 2006).

3.1.8.1.3 Kuruman Thornveld

Only a small portion (southwest corner) of the Project Footprint is located within the Kuruman Thornveld (SVk 9) vegetation type. This vegetation type is located in the North-West and Northern Cape Provinces, specifically on the flats in the vicinity of Postmasburg and Danielskuil (here west of the Kuruman Hills) in the south extending via Kuruman to Tsineng and Dewar in the north (Mucina & Rutherford, 2006).

This vegetation type is characterised with flat rocky plains and some sloping hills with a very well-developed, closed shrub layer and well-developed open tree stratum consisting of *Acacia erioloba* (Mucina & Rutherford, 2006).

The conservation status of the SVk 9 is least threatened with a target percentage of 16. Furthermore, none is conserved in statutory conservation areas and only 2% is already transformed. The erosion within this vegetation type is very low (Mucina & Rutherford, 2006).

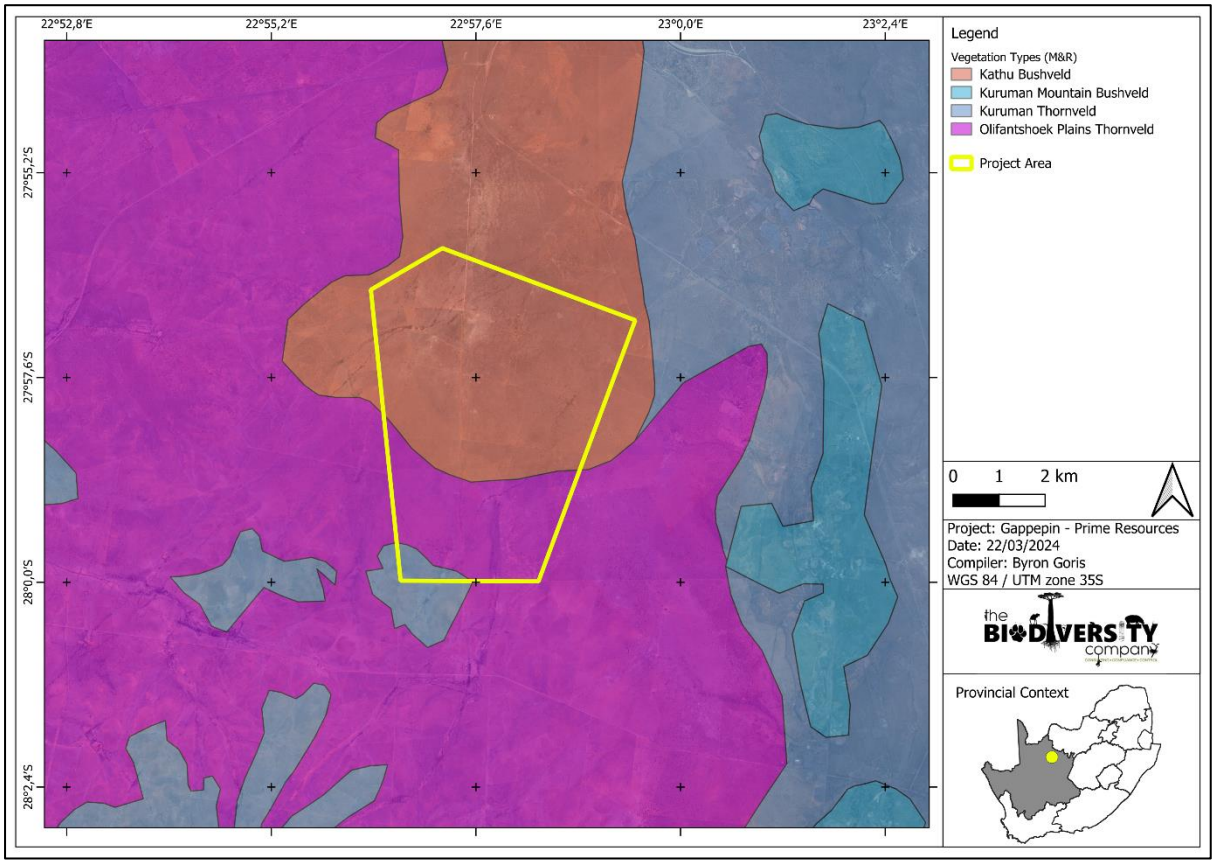


Figure 3-8 Vegetation type associated with the Project Area

3.1.8.2 Expected Flora Species

The POSA database indicates that 220 species of indigenous plants are expected to occur within the project area. The POSA species list will be used to inform the site assessment, and thereafter a full species list, including those confirmed to occur in the Project Footprint, will be provided in the final report). No species of conservation concern (SCCs) were indicated by the screening tool (Figure 3-14).

3.1.9 Faunal Assessment

3.1.9.1 Amphibians

Based on the FrogMap, 1 amphibian species is expected to occur within the project area (*Kassina senegalensis* [Bubbling Kassina]). No amphibian SCCs are expected to occur within the project area. The screening tool does not list any amphibian SCCs.

3.1.9.2 Reptiles

Based on the ReptileMAP database, 16 reptile species are expected to occur within the area (the full list will be provided in the final assessment). One (1) species is regarded as SCC (Table 3-3).

Table 3-3 Threatened reptile species that are expected to occur within the project area

Species	Common Name	Conservation Status	
		Regional	Global
Psammophis leightoni	Cape Sand Snake	VU	-

3.1.9.3 Mammals

The MammalMap lists 3 non-volant mammal species that could be expected to occur within the area (the full list will be provided in the final assessment). None of these expected species are regarded as threatened. The screening tool indicates no further sensitive mammal species likely to occur in the project area (Figure 3-15).

3.1.9.4 Avifauna

The SABAP2 Data lists 122 avifauna species that could be expected to occur within the area (the full list will be provided in the final assessment). None of these expected species are regarded as SCC.

The screening tool indicates one (1) sensitive avifauna species occurs in the project area, triggering a medium animal species theme sensitivity. The species is included in the table below. The site in question has the potential to be a suitable habitat for this vulture species but must be confirmed during the site visit. The project activities are however expected to have limited impacts to the species in the prospecting phase of the project. This is in part informed by the findings in section 3.1.6.

Table 3-4 Threatened avifauna species that are expected to occur within the project area.

Species	Common Name	Conservation Status		Screening Tool Sensitivity
		Regional	Global	
Gyps africanus	White-backed vulture	CR	CR	Medium

3.1.10 Climate

This region is characterised by summer and autumn rainfall with very dry winters. The mean annual precipitation is approximately 220 to 380 mm with frost frequently occurring during winter months (Figure 3-9). The mean minimum and maximum temperatures for Sishen is 2.2℃ and 37℃ for July and December respectively. (Mucina & Rutherford, 2006).

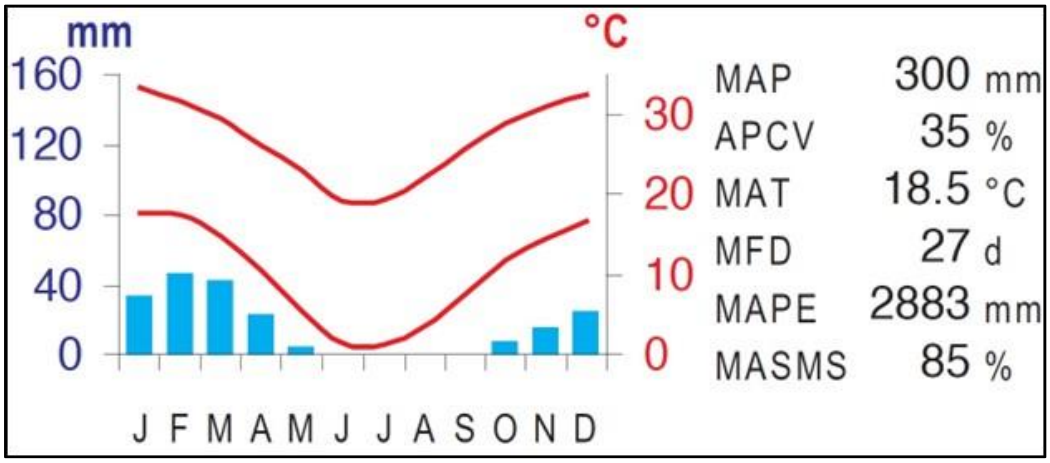


Figure 3-9 Climate for the Project Area based on the Kathu Bushveld (Mucina & Rutherford, 2006)

This region (Olifantshoek Plains Thornveld) is characterised by summer and autumn rainfall with very dry winters. The mean annual precipitation is approximately 200 to 350 mm with frost frequently occurring during winter months. The mean annual temperature for the region is recorded at 17.1℃ (Figure 3-10).

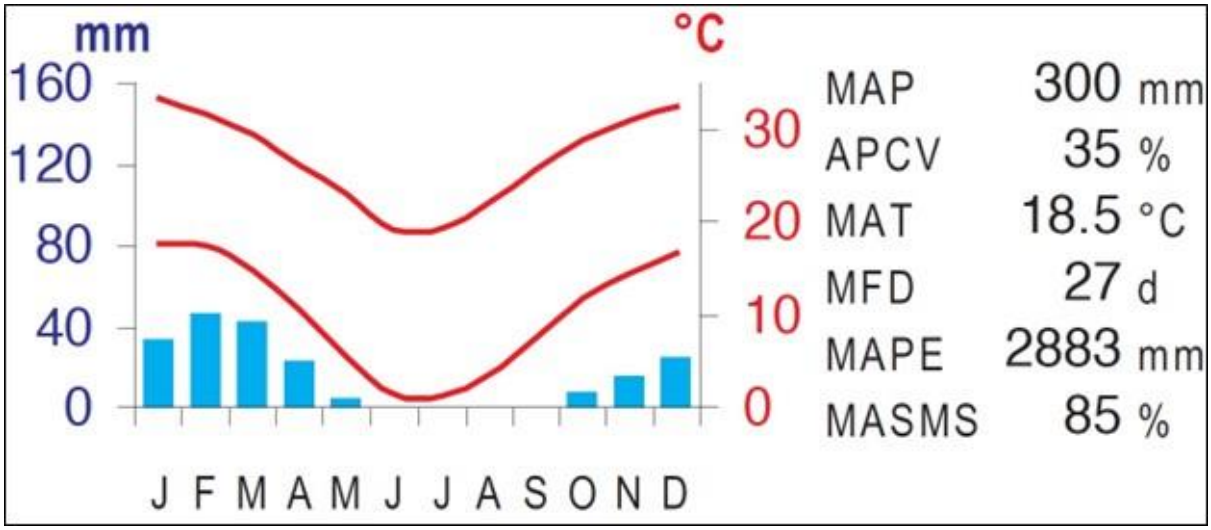


Figure 3-10 Climate for the Project Area based on the Olifantshoek Plains Thornveld (Mucina and Rutherford, 2006)

The region (Kuruman Thornveld) is characterised by summer and autumn rainfall with very dry winters. The mean annual precipitation is approximately 300 to 450 mm with frost occurring frequently in the winter months. The mean monthly maximum and minimum temperatures for Kuruman 35℃ and –3.3℃ for January and June, respectively (Figure 3-11).

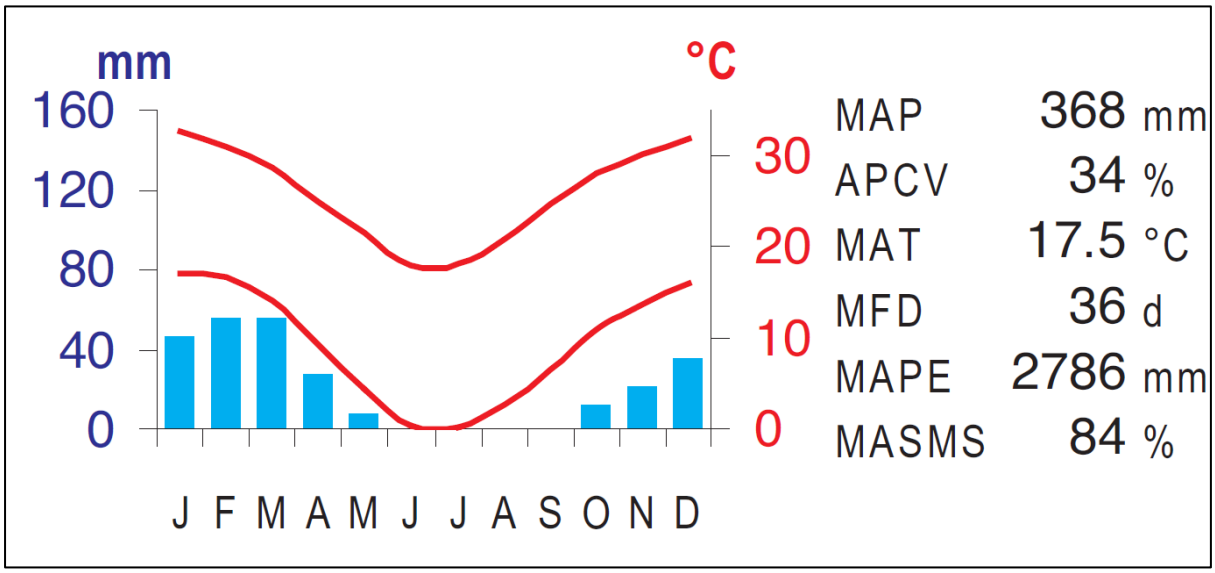


Figure 3-11: Climate for the Project Area based on the Kuruman Thornveld (Mucina and Rutherford, 2006)

3.1.11 Buffer Requirements based off Wetlands/Drainage features and desktop assessment (relevant for Terrestrial Sensitivity Screening)

The buffer requirements (Figure 3-12) for the wetlands and drainage features were calculated by D van Rooyen in the accompanying "Desktop Wetland Delineation and Impact Assessment" report – using the Site-Based Tool: Determination of buffer zone requirements for wetland ecosystems (Macfarlane *et al.*, 2014). The recommended buffer zones were calculated and are presented in Table 3-5 below. The soil type and erodibility within the wetlands was also considered in this assessment and contributed to the calculated buffer widths. The Desktop buffer for the wetlands were calculated to be 500 m and a 32 m buffer was determined using the Determination of buffer zone tool.

Table 3-5 Buffer requirements for the relevant wetland features

Aspect	Desktop Buffer	Sensitivity Buffer
Prospecting Rights Footprint	500 m	32 m

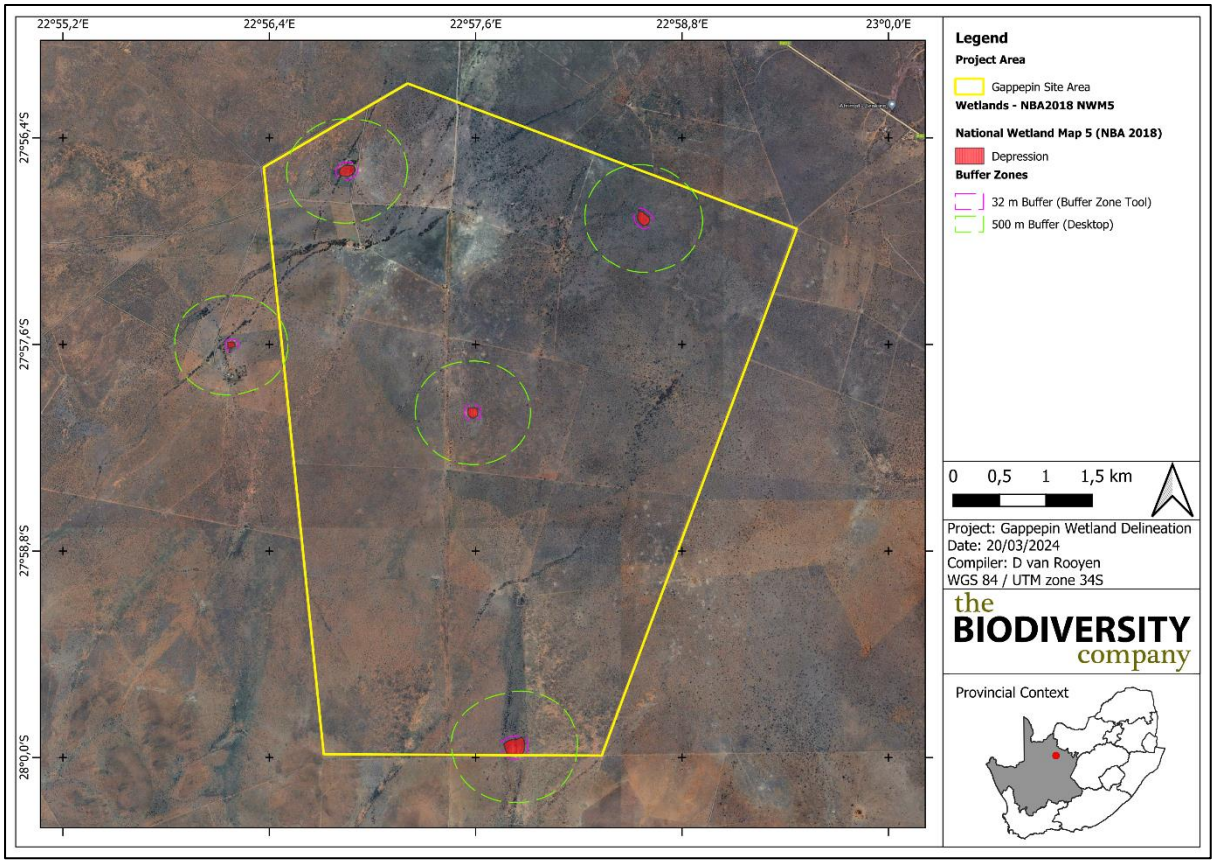


Figure 3-12 Recommended Buffers for the identified wetlands in relation to the proposed development

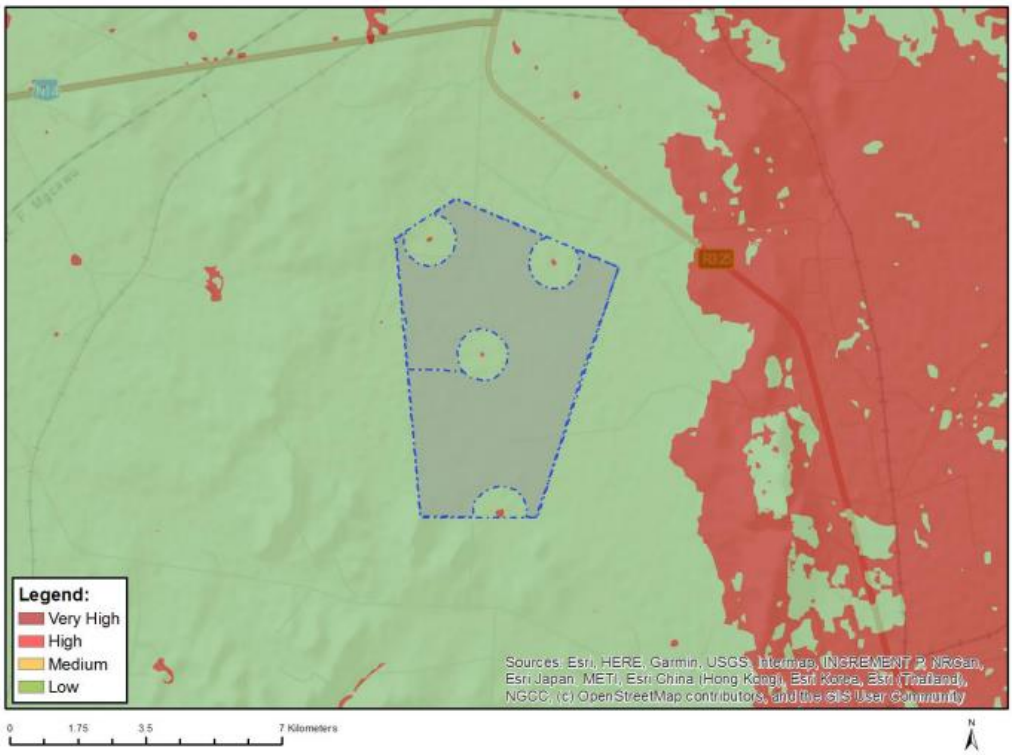
3.1.12 DFFE Screening Tool

According to the Screening Tool Report (Regulation 16(1)(v) of the Environmental Impact Assessment Regulations 2014, as amended), the following sensitivity classifications were gathered from the National Web-based Environmental Screening Tool:

- Terrestrial Biodiversity Theme sensitivity is Low for the project area (Figure 3-13);
- Plant Species Theme sensitivity is Low for the project area (Figure 3-14); and
- Animal Species Theme sensitivity is Medium for the project area, with the possibility of a medium sensitivity bird species being present (Figure 3-15).
- Aquatic Biodiversity Theme sensitivity as described in the accompanying "Desktop Wetland Delineation and Impact Assessment" report:
    - "Aquatic Biodiversity Theme sensitivity as "Very High" for small portions of the Proposed Site, assigned for the presence of Depressions, with the remainder of the site classed as "Low" if the Proposed Site do not avoid the "Very High" sensitivities."

- "Aquatic Biodiversity Theme sensitivity as "Low sensitivity" for the entire Project Site when the site avoids "Very High" sensitivities, the assigned "Very High sensitivity" is attributed to the depressions located within 500 m of the Project Site."

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY



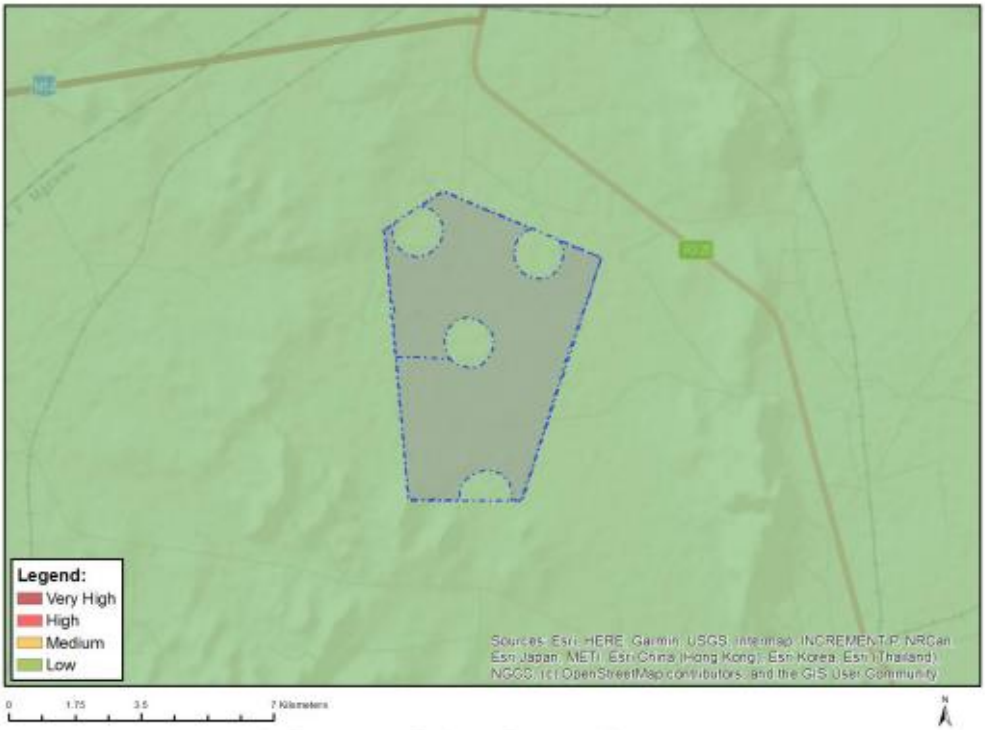
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

Figure 3-13 Relative terrestrial biodiversity theme sensitivity for the project area

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

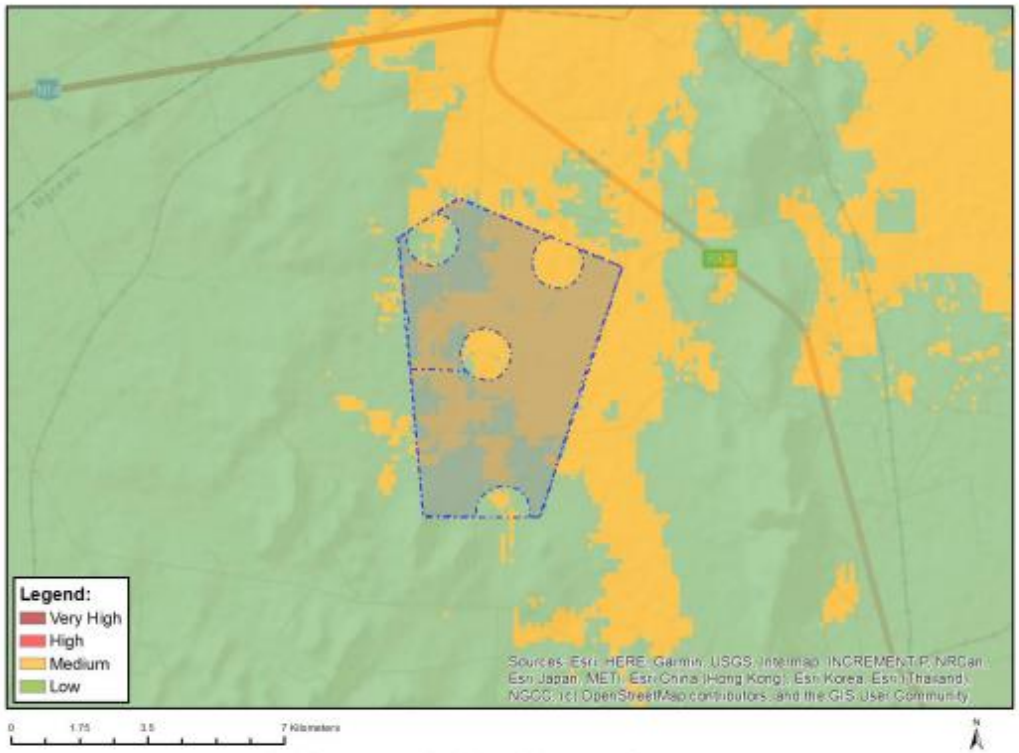
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

Figure 3-14 Relative plant species theme sensitivity for the project area

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Subject to confirmation
Medium	Aves-Gyps africanus

Figure 3-15 Relative animal species theme sensitivity for the project area

4 Conclusion

Based on the desktop assessment it can be said that the project area has a low sensitivity location from a terrestrial perspective with a low likelihood of SCC's occurring. The dominant land use type in the project area was Low Shrubland (64.626%), followed by Natural grassland (34.056%). From a freshwater perspective, Dry and Natural pans collectively make up 0.238% of the landcover. The assumption can be made that the vegetation in the project area may be in a relatively 'natural' state. Although the Ecosystem Threat Status is classified as LC, the project area overlaps with ecosystems that are either poorly or not protected.

4.1 Screening Tool Validation

The sensitivities described by the DFFE screening tool for Terrestrial Biodiversity (Figure 3-13), Plant Species (Figure 3-14), as well as Animal Species (Figure 3-15) themes are, in the view of this specialist from an initial desktop perspective, validated and agreed upon.

The Project Footprint occurs in a location which has been assigned as an "other natural area" and does not conflict with any Ecological Support Areas (ESAs) nor Critical Biodiversity Areas (CBAs). According to the relevant Ecosystem Threat Status spatial dataset the proposed project overlaps with a 'Least Concern' ecosystem (Figure 3-1), while there is also a relatively low expected SCC diversity in terms of plants and animals (Sections 3.1.8 and 3.1.9). The only SCC flagged by the screening tool was the avifauna species 'White-backed vulture', which then triggered a medium sensitivity rating for Animal Species theme (Figure 3-15). At the prospecting phase of this project, limited impacts to vultures are predicted but can be confirmed during an avifauna site visit. An avifauna specialist site visit will also be required if any further developments take place or permanent infrastructure is planned.

Overall, the screening tool sensitivities are recommended to remain undisputed, but must be revisited post-site visit. The proposed project is for the Prospecting Right Application for mineral resources. Development-related activities can have significant impacts on biodiversity and ecosystem services, often causing irreversible and large-scale habitat loss across large areas or areas important for the provision of important ecosystem services. The below recommendations are therefore necessary for consideration.

4.2 Recommendations

A field assessment must be undertaken prior to any invasive activities taking place in order to verify the results of the terrestrial and aquatic desktop assessments. On a terrestrial ecology front, a biodiversity survey is suggested which would include assessing the following (and then accompanying the assessments with relevant mitigation measures):

4.2.1 Fauna

The surveys will include the following:

- A survey of the project areas (if permitted);
- Compilation of an identified species list;
- Identify any Red Data or listed species present or potentially occurring in the area including SCC plants and animals identified in the accompanying scoping report;
- A habitat assessment and delineation; and
- An avifauna specialist site visit will be required if any further developments take place or permanent infrastructure is planned. Based on the desktop information available in

the scoping, the prospecting phase of this project is expected to have limited impacts to vultures.

4.2.2 Plants & vegetation

The surveys will include the following:

- A survey for Red and Orange Data plant species;
- Vegetation units will be identified, classified and delineated;
- Habitat types will be classified and delineated;
- The survey will be conducted in consultation with local authorities who have information to be considered; and
- The survey area will include the project area.

4.2.3 Habitat features

The surveys will include the following:

- The identification of these features and delineation thereof; and
- The location of any unique or protected habitat features.
- Based on the results of the field surveys, additional sensitive areas – over-and-above those described during the scoping phase – may be identified, delineated, and will be accompanied by recommendations which can include avoiding such locations during the undertaking of the project.

4.2.4 Impacts and Mitigations

Relevant and project-specific impacts and mitigation measures will be drafted post-site visit from a terrestrial perspective. It must be noted that regarding a specific mitigation included in the “Desktop Wetland Delineation and Impact Assessment” report:

- Revegetation with indigenous flora species is necessary to prevent erosion from occurring, to restore habitats to their natural state as soon as possible, and in the long term will prevent the project impacts from causing nearly irreversible desertification. In the scenario of waiting for natural re-vegetation processes to take place, periodic site monitoring will need to be initiated - it therein becomes more costly and challenging to determine at what point the natural processes are deemed unsuccessful and require intervention, while it also carries more potential long-term risk to the disturbed habitats within the project area.

5 References

BirdLife South Africa. (2017). Important Bird Areas Factsheet. http://www.birdlife.org (Accessed: November 2022).

Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. & Funke, N. (2011). Implementation Manual for Freshwater Ecosystem Priority Areas. Report to the Water Research Commission, Pretoria.

Land Type Survey Staff. (1972 - 2006). Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases. Pretoria: ARC-Institute for Soil, Climate, and Water.

Le Maitre, D.C., Walsdorff, A., Cape, L., Seyler, H., Audouin, M, Smith-Adao, L., Nel, J.A., Holland, M. and Witthüser. K. (2018) Strategic Water Source Areas: Management Framework and Implementation Guidelines for Planners and Managers. WRC Report No. TT 754/2/18, Water Research Commission, Pretoria

Mucina, L. & Rutherford, M.C. (Eds.). (2006). The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria, South African.

National Environmental Management: Biodiversity Act: National list of ecosystems that are threatened and in need of protection. (2011). https://www.gov.za/documents/national-environmental-management-biodiversity-act-national-list-ecosystems-are-threatened (Accessed: November 2022)

National Environmental Screening Tool. (2017). https://screening.environment.gov.za/screeningtool/index.html#/pages/welcome) (Accessed: April 2023).

NBA. (2018). National Biodiversity Assessment spatial data. http://bgis.sanbi.org/ (Accessed: April 2023)

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

SANBI-BGIS. (2017). Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning.

Skowno, A.L. & Monyeki, M.S. 2021. South Africa's Red List of Terrestrial Ecosystems (RLEs). Land, 10, 1048, 1-14.

Skowno, A.L., Raimondo, D.C., Poole, C.J., Fizzotti, B. & Slingsby, J.A. (eds.). (2019). South African National Biodiversity Assessment 2018. Technical Report Volume 1: Terrestrial Realm. South African National Biodiversity Institute, Pretoria.

Van Deventer, H., Smith-Adao, L., Collins, N.B., Grenfell, M., Grundling, A., Grundling, P-L., Impson, D., Job, N., Lötter, M., Ollis, D., Petersen, C., Scherman, P., Sieben, E., Snaddon, K., Tererai, F. and Van der Colff D. (2019). *South African National Biodiversity Assessment 2018: Technical Report.* Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6230.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. (2018). South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa.

6 Appendix Items

6.1 Appendix A – Specialist Declaration of Independence

I, Byron Goris, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Byron Goris

Terrestrial Ecologist

The Biodiversity Company

March 2024

I, Martinus Erasmus, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Martinus Erasmus

Ecologist

The Biodiversity Company

March 2024

6.2 Appendix B – Specialist CVs

Byron Goris

B.Sc Hons in Global Socio-Ecological Systems Change

Cell: +27 81 790 8603
Email: byron@thebiodiversitycompany.com
Identity Number: 9904145161083
Date of birth: 14 April 1999

Profile Summary

Environmental work experience across South Africa (2 years).

Theoretical and practical understanding of methodology in both aquatic, terrestrial, and global change ecology.

General training and experience in aspects of conservation, biogeography, and socio-economic sustainability.

Areas of Interest

Ecological systems approaches, global environmental change, socio-economic sustainability, multi/trans-disciplinarity, sports ecology, traditional medicinal plant science.

Key Experience

- Aquatic, Terrestrial, and Wetland Ecological Assessments
- Environmental Field work and basic field methodology
- Business sustainability
- Sports Ecology Research
- Habitat delineation
- Field work and research

Country Experience

South Africa

Nationality

South African

Languages

English – Proficient

Afrikaans – Basic

Qualifications

- BSc (Hons) Animals, Plants, and Environmental Sciences; University of the Witwatersrand
- BSc Biology, University of the Witwatersrand

CURRICULUM VITAE: Byron Goris

Martinus Erasmus

B-Tech Nature Conservation (*Pr Sci Nat*)

Cell: +27 82 448 1667
Email: martinus@thebiodiversitycompany.com
Identity Number: 9209035136082
Date of birth: 03 September 1992

Profile Summary

Working experience throughout Southern Africa as well as West Africa.

Specialist experience in exploration, mining, engineering, hydropower, private sector, and renewable energy.

Specialist guidance, support, and facilitation for compliance with legislative processes, in-country requirements, and international lenders.

Specialist expertise includes Botany and Terrestrial Ecology.

Areas of Interest

Mining, Oil & Gas, Renewable Energy & Bulk Services Infrastructure Development, Sustainability, and Conservation

Key Experience

- Familiar with World Bank and the International Finance Corporation requirements
- Environmental, Social, and Health Impact Assessments (ESHIA)
- Environmental Management Programmes (EMP)
- Rehabilitation Plans and Monitoring
- Botany, especially in the Limpopo, Mpumalanga, Gauteng, and North-West provinces in South Africa.
- Veld management and Veld condition

Country Experience

Eswatini
Guinea
Lesotho
Liberia
Mauritius
Mozambique
Nigeria
South Africa
Swaziland
Zambia

Nationality

South African

Languages

English – Proficient
Afrikaans – Proficient I

Qualifications

- B-Tech in Nature Conservation, Tshwane University of Technology, Pretoria, South Africa.
- National Diploma in Nature Conservation, Tshwane University of Technology, Pretoria, South Africa.
- Pr Sci Nat (118630)