BASIC ASSESSMENT FOR THE PROPOSED SQUARE KILOMETRE ARRAY (SKA) FIBRE-OPTIC CABLE ROUTE BETWEEN BEAUFORT WEST AND CARNARVON

TERRESTRIAL ECOLOGY, BIODIVERSITY AND SPECIES: SPECIALIST ASSESSMENT

Report prepared for:	*Report prepared by:*
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Contents

EXECUTIVE SUMMARY

Background

The South African Radio Astronomy Observatory (SARAO) leads South Africa's activities in the Square Kilometre Array (SKA) Radio Telescope. To transport the data for the SKA project a fibre-optic cable connection must be built between Carnarvon and Beaufort West to connect SKA to Cape Town. The results of an Environmental Screening Study by the CSIR indicated that, *inter alia*, a Basic Assessment (BA) procedure is required to obtain Environmental Authorisation for the proposed fibre-optic route. This report is in adherence to the *Procedures for the assessment and minimum requirements for reporting on identified environmental themes* in terms of Sections 24(5) (a) and (h) and 44 of the National Environmental Management Act, (Act No. 107 of 1998).

Terms of reference

The terms of reference are to provide a specialist assessment on the terrestrial ecology and biodiversity of the proposed SKA fibre-optic cable project between Beaufort West in the Western Cape and Carnarvon in the Northern Cape, a distance of 181 km. The cable will be installed 1 m from the fence of the adjacent private land and the route covers the road reserves of the R381 and R63. Surveys (fauna and flora) were conducted along the route for the classification of the vegetation into habitats, identification of sensitive habitats, compiling of species lists and at the same time to search for Species of Conservation Concern (SCC). The report presents the findings of the site survey and an evaluation of the significance of the impacts of the proposed development.

Environment

The Nuweveld Mountains of the Great Escarpment dominate the area north of the plains around Beaufort West, with plains and dolerite koppies, butts and mesas characteristic south of Loxton. The terrain north of Loxton is flat to gently sloping with isolated hills. The mean annual rainfall in the region ranges from 236 mm at Beaufort West, 249 mm at Carnarvon and 253 mm at Victoria West. The dominant geology consists of mudstone of the Ecca and Beaufort Groups, with dolerite intrusions forming koppies and high mountains. Alluvium occurs along the drainage lines.

Vegetation and habitat types

The route falls in the Nama-Karoo Biome and more specifically in the Upper Karoo Bioregion (NKu) from north of Beaufort West to Carnarvon. The plains around Beaufort West in the south lie in the Lower Karoo Bioregion (NKl). Six broad-scale vegetation types occur along the route: Gamka Karoo (NKl 1); Western Upper Karoo (NKu 1); Upper Karoo Hardeveld (NKu 2); Northern Upper Karoo (NKu 3); Eastern Upper Karoo (NKu 4); and Southern Karoo Riviere (AZi 6).

Based on the topography of the area, the following habitat types were distinguished along the route:

- Drainage lines (watercourses: channels, streams, rivers) and their associated banks;
- Bottomlands on the plains (broad floodplains, leegtes, vloere);
- Plains;
- Valleys in the mountains (bottomlands or valley floors);
- Low hills;
- Footslopes of koppies and mountains;
- Midslopes of mountains, usually steep;
- Plateaux in the mountains; and

- Mountains often comprising a mixture of upper slopes, scarps and crests.

These habitats and their dominant species are briefly described in the report. A checklist of the flora and fauna observed during the site survey as well as the flora and fauna reported to occur in the region were compiled from various sources.

Flora

During the field surveys along the fibre-optic cable route for the current investigation, 356 plant species were recorded. Combined, the NewPosa list and the list for the current study yielded 854 species, which could potentially occur in the environs of the fibre-optic route.

- None of the red list threatened species were recorded during the site survey;
- Fifty-eight species listed as Schedule 4 protected species in The Western Cape were recorded during the site survey in September/October 2020. Most of these protected species belonged to the Aizoaceae.
- Five species listed as Schedule 1 specially protected species and 90 species listed as Schedule 2 protected species in the Northern Cape were recorded during the site survey. Most of these species belonged to the Aizoaceae or Crassulaceae.
- No plant species, classified as threatened or protected (ToPS)) is listed for the study area.
- Twenty-one CITES Appendix II species are listed for the region including mostly *Anacampseros* species*, Aloe* species and *Euphorbia* species. Thirteen species listed by CITES were recorded during the site survey.
- Ten alien invasive species were observed along the fibre-optic cable route.

Fauna

The route falls within the distribution range of 82 terrestrial mammal species. Three IUCN threatened mammal species could occur in the environs of the fibre-optic cable route :

Riverine rabbit	*Bunolagus monticularis*	CR
Mountain reedbuck	*Redunca fulvorufula fulvorufula*	EN
Black-footed cat	*Felis nigripes*	VU

The roan antelope, sable antelope and bontebok listed in Appendix B also have an IUCN threatened status, but have been introduced in the area. These species as well as the mountain reedbuck are likely to occur only in the Karoo National Park or private nature reserves and should not be impacted by the fibre-optic cable project. The riverine rabbit is Critically Endangered due to fragmentation of its habitat in the semi-arid central Karoo region of South Africa. The area south of Loxton is regarded as prime riverine rabbit habitat, in particular around the Sak and Brak Rivers. It is associated with dense, discontinuous vegetation fringing the seasonal rivers of the central Karoo. In general the habitat in the road reserve and at stream crossings is not suitable habitat for the riverine rabbit and traffic and other activities would deter them from making burrows in the road reserve. Furthermore, the animals are nocturnal and thus not active while construction work will be in progress.

The southern mountain reedbuck is listed as Endangered due to large population declines in all protected areas for which long-term count data are available. The mountain reedbuck is present in the Karoo National Park where it seems to have been introduced. They may occur in the mountainous section of the fibre-optic cable route north of Beaufort West and next to the Karoo National Park. It is believed that the overhead cable infrastructure in the road reserve along the route will not interfere with the behaviour of the mountain reedbuck.

The black-footed cat has a very wide distribution and habitat preference and it is likely that they can/do occur within the region. However, they are usually sparsely distributed. Furthermore, the black-footed cat is nocturnal, which would reduce interaction with human activity in the area.

Fifty-seven reptile species are listed for the fibre-optic cable route and these comprise eight tortoises and terrapins; 15 snakes; and 34 lizards. Important habitats for reptiles include the drainage lines, cliffs and rocky outcrops. The Karoo dwarf tortoise *Chersobius boulengeri* has an IUCN threatened status (Endangered) and is endemic to the region.

Fourteen frog species are listed for the study area. Although none of the frog species listed in Appendix B has an IUCN threatened status.

In total 262 bird species are known to occur along the route of the fibre-optic cable. Of these species four are listed as Endangered and six as Vulnerable (IUCN status RSA):

Circus maurus	Black harrier	EN
Mycteria ibis	Yellow-billed stork	EN
Neotis ludwigii	Ludwig's bustard	EN
Polemaetus bellicosus	Martial eagle	EN
Afrotis afra	Southern black korhaan	VU
Aquila verreauxii	Verreaux's eagle	VU
Ciconia nigra	Black stork	VU
Cursorius rufus	Burchell's courser	VU
Falco biarmicus	Lanner falcon	VU
Sagittarius serpentarius	Secretarybird	VU

Wherever the proposed cabling is to be buried, it will not pose a risk to birds. It is also unlikely that nesting sites would be found in the road reserve. On the overhead sections, birds may use the poles as perches, but there will be no risk of electrocution. Overhead cables are restricted to the mountainous sections of the route and collisions by mountain dwelling species may occur. Plains species such as the Ludwig's bustard should therefore not be compromised. Nevertheless, it is recommended that bird collisions with the overhead cables are monitored after the erection of the cable.

The protected status of the fauna is provided in Appendix B.

Conservation

Vegetation types: All six vegetation types on site are listed as "least threatened".

Protected Areas: Except for a small section, the study area is not located in a protected area although it follows the eastern boundary of the Karoo National Park along the R381 route. In order to traverse the topographically and geologically difficult terrain of the Molteno Pass at the eastern side of the Karoo National Park, it is proposed that the fibre-optic cabling (overhead) be installed in the Park in a corridor where Eskom and Telkom infrastructure has already been established and currently still exists.

National Protected Areas Expansion Strategy (NPAES): The route of the fibre-optic cable does traverse areas earmarked by NPAES for future expansion of the Karoo National Park, but will not interfere with the protected areas expansion strategy, since it is confined to road reserves along existing roads that will not be closed for the purpose of park expansion.

Critical Biodiversity Areas (CBAs): CBAs are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species. The proposed construction of the fibre-optic cable will take place in the road reserve, a highly transformed habitat that is not representative of

the adjacent land on which the CBA identification was based. Consequently, the classification of the road reserve as CBA1 cannot be upheld.

- Additionally, the proposed SKA fibre-optic cable does not constitute any of the land uses considered to be undesirable in a CBA according to Pool-Stanvliet *et al*. (2017).
- Since the development will primarily take place in the road reserve it will have little impact on existing protected areas and it will also not affect the NPAES.
- Furthermore, the classification of the road reserve as CBA is questionable from a vegetation standpoint, although it might still be marginal riverine rabbit habitat. According to the definition of CBAs1, such areas should be "Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas". A road reserve does not comply with these conditions. The definition of CBAs2 refers to "Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses" and road reserves are not the best option to meet biodiversity targets.

Ecological Support Areas (ESAs): ESAs need to be maintained in at least a functional and often natural state, but some limited habitat loss may be acceptable.

- Ecological processes that operate within or across ESAs will not be altered by the fibre-optic cable project;
- The extent of the development is small and will not have a negative impact on the functionality of the broader ESA;
- Cable installation will not sever ecological corridors or introduce additional permanent barriers that impede migration and movement of flora and fauna. Thus, no loss of ecological connectivity in relation to the broader landscape is likely.

Ecological processes, function and drivers

These processes will temporarily be altered by the clearing of the vegetation for the trenches and poles. The impact is expected to be fairly small in relation to the adjacent landscape where no change to the ecological processes is anticipated. Overall, it is unlikely that the fibre-optic cable will contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions.

Road reserves often act as conduits for alien invasive species and the disturbance caused by the construction of the fibre-optic cable will inevitably create conditions favourable for invasion by alien species. Although the level of infestation along the route was fairly low, an alien invasive plant species monitoring and control programme, nevertheless, needs to be initiated to control alien invasive species.

Fire in this arid part of the Nama-Karoo is rare as a result of the high grazing pressure and variable rainfall and not considered as an important driver of vegetation dynamics.

Ecological sensitivity

An overall sensitivity model was applied to the data for each habitat within the vegetation types on site. The mountains, midslopes, mountain plateaux, mountain valleys and low hills were assigned a moderate sensitivity, meaning a sensitivity rating that is real and sufficiently important to require management, e.g. mitigation measures, management or protection of the rare/threatened fauna and flora, protection of a specific habitat on the property and/or rehabilitation. The sensitivity of the bottomlands, plains and footslopes was low, meaning the sensitivity should not have an influence on the decision about the project. A low sensitivity is usually applicable to habitats that have been transformed, especially by human activities. No buffers are applicable to the development, except along the watercourses, which will be dealt with by the aquatic specialist assessment.

Although none of the habitats were rated as highly sensitive from a vegetation point of view, construction activities in the specific locations of known riverine rabbit occupancy should proceed with the utmost care and consideration for these animals. None of the threatened plant species, which could potentially occur in the region, were encountered during the site survey. Furthermore, although none of the habitats were rated as highly sensitive from a vegetation point of view, this does not exclude the presence of protected plant species along the route. Permits are required for the destruction of protected species. The following species were considered as protected species in this report due to being provincially protected as well as ToPS or CITES listed, although none have an IUCN red list status:

Aloe spp.
Anacampseros albidiflora
Anacampseros cf. lanceolata
Anacampseros ustulata
Aristaloe aristata
Euphorbia clavarioides
Huernia barbata
Gonialoe variegata
Lessertia frutescens
Pachypodium succulentum
Mesembryanthemum emarcidum
Stapelia grandiflora
Stomatium difforme
Stomatium suaveolens
Stomatium villetii

Although there are some protected species on the overhead route, the construction of the overhead cable will not impact significantly on the flora and fauna of the area. Furthermore, it is recommended that the construction teams should avoid obvious rocky sheets (where *Anacampseros* spp. and *Stomatium* spp. may be found) and microsite the location of a post when conspicuous plants are present, e.g. *Aloe broomii*. If heavy machinery is used on steep slopes the impact on the vegetation will increase and appropriate mitigation measures should be implemented.

Some sites were identified where some micrositing of the underground trench should take place to avoid some of the protected species present. These sites are mostly where road cuttings occur through elevated areas and it is recommended that the trench is moved down to the foot of the cutting.

Screening tool verification

The screening tool rated the sensitivity of the Animal Species Theme as **High.** Animal species highlighted by the screening tool for the region included the riverine rabbit, mountain reedbuck and Karoo dwarf tortoise. The presence of two red listed bird species was singled out by the screening tool although our background study revealed the presence of 10 red listed species. **Our own findings concur with the screening tool on the animal theme, in particular as it relates to riverine rabbit habitat around Loxton**.

The screening tool rated the sensitivity of the Plant Species Theme as **Medium.** Plant species highlighted by the screening tool for the region included: *Cliffortia arborea* and sensitive species 704. Our background study corresponded with the screening tool on the possible presence of *Cliffortia arborea* along the route, however sensitive species 704 was not listed for the region on the NewPosa database. Neither of these species were encountered during the site visit. Based solely on the presence of red listed species which were not found along the route, **we would suggest to downgrade the rating of the Plant Species Theme to low**. However, many provincially protected/specially protected and CITES II listed species were recorded.

The screening tool rated the sensitivity of the Relative Terrestrial Biodiversity theme as **Very High.** Our background study disputes the findings of the screening tool on this theme, **and suggests a downgrade to Low.** Since the development will primarily take place in the road reserve it will have little impact on existing protected areas or the NPAES, and the classification of the road reserve as CBA is untenable (see part on Critical Biodiversity Areas above). Where the overhead cabling traverses the Karoo National Park, the physical impact footprint is very limited.

Environmental impacts

The key botanical issue is the fact that the study area is predominantly located in the fenced road reserve and therefore represents a habitat that is in essence transformed and continually disturbed. This habitat is seldom representative of the natural veld adjacent to the road reserve and furthermore, water run-off from the road surface contributes to an unnatural species assemblage in most areas. Rare plant species usually occur in specialised and localised habitats, which are mostly destroyed by road building.

The key faunal issue is the known occurrence of the Critically Endangered riverine habitat (*Bunolagus monticularis)*. The area south of Loxton is regarded as prime riverine rabbit habitat, in particular around the Sak and Brak Rivers.

Although the proposed fibre-optic cable may negatively impact the fauna and flora of the site in various ways, the extent of the impact is expected to be small. The potential impacts for the different phases of the project, identified during the current assessment, are listed below:

Direct and indirect Impacts identified during construction, operational and decommissioning phases:

- Potential impact 1: The clearing of natural vegetation and resultant loss of faunal habitat;
- Potential impact 2: The loss of threatened, protected and endemic plants/animals;
- Potential impact 3: Direct faunal mortalities due to trench digging, increased traffic and possible ingestion or ensnarement of animals due to waste material lying around during construction; bird collisions with the overhead cable during the operational phase could possibly occur;
- Potential impact 4: Increased noise levels due to heavy machinery;
- Potential impact 5: Increased dust deposition;
- Potential impact 6: Establishment of alien vegetation as a result of the clearing of the vegetation; and
- Potential impact 7: Increased water run-off and erosion.

Cumulative impacts identified included:

- Cumulative impact 1: Vegetation loss and habitat destruction and concommittant loss of SCC and protected species.
- Cumulative impact 2: Compromising integrity of CBAs, ESAs and NPAES.
- Cumulative impact 3: Increased water run-off and erosion.

Significance of environmental impact

The impacts of the proposed development on the terrestrial ecology were assessed based on the knowledge gained during the site visit and literature review. In summary:

- Cable installation will probably have a temporary impact on the composition and structure of vegetation. The vegetation in the road reserve contains a large proportion of pioneer plant species that will be able to recolonise the disturbed cable trench within a relatively short period of time. On the overhead sections the impact of the development on the vegetation is deemed to be even less than in the underground sections.
- Since the development footprint is small, the loss of habitat or species will be limited.
- The extent of clearing activities in the different vegetation types is small in relation to the remaining extent of the vegetation types and ecosystem threat status will not be affected.
- The impact on overall species and ecosystem diversity of the adjacent land will not be affected and even within the road reserve, the impact will be small.
- Due to the small area that will be disturbed along the route, the impact on populations of protected species will be negligible.
- Roads are permanent infrastructure and are fenced. The fibre-optic cable will mostly be installed in the road reserve, but will not contribute additional obstruction to animal movement.

The overall impact significance is provided in the table below:

Phase	Overall Impact Significance
Construction	Very low to Low
Operational	Very low
Decommissioning	Very low
Cumulative - Construction	Very low
Cumulative - Operational	Very low
Cumulative - Decommissioning	Very low

Legislative and permit requirements

The regulatory authorities for permit requirements are Department of Environment, Forestries and Fisheries (DEFF) Northern Cape Department of Environment and Nature Conservation (NCDENC) and CapeNature. The following legislation is relevant to the development and may require permits from the relevant authority:

- Protected tree species - National Forest Act (Act No. 84 of 1998): no protected tree species present;
- Threatened or Protected Species (ToPS) – National Environmental Management: Biodiversity Act (Act No. 10 of 2004): no ToPS protected plant species recorded for development; several ToPS protected animal species present, but none to be affected if mitigation measures are applied;
- Protected fauna and flora - Northern Cape Nature Conservation Act (Act No. 9 of 2009) (NCNCA) and Western Cape Nature and Environmental Conservation Ordinance (No. 19 of 1974) (WCNECO) as amended in the Western Cape Nature Conservation Laws Amendment Act (No. 3 of 2000). According to the legislation, no person may pick any flora on a public road or on the land on either side of such road within a distance of 90 m from the centre of such road in the Western Cape (or 100 m in the Northern Cape), without a permit. Furthermore, many of the species are protected/specially protected and separate permits may have to be issued for the destruction of individuals of these species.
- Several plant species are listed in Appendix II of CITES and procedures need to be followed as stipulated by CITES.
- The fibre optic cabling is proposed in the eastern section of the Karoo National Park so as to traverse the difficult terrain associated with the Molteno Pass. As such, Section 50(5) approval from the Karoo National Park in terms of the NEM:PAA is required (refer to Chapter 8.1).

Key environmental mitigation and management actions proposed

- Ensure that the placing of infrastructure takes the sensitivity mapping of the ecological assessment into account to avoid and reduce impacts on Habitats of Conservation Concern and protected species.
- Demarcate all infrastructure sites and delineate routing clearly to avoid unnecessary clearance of the vegetation.
- Avoid or minimise impacts that could potentially affect animal behaviour, in particular that of the riverine rabbit.
- Before trenches are dug, in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench.
- Construction of the trench in favoured riverine rabbit habitat should preferably not be conducted during the breeding season (August to May).
- Trenches should not be left open for long periods of time. Trenches should also be inspected for the presence of trapped animals immediately before they are filled.
- Construction crew, in particular the drivers, should undergo environmental training (induction) to increase their awareness of environmental concerns.
- Proper waste management procedures should be in place to avoid waste lying around and to remove all waste material from the site.

- Speed limits should be strictly adhered to.
- Dust control measures must be implemented.
- Permits have to be obtained for the removal of plants within the road reserve and/or NCNCA and WCNECO protected species.
- Implement a monitoring program for the early detection of alien invasive plant species and employ a control program to combat declared alien invasive plant species.

Statement regarding the acceptability or not

The very low impact significance and low sensitivity rating for many of the habitats means the project could go ahead without major constraints, provided the mitigation measures and management actions proposed to protect rare fauna and flora on the site are taken into consideration. We thus support the approval of the project.

LIST OF FIGURES

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ACRONYMS

AIS	Alien Invasive species
BA	Basic Assessment
BAR	Basic Assessment Report
CBA	Critical Biodiversity Area
CBD	Convention on Biodiversity
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CSIR	Council for Scientific and Industrial Research
DEFF	Department of Environment, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMPr	Environmental Management Plan Report
ESA	Ecological Support Area
IUCN	International Union for the Conservation of Nature
I&APs	Interested and Affected Parties
GIS	Geographical Information System
NC	Northern Cape province
NEMA	National Environmental Management Act
NEM:BA	National Environmental Management: Biodiversity Act
NCNCA	Northern Cape Nature Conservation Act
NPAES	National Protected Area Expansion Strategy
ONA	Other Natural Areas
PA	Protected Area
PWA	Protected Wild Animal
SEA	Strategic Environmental Assessment
SANBI	South African National Biodiversity Institute
SWSA	Strategic Water Source Area
ToPS	Threatened and Protected Species
ToR	Terms of Reference
WC	Western Cape province
WCNECO	Western Cape Nature and Environmental Conservation Ordinance

GLOSSARY

Alien invasive species	Any species whose establishment and spread outside of its natural distribution range (i) threatens ecosystems, habitats or other species or has a demonstrable potential to threaten ecosystems, habitats or other species; and (ii) may result in economic or environmental harm or harm to human health.
Alternative	A possible course of action, in place of another, that would meet the same purpose and need (of the proposal). Alternatives can refer to any of the following but are not limited to: alternative sites for development, alternative projects for a particular site, alternative site layouts, alternative designs, alternative processes and alternative materials.
Alluvium	Unconsolidated material deposited by flowing water
Biodiversity	The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems.
Category 1a Listed Invasive Species	Species listed by notice in terms of section 70(1)(a) of the act, as a species that must be combatted or eradicated. Species are listed in Notice 3 of the AIS list (National List of Invasive Species). Landowners are obliged to take immediate steps to control Category 1a species.
Category 1b Listed Invasive Species	Species listed by notice in terms of section 70(1)(a) of the act, as species that must be controlled or 'contained'. Species are listed in Notice 3 of the AIS list (National List of Invasive Species). Landowners are obliged to "control" the species in accordance with the requirements of Invasive Species Management Programme.
Category 2 Listed Invasive Species	Species which require a permit to carry out a restricted activity e.g. cultivation within an area specified in the Notice or an area specified in the permit, as the case may be. Category 2 includes plant species that have economic, recreational, aesthetic or other valued properties, notwithstanding their invasiveness. It is important to note that a Category 2 species that falls outside the demarcated area specified in the permit, becomes a Category 1b invasive species. Permit-holders must take all the necessary steps to prevent the escape and spread of the species.
Category 3 Listed Invasive Species	A species listed by notice in terms of section 70(1)(a) of the act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the act, as specified in the notice. Category 3 species are less-transforming invasive species which are regulated by activity. The principal focus with these species is to ensure that they are not introduced, sold or transported. However, Category 3 plant species are automatically Category 1b species within riparian and wetland areas.
Common indigenous animal	A species of indigenous wild animal listed in Schedule 3. (NCNCA 2009).
Common indigenous plant	A species of indigenous plant listed in Schedule 3. (NCNCA 2009).
Critical Biodiversity Areas	Areas required to meet biodiversity targets for ecosystems, species or ecological processes. CBAs are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species.
Damage-causing animal	An animal declared to be a damage-causing animal listed in Schedule 4. (NCNCA 2009).
Development	The building, erection, construction or establishment of a facility, structure or infrastructure, including associated earthworks or borrow pits, that is necessary for the undertaking of a listed or specified activity.
Development footprint	Any evidence of physical alteration as a result of the undertaking of any activity.
Ecological Support Areas	These are not essential for meeting biodiversity targets, but play an important role in supporting the functioning of Protected Areas or CBAs and are often vital for delivering ecosystem services. ESAs must be maintained in at least a functional and often natural state, but some limited habitat loss may be acceptable.
Endangered flora	Any species which is in danger of extinction and is specified in Schedule 3 or Appendix I of the CITES (WCNECO 1974).
Endangered wild animal'	A wild animal of any species which is in danger of extinction and is specified in Schedule I or Appendix I of the CITES (WCNECO 1974).
Exempted Alien Species	An alien species that is not regulated in terms of this statutory framework - as defined in Notice 2 of the AIS List.
Habitat	A place where a species or ecological community naturally occurs.
indigenous vegetation	Vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years.
Indigenous	A species that occurs, or has historically occurred, naturally in a free state in nature within the borders of the Republic, but excludes a species that has been introduced in the Republic as a result of human activity;.
Introduced	In relation to a species, means the introduction by humans, whether deliberately or accidentally, of a species to a place outside the natural range or natural dispersal potential of that species;
Linear activity	An activity that is arranged in or extending along one or more properties and which affects the environment or any aspect of the environment along the course of the activity, and includes railways, roads, canals, channels, funiculars, pipelines, conveyor belts, cableways, power lines, fences, runways, aircraft landing strips, firebreaks and telecommunication lines.
Mitigate	The implementation of practical measures to reduce adverse impacts or enhance beneficial impacts of an action.
"No-Go" option	The "no-go" development alternative option assumes the site remains in its current state, i.e. there is no development in the proposed project area.
Prohibited Alien Species	An alien species listed by notice by the Minister, in respect of which a permit may not be issued as contemplated in section 67(1) of the act. These species are contained in Notice 4 of the AIS List, which is referred to as the List of Prohibited Alien Species.
Protected animal	A species of wild animal listed as such in Schedule 2. (NCNCA 2009).

Protected plant	A species of plant listed as such in Schedule 2; NCNCA 2009.
Protected flora	Any species of flora specified in Schedule 4 or Appendix II of the CITES. (WCNECO 1974).
Protected wild animal	Any species of wild animal specified in Schedule 2 or Appendix II of the CITES. (WCNECO 1974).
Specially protected animal	Any animal listed as such in Schedule 1. (NCNCA 2009).
Specially protected plant	Any plant listed as such in Schedule 1. (NCNCA 2009).
Watercourse	Includes (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, pan, lake or dam into which, or from which, water flows; and a reference to a watercourse includes, where relevant, its bed and banks.
Wetland	Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms of the EIA Regulations under the National Environmental Management Act (Act No. 107 of 1998) (NEMA 2014, 2017, 2020).

Appointment of specialist

Ekotrust cc was commissioned by CSIR (EMS) Stellenbosch to provide an assessment on the terrestrial ecology and biodiversity of the SKA fibre-optic cable project between Beaufort West in the Western Cape and Carnarvon in the Northern Cape, a distance of 181 km.

Company profile:

Name of Company: Ekotrust cc
(Registration number: CK90/05465/23)
Sole Member: Dr Noel van Rooyen
Founding date: 1990

Ekotrust cc specialises in habitat evaluation, vegetation classification and mapping, floristic diversity assessments, rare species assessments, alien plant assessments and management, wildlife management, wildlife production and economic assessments, veld condition assessment, bush encroachment, fire management, carrying capacity, wildlife numbers and ratios.

Specialist declaration:

We, Noel van Rooyen and Gretel van Rooyen, as the appointed independent specialists, hereby declare that we:

- act as independent specialists in this application;
- 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;
- regard the information contained in this report, as it relates to our specialist input/study, to be objective, true and correct within the framework of assumptions and limitations;
- do not have and will not have any business, financial, personal or other interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations 2014, and amendments 2017, NEMA 2020 Procedures for the assessment and minimum requirements 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, and any specific environmental management act;
- declare that there are no circumstances that may compromise our objectivity in performing such work;
- 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;
- will comply with the Act, Regulations and all other applicable legislation;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- have no vested interest in the proposed activity proceeding;
- undertake to disclose to the applicant and the competent authority all material information in our 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; or the objectivity of any report, plan or document to be prepared by us for submission to the competent authority;

- all the particulars furnished by us in this form are true and correct; and
- realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Indemnity and conditions relating to this report:

The observations, findings, recommendations and conclusions provided in the current report are based on the compilers' best scientific and professional knowledge and other available information. If new information should become available Ekotrust cc reserves the right to modify aspects of the report. This report (hard copy and/or electronic) must not be amended or extended without the prior written consent of the author. Furthermore, any recommendations, statements or conclusions drawn from or based on this report must make reference to the report. If these recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety (as an Appendix).

Although Ekotrust cc has exercised due care in preparing this report, it accepts no liability, and by receiving this document, the client indemnifies Ekotrust cc against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

Signature of specialists:

Name of specialist:	Dr N van Rooyen	Prof. MW van Rooyen
Date:	12 November2021	12 November 2021

GENERAL INFORMATION

Study site: Road from Beaufort West over Loxton to Carnarvon (R63 and R381)

District Municipality: Pixley ka Seme
Local Municipality (Carnarvon): Kareeberg
Local Municipality (Loxton): Ubuntu

District Municipality: Central Karoo
Local Municipality (Beaufort West): Beaufort West

Approximate length of road: 181 km

Environmental Assessment Practitioner (EAP):

CSIR
SMART places (Environmental Management Services)
PO Box 320
Stellenbosch 7599
Contact person: Luanita Snyman-Van der Walt
Tel. +27 (0) 21 888 2490
Mobile: 072 182 9718
e-mail: lvdwalt1@co.za

Botanical assessment by:

This specialist assessment has been undertaken by Noel van Rooyen and Gretel van Rooyen of Ekotrust cc. Noel van Rooyen is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 401430/83 in the field of Botanical Sciences. Gretel van Rooyen is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 400509/14 in the field of Ecological Sciences. The *curriculum vitae* of the specialists are included in Appendix F of this assessment.

Dr Noel van Rooyen Pr.Sci.Nat; Reg. no. 401430/83 - Botanical Sciences
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gretel@ekotrust.co.za

TERMS OF REFERENCE

The Scope of Work for the terrestrial ecology specialist study includes the following tasks:

- Compilation of a specialist study in adherence to:
  - the gazetted *Procedures for the assessment and minimum requirements 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* (GG 43110 / 320, 20 March 2020);
  - any additional relevant legislation and guidelines that may be deemed necessary.
- The assessment should be based on existing information, national and provincial databases, South African National Biodiversity Institute (SANBI) mapping, professional experience and field work conducted.
- Undertake a site inspection to identify the site sensitivities, and verify them in terms of the National Web-Based Screening Tool (https://screening.environment.gov.za/).
- Liaise with SANBI to obtain information on sensitive species flagged in the National Web-Based Screening Tool (where species names are obscured / only numbered).
- Describe the terrestrial ecological features of the project area, with focus on features that are potentially impacted by the proposed project. The description should include the major habitat forms within the study site, giving due consideration to terrestrial ecology (flora and fauna), Species of Conservation Concern (SCC) or Protected Species.
- Specify development set-backs / buffers, and provide clear reasons for these recommendations.
- Map the sensitive ecological features within the proposed project area, showing any "no-go" areas (i.e. "very high" sensitivity).
- Provide input on the preferred infrastructure route following the sensitivity analysis.
- Provide sensitive features spatial data in a useable GIS format (kmz / shp).
- Assessment of direct, indirect and cumulative impacts associated with the proposed fibre-optic cable development, with and without mitigation.
- Address relevant concerns / comments raised by Interested and Affected Parties and Stakeholders, including the Competent Authority, during Public Participation Processes on the draft Basic Assessment Report (BAR).
- Identify relevant legislative requirements and permits that may be required.
- Recommend mitigation measures, best practice management actions, monitoring requirements, and rehabilitation guidelines for all identified impacts to be included in the Environmental Management Programme (EMPr).
- Update draft specialist study report after Environmental Assessment Practitioner (EAP) and client review (before public release) and after public review for submission to the Competent Authority for decision-making.
- Address any queries from the Competent Authority during the decision-making phase (as and when they arise).

LIMITATIONS, ASSUMPTIONS AND UNCERTAINTIES

The following assumptions, limitations or uncertainties are listed regarding the evaluation of the impacts of the proposed SKA Fibre-optic Cable project on the terrestrial ecology along the route.

- Surveys along the route were restricted to the area between the road and the fence. In some instances, the fences had been erected very close to the road shoulder and in these cases it is possible that the full statutory width of the road reserve could not be surveyed.
- The area has been poorly collected and the list of plant species that could potentially occur on site as obtained from the NewPosa database, was therefore taken from a far broader area than the study site.
- Rare and threatened plant and animal species are generally uncommon and/or localised and the once-off survey may fail to locate such species.
- Furthermore, rare plant species usually occur in specialised and localised habitats which are mostly destroyed by road building and sightings of rare plant species are therefore unlikely.
- The survey was conducted during dry conditions at the end of September/beginning of October 2020, which is not the ideal sampling season for botanical assessments in this summer rainfall area.
- No trapping (either camera trapping or by way of Sherman traps) was conducted for fauna, since these methods generally provide an underrepresentation of the full faunal diversity within the limited timeframe available.
- The drainage lines (watercourses: streams, rivers) along the route were not surveyed in detail, because the aquatic habitat will be part of the aquatic assessment (EnviroSci 2020).
- The study area predominantly covers the fenced road reserve and therefore represents a habitat that is in essence transformed and continually disturbed. This habitat is seldom representative of the natural veld adjacent to the road except where some sections were not transformed (e.g. in the mountain and where cuttings through the hills or ridges occur). Water run-off from the road surface contributes to an unnatural species assemblage in most areas.
- At the time that the study was conducted, the entire proposed fibre-optic cable route was designed to fall within the road reserve. It has since become apparent that small sections need to traverse the Karoo National Park. These sections were thus not inspected on foot during the site visit.

1. INTRODUCTION

The South African Radio Astronomy Observatory (SARAO) leads South Africa's activities in the Square Kilometre Array (SKA) Radio Telescope. SARAO is a National Facility, managed by the National Research Foundation (NRF), which incorporates all national radio astronomy telescopes and programmes. The SKA project is an international effort to build the world's largest radio telescope, with a square kilometer collecting area. The SKA project in South Africa will include the instruments and programmes such as the MeerKAT and KAT-7 telescopes in the Karoo, Northern Cape province.

Connectivity is required between the SKA core site in the Northern Cape and a data processing facility in Cape Town to transport the science data for the SKA project and its precursor, MeerKAT. Access to fibre-optics is required to transport this data due to the expected data throughputs for the SKA project. SARAO has built an overhead fibre-optic route between Carnarvon and the SKA core site to the north. Additionally, the South African National Research Network (SANReN) has procured access to fibre-optics between Beaufort West and Cape Town. A fibre-optic cable connection must, therefore, be built between Carnarvon and Beaufort West to connect SKA to Cape Town.

The details of the preferred and selected SKA fibre-optic route (Route A) are as follows:

- The fibre route starts from Beaufort West Transnet building, to a 3 m x 6 m signal repeater station at Loxton, and then on to the Carnarvon SKA Point of Presence (PoP) site (location where networking equipment may be accessed).
- The fibre duct and cable will be laid in a 1 m deep and 300 mm wide trench and be buried by backfilling and compacting the trench.
- The majority of the fibre route will be installed underground within the road reserves of roads R381 and R63, and 1 m from the fence of the adjacent private land (approximately 160 km).
- Approximately 21 km will be overhead due to it not being technically or financially feasible to trench on the Molteno Pass and some sections further north. In these sections, the proposed routing may deviate from the road reserve into adjacent land. The total pole length is 9 m, buried 1.5 m deep, with a resultant above-ground height of 7.5 m.
- There are watercourses to cross. Rivers will be crossed using directional drilling 2 m below the riverbed starting 32 m away from river banks.
- There is only one river with solid bedrock (the Brak River near Loxton) where directional drilling is not technically or financially feasible. Here the fibre cable will be attached to the existing road bridge.

SANReN (the Applicant for Environmental Authorisation (EA)) commissioned the Council for Scientific and Industrial Research (CSIR) Environmental Management Services (EMS) to conduct an Environmental Screening Study (ESS), which was completed in May 2020. The ESS reviewed geographic information and relevant environmental legislation to determine the EA and / or licenses that would apply to the proposed SKA fibre-optic cable. The results of the ESS indicated that, inter alia:

- A Basic Assessment (BA) procedure is required to obtain EA for the proposed fibre-optic route. This requirement is triggered by the following Listed Activities of the Environmental Impact Assessment Regulations (NEMA 2017):
- .
    - ***Listing Notice 1: Activity 19 - The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse.***
    - ***Listing Notice 2: Activity 12 – The clearance of an area of 300 m^2 or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan;***

- *(a) NORTHERN CAPE (i) within any critically endangered ecosystem or endangered ecosystem listed in terms of section 52 of NEM:BA or prior within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; (ii) within Critical Biodiversity Areas (CBAs) identified in bioregional plans; (iii) within the littoral active zone or 100 m inland from the high water mark of the sea or an estuary; (iv) on land where such land was zoned open space, conservation or had an equivalent zoning;*
- *(b) WESTERN CAPE (i) within any critically endangered ecosystem or endangered ecosystem listed in terms of section 52 of NEM:BA or prior within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; (ii) within Critical Biodiversity Areas (CBAs) identified in bioregional plans; (iii) within the littoral active zone or 100 m inland from the high water mark of the sea or an estuarine functional zone; (iv) on land where such land was zoned open space, conservation or had an equivalent zoning; (v) on land designated for protection or conservation purposes in an Environmental Management Framework or a Spatial Development Framework.*

- A terrestrial ecology (fauna and flora) specialist assessment is required as part of the BA.

The current report presents the specialist assessment of the terrestrial ecology component of the BA to obtain EA for the proposed fibre-optic route. The scope, purpose and objectives of the report have essentially been summarised in the Terms of Reference (ToR).

2. APPROACH AND METHODOLOGY

2.1 Approach

The study commenced as a desktop study, followed by field-based surveys from 27 September to 2 October 2020. The focus of the site visit was to conduct surveys (fauna and flora) along the route for the classification of the vegetation into habitats (or plant communities), identification of sensitive habitats, compiling of species lists and at the same time to search for Species of Conservation Concern (SCC).

Hard copy and digital information from spatial databases, such as daffarcgis.nda.agric.za, the geological survey maps (3022 Britstown; 3122 Victoria West; 3222 Beaufort West), land type maps (3022 Britstown; 3122 Victoria West; 3222 Beaufort West), topocadastral maps (nine 1:50 000 maps), vegetation types (Mucina & Rutherford 2006, 2018), NewPosa database of SANBI, and databases of the Animal Demography Unit, University of Cape Town, were sourced to provide information on topography, geology, land types, broad vegetation types, flora and fauna of the study area. Information on the long-term climate was sourced from the Weather Bureau (1988, 1998).

Satellite images (Google Earth) were used to identify broad habitat types along the fibre-optic cable route. The vegetation survey consisted of visiting the habitat types along the route and systematically recording plant species on site, and estimating their cover-abundance. A total of 157 sites were surveyed. Physical habitat features were also noted. During the site visit, digital photographs were taken, and representative photographs of the different habitats are included in the report. The site was also surveyed for rare, threatened and/or endemic plant species during the site visit.

The animal survey was limited to day-time visual assessments along the route. Animal species present along the route were mainly attained by means of direct or indirect sighting methods (animals, spoor, burrows, scats, sounds), whilst traversing the route by vehicle or on foot. Red listed species are generally uncommon and/or localised and the survey may have been insufficient to record their presence at or near the development.

2.2 Vegetation and flora

The plant species data were arranged per vegetation type, and within each vegetation type per habitat. These habitats and their dominant species are briefly described.

The checklist in Appendix A was compiled from various sources. All plant species (the term species is used here in a general sense to denote species, subspecies and varieties) recorded during the site visit are listed in the checklist. A plant species checklist of the route was also obtained from the NewPosa database of SANBI (newposa.sanbi.org) and is incorporated in Appendix A. The International Union for the Conservation of Nature (IUCN) status, conservation and protected status of all plant species provided in Appendix A were determined from available literature and Acts, e.g. NewPosa database (newposa.sanbi.org) and Red list database of SANBI (redlist.sanbi.org), National Environmental Management: Biodiversity Act (NEM:BA) (2007c) (ToPS list), NCNCA (2009), WCNECO (1974, as amended 2000) and CITES (2019).

2.3 Fauna

Species lists (the term species is used here in a general sense to denote species, subspecies and varieties) of the faunal component were sourced from the Animal Demography Unit, University of Cape Town website (adu.uct.ac.za) and consulting of available databases and/or relevant literature, e.g. Skinner and Chimimba (2005), Alexander and

Marais (2007), BirdlifeSA (birdlife.org.za), Bates *et al.* (2014), Leeming (2003) and Mecenero *et al.* (2013) to determine the diversity, conservation status and distribution of relevant faunal species.

2.4 Sensitivity assessment

Based on the environmental features and the species encountered in the on-site survey, a sensitivity assessment of each terrestrial habitat was done (Chapter 9). Sensitive features are presented spatially in GIS format (provided as a separate .kmz file).

2.5 Impact assessment

An assessment of the ecological impacts and their significance on the terrestrial system, is discussed and mitigation measures proposed. The impact assessment was based on the criteria and methodology outlined in the template received from the CSIR (SKA fibre TERRESTRIAL template Sept 2020).

2.6 Sources of information

Vegetation:

- Vegetation types occurring in the area were obtained from Mucina & Rutherford (2006, 2018);
- Conservation status of the vegetation types was obtained from Mucina & Rutherford (2006), National List of Threatened Ecosystems (NEMA 2011) and the most recent National Biodiversity Assessment (NBA) (SANBI 2018a);
- The route does not occur in any Centre of Endemism (Van Wyk & Smith 2001).
- Information on endemic or near-endemic species for the vegetation types was obtained from Mucina & Rutherford (2006);
- A plant species checklist of the route was obtained from the SANBI NewPosa database (Appendix A) (website accessed August 2020).
- The IUCN Red List Category for the plant species was extracted from the Threatened Species Programme (Red List of South African plants; website accessed October 2020) as well as the SANBI NewPosa database (website accessed August 2020).
- WCNECO (1974 as amended in 2000) and NCNCA (2009) were consulted to establish provincially specially protected and protected status of plant species.
- The National Protected tree list (NFA 2019) was consulted.

Fauna

- Lists of mammals, reptiles, birds, frogs, scorpions (Scorpiones), spiders (Arachnida), butterflies (Lepidoptera), lacewings (Neuroptera), dung beetles (Scarabinae) and dragonflies (Odonata) were extracted from the Animal Demography Unit, University of Cape Town website (http://vmus.adu.org.za; website accessed October 2020) and supplemented by information gathered in Bates *et al*. (2014) for reptiles; Skinner and Chimimba (2005) for mammals; Birdlife SA website for the birds; and Mecenero *et al.* (2013) for butterflies (Appendix B).
- The IUCN Red List Category for the animal species was extracted from Child *et al.* (2016), Bates *et al*. (2014) for reptiles; Skinner and Chimimba (2005) for mammals; BirdlifeSA website for the birds (birdlife.org.za); and Mecenero *et al.* (2013) for butterflies. No IUCN Categories are however available for lacewings, dung beetles, spiders and scorpions.
- WCNECO (1974) and NCNCA (2009) were consulted to establish provincially specially protected and protected status of animal species.

Other

- The website of the National Protected Areas Expansion Strategy (NPAES) was consulted for possible inclusion of the site into a protected area in future (accessed October 2020).
- The Northern and Western Cape Biodiversity Area Maps were consulted for inclusion of the route into a Critical Biodiversity Area or Ecological Support Area (biodiversityadvisor.sanbi.org; accessed October 2020).

3. REGULATORY FRAMEWORK

3.1 Introduction

The White Paper on the conservation and sustainable use of South Africa's biodiversity and the NEMA (Act No. 107 of 1998) specify that due care must be taken to conserve and avoid negative impacts on biodiversity and that the sustainable, equitable and efficient use of biological resources must be promoted. Various acts provide control over natural resources in terms of their conservation, the use of biological resources and avoidance of negative impacts on biodiversity. Some international conventions are also relevant to sustainable development.

3.2 Natural resources

Terrestrial and other ecosystems and their associated species are widely used for commercial, semi-commercial and subsistence purposes through both formal and informal markets. While some of this use is well managed and/or sustainable, much is thought to be unsustainable. "Use" in this case refers to direct use, such as collecting, harvesting, hunting and fishing for human consumption and production, as well as more indirect use such as ecotourism and wildlife ranching.

3.3 Convention on Biodiversity (CBD)

South Africa became a signatory to the United Nations Convention on Biological Diversity (CBD) in 1993, which was ratified in 1995. The CBD requires signatory states to implement objectives of the Convention, which are the conservation of biodiversity; the sustainable use of biological resources and the fair and equitable sharing of benefits arising from the use of genetic resources. According to Article 14 (a) of the CBD, each Contracting Party, as far as possible and as appropriate, must introduce appropriate procedures, such as environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biological diversity, to avoid or minimise these effects and, where appropriate, to allow for public participation in such procedures.

3.4 National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The NEMA is the framework environmental management legislation, enacted as part of the government's mandate to ensure every person's constitutional right to an environment that is not harmful to his or her health or well-being. It is administered by DEFF but several functions have been delegated to the provincial environment departments. One of the purposes of NEMA is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment. The Act further aims to provide for institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state and to provide for the administration and enforcement of other environmental management laws.

The EIA Regulations Listing Notices of 2010 were repealed in 2014 and replaced by NEMA (2014) and amended regulations and listings were published in 2017 (NEMA 2017) under the National Environmental Management Act. Listing Notice 1 (GRN No. 327), Listing Notice 2 (GRN No 325) and Listing Notice 3 (GRN No 324) of the 2017 Regulations list activities that may require EA prior to commencement of an activity and identify competent authorities in terms of sections 24(2) and 24D of the Act.

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 NEMA 1998, when applying for EA were published in the Government Gazette 43110, No 320, 20 March 2020.

3.5 National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEM:BA)

As the principal national act regulating biodiversity protection, NEM:BA, which is administered by DEA, is concerned with the management and conservation of biological diversity, as well as the use of indigenous biological resources in a sustainable manner. The term biodiversity, according to the Convention on Biodiversity (CBD), refers to the variability among living organisms from all sources including, *inter alia* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity in genes, species and ecosystems.

Threatened ecosystems

Section 53 of NEM:BA lists the threatened status of ecosystems, i.e. critically endangered ecosystems, endangered ecosystems, and vulnerable ecosystems. The list of threatened ecosystems was published in 2011 (NEM:BA 2011). Thirty-four percent of South Africa's 440 terrestrial ecosystems are considered threatened. Of these, 5% are critically endangered (mostly in fynbos and forest biomes), 13% are endangered (mostly in the grassland and savanna biomes), and 16% are vulnerable (mostly in the fynbos and grassland biomes). The recent 2018 NBA (SANBI 2018a) includes the updated extent and status of threatened ecosystems, although not yet formally adopted under the NEM:BA.

Threatened or Protected Species (ToPS) Regulations

Section 56 of NEM:BA makes provision for the declaration of species which are of such high conservation value, national importance or are considered threatened that they need protection, i.e. critically endangered species, endangered species and vulnerable species. Lists of species that are threatened or protected, and associated activities that are prohibited and/or exempted from restriction were published in 2007 (NEMBA 2007c). Any proposed development involving one or more threatened or protected species and/or prohibited/restricted activities will require a permit in term of these Threatened or Protected Species (ToPS) Regulations.

Alien and Invasive Species (AIS) Regulations

Chapter 5 of NEM:BA provides for the protection of biodiversity from alien and invasive species. The act defines alien species and provides lists of invasive species in regulations. The Alien and Invasive Species (AIS) Regulations, in terms of Section 97(1) of NEM:BA, was published in Government Notice R598 in Government Gazette 37885 in 2014 (NEM:BA 2014). The Alien and Invasive Species (AIS) lists were subsequently published in Government Notice R 864 of 29 July 2016 (NEM:BA 2016).

In terms of the aforementioned legislation, the following categories of declared alien and invasive plants are recognised in South Africa (see Glossary for explanations):

1. Exempted Alien Species
2. Prohibited Alien Species
3. Category 1a Listed Invasive Species
4. Category 1b Listed Invasive Species
5. Category 2 Listed Invasive Species
6. Category 3 Listed Invasive Species

3.6 The National Environmental Management: Protected Areas Act (Act No. 57 of 2003) (NEM:PAA)

The National Environmental Management: Protected Areas Act (NEM:PAA) provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; and for matters in connection therewith. Specifically, before any development, construction or farming may be permitted in a national park, nature reserve or world heritage site, prior written approval of the Park management authority is required in order to go ahead (Section 50(5)). The fibre optic cabling is proposed in the eastern section of the Karoo National Park so as to traverse the difficult terrain associated with the Molteno Pass. As such, Section 50(5) approval from the Karoo National Park in terms of the NEM:PAA is required (refer to Chapter 8.1).

3.7 National Forests Act (Act No. 84 of 1998) (NFA)

The National Forest Act (NFA) makes provision for the declaration of for example specially protected areas, forest nature reserves, forest wilderness areas and protected woodlands. The latest list of declared protected tree species in terms of the NFA was published in 2019 (NFA 2019). In terms of section 15(1) of this act, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any product derived from a protected tree, except under a license or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated. The competent authority responsible for considering and issuing the license in terms of the NFA will be the National DEFF.

3.8 Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA)

The objectives of the Conservation of Agricultural Resources Act (CARA) are to provide for the conservation of the natural agricultural resources by the maintenance of the production potential of the land, by combating and preventing erosion and weakening or destruction of the water resources, and by protecting natural vegetation and combating weeds and invader plants. In order to achieve the objectives, certain control measures are prescribed to which land users must comply. The activities mentioned relate to:

- the cultivation of virgin soil;
- the irrigation of land;
- the prevention or control of waterlogging or salinisation of land;
- the utilisation and protection of vleis, marshes and water courses;
- the regulation of the flow pattern of run-off water;
- the utilisation and protection of vegetation; and
- the restoration or reclamation of eroded land.

3.9 Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The Convention on the International Trade in Endangered Species (CITES) is an international agreement to which countries adhere voluntarily. The aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The species covered by CITES are listed in three appendices reflecting the degree

of protection that the species needs. Appendix I includes species that are threatened with extinction and trade in these species is permitted only in exceptional circumstances. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. Appendix III lists species that are protected in at least one country that has asked other CITES parties for assistance in controlling the trade (Website: www.cites.org, accessed October 2020).

4. STUDY AREA

4.1 Location

The project covers the route along the R381 between Beaufort Wes and Loxton and the R63 between Loxton and Carnarvon (Figures 1 & 2). The road covers both the Western Cape and the Northern Cape with the provincial boundary about 15 km south of Loxton. The area falls within the Central Karoo District Municipality in the Western Cape (Beaufort West Local Municipality) and the Pixley ka Seme District Municipality of the Northern Cape. The two local municipalities in the Northern Cape are the Ubuntu Local Municipality and the Kareeberg Local Municipality. The route starts at 32° 21' 03.0" S; 22° 34' 35.3" E in Beaufort West and ends at 30° 58' 12.3" S; 22° 08' 29.1" E in Carnarvon in the north.

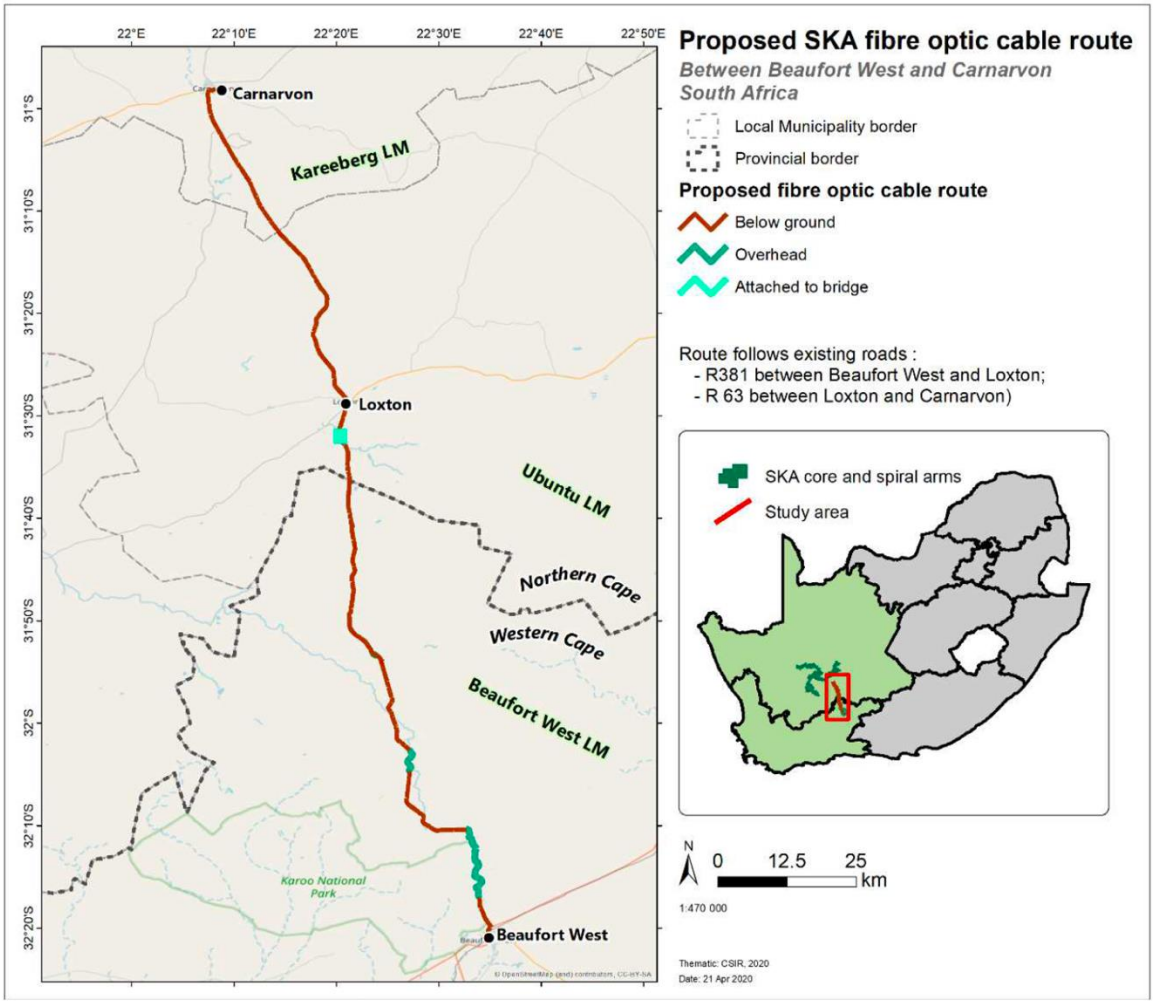


Figure 1:The proposed SKA fibre-optic cable route between Beaufort West and Carnarvon via the R381 and R63 roads (sourced from CSIR 2020).

The topocadastral quarter degree grid references and 1: 50 000 maps are:

- 3222 CC Beaufort West
- 3222 AB Rosedene
- 3122 CB Slangfontein
- 3122 AB Alarmkraal
- 3022 CC Carnarvon
- 3222 BA Kuilspoort
- 3122 CD Dunedin
- 3122 AD Loxton
- 3122 AA Flinkskop

Figure 2: Google image of SKA fibre-optic cable route between Beaufort West and Carnarvon.

4.2 Terrain morphology

The route starts in the south at Beaufort West at an altitude of approximately 855 m. The altitude increases to about 1600 m north of the Karoo National Park and then decreases to reach Loxton at 1400 m altitude. From Loxton the altitude decreases further to approximately 1250 m at Carnarvon in the north. The terrain in the north is flat to gently sloping with isolated hills. Dolerite koppies, butts and mesas are characteristic south of Loxton with the Nuweveld Mountains of the Great Escarpment dominating the area towards Beaufort West.

4.3 Climate

4.3.1 Regional climate (Mucina & Rutherford 2006)

The Eastern Upper Karoo covers most of the plains to the north of the Great Escarpment. The mean annual precipitation in this vegetation type is 295 mm (range from 180 mm in the west to 430 mm in the east) with a peak in rainfall in March. The annual precipitation coefficient of variation is 35%. Mean annual potential evaporation is 2360 mm, while the mean annual soil moisture stress is 82%. Mean annual temperature is 14.7°C and frost is frequent in winter with a mean of 52 days per annum.

The Upper Karoo Hardeveld covers the Great Escarpment north of Beaufort West. The mean annual precipitation in this area is 254 mm (range from 150 mm in the northwest to 350 mm in the east) with a peak in March. The annual precipitation coefficient of variation is 36%; mean annual potential evaporation is 2440 mm, while the mean annual soil moisture stress is 82%. Mean annual temperature is 14.7°C and frost is frequent in winter with a mean of 46 days per annum.

The Gamka Karoo covers the plains south of the Great Escarpment (around Beaufort West) and is one of the most arid units of the Nama-Karoo Biome. The mean annual precipitation of this area is 165 mm (range from about 100 mm in some areas between the Dwyka and Gamka Rivers to about 240 mm against the Great Escarpment) with a peak in March. The annual precipitation coefficient of variation is 38%; mean annual potential evaporation is 2483 mm, while the mean annual soil moisture stress is 84%. The mean annual temperature is 16.3°C and frost is frequent in winter with a mean of 27 days per annum.

Thus, although there is a substantial difference in mean annual rainfall in the three vegetation types, the coefficient of variation in the annual rainfall; the mean annual potential evaporation and mean annual soil moisture stress are similar for all three vegetation types. The mean annual temperature in the Gamka Karoo is somewhat higher than that of the other two vegetation types.

4.3.2 Rainfall

The mean annual rainfall in the region ranges from 157 mm at Williston to 174 mm at Fraserburg, 236 mm at Beaufort West, 249 mm at Carnarvon and 253 mm at Victoria West (Table 1).

Table 1: Rainfall at some weather stations in the general environs of the fibre-optic cable's route (Weather Bureau 1998)

	Mean Annual Rainfall (mm)				
Month	**Beaufort West**	**Carnarvon**	**Williston**	**Victoria West**	**Fraserburg**
Jan	35	21	8	26	16
Feb	30	42	19	39	24
Mar	30	45	29	50	31
Apr	20	37	20	25	20
May	11	12	13	18	15
June	8	11	8	9	9
July	9	6	13	8	8
Aug	14	7	6	7	8
Sep	12	7	8	11	8
Oct	21	16	9	14	10
Nov	27	21	15	21	12
Dec	19	24	9	25	13
Year	236	249	157	253	174

The mean annual rainfall as measured at Carnarvon is 249 mm (Table 2, Figure 3). The total annual rainfall at Carnarvon during dry and wet years respectively may range from 102 mm to 493 mm, indicating a high variation in the annual rainfall and therefore a rainfall scenario that is highly unpredictable. The rainy season at Carnarvon is predominantly from November to April when about 76% of the annual rainfall occurs. February, March and April are the wettest months and the driest period is from July to September, when less than 10 mm of rain per month is recorded. Maximum rainfall measured over a 24-hour period at Carnarvon was 77 mm, recorded in April. The highest monthly rainfall recorded was 145 mm, measured in February.

Table 2: Maximum rainfall (mm) in 24 hours, highest maximum and lowest monthly minimum rainfall at Carnarvon: 30° 58' S; 22° 00' E; 1280 m (Weather Bureau 1998)

	Rainfall (mm)			
Month	**Mean (month)**	**24 h max**	**Max per month**	**Min per month**
Jan	21	38	104	0
Feb	42	68	145	1
Mar	45	63	112	2
Apr	37	77	115	1
May	12	23	29	0
June	11	28	34	1
July	6	18	29	0
Aug	7	15	38	0
Sep	7	32	38	0
Oct	16	32	65	0
Nov	21	58	69	0
Dec	24	47	125	0
Year	249	77	493	102

The mean annual rainfall as measured at Beaufort West to the southwest is 236 mm per annum (Table 3, Figure 4). The total annual rainfall at Beaufort West during dry and wet years respectively may range from 129 mm to 472 mm, indicating the unpredictable nature of the rainfall. October to April is the main rainy season at Beaufort West when about 77% of the annual rainfall occurs. January to March are the wettest months and the driest period is from June to July, when less than 10 mm of rain per month is recorded. The maximum rainfall measured over a 24-hour period at Beaufort West was 83 mm in March. The highest monthly rainfall recorded was 164 mm, measured in January.

Table 3: Maximum rainfall (mm) in 24 hours, highest maximum and lowest monthly minimum rainfall at Beaufort West: 32° 18' S; 22° 14' E; 893 m (Weather Bureau 1998)

Month	**Mean (month)**	**24 h max**	**Max per month**	**Min per month**
Jan	35	50	164	0
Feb	30	67	133	0
Mar	30	83	83	2
Apr	20	30	65	2
May	11	70	78	0
June	8	18	26	0
July	9	34	42	0
Aug	14	55	73	0
Sep	12	41	58	0
Oct	21	48	68	0
Nov	27	47	70	2
Dec	19	38	106	0
Year	236	83	472	129

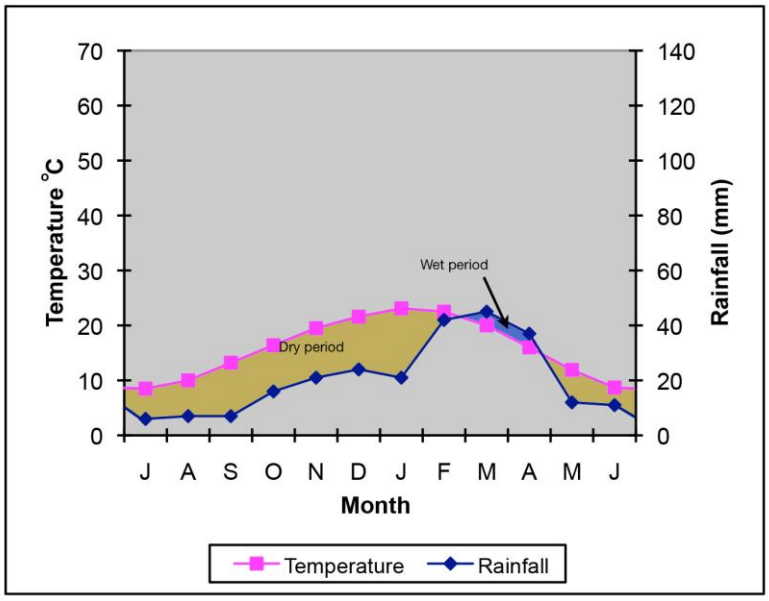


Figure 3: Climate diagram for Carnarvon. Months on X-axis are from July to June. When the rainfall curve is below the temperature curve it indicates a dry period.

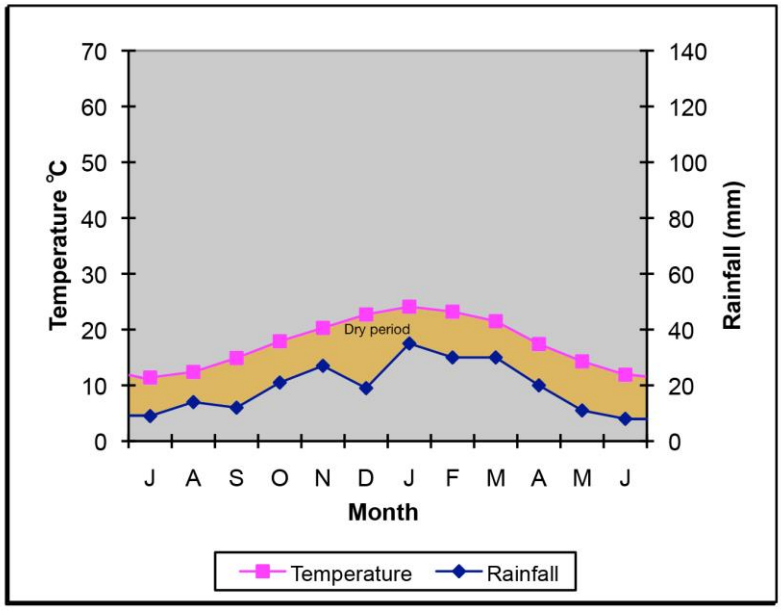


Figure 4: Climate diagram for Beaufort West. Months on X-axis are from July to June. When the rainfall curve is below the temperature curve it indicates a dry period.

4.3.3 Temperature

The mean annual temperature for Carnarvon is 16.0°C (Table 4) with the extreme maximum and minimum temperatures 39.0°C and -9.1°C respectively. The mean daily maximum for January is 31.4°C and for July it is 15.9°C, whereas the mean daily minimum for January is 14.8°C and for July it is 1.0°C. Frost may occur anytime from March to November.

The mean annual temperature for Beaufort West is 17.7°C (Table 5) with the extreme maximum and minimum temperatures 41.4°C and -5.6°C respectively. The mean daily maximum for January is 32.3°C and for July it is 18.4°C, whereas the mean daily minimum for January is 15.8°C and for July it is 4.3°C. Frost may occur from April to October.

Table 4: Temperature data (°C) for Carnarvon: 30° 58’ S; 22° 00’ E; 1280 m (Weather Bureau 1998)

	Temperature (°C)												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Max	31.4	30.3	27.4	23.0	18.9	15.7	15.9	17.9	21.6	24.9	28.0	29.9	23.8
*Ext. Max	38.5	38.6	36.6	33.6	28.8	23.0	25.1	27.7	34.0	35.6	36.5	39.0	39.0
Min	14.8	14.8	12.6	9.0	4.8	1.8	1.0	2.1	4.8	8.0	11.0	13.3	8.2
*Ext. Min	6.5	4.6	-3.7	-1.0	-4.2	-7.5	-7.5	-9.1	-6.5	-2.5	-0.5	1.6	-9.1
Mean	23.1	22.5	20.0	16.0	11.9	8.7	8.5	10.0	13.2	16.4	19.5	21.6	16.0

Max = mean daily maximum temperature for the month
*Ext. Max = extreme maximum temperature recorded per month
Min = mean daily minimum temperature for the month
*Ext. Min = extreme minimum temperature recorded per month
Mean = mean monthly temperature for each month and for the year

Table 5: Temperature data (°C) for Beaufort West: 32° 18’ S; 22° 14’ E; 893 m (Weather Bureau 1998)

	Temperature (°C)												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Max	32.3	31.2	28.9	24.4	21.1	18.5	18.4	19.8	22.8	25.7	28.4	31.0	25.2
*Ext. Max	41.4	40.7	38.8	36.0	32.2	28.8	28.5	33.8	36.2	38.8	40.5	40.3	41.4
Min	15.8	15.3	14.0	10.4	7.5	5.1	4.3	4.9	7.0	10.1	12.3	14.4	10.1
*Ext. Min	8.2	4.9	3.5	-0.3	-2.5	-4.9	-5.6	-5.4	-3.5	-0.5	3.0	4.3	-5.6
Mean	24.1	23.2	21.5	17.4	14.3	11.9	11.4	12.4	14.9	17.9	20.3	22.7	17.7

Max = mean daily maximum temperature for the month
*Ext. Max = extreme maximum temperature recorded per month
Min = mean daily minimum temperature for the month
*Ext. Min = extreme minimum temperature recorded per month
Mean = mean monthly temperature for each month and for the year

4.3.4 Cloudiness and relative air humidity

At Carnarvon, the cloud cover at 14:00 is the highest from February to April (2.8 - 3.0 eights) and in October (2.7 eights) and the lowest in June, July and August (1.8 - 2.1 eights) (Table 6). The highest mean relative air humidity (%) at 08:00 occurs during the autumn and winter months (April to July; 74 – 76%) and the lowest relative air humidity at 14:00 (25 - 26%) occurs in summer (November to January) (Weather Bureau 1988, 1998).

Table 6: Cloud cover at 14:00 and percentage relative air humidity at 08:00 and 14:00 at Carnarvon: 30° 58’ S; 22° 00’ E; 1280 m (Weather Bureau 1988, 1998)

	Cloud (0-8)	**Relative air humidity %**	
	14:00	**08:00**	**14:00**
Jan	2.4	56	25
Feb	3.0	64	32
Mar	2.9	71	36
Apr	2.8	75	39
May	2.4	76	38
June	2.1	76	39
July	1.8	74	35
Aug	2.0	69	32
Sept	2.5	64	29
Oct	2.7	56	27
Nov	2.5	53	25
Dec	2.4	55	26
Year	2.5	66	32

At Beaufort West, the cloud cover at 14:00 is the highest in April (3.3 eights) and from September to November (3.2 - 3.7 eights) and the lowest from December to March (2.4 - 2.8 eights) and May to August (2.7 - 2.9 eights) (Table 7). The highest mean relative air humidity (%) at 08:00 occurs during the autumn months (March and April; 70 – 74%)

and the lowest relative air humidity at 14:00 (26%) occurs in summer (December and January) (Weather Bureau 1988, 1998).

Table 7: Cloud cover at 14:00 and percentage relative air humidity at 08:00 and 14:00 at Beaufort West: 32° 18' S; 22° 14' E; 893 m (Weather Bureau 1988, 1998)

	Cloud (0-8)	Relative air humidity %	
	14:00	08:00	14:00
Jan	2.7	67	26
Feb	2.4	69	29
Mar	2.8	74	33
Apr	3.3	70	32
May	2.7	65	29
June	2.9	65	33
July	2.8	65	32
Aug	2.7	65	31
Sept	3.2	68	29
Oct	3.7	68	31
Nov	3.2	66	29
Dec	2.8	64	26
Year	2.9	68	30

4.4 Geology

The geology of the route is depicted in the 1:250 000 geological maps 3022 Britstown, 3122 Victoria West and 3222 Beaufort West (Figure 5). The dominant geology consists of mudstone of the Ecca and Beaufort Groups, with dolerite intrusions forming koppies and high mountains, e.g. Nuweveld Mountains. Alluvium occurs along the drainage lines.

Around Beaufort West the geology consists of mudstone (red in places) with siltstone and sandstone and thin greenish cherty beds near the base and thin pink tuff beds in the northeast (Teekloof Formation, Beaufort Group). Further north the main substrates are purple, green and grey mudstone and sandstone and red and purple mudstone with subordinate sandstone, both of the Teekloof Formation, Beaufort Group. Towards Loxton, the geology consists of mudstone (red in places) and sandstone with thin greenish cherty beds of the Abrahamskraal Formation, Beaufort Group. The area around Carnarvon is underlain by grey to blue-grey mudstone (or shale), siltstone and sandstone of the Carnarvon Formation, Ecca Group.

4.5 Land types

Land types denote areas that display a marked degree of uniformity with respect to terrain form, soil pattern and climate. A terrain unit within a land type is any part of the land surface with homogeneous form and slope. The route covers about 22 land types consisting of the Ag, Da, Db, Fb, Fc and Ib Land Types (Figure 6). The Ag land types are characterised by red-yellow apedal freely drained soils with a high base status and less than 300 mm deep, derived from grey mudstone, shale, siltstone and sandstone. The soils of the Da and Db land types are typically with prismacutanic and/or pedocutanic diagnostic horisons dominant, mainly red horisons in the Da land type and not red in the Db land type. The soils are derived from purple-green to grey mudstone and sandstone. The Fb land types consist of Glenrosa and/or Mispah soil forms where lime is rare or absent in the upland soils but generally present in low-lying soils. The Fc land types are similar, but lime is generally present in the entire landscape. The soils are derived from mudstone, shale and sandstone while dolerite intrusions are common. The Ib land type covers the high mountains and is typically rocky with miscellaneous land classes and soils.

Figure 5: Geology of the region along the fibre-optic route. (Note a slight mismatch between some of the geological sheets, e.g. Pt becoming Pth.)

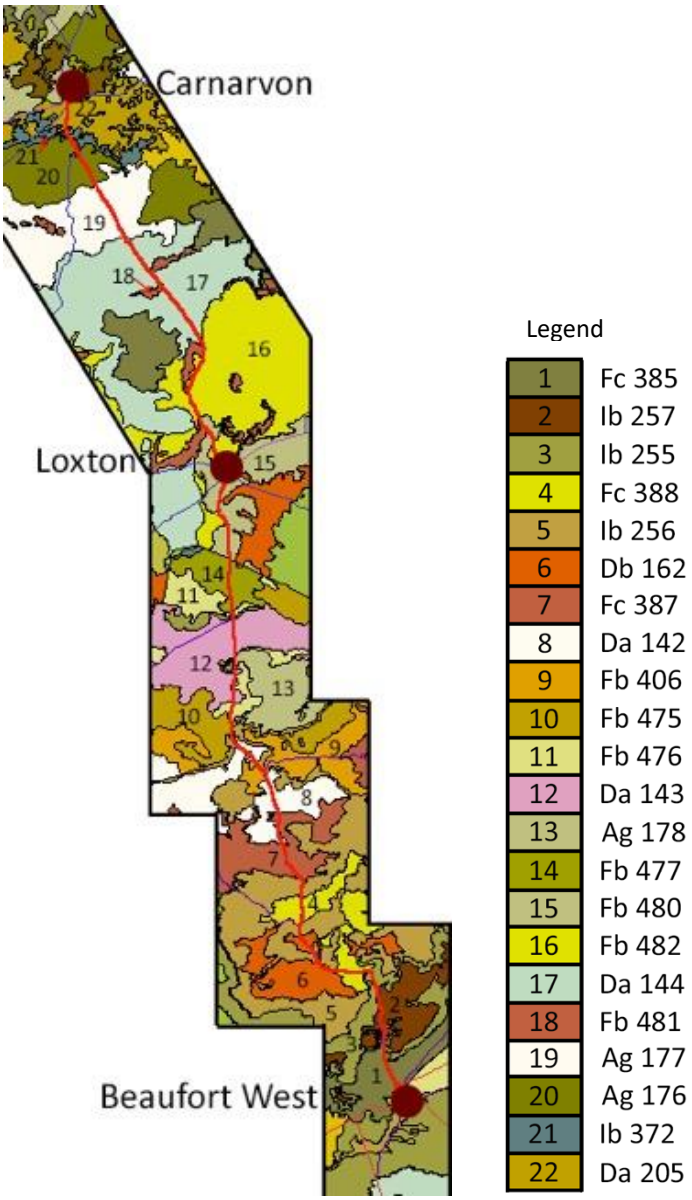


Figure 6: Land types of the region along the fibre-optic route.

5. VEGETATION

5.1 Overview

The route falls in the Nama-Karoo Biome and more specifically in the Upper Karoo Bioregion (NKu) from north of Beaufort West to Carnarvon. The plains around Beaufort West lie in the Lower Karoo Bioregion (NKl). The route does not fall within any Centre of Endemism according to Van Wyk & Smith (2001).

5.2 Broad-scale vegetation types

Six vegetation types (Mucina & Rutherford 2006; 2018) occur along the route (Figure 7).

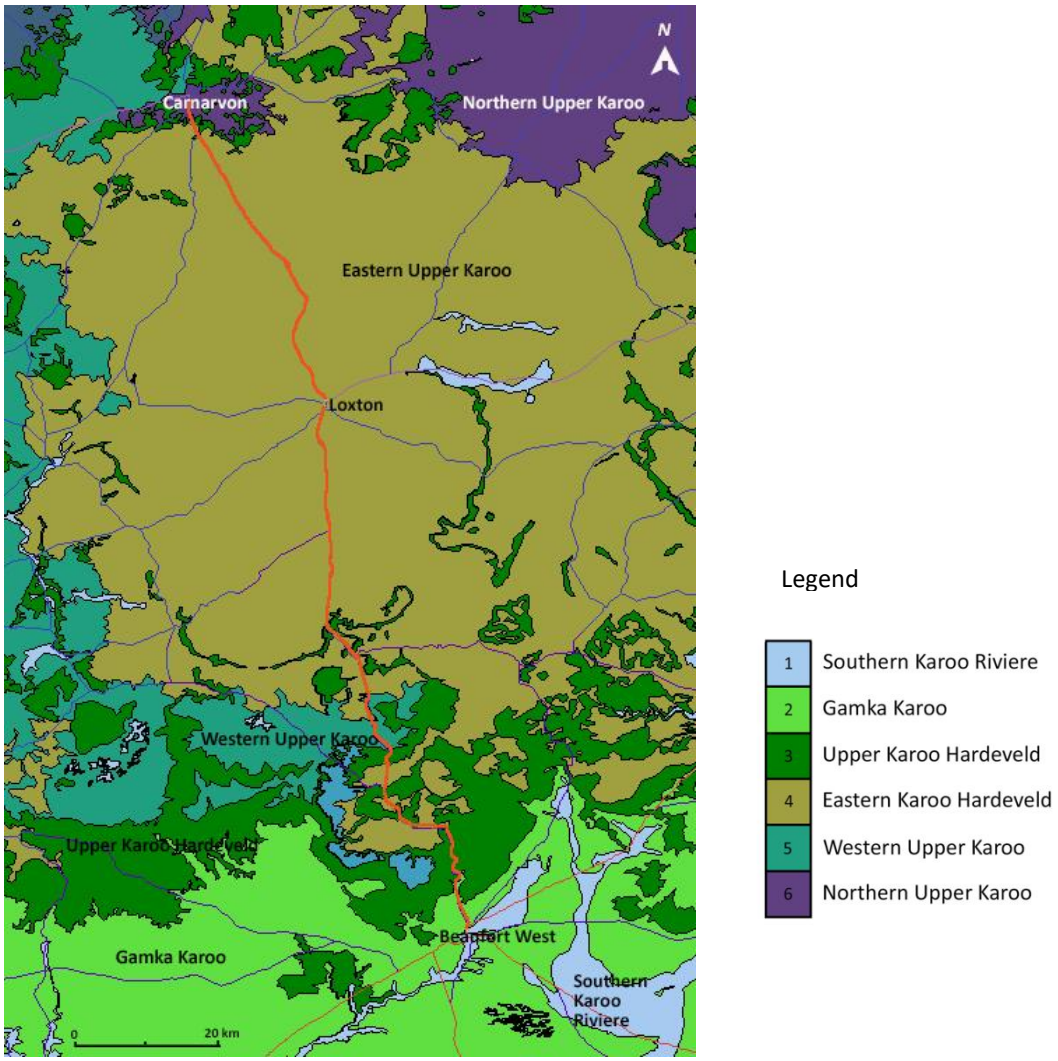


Figure 7. Vegetation types along the route from Carnarvon in the north to Beaufort West in the south.

5.2.1 Gamka Karoo (NKl 1)

This vegetation type occurs in the southern section of the route in the vicinity of Beaufort West. The vegetation type covers 20 325 km^2 in South Africa and occurs between the Great Escarpment (Nuweveld Mountains) in the north and Cape Fold Belt Mountains (Swartberg Mountains) in the south (Figure 7). It occurs on irregular to slightly undulating plains covered with dwarf spiny shrubland, dominated by Karoo dwarf shrubs (Figure 8). Mudrock and

sandstones of the Beaufort Group with some Ecca Group shales cover the area. The dominant shrub and dwarf shrub species are *Lycium* spp., *Rhigozum obovatum, Vachellia karroo, Searsia burchellii, Chrysocoma ciliata, Eriocephalus* spp*., Felicia muricata* and *Pentzia incana*. The most prominent grass species include *Aristida congesta, Aristida diffusa, Fingerhuthia africana, Stipagrostis ciliata, Stipagrostis obtusa* and *Eragrostis* spp.

Figure 8: Landscape of the Gamka Karoo (NKl 1) around Beaufort West.

The vegetation type is classified as 'least threatened' / 'least concern' with about 2.6% statutorily conserved in the Karoo National Park and some private nature reserves (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a). Only a small part has undergone transformation. Endemic plant species include *Chasmatophyllum stanleyi, Hereroa incurva, Hoodia dregei, Ruschia beaufortensis, Jamesbrittenia tenuifolia, Manulea karrooica* and *Piaranthus comptus*.

5.2.2 Western Upper Karoo (NKu 1)

This vegetation type covers 17 150 km^2 in South Africa and occurs on plains and much-dissected landscapes associated with the tributaries of the upper catchment of rivers such as the Sak River (Figures 7). Along the route of the fibre-optic cable this vegetation type covers a small section between the Upper Karoo Hardeveld and the Eastern Upper Karoo. A mixture of small-leaved shrubs and shrubby succulents with drought-resistant grasses is the determinant feature of the vegetation structure (Figure 9). The geological substrate includes Karoo sediments (mudstones, shales and arenite) of the Beaufort Group. The most prominent shrubs and dwarf shrubs include *Lycium cinereum, Rhigozum trichotomum, Chrysocoma ciliata, Eriocephalus ericoides, Pentzia globosa, Osteospermum spinescens* and *Tetragonia arbuscula*. The grass layer is dominated by *Aristida congesta, Enneapogon desvauxii, Stipagrostis ciliata* and *Stipagrostis obtusa.*

The vegetation type is classified as 'least threatened' / 'least concern', with none conserved in statutory conservation areas (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a). Very little of the area is transformed. Endemic plant species include *Stomatium villetii* and *Zaluzianskya bella*.

Figure 9: Landscape of the Western Upper Karoo (NKu1) between Beaufort West and Loxton.

5.2.3 Upper Karoo Hardeveld (NKu 2)

This vegetation type covers 11 734 km^2 in South Africa and is characterised by steep slopes of mesas, buttes and koppies supporting sparse, dwarf Karoo scrub (Figures 7 & 10). Dolerite dykes and sills with large boulders and stones often cover the landscape. Important shrubs and dwarf shrubs include *Lycium cinereum, Rhigozum obovatum, Cadaba aphylla, Ehretia rigida, Chrysocoma ciliata, Eriocephalus ericoides, Euryops lateriflorus, Pteronia glauca* and *Felicia muricata.* The prominent grasses include *Aristida* spp*., Cenchrus ciliaris, Enneapogon desvauxii, Eragrostis lehmanniana* and *Stipagrostis obtusa*.

Figure 10: Landscape along the route through the Upper Karoo Hardeveld (NKu2) north of Beaufort West.

The vegetation type is classified as 'least threatened' / 'least concern', although only about 6% is statutorily conserved in the Karoo National Park and Karoo Nature Reserve (Mucina & Rutherford 2006, NEMA 2011, SANBI 1028a). Endemic plant species include:

Adromischus fallax
Aloe chlorantha
Cineraria arctotidea
Adromischus humilis
Anisodontea malvastroides
Cineraria polycephala

Crassula barbata subsp*. broomii*
Euryops petraeus
Lachenalia aurioliae
Ornithogalum paucifolium subsp. *karooparkense*
Selago magnakarooica
Vellereophyton niveum
Delosperma robustum
Gethyllis longistyla
Lotononis azureoides
Mesembryanthemum expansum
Stomatium suaveolens

5.2.4 Northern Upper Karoo (NKu 3)

This vegetation type covers 41 829 km^2 and is characterised by flat to gently sloping terrain with isolated hills and many interspersed pans (Figures 7 & 11). It covers a small portion of the route around Carnarvon. The shrubland is dominated by dwarf karoo shrubs, grasses and *Senegalia mellifera*. The geological substrate consists of shales of the Ecca Group and Dwyka Group diamictites. Karoo dolerite sills and sheets support this vegetation complex in places. Wide stretches of land are covered by superficial deposits including calcretes of the Kalahari Group. Dominant shrubs and dwarf shrubs include *Senegalia mellifera, Boscia albitrunca, Lycium* spp*., Chrysocoma ciliata, Pentzia* spp*.* and *Oedera humilis.* The grass layer is characterised by *Aristida* spp., *Enneapogon desvauxii, Eragrostis* spp., *Stipagrostis* spp. and *Sporobolus fimbriatus*.

Figure 11: Landscape of the Northern Upper Karoo (NKu3) near Carnarvon.

The vegetation type is classified as 'least threatened' / 'least concern', with none conserved in statutorily conserved areas (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a). About 4% has been transformed by clearing for cultivation and building of dams. Endemic species include *Lithops hookeri, Stomatium pluridens, Atriplex spongiosa, Galenia exigua* and *Manulea deserticola.*

5.2.5 Eastern Upper Karoo (NKu 4)

This is the largest vegetation type in South Africa (covering 49 821 km^2) and also covers the largest portion of the fibre-optic cable route between Beaufort West and Carnarvon. The habitat consists of flat and gently sloping plains, interspersed with hills and rocky areas and is dominated by dwarf shrubs (Figures 7, 12 & 13). Mudrock and sandstone of the Beaufort Group are the dominant geological substrates. Prominent shrubs and dwarf shrubs include *Lycium* spp., *Chrysocoma ciliata, Eriocephalus ericoides, Pentzia incana, Pentzia globosa Phymaspermum parvifolium* and *Salsola calluna*. The grass layer is dominated by *Aristida* spp., *Cynodon incompletus, Eragrostis* spp., *Sporobolus fimbriatus* and *Stipagrostis ciliata*.

The vegetation type is classified as 'least threatened' / 'least concern', with about 2% of the unit transformed, and *ca*. 3% statutorily conserved in national parks and nature reserves (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a). Endemic plant species include:

Aspalathus acicularis subsp. *planifolia*
Chasmatophyllum rouxii
Hertia cluytiifolia
Phymaspermum scoparium
Rabiea albinota
Salsola tetrandra
Selago persimilis
Selago walpersii

Figure 12: Landscape of the Eastern Upper Karoo (NKu4) south of Loxton.

Figure 13: Landscape of the Eastern Upper Karoo (NKu4) between Loxton and Carnarvon.

5.2.6 Southern Karoo Riviere (AZi 6)

This vegetation type covers 5299 km^2 and includes the rivers and other drainage lines of the central Karoo, which support thickets and shrubland (Figures 14 & 15). Since this vegetation type is associated with rivers and drainage lines, the areas on site classified as this vegetation type should be considered as sensitive. It is classified as 'least threatened' / 'least concern' (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a), with about 5% statutorily conserved. Some 12% has been transformed for cultivation and building of dams (Mucina & Rutherford 2006). The

most prominent tree and shrub species include *Vachellia karroo, Searsia lancea, Diospyros lycioides, Tamarix usneoides, Euclea undulata, Salsola* spp. and *Lycium* spp. The only endemic species is the graminoid *Isolepis expallescens.*

Figure 14: Drainage line and valley in the mountains (Upper Karoo Hardeveld).

Figure 15: One of the major rivers (Brak River) in the Eastern Upper Karoo, south of Loxton.

5.3 Description of the habitats and associated physical environment along the route from Beaufort West to Carnarvon

The study area primarily covers the fenced road reserve and therefore represents a habitat that is in essence highly transformed and disturbed as a result of the physical impact of road construction, maintenance activities for road safety reasons, adjacent land-use and the presence of alien vegetation. It is intended as a buffer between the road and the adjacent land, often hosting other services such as electric or telephone cables. There is usually a clearly defined boundary (fence line) where the road reserve abuts the adjacent land. The road reserve vegetation is seldom representative of the natural veld adjacent to the road except where some sections were not transformed in the mountains and where cuttings through the hills or ridges occur.

Water run-off from the road surface contributes to an unnatural species assemblage in most areas. Precipitation run-off from roads promotes the spread and establishment of alien species. These species often colonise road verges, and then rapidly spread along this corridor, thus degrading the condition of the natural vegetation of the road verge and compromising the conservation value not only of the reserves, but also of the adjacent land. Roads have a significant impact on the chemical environment and major additions of heavy metals, salt and nutrients may occur in the road reserves. Use of herbicides to control vegetation growth along roads contributes further to the transformed nature of road reserves. Overall, the impacts of disturbance and transformation in road reserves override the effects of the natural physical environment and cause homogenisation of the roadside vegetation.

Rare plant species usually occur in specialised and localised habitats, which are mostly destroyed by road building and the potential of road reserves to be of conservation value is therefore limited. Nevertheless, some rare species find refuge in road reserves and in certain circumstances accrue reproductive advantages over non-verge populations. The plants in road verges are also a potential source of seeds.

The six vegetation types of the region were used as the basis for describing the habitats along the route. The dominant geological substrate and land types of each vegetation type are summarised in Table 8.

Table 8: Main geological substrates and land types within the six vegetation types distinguished along the route

Vegetation type	Dominant geological substrate (see Figure 5)	Land Type (see Figure 6)
Gamka Karoo (NKl 1)	Alluvium and calcrete (Quaternary and Tertiary deposits) (Qc and T-Qc).	Fc385 and Ib257
Western Upper Karoo (NKu1)	Grey to greenish shale, mudstone, subordinate sandstone and siltstone, greenish chert and tuff (Pt). Red and purple mudstone with subordinate sandstone (Pth)	Da142 and Fc387
Upper Karoo Hardeveld (NKu2)	Alluvium and calcrete in the lowlands (Qc). Grey to greenish shale, mudstone, subordinate sandstone and siltstone, greenish chert and tuff (Pt). Dolerite (Jd)	Da 142, Fc387, Fc388, Ib255, Ib256, Ib257, Ib259 and Ib356
Northern Upper Karoo (NKu3)	Blue-grey to green mudstone, subordinate sandstone and siltstone, with shale (Pc).	Ib372
Eastern Upper Karoo (NKu4)	Basically all geological substrates in the region.	Ag177, Ag178, Da142, Da143, Da144, Db162, Fb476, Fb480, Fb482, Fc387, Fc388, Fc406, Fc480, Ib256 and Ib356
Southern Karoo Riviere (AZi6)	All geological substrates in the region, except the blue-grey to green mudstone, subordinate sandstone and siltstone, with shale (Pc).	Da142, Da144, Fb480, Fc385, Fc388, Fc406, Ib255, Ib256 and Ib257

Nine habitat types were distinguished along the route. The habitat types were based on the topography of the area and included features such as drainage lines, floodplains, valleys, plains, hills, footslopes and midslopes of koppies and mountains, scarps, crests and plateaux of the hilly and mountainous areas along the route. It should, however, be noted that all nine habitat types were not necessarily represented along the route within each of the vegetation types. The following habitat types were distinguished:

1. Drainage lines (watercourses: channels, streams, rivers) and their associated banks
2. Bottomlands on the plains (broad floodplains, leegtes, vloere) (B)
3. Plains (P)
4. Valleys in the mountains (bottomlands or valley floors) (V)
5. Low hills (H)

6. Footslopes (Fs) of koppies and mountains
7. Midslopes (Ms) of mountains, usually steep
8. Plateaux in the mountains (Pl)
9. Mountains (M) often comprising a mixture of upperslopes, scarps ad crests.

5.3.1 Southern Karoo Riviere (AZi 6)

Drainage lines (watercourses: channels, streams, rivers) and their associated banks

In principle, the drainage lines are classified under the Southern Karoo Riviere (AZi6). Most of the drainage lines are ephemeral in nature and they range from narrow dry channels to broad rivers with floodplains (leegtes, vloere) in the north. Examples of drainage lines along the route include the tributaries of the Gamka River north of Beaufort West, the Sak River and Brak River on the plains on the way to Loxton and the Brak River and Soutpoort River north of Loxton (Figures 16–19). Although these drainage lines form part of the Southern Karoo Riviere, they could not be mapped at the scale of the national vegetation map. The numerous "leegtes" on the way to Carnarvon are described as part of the bottomlands habitat type in this report.

The most widespread plant species found along the fibre-optic cable route in the drainage lines included:

Anchusa riparia
Chloris virgata
Deverra denudata
Eragrostis bicolor
Galenia namaensis
Lycium cinereum
Salsola kali
Stipagrostis namaquensis

The following species were locally conspicuous:

Afroscirpiodes dioeca
Buddleja salviifolia
Eragrostis bergiana
Helichrysum pentziodes
Phragmites australis
Pseudochoerus inanus
Salix mucronata
Vachellia karroo

Other common species included:

Argemone ochroleuca
Diospyros austro-africana
Drosanthemum hispidum
Drosanthemum karrooense
Lycium oxycarpum
Melianthus comosus
Osteospermum spinescens
Pteronia erythrochaeta
Sporobolus iocladus
Suaeda fruticosa

Figure 16: Dry drainage line on the plains of the Gamka Karoo vegetation type.

Figure 17: Stream in the mountains of the Upper Karoo Hardeveld.

Figure 18: Ephemeral river (Sak River) on the plains of the Eastern Upper Karoo.

Figure 19: Ephemeral, Soutpoort River on the plains of the Eastern Upper Karoo.

5.3.2 Gamka Karoo (NKl 1)

Three habitat types were distinguished within the Gamka Karoo, *viz*. plains, low hills and footslopes.

Plains

These are flats or gently sloping plains which are occasionally interrupted by low hills. Widespread or dominant (d) species found along the fibre-optic cable route included:

Arctotis leiocarpa
Enneapogon desvauxii
Eragrostis lehmanniana
Felicia muricata
Fingerhuthia africana
Gazania lichtensteinii
Heteropogon contortus
Lacomucinaea lineata (d)
Lycium spp. (d)
Mesembryanthemum coriarium
Osteospermum scariosum
Pentzia spp.
Rhigozum obovatum
Sporobolus fimbriatus (d)
Stipagrostis ciliata
Stipagrostis obtusa (d)

Several alien invasive species, *Argemone ochroleuca, Pennisetum setaceum* and *Prosopis glandulosa,* were noted.

Low hills

Low hills were considered as landforms that are elevated compared to the surrounding land, but with gentle slopes and generally without scarps and cliffs. Within the road reserve section of this vegetation type, the low hills covered a relatively small area. The most prominent species included:

Enneapogon desvauxii
Enneapogon scaber
Drosanthemum hispidum (d)
Felicia muricata
Heteropogon contortus
Mesembryanthemum coriarium (d)
Osteospermum scariosum
Pentzia spp. (d)
Rhigozum obovatum
Ruschia spp.
Sericocoma avolans

The low hills were also the habitat for some of the more uncommon or protected species such as *Anacampseros* cf. *lanceolata* and *Astroloba foliolosa*.

Footslopes

The footslopes represent the transition to the more mountainous Upper Karoo Hardeveld. The most common species in this habitat along the fibre-optic route were:

Asparagus retrofractus
Enneapogon desvauxii
Fingerhuthia africana
Grewia robusta (d)
Pentzia incana
Rhigozum obovatum (d)
Searsia burchellii
Searsia lancea (d)
Vachellia karroo (d)

The alien invasive grass, *Pennisetum setaceum* was common within the road reserve in this habitat type.

5.3.3 Western Upper Karoo (NKu 1)

This is a fairly small unit within the fibre-optic cable route and is represented by three habitat types, *viz.* plains, low hills and footslopes. The description of the habitats is similar to that provided for the Gamka Karoo.

Plains

The most prominent species on the plains or gently undulating terrain along the fibre-optic route were:

Cynodon incompletus
Dimorphotheca cuneata
Eragrostis obtusa
Eriocephalus spp.
Galenia namaensis
Gazania krebsiana
Gonialoe variegata
Mesembryanthemum crystallinum
Pteronia sordida (d)
Oedera oppositifolia (d)

Low hills

The following species characterised the low hills along the fibre-optic route within the Western Upper Karoo:

Chrysocoma ciliata
Drosanthemum karrooense
Eriocephalus spp.
Gazania krebsiana
Lessertia frutescens
Mesembryanthemum grossum
Pteronia glauca
Pteronia sordida

Footslopes

On the footslopes in the Western Upper Karoo the following species were prominent along the fibre-optic route:

Diospyros austro-africana
Eragrostis obtusa (d)
Eriocephalus spp.
Galenia namaensis
Gazania krebsiana
Lessertia frutescens
Pentzia spinescens
Pteronia glauca
Pteronia sordida (d)
Oedera humilis
Oedera oppositifolia (d)

5.3.4 Upper Karoo Hardeveld

This vegetation unit is represented by the mountainous terrain along the fibre-optic cable route. Six habitat types were recognised within this vegetation type, *viz.* plains, valleys, footslopes, midslopes, mountains and plateaux (Figures 20-26).

Plains

These areas are relatively flat plains occurring between the hills and mountains. Prominent species in this habitat type noted along the fibre-optic route were:

Chrysocoma ciliata
Drosanthemum hispidum
Eragrostis obtusa
Eriocephalus brevifolius
Hermannia coccocarpa
Hermannia desertorum
Lycium cinereum (d)
Mesembryanthemum coriarium
Pentzia spp.
Oedera oppositifolia (d)
Sporobolus fimbriatus (d)

Valleys

The mountains are interrupted by valleys (valley floors) with a stream or river running through it (Figure 20). The most common species in the valleys along the fibre-optic route included:

Asparagus retrofractus (d)
Buddleja glomerata
Diospyros lycioides
Hermannia vestita
Lycium oxycarpum
Lacomucinaea lineata
Melianthus comosus (d)
Searsia lancea (d)
Sporobolus fimbriatus
Vachellia karroo (d)

Figure 20: Valley between the mountains with a relatively high cover of shrubby species.

Footslopes

The footslopes of the mountain and low hills along the fibre-optic route (Figure 21) are characterised by the following species:

Aristida diffusa (d)
Drosanthemum spp.
Eriocephalus spp. (d)
Felicia muricata
Galenia namaensis
Lycium cinereum (d)
Pentzia incana
Pteronia sordida
Sporobolus fimbriatus (d)

Figure 21: Footslope of a mountain along the route in the Upper Karoo Hardeveld.

Midslopes

Midslopes refer to moderate to steep slopes below the scarp/crest of mountains and were only found along the fibre-optic cable route in the Upper Karoo Hardeveld (Figures 22 & 23). The most prominent plant species on the midslopes included:

Aloe broomii
Aristida adscensionis
Aristida diffusa (d)
Carissa haematocarpa (d)
Gymnosporia szyszylowiczii (d)
Hermannia vestita
Heteropogon contortus
Lacomucinaea lineata

Cotyledon orbiculata
Dicerothamnus rhinocerotis
Digitaria eriantha (d)
Diospyros austro-africana (d)
Drosanthemum hispidum
Euclea crispa
Felicia filifolia
Fingerhuthia africana (d)
Grewia robusta (d)
Limeum aethiopicum
Lycium cinereum (d)
Rhigozum obovatum (d)
Searsia burchellii
Sporobolus fimbriatus (d)
Tarchonanthus minor
Themeda triandra
Vachellia karroo

Figure 22: Steep midslopes in the mountainous area of the Upper Karoo Hardeveld.

Figure 23: Steep midslopes in the mountainous area of the Upper Karoo Hardeveld.

Mountain plateaux

These areas included relatively flat to sloping terrain at mid-elevations in the mountains of the Upper Karoo Hardeveld (Figures 24 & 25). Along the fibre-optic cable route this habitat was characterised by the following species:

Aristida diffusa
Asparagus capensis
Cotyledon orbiculata
Dicerothamnus rhinocerotis
Digitaria eriantha (d)
Diospyros austro-africana
Fingerhuthia africana
Gymnosporia szyszylowiczii (d)
Heteropogon contortus
Rhigozum obovatum
Sporobolus fimbriatus
Tenaxia disticha

Eragrostis obtusa
Felicia filifolia (d)
Vachellia karroo

Figure 24: Plateaux at mid-elevations in the mountains of the Upper Karoo Hardeveld.

Figure 25: Plateaux in the background on mid-elevations in the mountains of the Upper Karoo Hardeveld.

Mountains

The Upper Karoo Hardeveld mountain habitat includes the steep upper slopes, scarp and crests of mountains, usually with large boulders (Figure 26). The most prominent plant species found in this habitat were:

Aloe broomii
Aristida diffusa (d)
Asparagus capensis
Buddleja glomerata
Dicerothamnus rhinocerotis
Digitaria eriantha (d)
Diospyros austro-africana (d)
Eriocephalus ericoides (d)
Euryops lateriflorus
Felicia filifolia
Hermannia comosa
Hermannia vestita
Heteropogon contortus
Lycium cinereum (d)
Melianthus comosus (d)
Pentzia spp.
Searsia burchellii (d)
Sporobolus fimbriatus (d)
Tarchonanthus minor
Tenaxia disticha
Themeda triandra
Vachellia karroo

Figure 26: Mountainous area with scarps and boulders (Upper Karoo Hardeveld).

5.3.5 Northern Upper Karoo (NKu 3)

The Northern Upper Karoo covers a small section of the route immediately to the south of Carnarvon. The only habitat type encountered in this section was the plains. The most prominent species were:

Calobota spinescens
Eragrostis lehmanniana
Eriocephalus decussatus (d)
Eriocephalus spinescens (d)
Mesembryanthemum coriarium
Senecio niveus
Stipagrostis ciliata
Stipagrostis obtusa

5.3.6 Eastern Upper Karoo (NKu 4)

The Eastern Upper Karoo covers the largest portion of the fibre-optic cable's route between Beaufort West and Carnarvon.

Bottomlands on the plains (broad floodplains, vloere, leegtes)

These are flat, very even surfaces of broad bottoms of rivers (leegtes, vloere) filled with silty and clayey alluvial deposits (Figure 27). They are found from south of Loxton (from the farm Rosedene) northwards to Carnarvon. The most widespread and common species in this habitat along the route included:

Aptosimum indivisum
Aristida adscensionis
Asparagus suaveolens (d)
Chrysocoma ciliata
Drosanthemum hispidum
Enneapogon desvauxii
Eragrostis obtusa
Eriocephalus spp. (d)
Felicia muricata
Fingerhuthia africana
Galenia namaensis
Indigofera meyeriana
Lycium horridum
Lycium cinereum
Pentzia spp.
Pteronia sordida
Oedera humilis (d)
Salsola kali
Salvia verbenaca
Senecio niveus
Sporobolus fimbriatus
Stipagrostis ciliata
Stipagrostis obtusa

Figure 27: Broad bottomlands on the plains of the Eastern Upper Karoo.

Plains

This habitat refers to flats and gently sloping plains interspersed with hills and rocky areas (Figures 28 & 29). Prominent species along the fibre-optic route in the Eastern Upper Karoo included:

Aristida adscensionis
Asparagus suaveolens
Chrysocoma ciliata
Drosanthemum spp.
Enneapogon desvauxii
Eragrostis lehmanniana
Eragrostis obtusa
Eriocephalus spp.
Felicia muricata
Fingerhuthia africana
Galenia namaensis
Hermannia cuneifolia
Lessertia inflata
Lycium cinereum
Mesembryanthemum spp.
Osteospermum spinescens
Pentzia spp.
Pteronia sordida
Pteronia staehelinoides
Oedera spp.
Ruschia spp.
Senecio niveus
Sesamum capense
Sporobolus fimbriatus
Stipagrostis obtusa

The invasive species, *Argemone ochroleuca* and *Salsola kali* were common in the road reserve in this habitat type.

Figure 28: Open bossieveld on the plains of the Eastern Upper Karoo.

Figure 29: Plains of the Eastern Upper Karoo.

Low hills

Most of the road cuttings along the fibre-optic cable route on the northern plains are part of this habitat type (Figures 30 & 31). The most widespread plant species included:

Drosanthemum spp. (d)
Enneapogon desvauxii
Eragrostis lehmanniana (d)
Eragrostis obtusa
Eriocephalus ericoides (d)
Euphorbia caterviflora
Fingerhuthia africana
Helichrysum pumilio
Hermannia cuneifolia
Hermannia grandiflora
Lycium cinereum (d)
Moraea miniata
Osteospermum spinescens (d)
Pentzia spp. (d)
Pteronia spp. (d)
Oedera spp. (d)
Ruschia spp.

Figure 30: Road cutting through low hills in the Eastern Upper Karoo.

Figure 31: Road cutting through low hills in the Eastern Upper Karoo.

Footslopes

This habitat refers to lower reaches of koppies, hills, inselbergs or mountains with gentle slopes. The following species occurred widespread within this habitat along the fibre-optic cable route:

Aristida adscensionis
Asparagus suaveolens
Chrysocoma ciliata (d)
Enneapogon desvauxii (d)
Eriocephalus ericoides (d)
Felicia muricata
Fingerhuthia africana
Gazania krebsiana
Hermannia grandiflora
Lycium cinereum
Pentzia incana (d)
Pteronia staehelinoides (d)
Pteronia sordida (d)
Oedera oppositifolia
Stipagrostis obtusa

6. FLORA: CHECKLISTS AND RED LISTED AND/OR PROTECTED SPECIES

Large sections of the study area have been very poorly collected botanically. However, in the Karoo National Park plant collection has been more active and the species list for the Upper Karoo Hardeveld can be considered as fairly representative of that vegetation type (Rubin & Palmer 1996, Rubin *et al.* 2001). A list of species that could be found in the region of the route of the fibre-optic cable (quarter degree grids: 3020CC; 3122AA, 3122AB, 3122AC, 3122AD; 3122CB, 3122CD; 3322AB, 3322AD, 3322BA, 3322BC) was downloaded from SANBI's website (SANBI: newposa.sanbi.org – accessed August 2020) (Appendix A). These 11 quarter degree grids produced a list of 758 plant species (the term species is used here in a general sense to denote species, subspecies and varieties). During the field surveys along the fibre-optic route for the current investigation, 356 species were recorded (Appendix A). Combined, the NewPosa list and the list for the current study yielded 854 species which could potentially occur in the region of the fibre-optic route.

The South African Threatened Species Programme website (redlist.sanbi.org) of SANBI; the NFA (2019); the NEMBA (2007c) (ToPS list); CITES (2019) appendices; the lists of protected plant species of the WCNECO (1974, as amended 2000), and the lists of protected species of the NCNCA (2009) were consulted to classify the species in the study area into the relevant IUCN or protected categories (Appendix A).

6.1 IUCN Red listed species

For the IUCN Categories, the following definitions were applied (see Figure 32). **The colours in Figure 32 were applied to the checklist of plants and animals in this section as well as in Appendices A and B.**

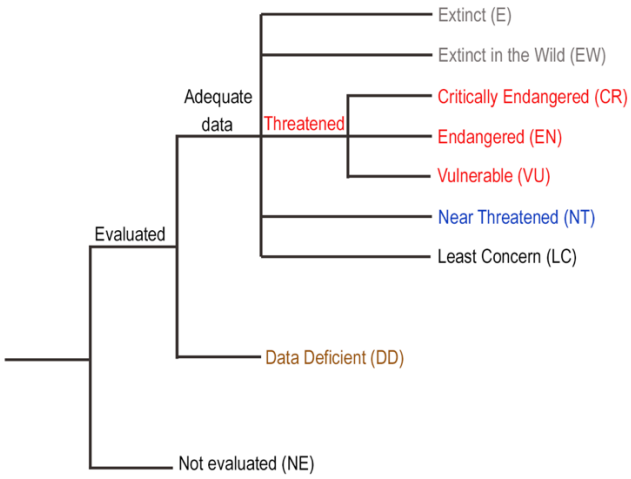


Figure 32: Schematic representation of the relationship between the various IUCN Red List Categories.

Threatened Species and Species of Conservation Concern (SCC)
Extinct Categories:

- **Extinct (E):** A species is Extinct when there is no reasonable doubt that the last individual has died. Species should be classified as Extinct only once exhaustive surveys throughout the species' known range have failed to record an individual.
- **Extinct in the Wild (EW):** A species is Extinct in the Wild when it is known to survive only in cultivation or as a naturalised population (or populations) well outside the past range.

Threatened Categories:

- **Critically Endangered (CR):** A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
- **Endangered (EN):** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria

for Endangered, indicating that it is facing a very high risk of extinction.
- **Vulnerable (VU):** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that it is facing a high risk of extinction.

Not Threatened Categories but of conservation concern:
- **Near Threatened (NT):** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.
- **Data Deficient (DD):** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A **DDD** taxon may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. The taxonomy of a **DDT** taxon is unresolved.

Not Threatened Categories:
- **Least Concern (LC):** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
- **Not Evaluated (NE):** A taxon is Not Evaluated when it is has not yet been evaluated against the five IUCN criteria. This category often applies to alien species.

Only three IUCN red listed species could potentially occur in the region according to the NewPosa list (Appendix A): *Annesorhiza filicaulis* (EN), *Cineraria vagans* (EN) and *Cliffortia arborea* (VU). Although both *Annesorhiza filicaulis* and *Cineraria vagans* are listed for the region, the current study area falls far beyond the known distribution of these species. Additionally, the screening tool highlighted the possibility of Sensitive species 704 (VU) occurring in the region. None of these IUCN red listed species were encountered during the site survey.

Data Deficient (DD) and Near Threatened (NT) species are not classified as threatened according to the IUCN classification. No Near Threatened species are listed for the region and only *Senecio erysimoides* and *Thesium sonderianum* are classified as DD. **Both species are further classified as DDT, implying that they are taxonomically unresolved and can therefore not be assessed. Neither of these species were encountered during the site survey.**

6.2 Protected species

6.2.1 Western Cape

One hundred and thirty three (133) plant species in Appendix A are listed as protected (Schedule 4) according to the WCNECO (as amended in 2000). Most of these Schedule 4 species are members of the Aizoaceae (64 species), Apocynaceae (25 species) or Iridaceae (20 species).

Fifty-eight (58) Schedule 4 protected species were recorded during the site survey in September/October 2020 (see Appendix A). Once again most of the protected species belonged to the Aizoaceae.

6.2.2 Northern Cape

The NCNCA contains an even more comprehensive list of protected species than the Western Cape. Appendix A contains 228 plant species that are listed as protected (Schedule 1 or 2) according to the NCNCA. The most prominent groups of protected species are members of the Aizoaceae (64 species), Crassulaceae (30 species), Apocynaceae (25 species) and Iridaceae (20 species).

Five specially protected species and 90 protected species were recorded during the site survey in September/October 2020 (see Appendix A). Most of the protected species encountered during the site visit belonged to the Aizoaceae or Crassulaceae.

6.3 ToPS list (NEM:BA 2007c)

No species, classified as protected within the NEMBA (2007c), is listed for the study area and none were found along the route.

6.4 CITES appendices

Appendix II of CITES lists species that are not necessarily now threatened with extinction, but that may become so unless trade is closely controlled. Twenty-one Appendix II species are listed for the region including mostly *Anacampseros* species*, Aloe* species and *Euphorbia* species. Thirteen species listed by CITES were recorded during the site survey (Appendix A).

6.5 National Forests Act (Act No. 84 of 1998) – Protected Tree Species

No nationally protected tree species is listed for the fibre-optic cable route (NFA 2019/2020) and none were recorded during the site visit.

6.6 Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA) and the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEM:BA 2014, 2016)

In total 41 alien species are listed for the study area (Appendix A) of which 16 are categorised as invasive. Alien species with an invasive categorisation need to be controlled during the construction and operational stages of the project. Alien invasive species listed for the study area, in terms of sections 70(1), 71(3) and 71A include the following (species recorded during the site survey are marked with an asterisk):

Atriplex lindleyi subsp*. inflata**	1b
*Atriplex nummularia**	2
*Salsola kali**	1b
*Cirsium vulgare**	1b
Cylindropuntia fulgida	1b
Cylindropuntia imbricata	1b
*Opuntia ficus-indica**	1b
Opuntia microdasys	1b
Tephrocactus articulatus	1a
Cuscuta campestris	1b
*Prosopis glandulosa**	1b WC; 3 NC
Prosopis velutina	1b WC; 3 NC
*Argemone ochroleuca**	1b
Pinus sp.*	1b, 2 or 3
*Pennisetum setaceum**	1b
*Populus alba**	2

See Section 12.3 for GPS coordinates of the alien invasive species observed along the route during the site visit.

7. FAUNA: CHECKLISTS AND RED LISTED AND/OR PROTECTED SPECIES

Species lists (the term species is used here in a general sense to denote species, subspecies and varieties) of the faunal component were sourced for the study area from the Animal Demography Unit, University of Cape Town website (http://vmus.adu.org.za) and supplemented by relevant literature to determine the conservation status.

7.1 Mammals

The route falls within the distribution range of 82 terrestrial mammal species (Appendix B) comprising 22 rodents; 19 even-toed ungulates (Artiodactyla); 18 carnivores (Carnivora); 4 hares and rabbits (Lagomorpha); 4 bats (Chiroptera); 4 shrews (Eulipotyphla); 3 elephant shrews (Macroscelidae); 2 odd-toed ungulates (Perissodactyla); 2 primates; 1 golden mole (Afrosoricida); 1 aardvark (Tubulidentata); 1 hyrax (Hyracoidea) and 1 proboscidean (Proboscidea).

7.1.1 IUCN threatened mammal species

Three IUCN threatened mammal species could occur in the environs of the fibre-optic cable route:

Riverine rabbit	***Bunolagus monticularis***	**CR**
Mountain reedbuck	***Redunca fulvorufula fulvorufula***	**EN**
Black-footed cat	***Felis nigripes***	**VU**

The roan antelope, sable antelope and bontebok listed in Appendix B also have an IUCN threatened status, but have been introduced in the area. These species as well as the mountain reedbuck are likely to occur only in the Karoo National Park or private nature reserves and should not be impacted by the fibre-optic cable. Mitigation measures for the riverine rabbit are provided in Chapter 11.

Riverine rabbit (*Bunolagus monticularis*)

The riverine rabbit is one of the most endangered mammals in the world due to fragmentation of its habitat in the semi-arid central Karoo region of South Africa, to which it is endemic. The extremely low animal numbers (approximately 150 – 210 mature individuals) for the riverine rabbit and with no subpopulation having more than 50 mature individuals, have resulted in a species status of 'Critically Endangered' under IUCN Red List criteria C2a(i). Presence data for the riverine rabbit indicates that 70% of the known population occurs in the Nama Karoo Biome, 24% in the Succulent Karoo Biome and 6% in the Fynbos Biome. The majority of riverine rabbit occupancy lies in the Upper Karoo Bioregion (approximately 80%), with about 12% in the Rainshadow Valley Karoo Bioregion, 4% in the Trans-Escarpment Succulent Karoo Bioregion, 3% in the Western Fynbos-Renosterveld Bioregion and 1% in the Lower Karoo Bioregion. An important habitat requirement for the riverine rabbit is alluvial soil for constructing stable breeding burrows (Coetzee 1994), however this soil type is also the most fertile for cultivation. In the past, ploughing by Karoo farmers transformed large areas of the original habitat and remaining patches were intensively grazed by livestock.

The area south of Loxton is regarded as prime riverine rabbit habitat, in particular around the Sak and Brak Rivers. It is associated with the dense, discontinuous vegetation fringing the seasonal rivers of the central Karoo. Specifically, it occurs in riverine vegetation on alluvial soils adjacent to seasonal rivers. Although it is predominantly a browser, the riverine rabbit is known to occasionally feed on grasses during the early wet rainy season when short, green grasses become available. When browsing, they show a particular preference for *Pteronia erythrochaeta*,

Bassia salsoloides, *Salsola glabrescens* and members of the Aizoaceae. They are unable to survive on heavily overgrazed or agriculturally transformed habitats, but have been found feeding on lucerne fields at night.

Subpopulations in the northern part of the distribution range (such as those around Loxton) are always associated with alluvial floodplains and narrow belts of riverine vegetation adjacent to seasonal rivers. However, in the southern Cape, they are not restricted to the alluvial floodplains and can also occur in abandoned cropland not associated with riverine vegetation.

This species is elusive and nocturnal, spending daylight hours in a scrape beneath riparian vegetation. They are solitary, and will only be found in breeding pairs for short periods, or in female-juvenile pairs for rearing purposes. Riverine rabbits have a single litter per year with 1–2 young per litter in a fur- and grass-lined subterranean chamber excavated in stable soils. Reproductive periodicity occurs from August through May. Home range has been estimated as 12 ha.

Comment: In general the habitat in the road reserve and at stream crossings is not suitable habitat for the riverine rabbit. Traffic would also deter the riverine rabbit from making burrows in the road reserve. Furthermore, the animals are nocturnal and thus not active while construction work will be in progress.

Southern Mountain reedbuck (*Redunca fulvorufula fulvorufula*)

The southern mountain reedbuck is listed as **Endangered A2b** (Taylor *et al*. 2016) due to large population declines in all protected areas for which long-term count data are available. Distribution maps of various authors show large disagreement on where the western boundary of their distribution lies (Friedman & Daly 2004; Skinner & Chimimba 2005; Skead 2011; Taylor *et al*. 2016). According to Du Plessis (1969) the past (historic) distribution of the mountain reedbuck in the Northern Cape was approximately east of a north-south line from Beaufort West northwards to Prieska past Postmasburg and Kuruman and then northeastwards to Gaberone, Botswana (Figure 33a). The fibre-optic route would thus more or less lie on the western boundary. The species has been extensively reintroduced into parts of its former range and according to the most recent distribution of the species in southern Africa (Taylor *et al.* 2016) the mountain reedbuck is indicated in the Karoo National Park where it seems to have been introduced (Figure 33b).

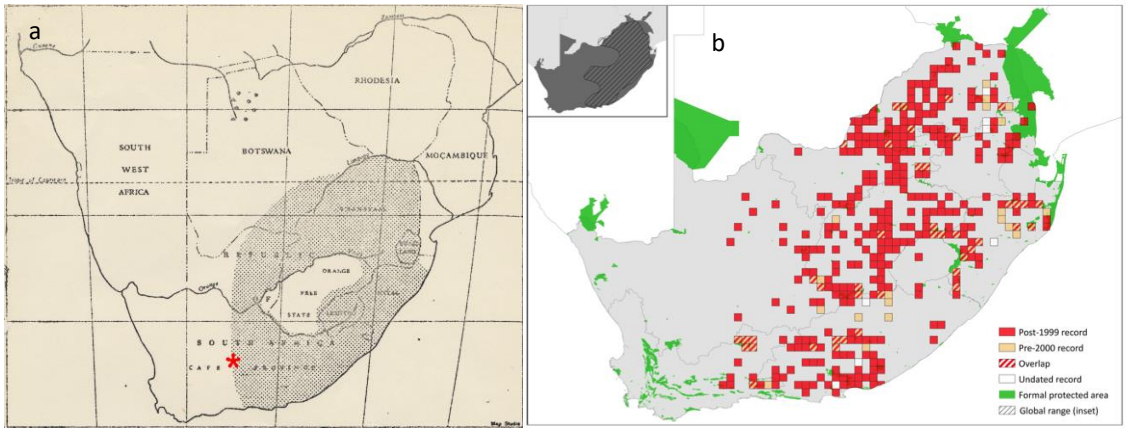


Figure 33. (a) Map of the past distribution of the southern mountain reedbuck (Du Plessis 1969); and (b) map showing past and present distribution of the species (Taylor *et al.* 2016).

It is important to note that because of their specialised habitat requirements, the distribution of the mountain reedbuck is patchy and discontinuous and that they are found only where there is suitable habitat. They favour grass-covered ridges and hillsides in broken rocky country or high-altitude grasslands. They are dependent on steep slopes, a well-developed grass layer and some scattered woody cover to evade predators. According to Rowe-Rowe (1983) the mountain reedbuck favours slopes with a gradient of 20° or more. In regions where cover is locally more

abundant in lower valleys than on upper slopes and ridges, it often prefers the lower slopes. They avoid the open conditions with no cover associated with the summits of mountainous areas as well as dense woody cover (Mason 1977; Oliver *et al.* 1978; Skinner & Chimimba 2005). They also occur in dry hilly areas (such as the Nama-Karoo), utilising steep slopes and the bases of hills for grazing. The extent of available slopes for predator evasion is regarded as an indicator of the quality of their territory (Dunbar & Roberts 1992).

Comment: The overhead infrastructure, proposed to traverse ridges and mountainous areas that are difficult to trench, will not interfere with the behaviour of the mountain reedbuck. No trenches are planned in areas possibly occupied by the mountain reedbuck. However, temporary dug trenches are also unlikely to pose a significant risk to the mountain reedbuck. Mitigation measures to reduce animal entrapment in open trenches are recommended (Chapter 11).

Black-footed cat (*Felis nigripes)*

The black-footed cat has a very wide distribution and habitat preference and it is likely that they can/do occur within the region. However, they are usually sparsely distributed. Furthermore, the black-footed cat is nocturnal, which would reduce interaction with human activity in the area.

7.1.2 Provincially protected mammal species

Thirty-two of the terrestrial mammal species in Appendix B are Schedule 2 protected wild animals (PWA) in the Western Cape, with the riverine rabbit and Cape Mountain zebra being the Schedule 1 endangered wild animals (EWA) (Appendix B). According to the Northern Cape Nature Conservation Act (NCNCA), 15 of the mammal species are Schedule 1 specially protected species (SPS), 61 Schedule 2 protected species (PS) and four Schedule 4 damage causing animals.

7.1.3 Nationally protected species: ToPS

According to ToPS legislation (NEMBA 2007c) seven species are protected, three are listed as Vulnerable, one as Endangered and one as Critically Endangered (see Chapter 12 and Appendix B).

7.2 Reptiles

Fifty-seven reptile species are listed for the fibre-optic cable route and these comprise eight tortoises and terrapins (Testudines); 15 snakes; and 34 lizards (Appendix B). Important habitats for reptiles include the drainage lines, cliffs and rocky outcrops. No trenches will be cut through the drainage lines and in the rocky areas the cable will be overhead, consequently the impact of the installation of the cable will be limited in these habitats.

One of the reptile species listed in Appendix B has an IUCN threatened status.

Chersobius boulengeri **Karoo dwarf tortoise** **EN**

The Karoo dwarf tortoise is an endemic species occurring in the region. Tortoises would be at risk of falling into open trenches during the construction phase of establishing the fibre-optic cable.

Comment: Some reptiles may inhabit the rocky areas where cuttings occur and it is recommended that trenches rather be dug along the road and not cross the cutting.

According to the WCNECO (1974, 2000) all lizards, all tortoises and turtles (except those listed in Schedule 1) and many snake genera are Schedule 2 protected species (Appendix B). Thus 44 of the 57 reptile species (77%) are

protected. In the Northern Cape, 18 of the 57 species (32%) are protected. None of the reptiles are listed under ToPS legislation (NEMBA 2007c), however Appendix II of CITES lists nine reptile species in which trade needs to be strictly controlled. Mitigation measures for the Karoo dwarf tortoise are provided in Chapter 11.

7.3 Amphibians

Important areas for amphibians include the major drainage lines along the route. This habitat will be discussed in detail in the aquatic assessment (EnviroSci 2020).

Fourteen frog species are listed for the study area (Appendix B). Although none of the frog species listed in Appendix B has an IUCN threatened status, all frog species are Schedule 2 protected species according to the WCNECO (1974, 2000). In the Northern Cape all frog species are Schedule 2 protected species, with the exception of those listed under Schedule 1 as specially protected species.

7.4 Avifauna

In total 262 bird species are known to occur along the route of the fibre-optic cable. Of these species four are listed as Endangered and six as Vulnerable (IUCN status RSA) (Appendix B):

Circus maurus	**Black harrier**	**EN**
Mycteria ibis	**Yellow-billed stork**	**EN**
Neotis ludwigii	**Ludwig's bustard**	**EN**
Polemaetus bellicosus	**Martial eagle**	**EN**
Afrotis afra	**Southern black korhaan**	**VU**
Aquila verreauxii	**Verreaux's eagle**	**VU**
Ciconia nigra	**Black stork**	**VU**
Cursorius rufus	**Burchell's courser**	**VU**
Falco biarmicus	**Lanner falcon**	**VU**
Sagittarius serpentarius	**Secretarybird**	**VU**

In the Western Cape all bird species are listed as protected, except for the very common ones. In the Northern Cape, 38 bird species are considered as specially protected and 206 as protected. The remaining species are classified as common indigenous species (see Appendix B for lists of species).

Wherever the proposed cabling is to be buried, it will not pose a risk to birds. It is also unlikely that nesting sites would be found in the road reserve. On the overhead sections, birds may use the poles as perches, but there will be no risk of electrocution. Overhead cables are restricted to the mountainous sections of the route and collisions by mountain dwelling species may occur. Plains species such as the Ludwig's bustard should therefore not be compromised. Nevertheless, it is recommended that bird collisions with the overhead cables are monitored for some time after the erection of the cable (see Chapter 11).

7.5 Scorpions

Sixteen scorpion species have been recorded for the region, with seven of them being protected in the Northern Cape, although none are listed as protected in the Western Cape (Appendix B). The red list status of South African scorpions is not available.

7.6 Spiders

Twenty-nine spider species have been recorded for the region, with two of them (baboon spiders) being specially protected in the Northern Cape, although none are listed as protected in the Western Cape (Appendix B). The red list status of South African spiders is not available.

8. CONSERVATION

8.1 National Environmental Management: Protected Areas Act (Act No. 10 of 2003)

In order to traverse the topographically and geologically difficult terrain of the Molteno Pass at the eastern side of the Karoo National Park, it is proposed that the fibre-optic cabling (overhead) be installed in the Park in a corridor where Eskom and Telkom infrastructure was historically established and currently still exists. To this end, Section 50(5) approval in terms of the NEM:PAA (see Chapter 3.6) is required in order to install the fibre-optic cabling in the Park.

8.2 National Protected Areas Expansion Strategy (NPAES)

The route of the fibre-optic cable does traverse areas earmarked by NPAES for future expansion of the Karoo National Park (Figure 34; NPAES, 2010). However, the proposed development will not interfere with the protected areas expansion strategy, since it is confined along existing roads that are unlikely to be closed in the future for the purposes of park expansion.

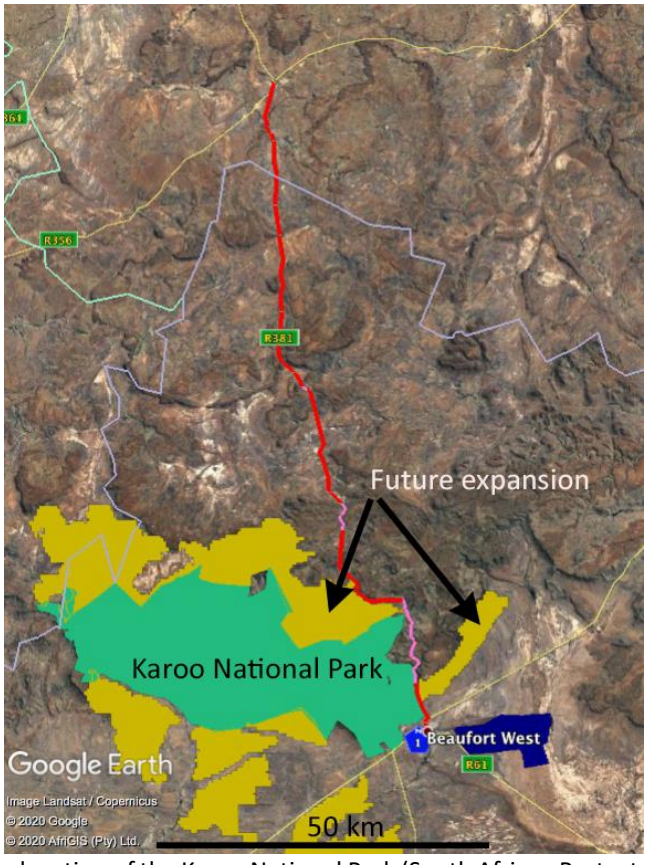


Figure 34: Map indicating the location of the Karoo National Park (South African Protected Areas database Q1, 2020) and areas for future expansion (National Protected Areas Expansion Strategy 2010).

8.3 National list of ecosystems that are threatened and in need of protection

All six vegetation types on site are listed as 'least threatened' / 'Least Concern' (Mucina & Rutherford 2006, NEMA 2011, SANBI 2018a).

8.4 Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) and Other Natural Areas (ONAs)

Critical Biodiversity Areas are areas required to meet biodiversity targets for ecosystems, species or ecological processes. An ESA is not essential for meeting biodiversity targets but plays an important role in supporting the ecological functioning in a CBA (Figure 35).

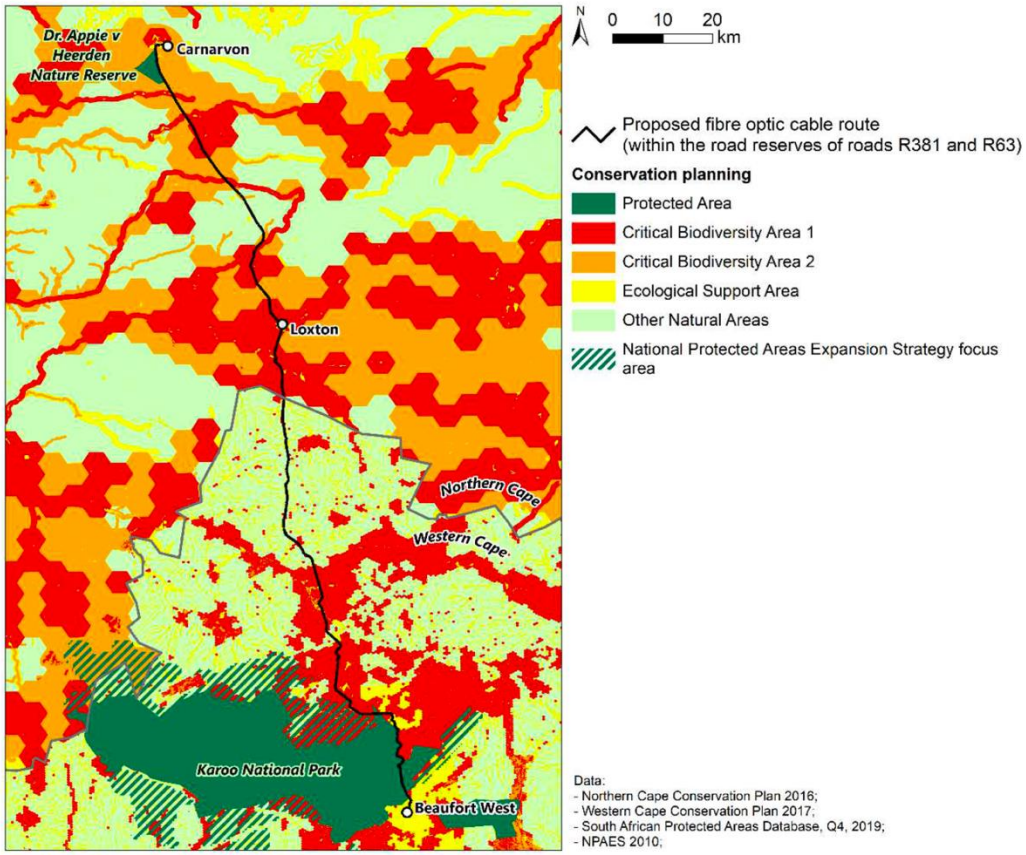


Figure 35: CBAs, ESAs and ONAs along the route of the fibre-optic cable in the Western Cape (biodiversityadvisor.sanbi.org) (source CSIR 2020).

8.4.1 Critical Biodiversity Areas (CBAs)

CBAs are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species.

Development within Critical Biodiversity Areas is not encouraged. According to the Western Cape Biodiversity Spatial Plan Handbook (Pool-Stanvliet *et al*. 2017) permissible land uses are those that are compatible with maintaining the natural vegetation cover of CBAs in a healthy ecological state, and that do not result in loss or degradation of natural habitat. Undesirable land uses in terrestrial CBAs are those that cause loss of natural habitat or ecosystem functionality, such as: (i) mining or prospecting; (ii) intensive agriculture (cultivation) or plantation forestry; (iii) residential, commercial or industrial developments; (iv) game-proof fences in CBA corridors; (v) linear infrastructure that disrupts the connectivity of CBA corridors; and (vi) extensive or intensive grazing that results in species diversity being lost through selective or over-grazing (Pool-Stanvliet *et al*. 2017). **The route of the fibre-optic cable does not constitute any of these CBA undesirable land uses.**

The main reasons provided for the mapping of the CBAs were: high sensitivity indicated in the shale gas SEA (without an indication of what caused the high sensitivity), water resource protection and Cape mountain zebra habitat. Although the area to the south of Loxton is prime riverine rabbit habitat it was not provided as reason for delineating CBAs in the Western Cape. Nevertheless, the watercourses picked up most of the riverine rabbit's favoured habitat.

It is important to take cognisance of the fact that the proposed construction of the fibre-optic cable will take place in the road reserve and that the road reserve is not representative of the adjacent land on which the CBA identification was based. Road reserves have been highly disturbed and degraded and often still contain piles of gravel used for road construction. Furthermore, sections of the road reserve are from time to time still being cleared of vegetation. Consequently, the classification of the road reserve as CBA1 cannot be upheld, even a CBA2 (degraded CBA) is difficult to reconcile with a road reserve. Where the routing deviates outside of the road reserve (overhead sections to traverse difficult terrain) the physical impact footprint will not result in significant loss of CBA-qualifying ecosystem features and function.

In summary:

- **The proposed SKA Fibre-optic Cable does not constitute any of the land uses considered to be undesirable in a CBA according to Pool-Stanvliet *et al*. (2017).**
- **Since most of the development will take place in the road reserve, the development will have no impact on the existing Dr Appie van Heerden Nature Reserve and will not affect the NPAES. Where the overhead fibre-optic cabling in the Molteno Pass section is proposed to transverse the Karoo National Park, relevant permissions to establish the infrastructure must be obtained (NEM:PAA Section 50(5)).**
- **Furthermore, the classification of the road reserve as CBA is questionable from a vegetation standpoint, although it might still be marginal riverine rabbit habitat.**
    - **The definition of a CBA1 is: "Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas" (SANBI 2018b). The road reserve by no means complies with these conditions.**
    - **The definition of a CBA2 is: "Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses". Road reserves are not the best option to meet biodiversity targets.**
    - **The question of whether or not the development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation therefore becomes irrelevant.**
- **Cable installation will probably have a temporary impact on the composition and structure of vegetation. Since the vegetation in the road reserve contains a large proportion of pioneer plant species is will be able to colonise the disturbed cable trench within a relatively short period of time.**
- **Since the development footprint is small, the loss of habitat or species will be limited.**
- **The extent of clearing activities in the different vegetation types is small in relation to the remaining extent of the vegetation types and ecosystem threat status will not be affected.**
- **The impact on overall species and ecosystem diversity of the adjacent land will not be affected and even within the road reserve, the impact will be small.**
- **Due to the small area that will be disturbed along the route, the impact on populations of species of conservation concern in the CBA will be negligible.**
- **Roads are permanent infrastructure and are fenced. The fence will thus always be a barrier that impedes migration or movement of large faunal species. The fibre-optic cable, where installed underground in the road reserve or overhead, will not contribute additional obstruction to animal movement.**

8.4.2 Ecological Support Areas (ESAs)

ESAs need to be maintained in at least a functional and often natural state, but some limited habitat loss may be acceptable. **It is important that the project should not compromise the functional (natural) state of the ESAs as required by the conservation plan of the Western Cape (Pool-Stanvliet et al. 2017).** The ESAs in both the Northern Cape and Western Cape follow the smaller watercourses.

- **Ecological processes that operate within or across the ESAs will not be altered by the trench or overhead structures.**
- **The extent of the development is small and will not have a negative impact on the functionality of the broader ESA.**
- **Cable installation will not sever ecological corridors or introduce barriers that impede migration and movement of flora and fauna. Thus, no loss of ecological connectivity in relation to the broader landscape is likely.**

8.4.3 Other Natural Areas (ONAs)

Other Natural Areas (ONAs) have not been identified as a priority, but retain most of their natural character and perform a range of biodiversity and ecological infrastructure functions. Land use guidelines for Terrestrial Other Natural Areas (ONAs) are not required to meet biodiversity targets.

ONAs represent the largest area in the region and form a matrix within which the CBAs and ESAs occur.

8.5 Ecological processes, functioning and drivers

Ecological processes include primary production, decomposition, nutrient cycling and fluxes of nutrients and energy. These processes will temporarily be altered by the clearing of the vegetation for the trenches and poles. The impact is expected to be fairly small in relation to the adjacent landscape where no change to the ecological processes is anticipated. The narrow width of the trench will not hinder pollination by airborne pollinators. Migration of ground-dwelling organisms will be hindered while the trench is open. It is therefore recommended that the trenches are not left open too long before the cabling is inserted and the trenched filled again. Once the trenches have been filled ecological connectivity will be restored and habitat fragmentation will not be an issue. Overall, it is unlikely that the fibre-optic cable will contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions. The installation of the cable will not cause any additional impediment to ecological corridors.

Road reserves often act as conduits for alien invasive species and the disturbance caused by the construction of the fibre-optic cable will inevitably create conditions favourable for invasion by alien species. However, the level of infestation along the route was fairly low and the most important invasive species were *Prosopis* spp. (not severe at this stage), *Argemone ochroleuca* (widespread but not severe), *Salsola kali* (widespread) and *Pennisetum setaceum* (local). Nevertheless, an alien invasive plant species monitoring and control programme needs to be initiated to control invasions.

Fire in this arid part of the Nama-Karoo is rare as a result of the high grazing pressure and variable rainfall and is thus not considered as an important driver of vegetation dynamics.

8.6 Key landscape features

A key landscape feature along the route of the fibre-optic cable is the riverine rabbit's habitat. This critically endangered species is associated with the dense vegetation on the alluvial soils fringing the seasonal rivers. It is particularly prominent around the Sak and Brak Rivers where plant species such as *Salsola* spp., *Pteronia*

erythrochaeta and *Helichrysum pentzioides* occur.

In the mountainous Upper Karoo Hardeveld where the cliff habitat could be regarded as key landscape feature, this habitat can be avoided because cabling will be overhead in that section. Where rocky outcrops occur in the path of the fibre-optic cable in the Eastern Upper Karoo, these can also be avoided by diverting the trench to the shoulder of the road.

8.7 Indigenous forests

No indigenous forests occur along the route of the fibre-optic cable.

8.8 Freshwater Ecosystem priority and area subcatchments

The route of the fibre fibre-optic cable will cross several water catchments that are classified as Freshwater Ecosystem Priority Areas (FEPAs). These are priority areas for conserving freshwater ecosystems and supporting sustainable use of water resources and upstream management areas (Driver *et al*. 2011) (Figure 36). No Strategic Water Source Areas (SWSAs) (CSIR 2017) occur in the region where the fibre-optic cable is proposed. The potential impacts of the proposed fibre-optic cable development on aspects of terrestrial ecology, that may result in knock-on effects to the status and functioning of FEPAs and SWSAs (e.g. increased water runoff and erosion), are not expected to be significant. The impacts of the development on these freshwater / aquatic ecosystems are discussed in more detail in the aquatic assessment (EnviroSci 2020).

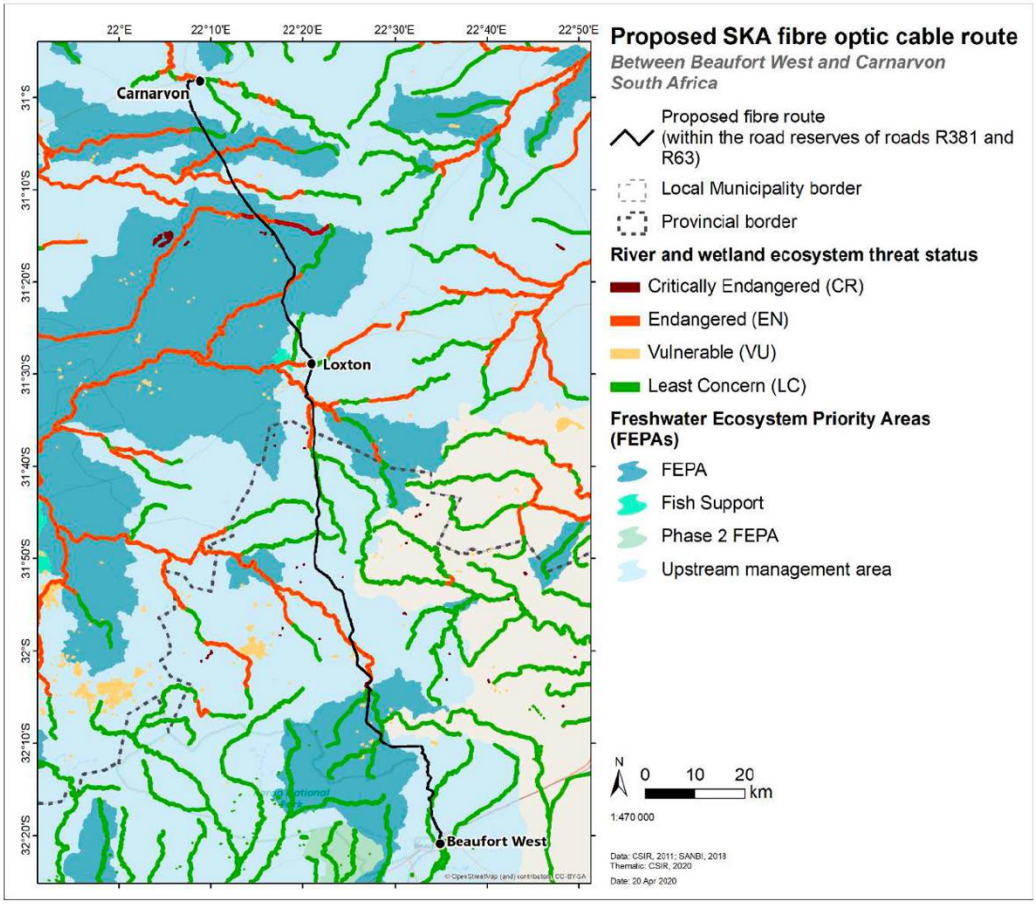


Figure 36: River ecosystem threat and freshwater priority areas in the project area proposed for the SKA fibre-optic cable route from Beaufort West to Carnarvon (source CSIR 2020).

9. ECOLOGICAL SENSITIVITY ANALYSIS

9.1 Introduction

Sensitivity is the vulnerability of a habitat to any impact, for example a dune, wetland or ridge system would be more vulnerable to development than would a sandy plain. Several features of a site can be identified and assessed to derive a sensitivity score, such as:

- Threatened status of the regional vegetation type wherein the proposed site is situated:
  - all vegetation types are classified as Least Threatened.
- Percentage of red listed plant species per habitat or site:
  - none of the red listed plant species, likely to occur in the region, were encountered.
- Number of protected tree species per habitat or site:
  - no protected tree species occur in the region.
- Percentage of provincially protected plant species per habitat:
  - The ranking from a high to low percentage of protected species was: Mountain plateaux > Midslopes > Valleys > Footslopes > Low hills = Mountain > Plains > Bottomlands > Drainage lines.
- Presence of endemic plant species per habitat or site (endemic to vegetation type):
  - the only endemic species (Mucina & Rutherford 2006) encountered in the road reserve was *Stomatium suaveolens* in the Upper Karoo Hardeveld.
- Conservation value of association (habitat) or site;
  - overall the watercourses, mountainous habitats, rocky sheets, as well as the floodplains (bottomlands) along the larger rivers were considered as having a higher conservation value.
- Species richness per habitat or per sample plot (number of plant species):
  - Species richness was ranked as follows from high to low: Mountain plateaux > Midslopes > Valleys > Footslopes > Low hills > Mountain > Plains > Bottomlands > Drainage line.
- Degree of connectivity and/or fragmentation of the habitat, i.e. high connectivity and low fragmentation infers a low rating:
  - the only naturally fragmented (micro)habitat was the rocky sheets which could occur within almost any of the broader habitat types.
- Soil erosion potential:
  - in general the mountainous areas are more prone to soil erosion, however, the repeated disturbance within the road reserve in almost any broader habitat type could lead to soil erosion locally.
- Resilience (this is a measure of the ability of a particular habitat to recover after an impact, i.e. high resilience infers low rating); in this instance recovering to its current state was considered not the recovery to an undisturbed vegetation state:
  - on the whole, the vegetation in the road reserve has already recovered from the impact of the road construction. It therefore differs from the adjacent undisturbed land. However, the vegetation is likely to recover to the same state after the construction of the fibre-optic cable. Where the fibre-optic cable deviates from the road reserve to traverse difficult terrain via overhead installation, the physical impact footprint of the installed wooden poles is limited.

9.2 Site survey to identify sensitive sites

To identify botanically sensitive areas along the 181 km route, Google satellite images were studied beforehand and the route stratified into relatively homogenous physiographic-physionomic units or habitats. The first level of stratification was thus the six vegetation types of the region and within each of them the different habitat types

represented the second level of stratification (see Chapter 5 for full description). Sites were then selected along the route to represent these habitats. However, sites were also selected at localities identified by SANReN as possible problem areas for the placement of the underground fibre-optic cable. These problem areas are mostly at road cuttings where the road cuts through hills or rises and where soil and rock were removed (mostly in the low hill habitat).

During the field survey, 157 sites were surveyed along the route and the vegetation, flora and fauna noted in the road reserve where the cable route was indicated (Figure 37). This gave an average of one survey site every 1.2 km. All identifiable plant species were noted and specific attention was given to protected species or SCCs. Based on the presence of plant species of conservation concern at each of the sites surveyed, a number of sites were identified where it may be necessary to micro-site the location of the trench.

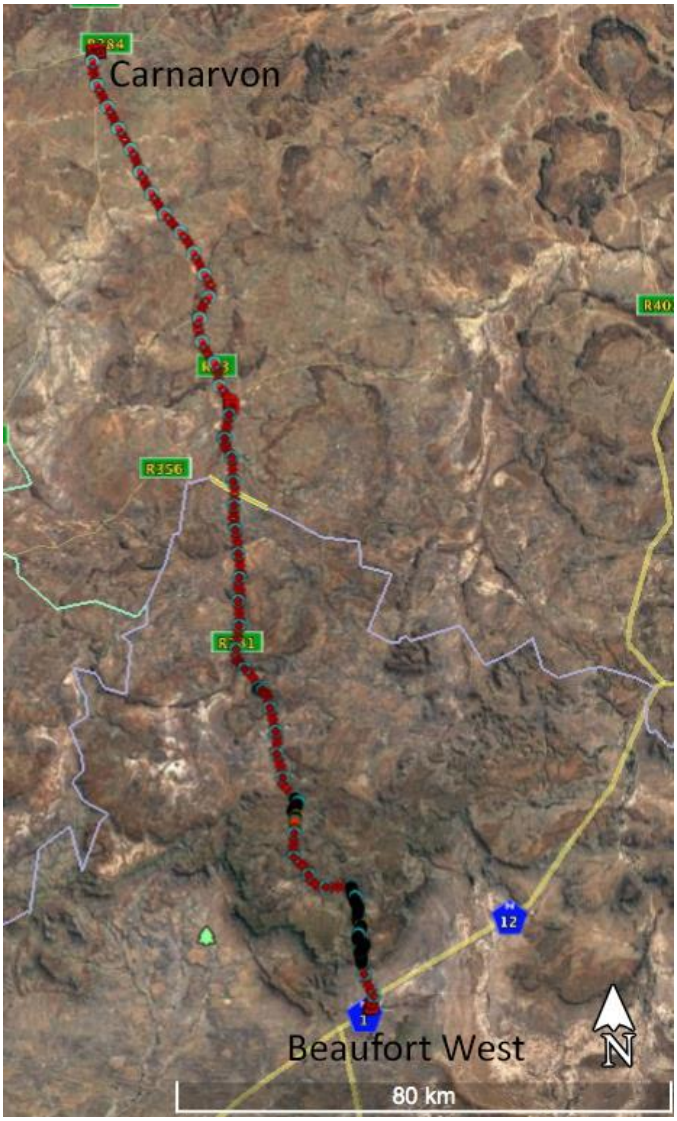


Figure 37: Map indicating the overhead sections (black dots) and the trench sections (red).

9.2.1 Sensitivity model

An **overall sensitivity model** (Table 9) was applied to the data for each habitat within the vegetation types on site. This was achieved by weighting each criterion and calculating the sum for the habitat, which reflects the sensitivity and sensitivity ranking. The brief description of the sensitivity rating of the parameters is provided below:

1. **Threatened status of the ecosystem** (depends on the percentage area intact, or degree of transformation) (Driver *et al*. 2005, Mucina & Rutherford 2006, NEM:BA 2011, SANBI 2018a). The ecosystems are classified into the following categories:
   - Low sensitivity: If "Least Threatened" (LT), the vegetation type has most of its habitat intact, i.e. more than 80%; or the vegetation type is adequately statutory or formally conserved in parks and reserves.
   - Moderate sensitivity: If "Vulnerable" (VU), the vegetation type has from 60% to 80% of the ecosystem intact; less than 40% has been transformed which could result in some ecosystem functioning being altered, and/or the ecosystem is statutory poorly conserved. For example, the vegetation type is rich in plant species but is not a pristine example of a vegetation type, therefore some transformation or disturbance occurred, such as human structures and degraded veld due to overgrazing and/or bush encroachment.
   - High sensitivity: If "Endangered" (EN), the vegetation type has from 40% to 60% of the ecosystem intact; or 40% to 60% transformed due to disturbance, cultivation or alien species; or the ecosystem is statutory poorly conserved e.g. less than about 3% conserved.
   - Very high sensitivity: If "Critically Endangered" (CR), the vegetation type has only 16% to 36% of the ecosystem intact. The richer the ecosystem is in terms of species, the higher the percentage threshold.

   Sensitivity category rating:

Low	(LT)	= 1
Moderate	(VU)	= 2
High	(EN)	= 3
Very high	(CR)	= 4

2. **Percentage of red list plant species** (listed higher than 'least concern', LC) (Threatened species Programme). The rating is determined by the presence of rare flora in a habitat (calculated as percentage of the total number of species per habitat).

   Sensitivity category rating:

None	(0%)	= 0
Low	(>0 – 2%)	= 1
Moderate	(>2 – 5%)	= 2
High	(>5%)	= 3

3. **Presence of protected tree species** (NFA 2019) refers to the presence of protected tree species in a habitat and is rated as follows:

   Sensitivity category rating:

None	(0 species)	= 0
Low	(1 - 2 species)	= 1
Moderate	(3 – 4 species)	= 2
High	(>4 species)	= 3

4. **Percentage of Northern Cape and/or Western Cape protected plant species** (NCNCA 2009; WCNECO, 1974 as amended). The rating depends on the percentage of protected species in relation to the total plant species per habitat.

   Sensitivity category rating:

None	(0%)	= 0
Low	(>0 - 10%)	= 1
Moderate	(>10 – 20%)	= 2
High	(>20%)	= 3

5. **Percentage of plant species endemic to the particular habitat** (Mucina & Rutherford 2006) refers to the number of species expressed as a percentage of the total number of species per habitat.

   Sensitivity category rating:

None	(0%)	= 0
Low	(>0 - 2%)	= 1
Moderate	(2–5%)	= 2
High	(>5%)	= 3

6. **Species richness per habitat** is expressed as mean number of species per plot.

   Sensitivity category rating:

Low	(<15)	= 1
Moderate	(15 – 30)	= 2

High	(>30)	= 3

7. **Conservation value of the habitat.** The assessment is made for the habitat in the broader region.

Sensitivity category rating:

Low	= 1
Moderate	= 2
High	= 3

8. **Degree of connectivity and/or fragmentation of the ecosystem.** The degree of connectivity with surrounding or adjacent natural areas and/or fragmentation of habitats, thus high degree of connectivity and low degree of fragmentation infer a high rating.

Sensitivity category rating (note reverse order)*:*

Low	= 3
Moderate	= 2
High	= 1

9. **Erosion potential of the soil.** The erosion potential of the soil is indicated as low, moderate or high, e.g. coarse sandy soils on plains have a low erosion potential.

Sensitivity category rating:

Low	= 1
Moderate	= 2
High	= 3

10. **Resilience** is a measure of the ability of a particular road reserve habitat to recover to its current state after an impact, i.e. high resilience infers low rating.

Sensitivity category rating (note reverse order):

Low	= 3
Moderate	= 2
High	= 1

Each criterium is weighted as follows in the model:

Threatened status of the vegetation type	x5
Percentage of red list plant species	x4
Presence of protected tree species	x3
Percentage of Northern Cape or Western Cape protected species	x4
Percentage of endemic species to vegetation type	x2
Species richness	x2
Conservation value (habitat)	x4
Degree of connectivity/fragmentation of habitat	x2
Erosion potential	x2
Resilience	x3

9.2.2 Sensitivity rating

The sum of all criteria is obtained per habitat and interpreted as follows:

≤ 39	= low	(L)	(rating scale = 1)
40 – 54	= moderate	(M)	(rating scale = 2)
55 – 69	= high	(H)	(rating scale = 3)
> 70	= very high	(VH)	(rating scale = 4)

In general, these sensitivity ratings are interpreted as follows:

- **Low** sensitivity means the sensitivity should not have an influence on the decision about the project. It is

usually applicable to habitats that have been transformed, especially by human activities. However, any protected species must be avoided, or may not be removed/destroyed without a permit.

- **Moderate** means a sensitivity rating that is real and sufficiently important to require management, e.g. mitigation measures, management or protection of the rare/threatened fauna and flora, protection of a specific habitat on the property and/or rehabilitation.
- **High** means a sensitivity rating where the habitat should be excluded from any development.
- **Very high** means a sensitivity rating that should influence the decision whether or not to proceed with the project.

Table 9: Sensitivity of the habitats within vegetation types (see Figure 38)

Vegetation types	NKU 1	NKU 1	NKU 1	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	NKu 3	NKu 4	NKu 4	NKu 4	NKu 4	NKl 1	NKl 1	NKl 1	AZi6
Habitats	Fs	H	P	Fs	H	M	MS	Pl	P	V	P	B	Fs	H	P	Fs	H	P	Dl
Threatened status (x5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
% Red data species (x4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of protected trees (x3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% NCNCA/WCNECO species (x4)	12	12	12	8	8	8	8	8	12	8	8	8	12	12	12	4	12	4	8
% Endemic species (x2)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Conservation value (x4)	4	8	4	4	8	12	12	12	4	12	4	8	4	8	4	4	8	4	12
Species richness (x2)	4	4	4	4	4	4	6	6	4	4	4	4	4	4	4	4	4	4	4
Connectivity (x2)	2	4	2	2	4	4	2	4	2	4	2	2	2	4	2	2	4	2	2
Erosion (x2)	2	2	2	2	2	4	4	2	2	4	2	2	2	2	2	2	2	2	4
Resilience (x3)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Sum:	35	41	35	31	37	43	43	43	35	43	31	35	35	43	35	27	41	27	41
Sensitivity rating:	L	M	L	L	L	M	M	M	L	M	L	L	L	M	L	L	M	L	M

NKu1 = Western Upper Karoo; NKu2 = Upper Karoo Hardeveld; NKu3 = Northern Upper Karoo; NKu4 = Eastern Upper Karoo; NKl1 = Gamka Karoo
B = Bottomlands; FS = Footslopes; H = Low hills; MS = Midslope; M = Mountain; P = Plain; Pl = Plateau; V = Valley.

Overall, the mountainous parts, and drainage lines were more sensitive than the plains and footslopes. Thus, the mountains, midslopes, mountain plateaux, valleys in the mountains and low hills were assigned a moderate sensitivity, whereas the sensitivity of the bottomlands, plains and footslopes was low. No buffers are applicable to the development, except along the watercourses, which is dealt with in the aquatic specialist assessment (EnviroSci 2020). The sensitivity map (Figure 38) is additionally provided as a .kmz file.

Although none of the habitats were rated as highly sensitive from a vegetation point of view, construction activities in the specific locations of known riverine rabbit occupancy should proceed with the utmost care and consideration for these animals (locations identified on .kmz file) (see mitigation measures in Chapter 11).

Furthermore, although none of the habitats were rated as highly sensitive from a vegetation point of view and no red listed species were encountered, this does not exclude the presence of protected species along the route. In the NCNCA (2009) and to a lesser extent WCNECO (1974, 2000), a number of families and genera, for example the families Aizoaceae, (formerly Mesembryanthemaceae), Crassulaceae and Iridaceae and genera such as *Mesembryanthemum, Lessertia, Nemesia, Manulea* and *Oxalis* are listed as either Specially Protected Species/Flora or Protected Species/Flora. This blanket classification may be because of the presence of one or two species of vulnerable or higher conservation (IUCN) status in the genus. Unfortunately, this then includes many species that are either common, or even weedy, e.g. *Crassula muscosa, Drosanthemum hispidum*, *Euphorbia inaequilatera*, *Galenia namaensis, Lessertia inflata*, *Mesembryanthemum coriarium, Moraea miniata, Ruschia intricata* or *Oxalis obtusa* that do not need to be awarded special conservation status. To decide on which protected species to consider as being more conservation worthy a subjective judgement had to be made. The following provincially protected

species were considered as conservation worthy in this report due to being provincially protected as well as CITES listed, although none have an IUCN red list status:

Aloe spp.
Anacampseros albidiflora
Anacampseros cf. lanceolata
Anacampseros ustulata
Aristaloe aristata
Euphorbia clavarioides
Huernia barbata
Gonialoe variegata
Lessertia frutescens
Pachypodium succulentum
Mesembryanthemum emarcidum
Stapelia grandiflora
Stomatium difforme
Stomatium suaveolens
Stomatium villetii

9.3 Sites where caution should be applied when siting the trench or poles

Specific sites where precautionary measures should be taken are highlighted in the following section.

9.3.1 Overhead section

It is our judgement that although there are some conservation worthy protected species present on the proposed overhead route sections (Figures 38 & 39), the construction of the overhead cable will not impact significantly on the flora and fauna of the area. The area that will be disturbed by the erection of posts for the overhead cable will be negligible and the impact on the vegetation will not be a concern. However, should heavy machinery be used against the steep slopes for the excavation of holes for the posts, then it is cautioned that the impact will increase and that mitigation measures need to be implemented, such as re-aligning the route to less sensitive areas. It is, however, understood that a hand-held drill and and manual labour will be employed to plant posts in areas inaccessible by truck-mounted drills and pole-planting equipment. Four sites were identified where posts should be placed with caution (see Figure 38 - kmz, GPS).

Furthermore, it is recommended that the construction teams should avoid obvious rocky sheets (where *Anacampseros* spp. and *Stomatium* spp. may be found) and microsite the location of a post when conspicuous plants are present, e.g. *Aloe broomii*.

It should be noted that the actual watercourses and river crossings were not assessed for sensitivity in the current study, but that the sensitivity found in the aquatic study should be used for reporting. The drainage lines referred to in the habitat analysis were generally slightly further from the actual watercourse.

GPS coordinates of the four cable overhead sensitive sites:

Site 1: 32° 16' 13.45" S; 22° 33' 48.14" E; 972 m
Site 2: 32° 15' 56.90" S; 22° 33' 46.57" E; 1014 m
Site 3: 32° 15' 30.70" S; 22° 34' 11.90" E; 1125 m
Site 4: 32° 04' 22.19" S; 22° 27' 15.58" E; 1558 m

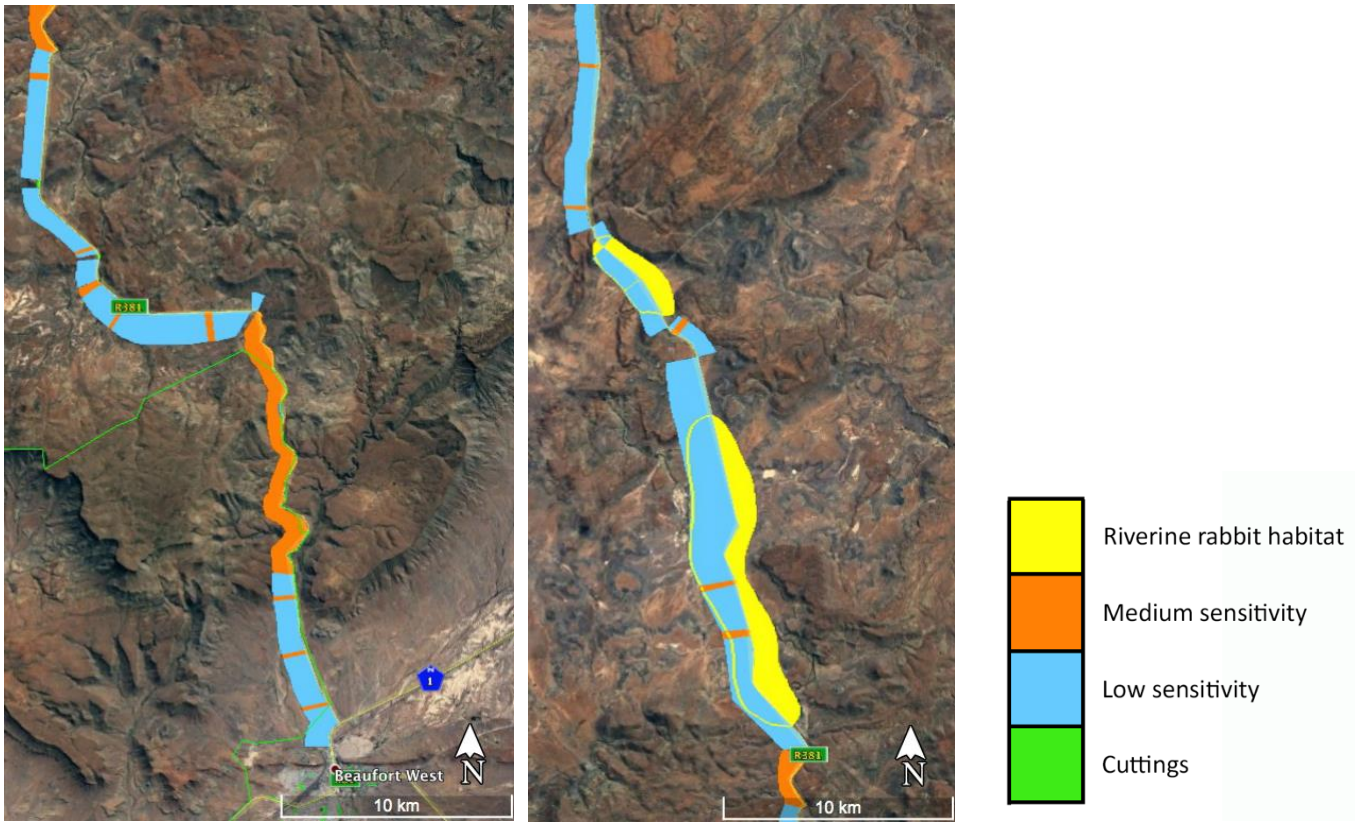
9.3.2 Underground section

Eight sites were identified where some micrositing should take place to avoid some of the conservation worthy protected present. These sites are mostly where road cuttings occur through elevated areas (Figures 38 & 40). It is recommended that the trench is moved down to the foot of the cutting, but as far as possible from the road itself. The reasons being:

- The rocky substrate and rocky sheets on top of the cuttings are the habitat for some of these species.
- The digging of the trench will most probably destroy these species on these localised sites.
- There is limited space between the existing fences over some of these cuttings and the steep slope down to the road.

GPS coordinates of the eight underground (trench) sensitive sites:

Site 5: 32° 18' 17.23" S; 22° 34' 11.94" E; 900 m
Site 6: 32° 10' 24.72" S; 22° 31' 27.16" E; 1595 m
Site 7: 32° 10' 12.84" S; 22° 29' 12.37" E; 1600 m
Site 8: 32° 04' 59.60" S; 22° 27' 07.60" E; 1600 m
Site 9: 32° 00' 15.84" S; 22° 25' 46.48" E; 1496 m
Site 10: 32° 28' 11.21" S; 22° 20' 48.92" E; 1368 m
Site 11: 31° 13' 33.95" S; 22° 15' 47.30" E; 1412 m
Site 12: 31° 12' 16.28" S; 22° 14' 32.58" E; 1390 m



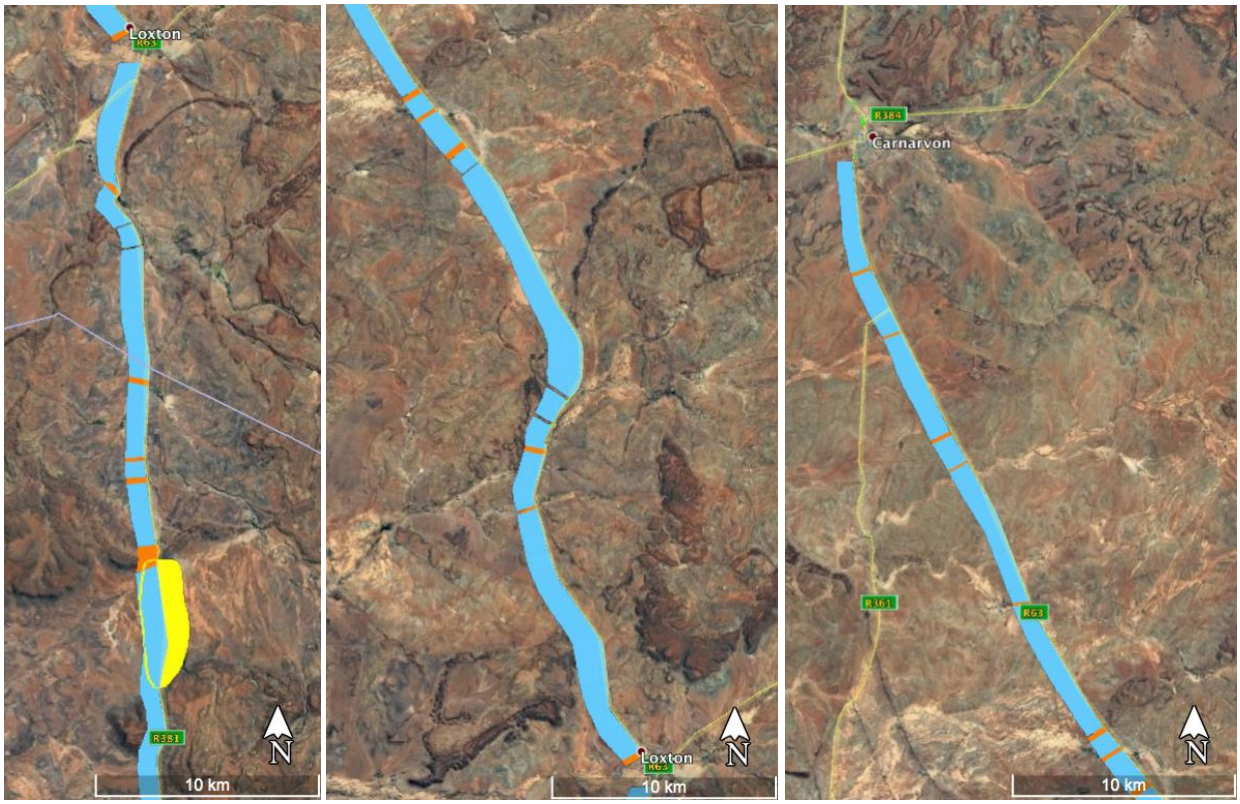


Figure 38: Sensitivity map of habitats along the route of the fibre-optic cable.

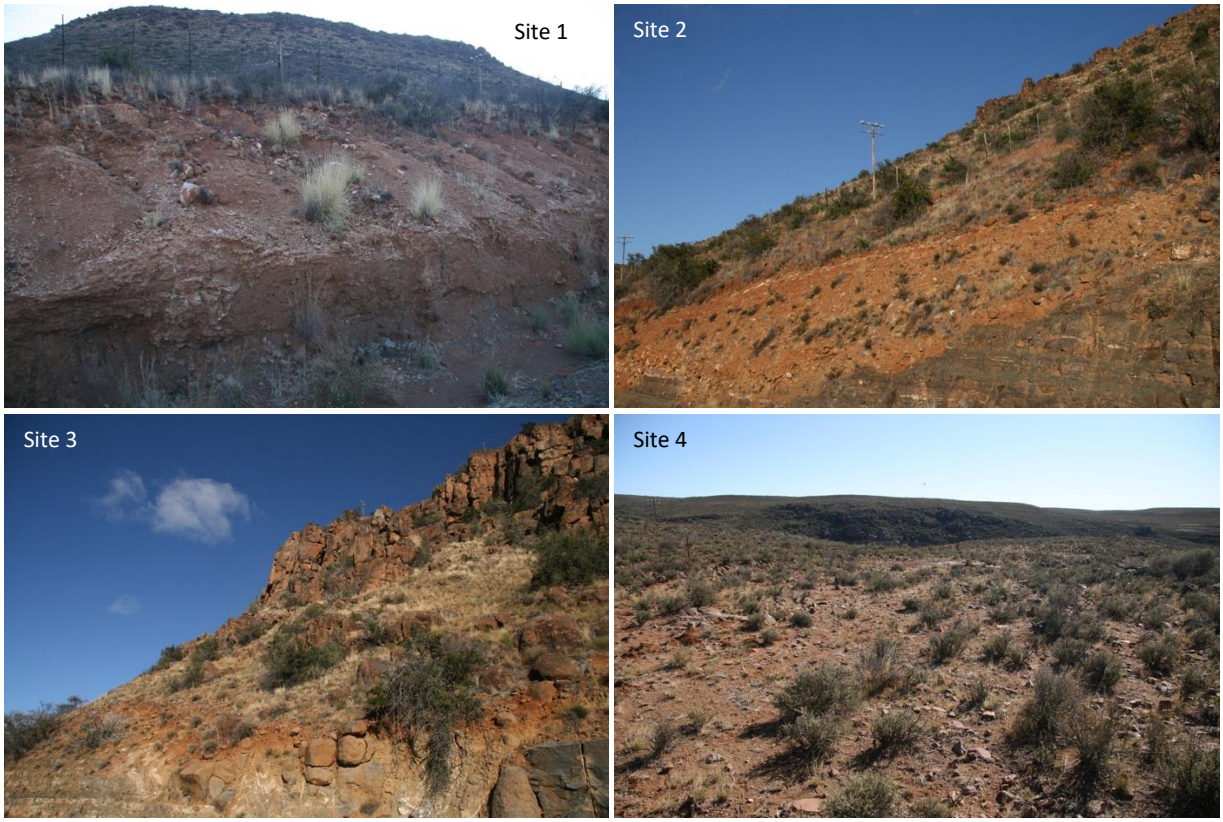


Figure 39: Instances on the overhead section of the cable where care should be taken when siting the exact location of posts. (a) Site 1; (b) Site 2; (c) Site 3; and (d) Site 4 (see text for GPS co-ordinates).

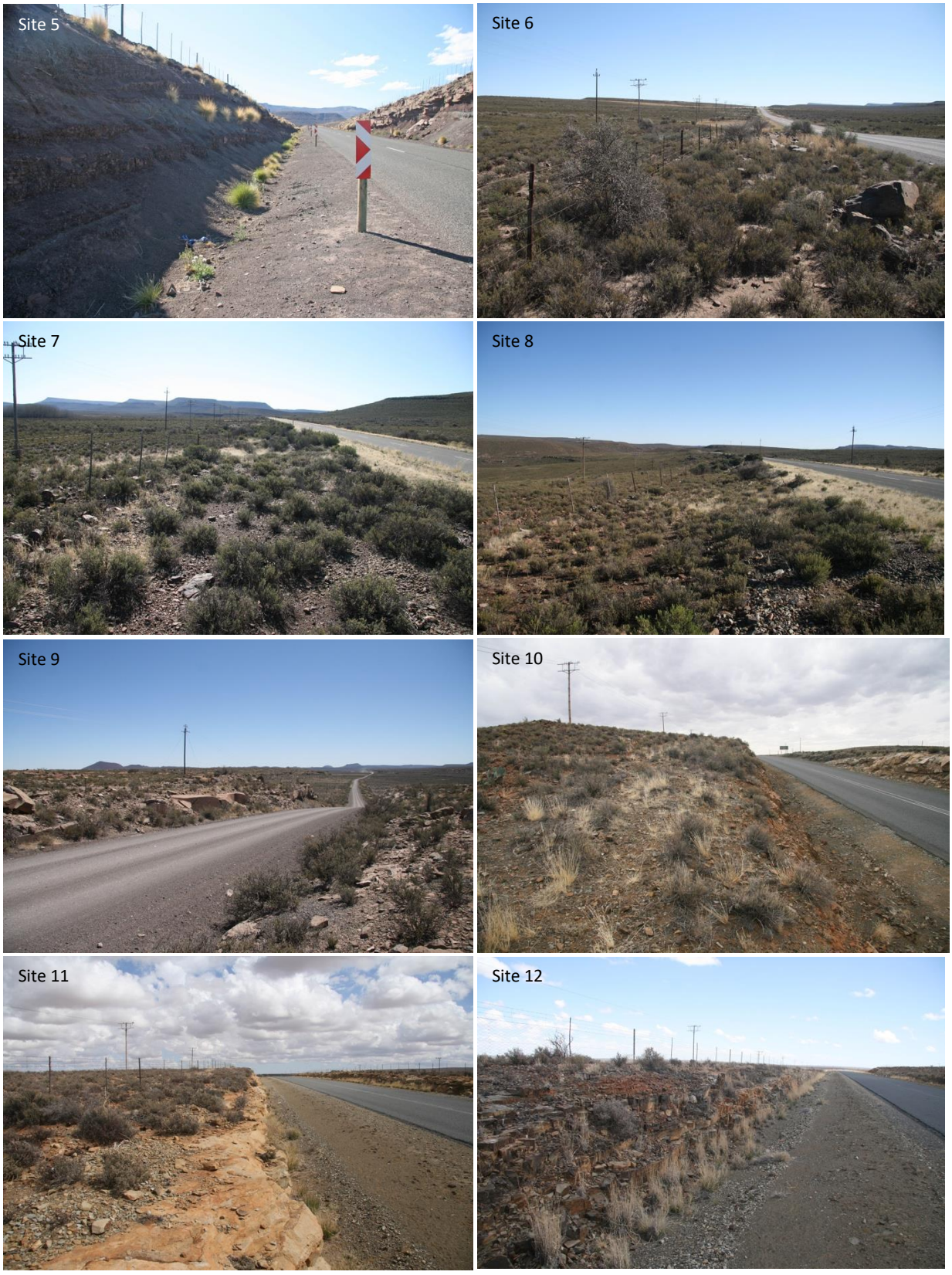


Figure 40: Instances on the underground section where trench location needs to be reconsidered. (a) Site 5; (b) Site 6; (c) Site 7; (d) Site 8 (e) Site 9; (f) Site 10; (g) Site 11; and (h) Site 12 (see text for GPS co-ordinates).

9.3.3 Some observed difficulties with trench placement

Most of the fibre-optic cable route is planned within the road reserve and 1 m from the fence of the private land. It was noticed that the fences along the road could be from 2 m up to > 100 m from the edge of the actual road. In some instances the fences going over the cutting was within 1 m of the edge of the cutting itself, leaving no space for the trench. The steep slopes and rockiness of the cuttings are also not suitable for trenching. From an ecological perspective it would be preferred that the trench follow the foot of the cutting next to the shoulder of the road to cause minimum damage to the habitat on top of the cutting. At some cuttings the fence was even placed directly on the edge to the steep edge.

At four specific areas conservation worthy protected species were noted on the top of the cuttings. GPS coordinates of the four road cuttings (where the trench should be directly next to the road) (Figure 41):

Site 13: 32° 09' 02.54" S; 22° 28' 28.68" E; 1583 m
Site 14: 32° 07' 25.51" S; 22° 26' 50.76" E; 1649 m
Site 15: 31° 20' 17.82" S; 22° 18' 13.62" E; 1391 m
Site 16: 31° 19' 41.41" S; 22° 18' 42.35" E; 1395 m

Locations of riverine rabbit habitat (Figure 38):

Between 32° 02' 27" S; 22° 27' 00" E & 31° 55' 14" S; 22° 24' 43" E
Between 31° 52' 53" S; 22° 23' 13" E & 31° 51' 07" S; 22° 21' 35" E
Between 31° 44' 00" S; 22° 21' 36" E & 31° 40' 53" S; 22° 21' 32" E

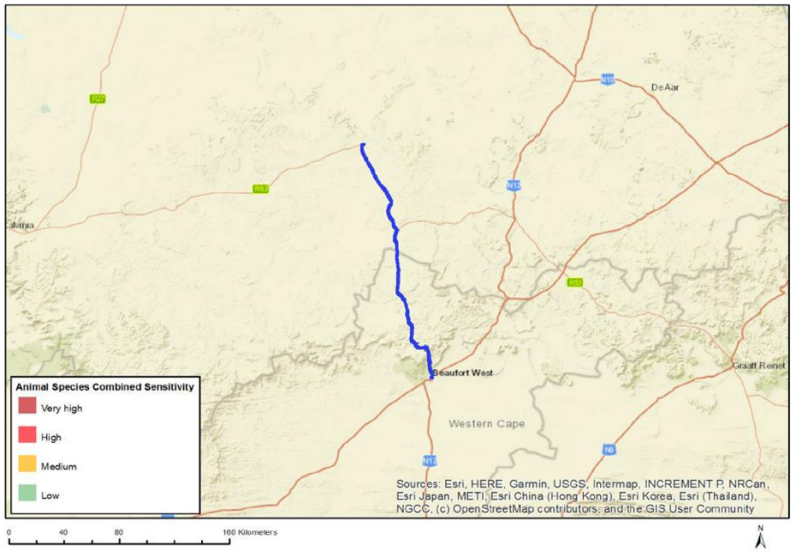
Figure 41: Instances on the underground section where trench where the trench cannot go over the cutting, but should be next to the road. (a) Site 13; (b) Site 14; (c) Site 15; and (d) Site 16 (see text for GPS co-ordinates).

9.4 Summary of screening tool results

The screening tool rated the sensitivity of the Animal Species Theme as **High** (Figure 42). The following animal species were highlighted:

Sensitivity	Feature(s)
High	Aves-*Aquila verreauxii*
High	Aves-*Circus maurus*
High	Mammalia-*Bunolagus monticularis*
High	Mammalia-*Redunca fulvorufula fulvorufula*
Medium	Mammalia-*Bunolagus monticularis*
Medium	Reptilia-*Chersobius boulengeri*

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



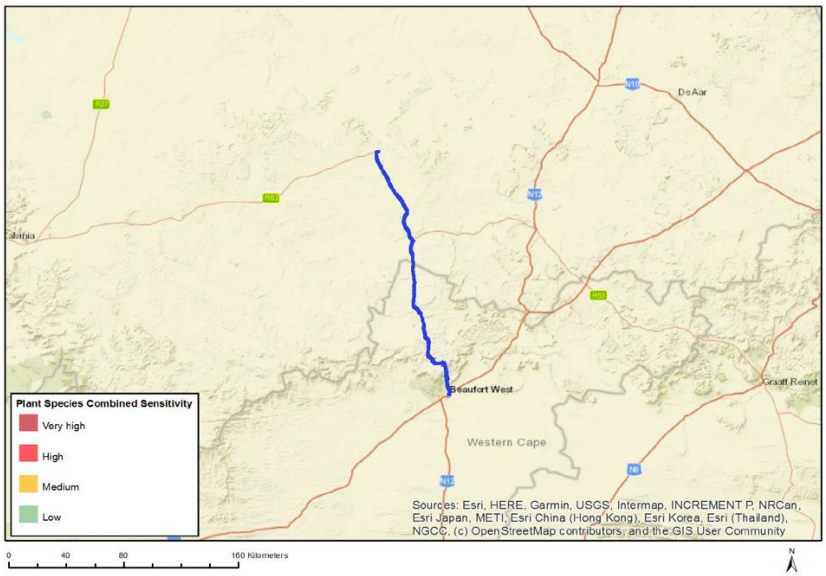
Very high sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	x		

Figure 42: Map and outcome of Animal Species Theme sensitivity generated by the screening tool. Unfortunately the mapping scale of the screening tool output does not allow colours of the categories to be visible.

The screening tool rated the sensitivity of the Plant Species Theme as **Medium** (Figure 43). The following plant species were highlighted:

Sensitivity	Feature(s)
Medium	*Cliffortia arborea*
Medium	Sensitive species 704

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY



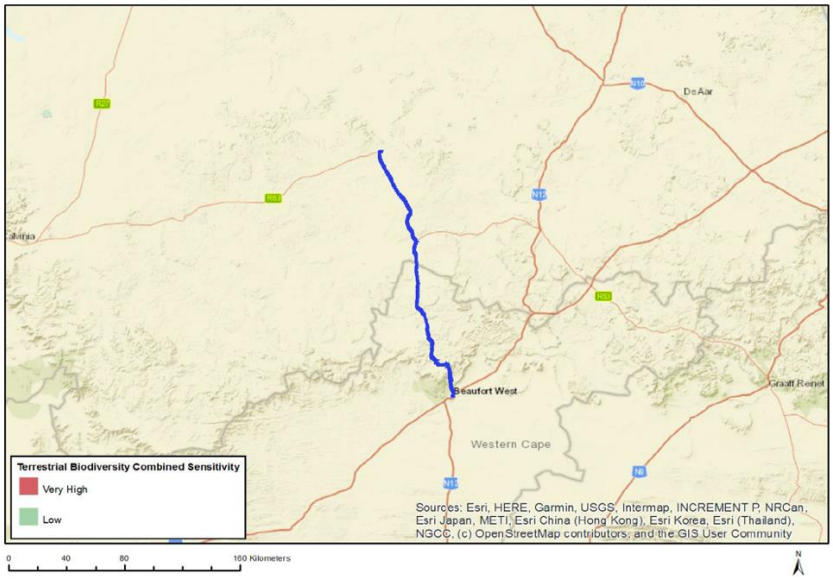
Very high sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		x	

Figure 43: Map and outcome of Plant Species Theme sensitivity generated by the screening tool. Unfortunately the mapping scale of the screening tool output does not allow colours of the categories to be visible.

The screening tool rated the sensitivity of the Relative Terrestrial Biodiversity theme as **Very High** (Figure 44). The following features were highlighted:

Sensitivity	Feature(s)
Very high	Ecological Support Area
Very high	Ecological Support Area 1
Very high	Ecological Support Area 2
Very high	Critical Biodiversity Area 1
Very high	Critical Biodiversity Area 2
Very high	Focus Areas for land-based protected areas expansion
Very high	Freshwater ecosystem priority area quinary catchments
Very high	Karoo National Park
Very high	Dr Appie van Heerden Nature Reserve

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY



Very high sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
x			

Figure 44: Map and outcome of Relative Terrestrial Biodiversity sensitivity generated by the screening tool. Unfortunately the mapping scale of the screening tool output does not allow colours of the categories to be visible.

9.5 Screening tool in relation to background study and site verification

9.5.1 Animal theme

Mammals: Our background study concurred with the presence of the riverine rabbit (Collins *et al.* 2016) and the mountain reedbuck (Taylor *et al.* 2016) in the region. The presence of the riverine rabbit was furthermore confirmed by one of the landowners (Mr Johan Moolman) of the farm Dunedin and the notice board of the Endangered Wildlife Trust at Slangfontein. The background study also listed the presence of the black-footed cat in the region. A brief description of the habitat preference and of the impact of the development on the riverine rabbit is provided in Chapter 7. It is believed that the mountain reedbuck was introduced in the Karoo National Park and is unlikely to be encountered free-roaming in the road reserve. This will also be the case for the other red listed species introduced in the region (see Appendix B).

Reptiles: Our background study confirmed the presence of the Karoo dwarf tortoise. See Chapter 11 for possible impact and mitigation measures.

Birds: The presence of two red listed bird species was singled out by the screening tool although our background study revealed the presence of 10 red listed species. Additionally, Ludwig's bustard was sighted during the site survey. See Chapter 11 for possible impact and for mitigation measures.

9.5.2 Plant theme

Our background study corresponded with the screening tool on the possible presence of *Cliffortia arborea* along the route, however sensitive species 704 was not listed for the region on the NewPosa database. Neither of these species was encountered during the site visit. *Cliffortia arborea* is a conspicuous species in the high mountains and would have been spotted easily if it had been present. Sensitive species 704, on the other hand, is a small, cryptic species,

preferring quartz patches. Along the fibre-optic cable route quartz patches were not noted and thus it can be assumed that the species is unlikely to occur along the route. Two other red listed species were listed on the NewPosa database for the region. However, these species seem to be beyond their known distribution range and could thus either be wrong identifications or specimens grown in collections. Based solely on the presence of red listed species which were not found along the route, we would suggest to downgrade the rating of the Plant Species Theme to low. However, many provincially protected/specially protected and CITES II listed species were recorded which could imply a medium rating.

9.5.3 Relative terrestrial biodiversity theme

This theme considers the presence of protected areas, NPAES, CBAs, ESAs and NFEPAs. Our background study concurred with the findings of the screening tool (see Chapter 8). Since the development will take place mostly in the road reserve it will have no impact on the Dr Appie van Heerden Nature Reserve or affect the NPAES. Installation of overhead fibre-optic cable proposed in the Karoo National Park must be done in consultation with SANParks and with correct approvals in terms of NEM:PA. The classification of the road reserve as CBA is questionable from a vegetation standpoint, although it might still be marginal riverine rabbit habitat. However, the presence of the riverine rabbit appeared not to be mentioned as a criterion in the CBA mapping of the Western Cape. Overall the impact of the route within the identified CBAs and ESAs is believed to be small. In the Western Cape NFEPA was considered in delineating CBAs, however in the Northern Cape a relatively long stretch between Loxton and Carnarvon was identified as a NFEPA that was not incorporated into the delineation of the CBAs.

See Appendix D for a complete discussion of the site verification.

10. IDENTIFICATION OF ENVIRONMENTAL IMPACTS

10.1 Introduction

In this section the issues, risks and impacts associated with the installation of the fibre-optic cable from a terrestrial ecology viewpoint is presented.

10.2 Key issues

The key botanical issue is the fact that the majority of the study area covers the fenced road reserve and therefore represents a habitat that is in essence transformed and continually disturbed. This habitat is seldom representative of the natural veld adjacent to the road reserve. Furthermore, water run-off from the road surface contributes to an unnatural species assemblage in most areas. Rare plant species usually occur in specialised and localised habitats, which are mostly destroyed by road building.

The key faunal issue is the known occurrence of the critically endangered riverine habitat (*Bunolagus monticularis)*. The area south of Loxton is regarded as prime riverine rabbit habitat, in particular around the Sak and Brak Rivers.

The proposed fibre-optic cable may negatively impact the fauna and flora of the site in various ways, albeit to a rather insignificant degree. The potential impacts for the different phases of the project, identified during the current assessment, are listed below. The significance of these impacts are assessed in Chapter 11.

10.3 Impacts during the construction phase

10.3.1 Direct impacts during the construction phase

- Potential impact 1: The clearing of natural vegetation and resultant loss of faunal habitat;
- Potential impact 2: The loss of threatened, protected and endemic plants/animals;
- Potential impact 3: Direct faunal mortalities due to construction, trench digging and increased traffic;
- Potential impact 4: Increased noise levels due to heavy machinery;
- Potential impact 5: Increased dust deposition.

10.3.2 Indirect impacts during the construction phase

- Potential impact 1: Establishment of alien vegetation as a result of the clearing of the vegetation;
- Potential impact 2: Increased water run-off and erosion.

10.4 Impacts during the operational phase

10.4.1 Direct impacts during the operational phase

- Potential impact 1: Direct faunal mortalities due to bird collisions with overhead cable and possibly increased traffic for cable maintenance.

10.4.2 Indirect impacts during the operational phase

- Potential impact 1: Establishment of alien vegetation will continue.

10.5 Impacts during the decommissioning phase

10.5.1 Direct impacts during the decommissioning phase

- Potential impact 1: Some clearing of natural vegetation due to removal of infrastructure.

10.5.2 Indirect impacts during the decommissioning phase

- Potential impact 1: Establishment of alien vegetation
- Potential impact 2: Possible ingestion or ensnarement of animals due to waste material lying around.

10.6 Cumulative impacts

- Cumulative impact 1: Vegetation loss and habitat destruction and concommittant loss of SCC and protected species
- Cumulative impact 2: Compromising integrity of CBA, ESA and NPAES
- Cumulative impact 3: Increased water run-off and erosion.

10.7 Summary of issues identified during the public participation process

Table 10: Comments Received from Stakeholders during the Public Consultation Phase

Comments received from CapeNature

Comment	Response
CapeNature would like to reiterate that all endangered species or protected species listed in Schedules 3 and 4 respectively, in terms of the Western Cape Nature Conservation Laws Amendment Act, 2000 (Act No. 3 of 2000) may not be picked or removed without the relevant permit, which must be obtained from CapeNature. This is also to ensure that rescued plant material is accounted for and used in the rehabilitation or relocation process.	Permits for the removal of protected plant species as listed in the Western Cape Nature Conservation Laws Amendment Act, 2000 (Act No. 3 of 2000) and Northern Cape Nature Conservation Act (Act No. 9 of 2009) will be sought as soon as EA i(s received (if granted).
Will translocation of the endemic plant species that was recorded be considered as part of the mitigation measure?	Only two species endemic to a national vegetation type were recorded during the site visit: *Stomatium suaveolens* is endemic to the Upper Karoo Hardeveld and *Stomatium villetii* to the Western Upper Karoo (Mucina& Rutherford 2006). According to the checklist drawn from the NewPosa database of the South African National Biodiversity Institute (SANBI), which covers an extensive area surrounding the SKA fibre optic route, a few more species endemic to the Upper Karoo Hardeveld could potentially be found along the route (see Appendix A). Within this vegetation type, cabling will however, for the most part, be overhead and the chances of finding endemic species on the spots where the poles will be planted, is likely to be small. *Stomatium villetii*, is listed as endemic to the Western Upper Karoo by Mucina & Rutherford (2006). It is a fairly widespread species, with its main centre of occurrence in the Roggeveld. Following SANBI's guidelines no translocation of the species endemic to a national vegetation type is proposed as part of the mitigation measures. SANBI's "Guidelines for Environmental Impact Assessments" (www.redlist.sanbi.org/eiaguidelines.php) state the following:

Comment	Response
	"*In situ conservation is vital and should be recommended **as the only option** for conserving species of conservation concern. Ex situ conservation, i.e. the removal of a subpopulation from its natural habitat to an artificial environment, a practice often termed 'search and rescue', will result in the erosion of the inherent genetic diversity and characteristics of that species and increase its extinction risk in the wild. Similarly, translocation of subpopulations is an unacceptable conservation measure."* *"Translocations are expensive and rarely successful. Even if they are successful, translocated individuals may harm other species within the receiving environment, the translocated individuals may transmit pathogens and/or parasites, and translocation may result in rapid changes in the species itself."* The implications of these guidelines are that translocation of red-listed species is not encouraged as a conservation measure since the translocated species may have undesirable ecological effects, such as: • Habitat alteration by translocated species may be harmful to other species. • Transmission of pathogens or parasites may occur. • Translocation may result in rapid changes in the species itself. • Translocations are expensive and rarely successful. • Success entails not only survival of the translocated individuals, but also establishment of a self-sustaining, viable population which is able to adapt to changing environmental conditions. • Relocation of rescued plants to undisturbed habitats alters the natural species composition of the receiving site.
CapeNature reminds the applicant that it is a legal requirement to remove alien species in terms of the Alien and Invasive Species Regulations, NEM:BA, 2014, specific alien plant species are either prohibited or listed as requiring a permit; aside from restricted activities concerning, *inter alia*, their spread, and should be removed. We strongly support the recommendation for an Alien Invasive Control Plan and this plan must be included in the Environmental Management Programme (EMPr). The following can be included in the plan: • delineate locations of invasive alien plants in relation to the construction areas and illustrate this on a map; • stipulate a timeframe and strategy for alien plant removal (which are potentially the best months of the year to destabilise and remove the alien plants, based on weather conditions/patterns); • list potential methods of clearing (i.e. herbicides or cutting); and • list suitable species that occur commonly (with pictures of these species) within the construction sites in an arid ecosystem. If at any stage during the construction phase any alien species are noted they should be eradicated using suitable methods. Confirmation of eradication of all such species must be recorded within the last monitoring report. The removal of invasive alien plant species must be continuous and should continue beyond the operational phase.	The EMPr contains an Alien Invasive Plant (AIP) management plan which recommends monitoring the disturbance footprint (i.e. where trenches were dug and backfilled) for the establishment of AIPs. See Section 4.8 of the EMPr. The AIP management plan further recommends that the "location of established alien invasive plants [be] recorded (geographic coordinates in Degrees, Minutes, Seconds / Decimal Degrees)". The Alien invasive plant management plan includes a list of NEM:BA(2020) listed alien invasive species known to occur in the region, as well as an indication of the species recorded during the site survey. The GPS locations of where AIPs were observed along the route has been included in Chapter 12 (Section 12.3) in the final report. Images of the most prominent AIP species have been included in the AIP management plan. It must be noted that the long-term and ongoing vegetation management of the road reserves lies with the relevant provincial roads and public works department. It is recommended that during installation of the underground cabling, trenched and backfilled areas (disturbance footprint) will periodically be monitored by the ECO, for AIPs and for up to 6 months after construction. Clearing of alien invasive plant species can be achieved by (Versveld *et al.* 1998, Van Rooyen 2005): • ***Mechanical and or/chemical control:*** Alien invaders can be controlled by mechanical and/or chemical means. Mechanical means include ringbarking (girdling), uprooting, chopping, slashing and felling. An axe or chain saw or brush cutter can be used. Stumps or ringbarked stems should be treated **immediately** with a chemical herbicide. (A large number of herbicides are registered for the control of AIPs (Van Zyl 2012).) Follow-up treatment might be needed and therefore sites where control was applied should be revisited within 3 to 6 months after the initial control operation and further control steps taken if necessary. • ***Biological control:*** Biological control is the most cost-effective and sustainable control method against heavy infestations of AIP species. Biological control involves the use of host-specific natural enemies of weeds or invaders from the plant's country of origin, to either kill or remove the invasive potential of these plants. It may only be initiated by and carried out under the supervision of an organisation that practises and researches biological control of weeds and invader plants. Effective bio-control agents cause the gradual thinning of dense stands of invading alien plants, thus allowing the natural vegetation to return as part of the natural process. The Plant Health and Protection Unit of the Agricultural Research Council should be contacted for assistance with biological control (https://www.arc.agric.za/arc-ppri/Pages/ARC-PPRI).

Comment	Response
	Prosopis glandulosa (honey mesquite) is the most important AIP species along the route. Infestations are generally most severe in drainage lines and it is often abundant around homesteads. The following guidelines for controlling *Prosopis* species are taken from Milton (2017). Although young trees (2 m tall) can be foliar sprayed, this is difficult and has limited success. The window for spraying is limited both on a daily and annual basis. Trees cannot be sprayed during the heat of the day and should only be treated late summer to autumn. The best method to control *Prosopis* trees is to use cut stump operations. Herbicides that may be used include: Triclopyr 480g EC with diesel; Triclopyr/clorpyralid (270/90) in water; Picloram/ Triclopyr 50 50 Gel; and Triclopyr 360 SL in water (Milton 2017). Triclopyr 480 EC is not a widely used option due to the cost of the diesel, but it is widely accepted as the product that is the most reliable. Follow-up treatments of felled trees will need to continue for at least 24 months. Coppice growth can be treated with one of the registered herbicides but Triclopyr/clorpyralid (270/90) is possibly the best. Use the herbicide according to the label and ensure thorough wetting of all leaves. Herbaceous species could either be sprayed with a herbicide during the growing season or if the density of the AIP is low, they could be manually or mechanically removed. It is important that staff (a) receive the appropriate training in the use of herbicides; (b) are equipped with the necessary personal protective equipment while using herbicides; and (c) the herbicide manufacturer's instructions are meticulously followed.
CapeNature recommend that camera trap monitoring be used for surveying Riverine Rabbit and their threats. To improve the understanding and population trends for this species along the proposed cable routes. We propose that the Endangered Wildlife Trust (EWT) be contacted to assist with the deployment of camera traps or obtaining data on the occurrence of Riverine Rabbit and have a specialist delineate suitable buffers.	Camera trapping of the riverine rabbit is generally used to establish the presence of the riverine rabbit. However, in the case of the fibre optic cable, the presence of these animals is a given in the area to the south of Loxton. Comments from EWT indicated that "the distribution of rabbits on the farms adjacent to the R381 is reasonably well documented, with historical sightings (physical and with camera traps). As such, we [EWT] do not feel that camera trapping the road reserve will add value to understanding Riverine Rabit distribution in the area. Riverine Rabbit occurrence on the farms along the R63 is less well documented, but few suitable riparian floodplain areas occur along this route, and we do not feel it is necessary to camera trap this route either. We agree that it is highly unlikely that burrows would occur in the road reserve given the disturbance factor of the traffic, but due diligence requires this be checked (active burrows are lined with fur and often the entrance is closed with fur as well)." Although the Riverine Rabbit may cross the road reserve when moving around the landscape, it is unlikely that they should make their burrows in the road reserve. Nevertheless, before trenches are dug in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench. Furthermore, construction of the trench in favoured Riverine Rabbit habitat should preferably not be conducted during the breeding season (August to May).
In the area, many of the mammals are crepuscular or nocturnal and thus difficult to observe directly. Measures must be in place for faunal species entering during construction and operational phases. Therefore, we recommend that mitigation measure for faunal habitat should also include the prevention of poaching. The applicant must consider placing tortoise proof fencing to prevent any road mortalities, unless suitable underpasses in which tortoises can walk through underneath the road will be build. Also, considering the impact of laying underground ducting on fossorial animals, with mitigation.	This project does not involve the construction of roads. It involves the installation of fibre optic cables, predominantly underground within the road reserves of existing roads. Suggested measures regarding placement of fences around or underneath existing roads are not relevant or reasonable to include as management actions for the proposed Fibre Optic Project. Measures have been included in the EMPr to prevent poaching, and to minimise impacts and rescue animals that potentially get stuck in open trenches between them being dug and backfilled.
There is no mention of a rehabilitation plan in the dBAR and CapeNature recommends that a rehabilitation plan be compiled for the duration of this project. Suitable indigenous vegetation must be used during the rehabilitation. We recommend a	A rehabilitation plan will be included in the Environmental Management Programme Report. Active rehabilitation is a costly exercise and it is questionable whether planting indigenous plants is justified in a road reserve that is continuously disturbed. Furthermore, under the harsh climatic conditions in the region active

Comment	Response
rehabilitation plan be compiled with inputs from a local Botanist to inform the plan with regards to the relevant local plant species for planting and stabilising during rehabilitation activities.	rehabilitation by means of planting indigenous species is probably not feasible (as also pointed out by EWT). On the overhead section no rehabilitation of the small patches disturbed for the planting of poles will be necessary. The soil in arid regions is generally replete with a store of seeds in the so-called seedbank (predominantly of annual species). Where the cable will be buried, the trenches should not be left open for long periods. Thus the seedbank should not unduly decay before the topsoil is returned during backfilling. Returning the topsoil over the fairly narrow trenches should be sufficient to kick-start the revegetation process. After backfilling the trenches, the area should be brush packed with the removed vegetation. Should the planting of indigenous species be essential in designated spots, some species that could be used in rehabilitation include: *Pentzia incana, Chrysocoma ciliata, Lycium cinereum, Fingerhuthia africana, Eriocephalus ericoides, Hermannia grandiflora, Felicia filifolia, Pteronia glauca, Sporobolus fimbriatus, Eragrostis obtusa, Eragrostis lehmanniana* and *Lessertia frutescens*. These species are all available at the Renu-Karoo nursery in Prince Albert, either as plants, plugs or seed.
There are a few quite extensive renewable developments planned in the general areas thus in section 8.4 the cumulative impacts of the proposed Nuweveld WEF must be included and not just the Gamka Karoo project.	The Nuweveld Development (14/12/16/3/3/2/2042; 2043; 2044; and 2366: Nuweveld Wind Farm (North; East; West, and Gridline)) has been included, but does not change the outcome of the cumulative impact assessment since the contribution of the fibre optic cable, predominantly installed in previously disturbed road reserve, to these impacts is relatively small to negligible, resulting in overall low to very low cumulative impact.
In conclusion, CapeNature reminds the applicant when assessing the impact of the proposed activity on CBA, the reasons behind CBA delineation should be investigated and critically assess whether these will be compromised by the proposed project. The loss of CBA and natural habitat should be avoided (Pool-Stanvliet *et al.* 2017). Although, the vegetation type is Least Threatened (LT), kindly note that any loss to natural habitat should be avoided. Recovery following rehabilitation in arid habitats can take more than a few decades, even from temporary disturbances, due to the on-going drought. Post construction monitoring of the impacts should be observed for more than one year.	Please note this issue was addressed in the report: CBAs are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species. The proposed construction of the fibre-optic cable will take place in the road reserve, a highly transformed habitat that is not representative of the adjacent land on which the CBA identification was based. Consequently, the classification of the road reserve as CBA1 or CBA2 cannot be upheld. • Additionally, the proposed SKA fibre-optic cable does not constitute any of the land uses considered to be undesirable in a CBA according to Pool-Stanvliet *et al*. (2017). • Since the development will primarily take place in the road reserve it will have little impact on existing protected areas and it will also not affect the NPAES. • Furthermore, the classification of the road reserve as CBA is questionable from a vegetation standpoint, although it might still be marginal Riverine Rabbit habitat. According to the definition of a CBA1, such areas should be "Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas". A road reserve does not comply with these conditions. The definition of a CBA2 refers to "Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses" and road reserves are not the best option to meet biodiversity targets.

11. ASSESSMENT OF SIGNIFICANCE OF ENVIRONMENTAL IMPACTS

11.1 Introduction and approach

The Square Kilometre Array (SKA) is hosted by South Africa and Australia and will extend to eight African countries and is one of the largest multinational scientific collaboration projects. The project will collect a vast volume of data daily which requires immense data connectivity needs, amongst others the connection between the SKA core site and the data processing facility in Cape Town. Meeting the advanced technological and engineering needs of the project will result in local skills development, enable science and technology research and generate employment opportunities. The 'no-go' option (i.e. the proposed fibre-optic cable is not installed) would thus undermine the goals of the SKA project.

The impacts of the proposed development on the terrestrial ecology were assessed based on the knowledge gained during the site visit and literature review. The methodology follows the guidelines provided by the CSIR as set out below (DEAT Guideline 5: Assessment of Alternatives and Impacts (DEAT 2006), the following methodology is applied to the prediction and assessment of impacts and risks):

Potential impacts and risks have been rated in terms of the direct, indirect and cumulative impacts:

- **Direct impacts:** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
- **Indirect impacts:** are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.
- **Cumulative impacts:** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

The impact assessment methodology includes the following aspects:

- **Nature of impact/risk** - The type of effect that a proposed activity will have on the environment.

- **Status** - Whether the impact/risk on the overall environment will be:
    - Positive - environment overall will benefit from the impact/risk;
    - Negative - environment overall will be adversely affected by the impact/risk; or
    - Neutral - environment overall will not be affected.

- **Spatial extent** – The size of the area that will be affected by the impact/risk:
    - Site specific;
    - Local (<10 km from site);
    - Regional (<100 km of site);
    - National; or
    - International (e.g. Greenhouse Gas emissions or migrant birds).

- **Duration** – The timeframe during which the impact/risk will be experienced:
    - Very short term - instantaneous;
    - Short term - less than 1 year;
    - Medium term - 1 to 10 years;
    - Long term - the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration); or
    - Permanent - mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e. the impact will occur beyond the project decommissioning).

- **Consequence** – The anticipated consequence of the risk/impact:
    - Extreme - extreme alteration of natural systems, patterns or processes, i.e. where environmental functions

and processes are altered such that they permanently cease;
- Severe - severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease;
- Substantial - substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease;
- Moderate - notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner; or
- Slight - negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected.

- **Reversibility of the Impacts** - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):
  - High reversibility - impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment;
  - Moderate reversibility of impacts;
  - Low reversibility of impacts; or
  - Impacts are non-reversible - impact is permanent, i.e. this is the least favourable assessment for the environment.

- **Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks** – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase):
  - High irreplaceability of resources - project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment;
  - Moderate irreplaceability of resources;
  - Low irreplaceability of resources; or
  - Resources are replaceable - the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment.

Using the criteria above, the impacts are further assessed in terms of the following:

- **Probability** – The probability of the impact/risk occurring:
  - Extremely unlikely (little to no chance of occurring);
  - Very unlikely (<30% chance of occurring);
  - Unlikely (30-50% chance of occurring)
  - Likely (51 – 90% chance of occurring); or
  - Very Likely (>90% chance of occurring regardless of prevention measures).

To determine the significance of the identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure 45).

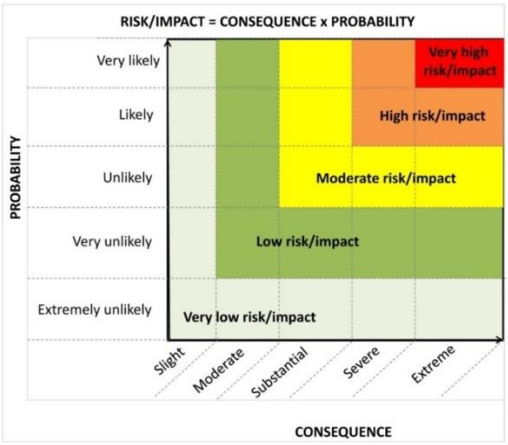


Figure 45: Guide to assessing risk/impact significance as a result of consequence and probability.

- **Significance** – Will the impact cause a notable alteration of the environment?
  - Very low - the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making;
  - Low - the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making;
  - Moderate - the risk/impact will result in moderate alteration of the environment and can be reduced or

avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated;
- High - the risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making; and
- Very high - the risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating).

With the implementation of mitigation measures, the residual impacts/risks are ranked as follows in terms of significance:
- Very low = 5;
- Low = 4;
- Moderate = 3;
- High = 2; and
- Very high = 1.

Confidence – The degree of confidence in predictions based on available information and specialist knowledge:
- Low;
- Medium; or
- High.

11.2 Impacts during the construction phase and their significance

11.2.1 Direct impacts during the construction phase

The clearing of vegetation

Nature: Natural vegetation will be cleared for the trench to bury the cable and for planting the overhead poles. The removal of indigenous vegetation may cause a loss of individuals of threatened, protected and endemic species and will also be accompanied by a loss of faunal habitat. Overall, this may lead to an impoverished biodiversity at those sites. Vegetation loss is generally also associated with increased water run-off and erosion (see indirect impacts).

Some destruction of the vegetation adjacent to the footprint will also inevitably occur due to the use of heavy machinery to dig the trench and holes for the overhead poles. Unnecessary clearing of vegetation beyond the footprint of the development can however, largely be avoided.

Proposed mitigation measures:
- Construction crew, in particular the drivers and operators of heavy machinery, should undergo environmental training (induction) to increase their awareness of environmental concerns.
- Vegetation clearance should be confined to the footprint of the development and unnecessary clearance should be avoided.
- The cliffs and rocky sheets should be avoided.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short to medium term	Short to medium term
Consequence (Severity)	Moderate	Moderate
Probability	Very likely	Likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Low**
Confidence level of assessment	High	High

The loss of threatened (Species of Conservation Concern – SCC), protected & endemic plants

Nature: The loss of the vegetation for trench digging and pole planting may cause a loss of individuals of SCC. The site visit did however not reveal the presence of any species with an **IUCN threatened status**. Many provincially protected plant species were present, most of them are quite common and some are even weedy. The rare protected species are often habitat specialists (e.g. found on rocky sheets) and in those cases the habitat should be avoided (see Chapter 9 for sites to avoid). Where protected species cannot be avoided, permits need to be obtained for the destruction of provincially protected or specially protected species. Only one species listed as endemic to a vegetation type was encountered.

Proposed mitigation measures:

- Construction crew, in particular the drivers and operators of heavy machinery, should undergo environmental training (induction) to make them aware of the importance of protected species.
- Placement of the trench or poles should be done in such a way as to minimise the impact on protected species (see sensitivity map). For example, micrositing of poles to avoid protected species; and at cuttings the trench should follow the bottom of the cutting and not over the top.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Long-term	Long-term
Consequence (Severity)	Moderate	Moderate
Probability	Likely	Likely
Reversibility	Low	Low
Irreplaceability	Moderate	Moderate
Significance	**Low**	**Low**
Confidence level of assessment	Medium	Medium

Direct faunal mortalities

Nature: Faunal mortalities may be caused by groundworks during construction activities, construction vehicles and waste material. In particular slow-moving species such as tortoises, might be prone to these mortalities. Animals could fall into the trench and be unable to get out unassisted. Fatalities might arise when animals ingest waste material or become ensnared in wires.

Proposed mitigation measures:

- Construction crew, in particular the drivers and operators of heavy machinery, should undergo environmental training (induction) to increase their awareness of environmental concerns. Although all road kills cannot be avoided, the increased awareness of drivers should be able to reduce the number of fatalities.
- Before trenches are dug in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench.
- Construction of the trench in favoured riverine rabbit habitat should preferably not be conducted during the breeding season (August to May).
- Trenches should not be left open for long periods of time. Trenches should also be inspected regularly for the presence of trapped animals and immediately before they are filled.
- Proper waste management procedures should be in place to avoid waste lying around and to remove all waste material from the site.
- Speed limits should be strictly adhered to.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence (Severity)	Moderate	Moderate
Probability	Likely	Unlikely
Reversibility	Low	Low
Irreplaceability	Moderate	Moderate
Significance	**Low**	**Low**
Confidence level of assessment	Medium	Medium

Increased dust deposition

Nature: The cable follows long stretches of gravel road between Beaufort West and Loxton and dust caused by vehicles may remain in the air for a long time. Increased dust deposition can harm physiological processes of plants and results in reduced photosynthetic capacity. The dust layer on the vegetation may also deter herbivores. The increased dust levels will be temporary.

Proposed mitigation measures:

- Excessive dust can be reduced by spraying water onto the soil to control dust generation.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence (Severity)	Slight	Slight
Probability	Likely	Likely
Reversibility	High	High
Irreplaceability	-	-
Significance	**Very low**	**Very low**
Confidence level of assessment	High	High

Increased human activity and noise levels

Nature: Construction activities will increase human presence and noise levels at the site. These activities may adversely affect animal behaviour.

Proposed mitigation measures:

- No construction should be done at night.
- Ensure all equipment is of good quality, good condition and maintained regularly;
- Ensure that all operators of construction equipment receive proper training in the use of the equipment and that the equipment is serviced regularly.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Very short-term	Very short-term
Consequence (Severity)	Slight	Slight
Probability	Likely	Likely
Reversibility	High	High
Irreplaceability	-	-
Significance	**Very low**	**Very low**
Confidence level of assessment	High	High

11.2.2 Indirect impacts during the construction phase

Establishment of alien vegetation

Nature: As a result of the clearance of indigenous vegetation and resulting degradation, alien species might invade the area. Alien invasive species are generally more common in road reserves than the adjacent undisturbed farm land. Nine declared invasive species were recorded en route. Increased vehicle traffic may further facilitate the introduction of seeds of alien species. Infestation by invasive alien species may cause changes to the structure and functioning of the ecosystem which often exacerbates the further loss of indigenous vegetation.

Proposed mitigation measures:

- Implement a monitoring program for the early detection of alien invasive plant species.
- Employ a control program to combat declared alien invasive plant species.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Local	Local
Duration	Long-term	Long-term
Consequence (Severity)	Moderate	Slight
Probability	Very likely	Likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Very low**
Confidence level of assessment	Medium	Medium

Increased erosion and water run-off

Nature: Increased water run-off and erosion may be caused by the clearing of the vegetation, especially against slopes and going over cuttings. It is improbable that the increased run-off and erosion will affect hydrological processes in the area and change water and silt discharge into the streams.

Proposed mitigation measures:

- Clearing of vegetation should be restricted to the footprint of the proposed development.
- Avoid going over cuttings, but rather place trench next to the road shoulder.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Local	Local
Duration	Medium-term	Medium-term
Consequence (Severity)	Moderate	Slight
Probability	Likely	Likely
Reversibility	Low	Low
Irreplaceability	Moderate	Moderate
Significance	**Low**	**Very low**
Confidence level of assessment	Medium	Medium

11.3 Impacts during the operational phase and their significance

11.3.1 Direct impacts during the operational phase

It is anticipated that human activities during the operational phase will be for maintenance purposes and only arise when faulty cables need to be replaced. These activities are done through the manholes and no further disturbance of the soil or vegetation is expected.

Direct faunal mortalities

Nature: Faunal mortalities may be caused by maintenance vehicles or other maintenance activities and waste material. In particular slow-moving species such as tortoises, might be prone to road mortalities. Fatalities might also arise when animals ingest waste material or become ensnared in wires. Bird collisions might occur with the overhead cable.

Proposed mitigation measures:

- Maintenance crew should undergo environmental training to increase their awareness of environmental concerns.
- All excess cables and waste material should be removed from the site.
- A monitoring programme by an avifaunal specialist should be initiated to determine the extent of bird collisions with the overhead cable. If recorded annual collision rates of Red Data species exceed the mortality threshold of the directly affected populations of those species as determined by an avifaunal specialist after consultation with other avifaunal specialists and BirdLife South Africa, bird flight diverters should be attached to the sections demarcated by the avifaunal specialist.
- Speed limits should be strictly adhered to.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short-term (possibly long-term)	Short-term
Consequence (Severity)	Moderate	Slight
Probability	Unlikely	Unlikely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Very low**
Confidence level of assessment	Medium	Medium

11.3.2 Indirect impacts during the operational phase

Establishment of alien vegetation

Nature: As a result of the loss of indigenous vegetation and resulting degradation, alien species might invade the area. Alien invasive species are generally more common in road reserves than the adjacent undisturbed farm land. The invasion by alien species will continue unless controlled. Increased vehicle traffic may further facilitate the introduction of seeds of alien species. Infestation by invasive alien species may cause changes to the structure and functioning of the ecosystem which often exacerbates the further loss of indigenous vegetation.

Proposed mitigation measures:

- Implement a monitoring program for the early detection of alien invasive plant species.
- Employ a control program to combat declared alien invasive plant species.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Local	Local
Duration	Long-term	Long-term
Consequence (Severity)	Moderate	Slight
Probability	Likely	Likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Very Low**
Confidence level of assessment	Medium	Medium

11.4 Impacts during the decommissioning phase and their significance

It has been assumed that the underground conduits will be left in place, but that the manholes, poles, overhead cables, and other aboveground structures will be removed during decommissioning. Consequently, few environmental impacts during this phase are anticipated.

11.4.1 Direct impacts during the decommissioning phase

The clearing of natural vegetation

Nature: Clearing of natural vegetation will be limited to the small sites where the infrastructure will be removed. Due to the small area that will be impacted it is unlikely that individuals of threatened, protected and endemic species will be lost or that any appreciable loss of faunal habitat will occur.

Proposed mitigation measures:

- Unnecessary clearance of natural vegetation should be avoided.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence (Severity)	Slight	Slight
Probability	Very likely	Very likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Very low**	**Very low**
Confidence level of assessment	Medium	Medium

Direct faunal mortalities

Nature: Faunal mortalities may be caused by vehicles or other decommissioning activities and waste. In particular slow-moving species such as tortoises, might be prone to road mortalities. Fatalities might also arise when animals ingest waste material or become ensnared in it.

Proposed mitigation measures:

- Decommissioning crew should undergo environmental training to increase their awareness of environmental concerns.
- Speed limits should be adhered to.
- Proper waste management procedures should be in place and no material should be left on site in order to prevent instances of ensnarement or ingestion of foreign material.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence (Severity)	Moderate	Slight
Probability	Likely	Unlikely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Very low**
Confidence level of assessment	Medium	Medium

11.4.2 Indirect impacts during the decommissioning phase

Establishment of alien vegetation

Nature: Invasion by alien invasive species is an ongoing process and will usually follow after any soil disturbance and loss of vegetation. Alien invasive species are generally more common in road reserves than the adjacent undisturbed farm land. Disturbance during the decommissioning phase is, however, believed to be minimal.

Proposed mitigation measures:

- Implement a monitoring program for the early detection of alien invasive plant species.
- Employ a control program to combat declared alien invasive plant species.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Local	Local
Duration	Long-term	Long-term
Consequence (Severity)	Slight	Slight
Probability	Likely	Likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Very low**	**Very low**
Confidence level of assessment	Medium	Medium

11.5 Cumulative impacts

The existing and proposed developments that were taken into consideration for cumulative impacts include:

- The existing road/s;
- Existing linear infrastructure adjacent to the road reserve on private land, such as powerlines and telephone lines (the latter no longer functional and will probably be removed);
- Existing powerline in Karoo National Park;
- Proposed renewable energy projects around Beaufort West
    - Beaufort West Photovoltaic Park;
    - Beaufort West Solar Power Plant sites 2 & 3;
    - Lombaardskraal Wind & Solar;
    - Beaufort West Wind Energy Project (Lapsed);
    - Steenrotsfontein Solar Energy Facility (Lapsed);
- Proposed housing development and expansion near Beaufort West;
- Loxton landfill;
- Uranium mining (southeast of Beaufort West);
- Proposed shale gas extraction (southwest of Loxton);
- Prospecting for unspecified mineral (west of road between Carnarvon & Loxton); and
- The Nuweveld Development (Nuweveld Wind Farm North; East; West, and Gridline).

The majority of these large developments (renewable energy, uranium mining) are close to Beaufort West, mainly to the south, southeast and northeast. These developments fall predominantly in the Gamka Karoo Vegetation Type with some sections in the Southern Karoo Riviere. Only about 4% of the route of the fibre-optic cable passes through the Gamka Karoo and this section is highly degraded due to its close proximity to Beaufort West.

Developments in the Eastern Upper Karoo include the proposed shale gas exploration, mining for an unspecific mineral and the powerline in the Karoo National Park. The powerline follows the R381 for part of its course and is thus in the same proximity as the proposed fibre-optic route. However, powerlines on the smaller roads generally do not occur in the road reserve. The projects with the greatest negative impact would be the proposed shale gas extraction as wellasthe Nuweveld WEFs, since they coincide with the habitat of the riverine rabbit.

Vegetation loss and habitat destruction due to developments

Nature: Vegetation loss and habitat destruction will occur. The habitat destruction will lead to changes in the physical features of the habitat, with concomitant changes in ecological processes. Secondary vegetation will develop at sites where the vegetation was cleared or the soil compacted. The species composition may change and alien species might

invade. Vegetation loss will also constitute the loss of animal habitat. Considering all the developments in the region, the most severe impact will be on the Gamka Karoo's fauna and flora. However, the contribution of the fibre optic cable to further transformation and degradation of habitat is negligible.

Proposed mitigation measures:

- All projects should adhere to the site-specific recommendations of the ecologists to ensure that impacts are mitigated where possible.

Significance considering contribution of fibre optic cable to developments in the Gamka Karoo without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Regional	Regional
Duration	Long-term	Long-term
Consequence (Severity)	Moderate (in Gamka Karoo)	Slight
Probability	Likely	Likely
Reversibility	Moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Very low**
Confidence level of assessment	Medium	Medium

Loss of Species of Conservation Concern (SCC)

Nature: The loss of vegetation in the Gamka Karoo might cause the loss of SCC. This would primarily be applicable to threatened and rare plant species that have a restricted distribution range. Although the fibre-optic cable will not contribute to the loss of SCC, the other projects might do so.

In the Eastern Upper Karoo the riverine rabbit populations could be affected.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Regional	Regional
Duration	Long-term	Long-term
Consequence (Severity)	Moderate (in Gamka Karoo)	Moderate (in Gamka Karoo)
Probability	Likely	Likely
Reversibility	Low to moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Low**
Confidence level of assessment	Medium	Medium

Compromising integrity of CBA, ESA and NPAES due to developments in the Gamka Karoo

Nature: According to the mapping of CBAs in the Western and Northern Cape, several of the proposed developments are located/partially located within CBAs. Development within CBAs is not encouraged as such development may result in biodiversity loss and therefore compromise the integrity of the CBA. Development is only permitted in a CBA on condition approval is granted by the relevant competent authority. The loss of the area might also have an effect on the future suitability of the terrain as protected area, although only a small portion next to the Karoo National Park is earmarked for the National Protected Area Expansion. Considering the large number of developments in the Gamka Karoo, the CBAs in this vegetation type could be compromised and consequently the

biodiversity target for the ecosystem could be affected. The contribution of the fibre optic cable to compromising the integrity of CBAs, ESAs and NPAES is however small.

Proposed mitigation measures:

- Avoid placing large infrastructure in CBAs.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Regional	Regional
Duration	Long-term	Long-term
Consequence (Severity)	Moderate (in Gamka Karoo)	Moderate (in Gamka Karoo)
Probability	Likely	Likely
Reversibility	Low to moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Low**
Confidence level of assessment	Medium	Medium

Increased erosion and water run-off due to all developments in the Gamka Karoo

Nature: Increased water run-off and erosion will alter hydrological processes and might affect catchments and downstream habitats especially since increased erosion and water run-off will occur on all mountain slopes in the area. This is primarily relevant in the Upper Karoo Hardeveld Vegetation Type and might affect conditions in the Gamka Karoo.

Proposed mitigation measures:

- Structures to control erosion should be implemented.

Significance without and with mitigation measures:

Parameter	Without mitigation	With mitigation
Status	Negative	Negative
Spatial extent	Regional	Regional
Duration	Long-term	Long-term
Consequence (Severity)	Moderate	Moderate
Probability	Likely	Likely
Reversibility	Low to moderate	Moderate
Irreplaceability	Low	Low
Significance	**Low**	**Low**
Confidence level of assessment	Medium	Medium

11.6 Impact assessment summary

Tables 11 – 14 summarise the impact assessment across all phases of the development and the integrated assessment post-mitigation per phase is provided in Table 15.

Table 11: Summary assessment of (a) direct and (b) indirect impacts and their mitigation measures during the construction phase

(a)

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE: DIRECT IMPACTS						
The clearing of vegetation	Status	Negative	Low	Vegetation clearance should be confined to the footprint of the development and unnecessary clearance should be avoided. The cliffs and rocky sheets should be avoided. Construction crew, in particular the drivers, should undergo environmental training to increase their awareness of environmental concerns.	Low - 4	High
	Spatial Extent	Site specific				
	Duration	Short to medium-term				
	Consequence	Moderate				
	Probability	Very likely				
	Reversibility	Moderate				
	Irreplaceability	Low				
The loss of threatened (SCC), protected & endemic plants	Status	Negative	Low	Construction crew, in particular the drivers, should undergo environmental training (induction) to make them aware of the importance of protected species. Placement of the trench or poles should be done in such a way as to minimise the impact on protected species (see sensitivity map). For example, micrositing of poles to avoid protected species; and at cuttings the trench should follow the bottom of the cutting and not over the top.	Low - 4	Medium
	Spatial Extent	Site specific				
	Duration	Long-term				
	Consequence	Moderate				
	Probability	Likely				
	Reversibility	Low				
	Irreplaceability	Moderate				
Direct faunal mortalities	Status	Negative	Low	Construction crew, in particular the drivers, should undergo environmental training to increase their awareness of environmental concerns. Before trenches are dug in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench. Construction of the trench in favoured riverine rabbit habitat should preferably not be conducted during the breeding season (August to May). Trenches should not be left open for long periods of time. Trenches should also be inspected for the presence of trapped animals before they are filled again. Proper waste management procedures should be in place to avoid waste lying around and to remove all waste material from the site. Speed limits should be strictly adhered to.	Low - 4	Medium
	Spatial Extent	Site specific				
	Duration	Short-term				
	Consequence	Moderate				
	Probability	Likely				
	Reversibility	Low				
	Irreplaceability	Moderate				
Increased dust deposition	Status	Negative	Very low	Excessive dust can be reduced by spraying water onto the soil to control dust generation.	Very low - 5	High
	Spatial Extent	Site specific				
	Duration	Short-term				
	Consequence	Slight				
	Probability	Likely				
	Reversibility	High				
	Irreplaceability	-				
Increased noise levels and human activity	Status	Negative	Very low	No construction should be done at night. Ensure all equipment is of good quality, good condition and maintained regularly. Ensure that all operators of construction equipment receive proper training in the use of the equipment and that the equipment is serviced regularly.	Very low - 5	High
	Spatial Extent	Site specific				
	Duration	Very short-term				
	Consequence	Slight				
	Probability	Likely				
	Reversibility	High				
	Irreplaceability	-				

(b)

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE: INDIRECT IMPACTS						
Establishment of alien vegetation	Status	Negative	Low	Implement a monitoring program for the early detection of alien invasive plant species. Employ a control program to combat declared alien invasive plant species.	Very low - 5	Medium
	Spatial Extent	Local				
	Duration	Long-term				
	Consequence	Moderate				
	Probability	Very likely				
	Reversibility	Moderate				
	Irreplaceability	Low				
Increased erosion and water run-off	Status	Negative	Low	Clearing of vegetation should be restricted to the footprint of the proposed development. Avoid going over cuttings, but rather place trench next the road shoulder.	Very low - 4	Medium
	Spatial Extent	Local				
	Duration	Medium-term				
	Consequence	Moderate				
	Probability	Likely				
	Reversibility	Low				
	Irreplaceability	Moderate				

Table 12: Summary assessment of (a) direct and (b) indirect impacts and their mitigation measures during the operational phase

(a)

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE: DIRECT IMPACTS						
Direct faunal mortalities	Status	Negative	Low	Maintenance crew should undergo environmental training to increase their awareness of environmental concerns. All excess cables and waste material should be removed from the site. A monitoring programme should be initiated to determine the extent of bird collisions with the overhead cable. Speed limits should be strictly adhered to.	Very low - 5	Medium
	Spatial Extent	Site specific				
	Duration	Short-term (possibly long-term, monitoring to be done)				
	Consequence	Moderate				
	Probability	Unlikely				
	Reversibility	Moderate				
	Irreplaceability	Low				

(b)

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE: INDIRECT IMPACTS						
Establishment of alien vegetation	Status	Negative	Low	Implement a monitoring program for the early detection of alien invasive plant species. Employ a control program to combat declared alien invasive plant species.	Very low - 5	Medium
	Spatial Extent	Local				
	Duration	Long-term				
	Consequence	Moderate				
	Probability	Likely				
	Reversibility	Moderate				
	Irreplaceability	Low				

Table 13: Summary assessment of (a) direct and (b) indirect impacts and their mitigation measures during the decommissioning phase

(a)

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
DECOMMISSIONING PHASE: DIRECT IMPACTS						
Clearing of natural vegetation	Status	Negative	Very low	Unnecessary clearance of natural vegetation should be avoided.	Very low - 5	Medium
	Spatial Extent	Site specific				
	Duration	Short-term				
	Consequence	Slight				
	Probability	Very likely				
	Reversibility	Moderate				

	Irreplaceability	Low				
Direct faunal mortalities	Status	Negative	Low	Decommissioning crew should undergo environmental training to increase their awareness of environmental concerns. Speed limits should be adhered to. Proper waste management procedures should be in place and no material should be left on site in order to prevent instances of ensnarement or ingestion of foreign material.	Very low - 5	Medium
	Spatial Extent	Site specific				
	Duration	Short-term				
	Consequence	Moderate				
	Probability	Likely				
	Reversibility	Moderate				
	Irreplaceability	Low				

(b)

Impact	***Impact Criteria***		***Significance and Ranking (Pre-Mitigation)***	***Potential mitigation measures***	***Significance and Ranking (Post-Mitigation)***	***Confidence Level***
DECOMMISSIONING PHASE: INDIRECT IMPACTS						
Establishment of alien vegetation	Status	Negative	Very low	Implement a monitoring program for the early detection of alien invasive plant species. Employ a control program to combat declared alien invasive plant species.	Very low -5	Medium
	Spatial Extent	Local				
	Duration	Long-term				
	Consequence	Slight				
	Probability	Likely				
	Reversibility	Moderate				
	Irreplaceability	Low				

Table 14: Summary assessment of cumulative impacts

Impact	***Impact Criteria***		***Significance and Ranking (Pre-Mitigation)***	***Potential mitigation measures***	***Significance and Ranking (Post-Mitigation)***	***Confidence Level***
CONSTRUCTION PHASE:						
Loss of vegetation, habitat and SCC: compromising CBAs; soil erosion	Status	Negative	Very low	All projects should adhere to the site-specific recommendations of the ecologists to ensure that impacts are mitigated where possible. Avoid placing large infrastructure in CBAs. Erosion control measures should be implemented at all times**.**	Very low	Medium
	Spatial Extent	Local				
	Duration	Short-term				
	Consequence	Slight				
	Probability	Likely				
	Reversibility	Moderate				
	Irreplaceability	Low				
OPERATIONAL PHASE (the fibre-optic cable will make no contribution to the cumulative impacts during the operational phase)						
Loss of vegetation, habitat and SCC: compromising CBAs; soil erosion	Status			Project activities are likely to be minimal during this phase and only monitoring of alien invasive species and possible bird collisions should be continued.		
	Spatial Extent					
	Duration					
	Consequence					
	Probability					
	Reversibility					
	Irreplaceability					
DECOMMISSIONING PHASE (the fibre-optic cable will make no contribution to the cumulative impacts during the decommissioning phase)						
Loss of vegetation, habitat and SCC: compromising CBAs; soil erosion	Status			Avoid unnecessary clearance of vegetation.		
	Spatial Extent					
	Duration					
	Consequence					
	Probability					
	Reversibility					
	Irreplaceability					

Table 15: Overall Impact Significance (Post Mitigation)

Phase	**Overall Impact Significance**
Construction	Very low to Low
Operational	Very low
Decommissioning	Very low
Nature of Impact	**Overall Impact Significance**
Cumulative - Construction	Very low
Cumulative - Operational	Very low
Cumulative - Decommissioning	Very low

12. LEGISLATIVE AND PERMIT REQUIREMENTS

The following legislation is relevant to the development and may require permits from the relevant authority.

12.1 National Forest Act (Act No. 84 of 1998)(NFA 2019)

The National Forest Act provides for the protection of forests, as well as for specific tree species. In the case where a protected tree would have to be destroyed by the fibre-optic cable an application for a license granted by the Minister (or a delegated authority) would have to be made. **However, no protected trees, according to the protected tree list (NFA 2019), were observed and it is unlikely that any such species occur within the development footprint.**

12.2 National Environmental Management: Biodiversity Act (Act No. 10 of 2004)(NEMBA 2007c)

NEMBA also deals with endangered, threatened and otherwise controlled species, under the ToPS Regulations (Threatened or Protected Species Regulations). A ToPS permit is required for any activities involving any ToPS listed species.

No threatened or protected **plant species** (ToPS) were recorded during the site survey on the SKA fibre-optic study site. None of the mammals or carnivores are expected to be negatively affected by the development, but avifaunal collisions need to be monitored. The following protected **faunal species** (ToPS) are listed for the region:

Mammals:

Black wildebeest	*Connochaetes gnou*	Protected
Black-footed cat	*Felis nigripes*	Protected
Bontebok	*Damaliscus pygargus pygargus*	VU
Brown hyena	*Parahyaena brunnea*	Protected
Cape fox	*Vulpes chama*	Protected
Cape mountain zebra	*Equus zebra zebra*	EN
Elephant	*Loxodonta africana*	Protected
Honey badger	*Mellivora capensis*	Protected
Lion	*Panthera leo*	VU
Riverine rabbit	*Bunolagus monticularis*	CR
Roan antelope	*Hippotragus equinus*	VU
South African hedgehog	*Atelerix frontalis*	Protected

Amphibians

Giant bull frog	*Pyxicephalus adspersus*	Protected

Avifauna:

Black stork	*Ciconia nigra*	VU
Blue crane	*Grus paradiseus*	EN
Kori bustard	*Ardeotis kori*	VU
Lesser kestrel	*Falco naumanni*	VU
Ludwig's bustard	*Neotis ludwigii*	VU (possible collisions should be monitored)
Martial eagle	*Polemaetus bellicosus*	VU
Peregrine falcon	*Falco peregrinus*	VU

12.3 Conservation of Agricultural Resources Act (Act No. 43 of 1983)

The Conservation of Agricultural Resources Act provides for the regulation of control over the utilisation of the natural agricultural resources in order to promote the conservation of soil, water and vegetation and provides for combating weeds and invader plant species.

Currently alien abundance at the site is relatively low, however, disturbance associated with the construction phase would encourage alien invasion and woody species, in particular species such as *Prosopis glandulosa* would need to be cleared on a regular basis. No permitting would be required for such activities, but an alien invasive species control programme should be initiated.

Alien species recorded on site during the site survey include:

Argemone ochroleuca	1b
Atriplex lindleyi subsp. *inflata*	1b
Atriplex nummularia	2
Salsola kali	1b
Cirsium vulgare	1b
Opuntia ficus-indica	1b
Pennisetum setaceum	1b
Prosopis glandulosa	1b in Western Cape; 3 in Northern Cape
Pinus spp.	1b, 2 or 3
Populus alba	2

Additionally the following invasive alien species are listed for the region:

Cuscuta campestris	1b
Cylindropuntia fulgida	1b
Cylindropuntia imbricata	1b
Opuntia microdasys	1b
Tephrocactus articulatus	1a
Prosopis velutina	1b WC; 3 NC

GPS co-ordinates of the locations where alien invasive species were noted during the site visit:

Site no.	Latitude	Longitude	AIS
1	-31.578482324257493	22.351330434903502	*Prosopis glandulosa; Argemone ochroleuca*
3	-31.564471889287233	22.351485919207335	*Argemone ochroleuca*
6	-31.535963024944067	22.339644050225616	*Opuntia ficus-indica; Pennisetum setaceum; Argemone ochroleuca; Salsola kali*
7	-31.529798470437527	22.338714078068733	*Pennisetum setaceum; Salsola kali*
12	-32.326291417703032	22.581098601222038	*Pennisetum setaceum; Argemone ochroleuca; Opuntia ficus-indica*
15	-31.442227112129331	22.329303799197078	*Opuntia ficus-indica*
18	-31.405140459537506	22.310112761333585	*Opuntia ficus-indica*
20	-31.383881606161594	22.300291182473302	*Salsola kali*
27	-31.328043714165688	22.311192601919174	*Rubus sp.; Populus alba*
28	-31.321605406701565	22.316665314137936	*Salsola kali*
44	-31.185463769361377	22.226817514747381	*Salsola kali*
49	-31.153812780976295	22.206662809476256	*Argemone ochroleuca*
75	-32.179806092754006	22.550603058189154	*Salsola kali*
76	-32.178136585280299	22.549478206783533	*Argemone ochroleuca*
79	-32.173398295417428	22.534499410539865	*Opuntia ficus-indica*
87	-32.14760810136795	22.470128322020173	*Argemone ochroleuca*
88	-32.13607938028872	22.454220810905099	*Argemone ochroleuca*
90	-32.123804669827223	22.447037436068058	*Populus sp.; Pinus sp.*
92	-32.083255453035235	22.451799027621746	*Atriplex lindleyi*
104	-32.296543037518859	22.566140927374363	*Prosopis glandulosa; Atriplex numularia*
108	-31.999783851206303	22.42759452201426	*Opuntia ficus-indica*
109	-31.998780285939574	22.426715176552534	*Opuntia ficus-indica*

110	-31.997171882539988	22.426555082201958	*Salsola kali*
111	-31.988672968000174	22.423765501007438	*Salsola kali; Argemone ochroleuca*
113	-31.971963979303837	22.418998209759593	*Salsola kali*
114	-31.95942590944469	22.422596560791135	*Eucalyptus camaldulensis*
117	-31.945296116173267	22.419033832848072	*Atriplex numularia; Argemone ochroleuca*
123	-31.88387168571353	22.389871096238494	*Salsola kali*
125	-31.872699614614248	22.383178481832147	*Salsola kali*
126	-32.270740773528814	22.562952451407909	*Salsola kali; Argemone ochroleuca*
127	-31.8685766402632	22.379885483533144	*Salsola kali*
129	-31.850922675803304	22.358646830543876	*Salsola kali; Argemone ochroleuca*
130	-31.847537895664573	22.357084024697542	*Salsola kali; Argemone ochroleuca*
131	-31.843777690082788	22.355074547231197	*Salsola kali*
132	-31.839389428496361	22.354265861213207	*Salsola kali*
135	-31.814453350380063	22.356553785502911	*Salsola kali*
136	-31.797465244308114	22.359079588204622	*Salsola kali*
137	-32.264775792136788	22.564690858125687	*Salsola kali*
138	-31.796350451186299	22.359021753072739	*Salsola kali*
140	-31.77139182575047	22.35888303257525	*Salsola kali*
141	-31.751633668318391	22.362595042213798	*Salsola kali*
142	-31.745016658678651	22.361387880519032	*Salsola kali*
145	-31.694365069270134	22.359150247648358	*Salsola kali; Opuntia ficus-indica*
147	-31.681243116036057	22.358097396790981	*Salsola kali*
149	-31.656922856345773	22.354144910350442	*Salsola kali*
152	-31.64197607897222	22.352251438423991	*Salsola kali*
155	-31.619573347270489	22.353494390845299	*Argemone ochroleuca*
156	-31.608846355229616	22.354171397164464	*Salsola kali*

12.4 Northern Cape Nature Conservation Act (Act No. 9 of 2009) (NCNCA 2009)

12.4.1 Flora (see Appendix A):

Under this Act, lists of provincially protected and endangered fauna and flora are provided. Some activities are restricted when dealing with protected species:

- According to Section 49. (1): No person may, without a permit - pick[1], import, export, transport, possess, cultivate or trade in a specimen of a specially protected plant.
- Section 50. (1): No person may, without a permit - pick, import, export, transport, cultivate or trade in a specimen of a protected plant.

Additionally:

- Section 51. (1): No person may, without a permit , pick an indigenous plant - **on a public road; on land next to a public road within a distance of 100 m; or within an area bordering a natural water course up to a distance of 100 m on either side of the natural water course.**

Five Schedule 1 Specially Protected Species and 90 Protected Species were observed on site - all with a Least Concern status.

In the NCNCA (2009) (and to a lesser extent WCNECO (2000)), a number of families and genera, for example the family Aizoaceae, (formerly Mesembryanthemaceae), Crassulaceae, Iridaceae and Oxalidaceae and genera such as *Lessertia, Nemesia, Manulea* and *Oxalis* are listed as either Specially Protected Species or Protected Species. This blanket classification may be because of the presence of one or two species of vulnerable or higher status in the genus. Unfortunately, this then includes many species that are either common, or even weedy, e.g. *Galenia*

[1] The definition of "pick" includes to collect, to cut, to chop off, to take, to gather, to pluck, to uproot, to break, to damage or to destroy

spp., ***Drosanthemum hispidum, Mesembryanthemum* spp.**, ***Ruschia intricata, Euphorbia inaequilatera* or *Moraea miniata* that do not need to be awarded special conservation status.**

Of particular relevance to the site are protected species within the following genera and families:

Schedule 1: Specially Protected Flora

- Family GERANIACEAE — all *Pelargonium* spp.
- Genus *Lessertia* — all species.

Schedule 2: Protected Flora

- Aizoaceae (Mesembryanthemaceae) — all species
- Amaryllidaceae — all species except those listed in Schedule 1
- Apiaceae — all species except those listed in Schedule 1
- Apocynaceae — all species except those listed in Schedule 1
- Asphodelaceae — all species except those listed in Schedule 1 & *Aloe ferox*
- Crassulaceae — all species except those listed in Schedule 1
- Euphorbiaceae — *Euphorbia* spp. - all species
- Iridaceae — all species except those listed in Schedule 1
- Anacampserotaceae (Portulacaceae) — *Anacampseros* spp.
- Scrophulariaceae — *Jamesbrittenia Manulea*, *Nemesia* - all species

In the case of the fibre-optic cable, permits may not be needed only for the protected species, since all plants, regardless of their protected status, that will be cleared for the fibre-optic cable fall within 100 m of the public road. **This would imply that a permit would be needed for all plants or alternatively for the number of hectares to be cleared of vegetation.**

12.4.2 Fauna permit requirements

The NCDENC is the regulatory authority in the Northern Cape for the issuing of permits for fauna, flora, hunting and CITES. Under the Act, the majority of mammals, reptiles and amphibians are listed as protected species (see Appendix B). No permits are required for animal species since none should be harmed by the development.

12.5. Western Cape Nature and Environmental Conservation Ordinance (No. 19 of 1974) as amended in the Western Cape Nature Conservation Laws Amendment Act (No. 3 of 2000)

12.5.1 Flora (see Appendix A):

Fifty-eight Schedule 4 Protected Species were observed on site - all with Least Concern status.

A permit is required if any of the following activities are involved:
Section 63. (1) No person shall:

a) uproot the plant in the process of picking the flower of any flora; _
b) without a permit—
   i. pick any endangered or protected flora, or
   ii. pick any flora on a public road or **on the land on either side of such road within a distance of ninety metres from the centre of such road**, or
c) pick any protected or indigenous unprotected flora on land of which he or she is not the owner, without the permission of the owner of such land or of any person authorised by such owner to grant such permission.

Schedule 3: Endangered flora

No Schedule 3 plant species were recorded on site.

Schedule 4: Protected flora

A number of plant genera and families are listed in their entirety as protected and of particular relevance to the site are species within the following genera and families:

- Amaryllidaceae — all species
- Apocynaceae — all species (except those specified in Schedule 3)
- Iridaceae — all species
- Asphodelaceae (Liliaceae) — all species of *Aloe* except those in Schedule 3 and *Aloe ferox*.
- Aizoaceae (Mesembryanthemaceae) — all species

Permit requirements for the Western Cape would basically be the same as for the Northern Cape (see Section 12.4 above), since in both cases no plants in the road reserve may not be destroyed.

12.5.2 Fauna permit requirements

CapeNature is the regulatory authority in the Western Cape for the issuing of permits for fauna, flora, hunting and CITES. Under the Act, the majority of mammals, reptiles and amphibians are listed as protected species (see Appendix B). However, no permits are required for animal species since none should be harmed by the development.

12.6 CITES (Convention on the International Trade in Endangered Species of Wild Fauna and Flora)

South Africa is a signatory to CITES and as such must comply with the import, export and re-export procedure as stipulated by CITES. CapeNature and NCDENC are the CITES Management and Scientific Authority for exports out of and imports into the respective provinces from or to other countries. The following species occurring in the study area are CITES listed. However, no permits are required for animal species since none should be harmed by the development. The following are CITES listed species:

Plant species:

Anacampseros	all species
Aloe	all species (thus would include current genera such as *Aristaloe* and *Gonialoe)*
Euphorbia	all succulent species

Animal species:

Bontebok	*Damaliscus pygargus pygargus*	CITES App II
Black-footed Cat	Felis nigripes	CITES App I
Lion	*Panthera leo*	CITES App II

13. ENVIRONMENTAL MANAGEMENT PROGRAMME INPUT

Impact	Mitigation / Management Objectives	Mitigation / Management actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
• **IMPACTS ON TERRESTRIAL ECOLOGY**					
• **DESIGN PHASE**					
Potential impact on terrestrial ecology as a result of the proposed fibre-optic cable.	Avoid or minimise impacts on terrestrial ecology on site regarding the placement of the infrastructure. Avoiding cliffs and rocky sheets will reduce the chances of protected species loss.	Ensure that the placing of infrastructure takes the sensitivity mapping of the ecological assessment into account to avoid and reduce impacts on Species and Habitats of Conservation Concern.	Ensure that this is taken into consideration during the planning and design phase.	During design cycle and before construction commences.	Project Developer and Appointed Ecological Specialist.
B. CONSTRUCTION PHASE					
Clearance of vegetation	Confine vegetation clearance to footprint and minimise disturbance of adjacent areas.	Demarcate all infrastructure sites and delineate routing clearly to avoid unnecessary clearance of the vegetation. Permits have to be obtained for the removal of plants within the road reserve and/or NCNCA and WCNECO protected species. Appoint a suitably qualified ecologist to advise on micro-siting of trenches and poles during construction.	Ensure that mitigation measures are enforced.	Daily, during active construction	The Environmental Control Officer (ECO) should monitor and report any incidents to the Holder of the EA. Ecologist to advise on micro-siting.
Impact on animal species	Avoid or minimise impacts that could potentially affect animal behaviour.	Construction crew, in particular the drivers, should undergo environmental training (induction) to increase their awareness of environmental concerns. Before trenches are dug in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench. Construction of the trench in favoured riverine rabbit habitat should preferably not be conducted during the breeding season (August to May). Trenches should not be left open for long periods of time. Trenches should also be inspected for the presence of trapped animals immediately before they are filled. Proper waste management procedures should be in place.	Ensure compliance with these mitigation measures.	Daily, during active construction	The ECO should monitor and report to the Holder of the EA. Ecologist to advise on micro-siting.

Impact	Mitigation / Management Objectives	Mitigation / Management actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
		Avoid waste lying around and remove waste material from site. Speed limits should be strictly adhered to. Appoint a suitably qualified ecologist to advise on micro-siting of trenches and poles during construction.			
Increased dust levels	Avoid or minimise increased dust levels.	Dust control measures should be implemented.	Ensure that dust control measures are in place.	Daily, as required	The ECO should monitor and report to the Holder of the EA.
Alien species invasion	Avoid invasion by alien species.	Implement a monitoring program for the early detection of alien invasive plant species. A control program to combat declared alien invasive plant species should be employed.	Ensure implementation of a control programme to combat alien invasive plants.	Every three months	The ECO should monitor and report to the Holder of the EA.
Clearance of vegetation and digging trenches	Rehabilitating trenches	Active rehabilitation is costly and it is questionable whether planting indigenous plants is justified in a road reserve that is continuously disturbed. Furthermore, under the harsh climatic conditions in the region active rehabilitation by means of planting indigenous species is probably not feasible (also pointed out by EWT). On the overhead section no rehabilitation of the small patches disturbed for the planting of poles will be necessary. The soil in arid regions is generally replete with a store of seeds in the so-called seedbank. Where the cable will be buried, trenches should not be left open for long periods. Thus the seedbank should not unduly decay before the topsoil is returned during backfilling. Returning the topsoil over the fairly narrow trenches should be sufficient to kick-start the revegetation process. After backfilling, the area should be brush packed with the removed vegetation. Should the planting of indigenous species be essential in designated spots, a list of species is provided in Section 10.7.	Ensure backfilling of trenches; covering with topsoil; and brush packing.	After laying cable	The ECO should monitor and report to the Holder of the EA.
C. OPERATIONAL PHASE					
Impact on animal species	Avoid or minimise impacts that could potentially affect animal behaviour.	Implement a monitoring programme to determine the extent of bird collisions with the overhead cable.	Ensure compliance with these mitigation measures.	Every six months	The ECO should monitor and report to the Holder of the EA.

Impact	Mitigation / Management Objectives	Mitigation / Management actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
		Proper waste management procedures should be put in place.			
Alien species invasion	Avoid invasion by alien species.	Implement a monitoring program for the early detection of alien invasive plant species and a control program to combat declared alien invasive plant species should be employed.	Ensure implementation of a control programme to combat alien invasive plants.	Every three months	The ECO should monitor and report to the Holder of the EA.
C. DECOMMISSIONING PHASE					
Clearance of vegetation	Minimise disturbance and clearance of vegetation.	Unnecessary clearance of natural vegetation should be avoided.	Ensure that mitigation measures are enforced.	Every three months	The ECO should monitor and report to the Holder of the EA.
Impact on animal behaviour	Avoid or minimise impacts that could potentially affect animal behaviour.	Proper waste management procedures should be put in place.	Ensure compliance with these mitigation measures.	Every three months	The ECO should monitor and report to the Holder of the EA.
Alien species invasion	Avoid invasion by alien species.	Implement a monitoring program for the early detection of alien invasive plant species and a control program to combat declared alien invasive plant species should be employed.	Ensure implementation of a control programme to combat alien invasive plants.	Every three months	The ECO should monitor and report to the Holder of the EA.

14. FINAL SPECIALIST STATEMENT AND AUTHORISATION RECOMMENDATION

The very low impact significance and low sensitivity rating for many of the habitats means the project could go ahead without major constraints, provided the mitigation measures and management actions proposed to protect rare fauna and flora on the site are taken into consideration. **We thus recommend EA may be granted for the proposed project, provided all mitigation measures are implemented.**

A brief summary of the most important considerations is provided below:

Vegetation and flora:

- **Road reserve vegetation:** The key botanical issue is the fact that the majority of the study area covers the fenced road reserve and therefore represents a habitat that is in essence transformed and continually disturbed. This habitat is seldom representative of the natural veld adjacent to the road reserve. Furthermore, water run-off from the road surface contributes to an unnatural species assemblage in most areas and often favours alien invasive species. Rare plant species usually occur in specialised and localised habitats, which are mostly destroyed by road building. The overhead cabling sections may be installed outside of the road reserve, in adjacent land, but here the physical impact footprint of the poles is small and can be micro-sited so as to avoid disturbance to or destruction of important and / or sensitive species.
- **Vegetation types:** All six vegetation types on site are listed as "least threatened".
- **Threatened plant species:** No red list threatened plant species were encountered during the field survey.
- **Habitats:** None of the habitats had a high sensitivity.
- **Overall sensitivity of plant theme:** Rated as low (on the basis of red list plants) to medium (based on the presence of provincially protected plants).

Fauna:

- **Threatened animal species:** The key faunal issue is the known occurrence of the Critically Endangered riverine habitat (*Bunolagus monticularis)*. The area south of Loxton is regarded as prime riverine rabbit habitat, in particular around the Sak and Brak Rivers. The mountain reedbuck and Karoo dwarf tortoise and additionally, a number of threatened bird species also occur in the region.
- **Overall sensitivity of animal theme:** This is rated as high. However, if the suggested mitigation measures are followed the threatened animal species should not be negatively affected.

Conservation:

- **Protected Areas:** In order to traverse the topographically and geologically difficult terrain of the Molteno Pass at the eastern side of the Karoo National Park, it is proposed the fibre-optic cabling (overhead) be installed in the Park in a corridor where Eskom and Telkom infrastructure has historically been established and currently still exists. To this end, Section 50(5) approval in terms of the NEM:PAA must be obtained.
- **National Protected Areas Expansion Strategy (NPAES):** The route of the fibre-optic cable does traverse areas earmarked by NPAES for future expansion of the Karoo National Park, but will not interfere with the protected areas expansion strategy, since it is confined along existing roads that will not be closed.
- **Critical Biodiversity Areas (CBAs):** The proposed construction of the fibre-optic cable will take place in the road reserve, a highly transformed habitat that is not representative of the adjacent land on which the CBA identification was based. Consequently, the classification of the road reserve as CBA1 is untenable.
- The proposed SKA fibre-optic cable does not constitute any of the land uses considered to be undesirable in a CBA according to Pool-Stanvliet *et al*. (2017).
- **Ecological Support Areas (ESAs):** Ecological processes that operate within or across ESAs will not be altered by the cable project. The extent of the development is small and will not have a negative impact on the

functionality of the broader ESA. Thus no additional loss of ecological connectivity in relation to the broader landscape is likely.

Ecological processes, function and drivers:

- Overall, it is unlikely that the fibre-optic cable will contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions.
- Road reserves often act as conduits for alien invasive species and the disturbance caused by the construction of the cable, especially where trenching will take place, will inevitably create conditions favourable for invasion by alien species.

Significance of environmental impacts:

Overall the significance of the environmental impacts was rated as low to very low. In summary:

- Cable installation will probably have a temporary impact on the composition and structure of vegetation. Since the vegetation in the road reserve contains a large proportion of pioneer plant species is will be able to recolonise the disturbed cable trench within a relatively short period of time.
- Since the development footprint is small, the loss of habitat or species will be limited.
- The extent of clearing activities in the different vegetation types is small in relation to the remaining extent of the vegetation types and ecosystem threat status will not be affected.
- None of the habitats identified were rated as sensitive, and the overall impact per habitat type will be small.
- The impact on overall species and ecosystem diversity of the adjacent land will not be affected and even within the road reserve, the impact will be small.
- Due to the small area that will be disturbed along the route, the impact on populations of protected species will be negligible.
- Roads are permanent infrastructure and are fenced. The fibre-optic cable will predominantly be installed in the road reserve, but will not contribute additional obstruction to animal movement.

Key environmental mitigation and management actions proposed

- Appoint a suitably qualified ecologist to advise on micro-siting trench routing and pole placement during construction.
- Ensure that the placing of infrastructure takes the sensitivity mapping of the ecological assessment into account to avoid and reduce impacts on species and habitats of conservation concern.
- Demarcate all infrastructure sites and delineate the routing clearly to avoid unnecessary clearance of the vegetation.
- Avoid or minimise impacts that could potentially affect animal behaviour, in particular that of the riverine rabbit.
- Before trenches are dug in those areas that have been indicated as prime habitat for the riverine rabbit, the route should be walked on foot to ensure that no burrows are present in the path of the trench.
- Construction of the trench in favoured riverine rabbit habitat should preferably not be conducted during the breeding season (August to May).
- Trenches should not be left open for long periods of time. Trenches should also be inspected for the presence of trapped animals immediately before they are filled.
- Construction crew, in particular the drivers, should undergo environmental training (induction) to increase their awareness of environmental concerns.
- Proper waste management procedures should be in place to avoid waste lying around and to remove all waste material from the site.
- Speed limits should be strictly adhered to.
- Dust control measures should be implemented.

- Permits have to be obtained for the removal of plants within the road reserve and/or NCNCA and WCNECO protected species.
- Implement a monitoring program for the early detection of alien invasive plant species. Employ a control program to combat declared alien invasive plant species.

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APPENDIX A

PLANT SPECIES CHECKLISTS

[1]IUCN category
[2]Western Cape Nature and Environmental Conservation Ordinance (WCNECO)
[3]Northern Cape Nature Conservation Act (NCCA)
[4] Newposa list (SANBI)
[5] Plants observed during September/October 2020 site visit

Family	Species	IUCN[1]	WCNECO[2] SCH 4	NCNCA[3] SCH 1	NCNCA[3] SCH 2	CITES	ToPS	ENDEMIC	Invasive	Alien/ aturalised	NEWPOSA[4]	CURRENT[5]
Acanthaceae	*Barleria stimulans*	LC									x	
Acanthaceae	*Blepharis capensis*	LC									x	x
Acanthaceae	*Blepharis mitrata*	LC									x	x
Acanthaceae	*Justicia incana*	LC									x	x
Acanthaceae	*Justicia orchioides* subsp. *glabrata*	LC									x	
Acanthaceae	*Justicia spartioides*	LC									x	x
Acanthaceae	*Monechma* sp.	-										x
Achariaceae	*Guthriea capensis*	LC									x	
Achariaceae	*Kiggelaria africana*	LC									x	x
Aizoaceae	*Aizoon rigidum*	LC	x		x						x	x
Aizoaceae	*Aloinopsis rosulata*	LC	x		x						x	
Aizoaceae	*Antimima* sp.		x		x						x	
Aizoaceae	*Cephalophyllum* sp.		x		x							x
Aizoaceae	*Chasmatophyllum stanleyi*	LC	x		x			X			x	
Aizoaceae	*Delosperma aberdeenense*	LC	x		x						x	
Aizoaceae	*Delosperma lootsbergense*	LC	x		x						x	
Aizoaceae	*Delosperma* sp.		x		x							x
Aizoaceae	*Drosanthemum calycinum*	LC	x		x						x	
Aizoaceae	*Drosanthemum hispidum*	LC	x		x						x	x
Aizoaceae	*Drosanthemum karrooense*	LC	x		x							x
Aizoaceae	*Drosanthemum lique*	LC	x		x						x	x
Aizoaceae	*Drosanthemum parvifolium*	LC	x		x						x	
Aizoaceae	*Drosanthemum vespertinum*	LC	x		x						x	
Aizoaceae	*Galenia* cf. *papulosa*	-	x		x							x
Aizoaceae	*Galenia fruticosa*	LC	x		x						x	
Aizoaceae	*Galenia glandulifera*	LC	x		x						x	
Aizoaceae	*Galenia meziana*	LC	x		x							x
Aizoaceae	*Galenia namaensis*	LC	x		x						x	x
Aizoaceae	*Hereroa concava*	LC	x		x						x	cf.
Aizoaceae	*Malephora crocea*	LC	x		x						x	
Aizoaceae	*Malephora thunbergii*	LC	x		x						x	
Aizoaceae	*Mesembryanthemaceae* sp. 1		x		x							x
Aizoaceae	*Mesembryanthemum articulatum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum coriarium*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum crystallinum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum emarcidum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum excavatum*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum geniculiflorum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum granulicaule*	LC	x		x						x	cf.
Aizoaceae	*Mesembryanthemum grossum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum guerichianum*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum inachabense*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum noctiflorum* subsp. *noctiflorum*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum noctiflorum* subsp. *stramineum*	LC	x		x						x	x
Aizoaceae	*Mesembryanthemum oubergense*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum stenandrum*	LC	x		x						x	
Aizoaceae	*Mesembryanthemum tetragonum*	LC	x		x						x	x

Aizoaceae	*Plinthus karooicus*	LC	x	x				x		
Aizoaceae	*Ruschia altigena*	LC	x	x				x		
Aizoaceae	*Ruschia cradockensis subsp. triticiformis*	LC	x	x				x	x	
Aizoaceae	*Ruschia hamata*	LC	x	x				x		
Aizoaceae	*Ruschia indurata*	LC	x	x				x		
Aizoaceae	*Ruschia intricata*	LC	x	x				x	x	
Aizoaceae	*Ruschia pauciflora*	LC	x	x				x		
Aizoaceae	*Ruschia* sp. 1		x	x					x	
Aizoaceae	*Ruschia* sp. 2		x	x					x	
Aizoaceae	*Ruschia spinosa*	LC	x	x				x	x	
Aizoaceae	*Schlechteranthus spinescens*	LC	x	x				x	cf.	
Aizoaceae	*Stomatium difforme*	LC	x	x				x	x	
Aizoaceae	*Stomatium suaveolens*	LC	x	x		x		x	x	
Aizoaceae	*Stomatium villetii*	LC	x	x		x		x	x	
Aizoaceae	*Tetragonia acanthocarpa*	LC	x	x					x	
Aizoaceae	*Tetragonia arbuscula*	LC	x	x				x		
Aizoaceae	*Tetragonia robusta*	LC	x	x				x		
Aizoaceae	*Tetragonia spicata*	LC	x	x				x	x	
Aizoaceae	*Tetragonia* sp. 1	-	x	x					x	
Aizoaceae	*Tetragonia* sp. 2	-	x	x					x	
Aizoaceae	*Trichodiadema attonsum*	LC	x	x				x		
Aizoaceae	*Trichodiadema barbatum*	LC	x	x				x		
Aizoaceae	*Trichodiadema densum*	LC	x	x				x		
Aizoaceae	*Trichodiadema intonsum*	LC	x	x				x		
Aizoaceae	*Trichodiadema pomeridianum*	LC	x	x				x		
Aizoaceae	*Trichodiadema setuliferum*	LC	x	x					x	
Alliaceae	*Tulbaghia leucantha*	LC						x		
Amaranthaceae	*Amaranthus* sp.	-							x	
Amaranthaceae	*Atriplex lindleyi subsp. inflata*	NE					1b	x	x	x
Amaranthaceae	*Atriplex nummularia sunsp. nummularia*	NE					2	x	x	x
Amaranthaceae	*Atriplex semibaccata*	LC						x	x	x
Amaranthaceae	*Atriplex vestita*	LC								x
Amaranthaceae	*Bassia salsoloides*	LC								x
Amaranthaceae	*Chenopodium schraderianum*	NE						x	x	
Amaranthaceae	*Salsola aphylla*	LC							x	
Amaranthaceae	*Salsola atrata*	LC							x	
Amaranthaceae	*Salsola dealata*	LC							x	
Amaranthaceae	*Salsola kali*	NE					1b	x	x	x
Amaranthaceae	*Salsola minutifolia*	LC							x	
Amaranthaceae	*Salsola rabieana*	LC							x	
Amaranthaceae	*Salsola seminuda*	LC							x	
Amaranthaceae	*Salsola spp.*	-								x
Amaranthaceae	*Salsola tuberculata*	LC							x	
Amaranthaceae	*Sericocoma avolans*	LC							x	x
Amaranthaceae	*Suaeda fruticosa*	LC								x
Amaryllidaceae	*Ammocharis coranica*	LC	x	x						x
Amaryllidaceae	*Boophone disticha*	LC	x	x						x
Amaryllidaceae	*Gethyllis longistyla*	LC	x	x		X			x	
Amaryllidaceae	*Gethyllis transkarooica*	LC	x	x					x	cf.
Amaryllidaceae	*Haemanthus humilis* subsp. *humilis*	LC	x	x					x	
Anacampserotaceae	*Anacampseros albidiflora*	LC	x	x	x					x
Anacampserotaceae	*Anacampseros filamentosa* subsp. *filamentosa*	LC	x	x	x				x	
Anacampserotaceae	*Anacampseros lanceolata* subsp. *lanceolata*	LC	x	x	x				x	cf
Anacampserotaceae	*Anacampseros ustulata*	LC	x	x	x				x	x
Anacardiaceae	*Searsia burchellii*	LC							x	x
Anacardiaceae	*Searsia lancea*	LC							x	x
Anacardiaceae	*Searsia pallens*	LC							x	
Anacardiaceae	*Searsia undulata*	LC							x	
Apiaceae	*Annesorhiza filicaulis*	EN							x	
Apiaceae	*Berula thunbergii*	LC			x				x	
Apiaceae	*Bupleurum mundii*	LC			x				x	
Apiaceae	*Chamarea longipedicellata*	LC			x				x	
Apiaceae	*Conium chaerophylloides*	LC			x				x	
Apiaceae	*Deverra denudata* subsp. *aphylla*	LC			x				x	x
Apiaceae	*Heteromorpha arborescens*	LC			x				x	x
Apiaceae	*Notobubon ferulaceum*	LC			x				x	
Apiaceae	*Notobubon laevigatum*	LC			x				x	
Apiaceae	*Torilis arvensis*	NE						x	x	
Apocynaceae	*Asclepias monticola*	LC	x	x					x	
Apocynaceae	*Brachystelma circinatum*	LC	x	x					x	
Apocynaceae	*Carissa bispinosa*	LC	x	x					x	x
Apocynaceae	*Carissa haematocarpa*	LC	x	x						x

Apocynaceae	*Ceropegia filiformis*	LC	x	x			x		
Apocynaceae	*Ceropegia stapeliiformis* subsp. *stapeliiformis*	LC	x	x			x		
Apocynaceae	*Duvalia angustiloba*	LC	x	x			x		
Apocynaceae	*Duvalia maculata*	LC	x	x			x		
Apocynaceae	*Gomphocarpus filiformis*	LC	x	x			x		
Apocynaceae	*Gomphocarpus fruticosus* subsp. *fruticosus*	LC	x	x			x	x	
Apocynaceae	*Gomphocarpus tomentosus* subsp. *tomentosus*	LC	x	x			x	x	
Apocynaceae	*Hoodia flava*	LC	x	x			x		
Apocynaceae	*Huernia barbata* subsp. *barbata*	LC	x	x			x	x	
Apocynaceae	*Huernia humilis*	LC	x	x			x		
Apocynaceae	*Microloma armatum*	LC	x	x			x		
Apocynaceae	*Pachypodium succulentum*	LC	x	x	x		x	x	
Apocynaceae	*Piaranthus comptus*	LC	x	x		X	x		
Apocynaceae	*Piaranthus geminatus* subsp. *geminatus*	LC	x	x			x		
Apocynaceae	*Schizoglossum aschersonianum* var. *longipes*	LC	x	x			x		
Apocynaceae	*Schizoglossum bidens* subsp. *atrorubens*	LC	x	x			x		
Apocynaceae	*Schizoglossum bidens* subsp. *bidens*	LC	x	x			x		
Apocynaceae	*Stapelia grandiflora*	LC	x	x			x	x	
Apocynaceae	*Tridentea jucunda*	LC	x	x			x		
Apocynaceae	*Xysmalobium gomphocarpoides* var. *gomphocarpoides*	LC	x	x			x		
Apocynaceae	*Xysmalobium gomphocarpoides* var. *parvilobum*	LC	x	x			x		
Araliaceae	*Cussonia paniculata*	LC		x			x	x	
Asparagaceae	*Asparagus aethiopicus*	LC					x		
Asparagaceae	*Asparagus asparagoides*	LC						x	
Asparagaceae	*Asparagus burchellii*	LC					x		
Asparagaceae	*Asparagus capensis* var. *capensis*	LC					x	x	
Asparagaceae	*Asparagus concinnus*	LC					x		
Asparagaceae	*Asparagus exuvialis*	LC						x	
Asparagaceae	*Asparagus laricinus*	LC					x	x	
Asparagaceae	*Asparagus mucronatus*	LC					x		
Asparagaceae	*Asparagus retrofractus*	LC					x	x	
Asparagaceae	*Asparagus sp.*	-						x	
Asparagaceae	*Asparagus striatus*	LC					x	x	
Asparagaceae	*Asparagus suaveolens*	LC					x	x	
Asphodelaceae	*Aloe affinis*	LC	x	x	x		x		
Asphodelaceae	*Aloe broomii*	LC	x	x	x			x	
Asphodelaceae	*Aloe claviflora*	LC	x	x	x		x	x	
Asphodelaceae	*Aristaloe aristata*	LC	x	x	x		x	x	
Asphodelaceae	*Astroloba foliolosa*	LC		x			x	x	
Asphodelaceae	*Bulbine abyssinica*	LC		x			x	x	
Asphodelaceae	*Bulbine frutescens*	LC		x			x		
Asphodelaceae	*Bulbine narcissifolia*	LC		x			x		
Asphodelaceae	*Bulbine triebneri*	LC		x			x		
Asphodelaceae	*Gasteria disticha* var. *disticha*	LC		x			x		
Asphodelaceae	*Gonialoe variegata*	LC	x	x	x		x	x	
Asphodelaceae	*Haworthia marumiana* var. *marumiana*	LC	x	x			x		
Asphodelaceae	*Haworthia semiviva*	LC	x	x			x		
Asphodelaceae	*Haworthiopsis nigra* var. *diversifolia*	-		x			x		
Asphodelaceae	*Haworthiopsis nigra* var. *nigra*	-		x			x		
Asphodelaceae	*Haworthiopsis tessellata* var. *tessellata*	LC		x			x		
Asphodelaceae	*Kniphofia uvaria*	LC	x	x			x		
Asphodelaceae	*Trachyandra acocksii*	LC		x			x		
Asphodelaceae	*Trachyandra jacquiniana*	LC					x		
Aspleniaceae	*Asplenium cordatum*	LC					x		
Aspleniaceae	*Asplenium trichomanes* subsp. *quadrivalens*	LC					x		
Asteraceae	*Amellus tridactylus* subsp. *olivaceus*	LC					x	x	
Asteraceae	*Amphiglossa* sp.	-						x	
Asteraceae	*Amphiglossa triflora*	LC						x	
Asteraceae	*Arctotheca calendula*	LC						x	
Asteraceae	*Arctotis arctotoides*	LC					x		
Asteraceae	*Arctotis dimorphocarpa*	LC					x		
Asteraceae	*Arctotis leiocarpa*	LC					x	x	
Asteraceae	*Arctotis microcephala*	LC					x		
Asteraceae	*Arctotis perfoliata*	LC					x		
Asteraceae	*Arctotis subacaulis*	LC					x		
Asteraceae	*Artemisia afra*	LC						x	
Asteraceae	*Athanasia linifolia*	LC					x		
Asteraceae	*Athanasia microcephala*	LC					x		
Asteraceae	*Berkheya carlinifolia*	LC					x	x	
Asteraceae	*Berkheya glabrata*	LC					x		
Asteraceae	*Berkheya pinnatifida* subsp. *pinnatifida*	LC					x		

Asteraceae	*Berkheya spinosa*	LC				x	x
Asteraceae	*Caputia tomentosa*	LC				x	
Asteraceae	*Chrysocoma ciliata*	LC				x	x
Asteraceae	*Chrysocoma obtusata*	LC				x	
Asteraceae	*Chrysocoma sp.*	-					x
Asteraceae	*Cineraria aspera*	LC				x	
Asteraceae	*Cineraria mollis*	LC				x	
Asteraceae	*Cineraria vagans*	EN				x	
Asteraceae	*Cirsium vulgare*	NE		1b	x	x	
Asteraceae	*Conyza scabrida*	-				x	cf.
Asteraceae	*Cotula microglossa*	LC				x	cf.
Asteraceae	*Cotula sororia*	LC				x	
Asteraceae	*Cotula* sp. 1						x
Asteraceae	*Curio acaulis*	LC				x	
Asteraceae	*Curio articulatus*	LC				x	
Asteraceae	*Curio radicans*	LC				x	x
Asteraceae	*Cuspidia cernua subsp. annua*	LC				x	
Asteraceae	*Dicerothamnus rhinocerotis*	LC				x	x
Asteraceae	*Dicoma capensis*	LC					x
Asteraceae	*Dicoma picta*	LC				x	
Asteraceae	*Dimorphotheca cuneata*	LC				x	x
Asteraceae	*Dimorphotheca pinnata* var. *pinnata*	LC				x	
Asteraceae	*Dimorphotheca polyptera*	LC				x	
Asteraceae	*Eriocephalus africanus* var. *paniculatus*	LC				x	
Asteraceae	*Eriocephalus brevifolius*	LC				x	x
Asteraceae	*Eriocephalus decussata*	LC					x
Asteraceae	*Eriocephalus ericoides* subsp. *ericoides*	LC				x	x
Asteraceae	*Eriocephalus eximius*	LC				x	
Asteraceae	*Eriocephalus glandulosus*	LC				x	
Asteraceae	*Eriocephalus microcephalus*	LC				x	
Asteraceae	*Eriocephalus spinescens*	LC				x	x
Asteraceae	*Eriocephalus tenuifolius*	LC				x	
Asteraceae	*Eumorphia corymbosa*	LC				x	
Asteraceae	*Euryops abrotanifolius*	LC				x	x
Asteraceae	*Euryops anthemoides* subsp. *anthemoides*	LC				x	
Asteraceae	*Euryops cuneatus*	LC				x	
Asteraceae	*Euryops empetrifolius*	LC				x	
Asteraceae	*Euryops imbricatus*	LC				x	x
Asteraceae	*Euryops lateriflorus*	LC				x	x
Asteraceae	*Euryops oligoglossus* subsp. *oligoglossus*	LC				x	x
Asteraceae	*Euryops oligoglossus* subsp. *racemosus*	LC				x	
Asteraceae	*Euryops subcarnosus* subsp. *vulgaris*	LC				x	
Asteraceae	*Euryops trifidus*	LC				x	x
Asteraceae	*Euryops* sp.	-					x
Asteraceae	*Felicia fascicularis*	LC				x	
Asteraceae	*Felicia filifolia* subsp. *bodkinii*	LC				x	
Asteraceae	*Felicia filifolia* subsp. *filifolia*	LC				x	x
Asteraceae	*Felicia hirsuta*	LC				x	x
Asteraceae	*Felicia muricata* subsp. *muricata*	LC				x	x
Asteraceae	*Felicia namaquana*	LC				x	
Asteraceae	*Felicia ovata*	LC				x	
Asteraceae	*Garuleum bipinnatum*	LC				x	x
Asteraceae	*Gazania ciliaris*	LC				x	
Asteraceae	*Gazania heterochaeta*	LC				x	
Asteraceae	*Gazania krebsiana*	LC					x
Asteraceae	*Gazania krebsiana* subsp. *arctotoides*	LC				x	
Asteraceae	*Gazania krebsiana* subsp. *serrulata*	LC				x	
Asteraceae	*Gazania lichtensteinii*	LC				x	x
Asteraceae	*Gazania rigida*	LC				x	x
Asteraceae	*Gazania tenuifolia*	LC					x
Asteraceae	*Geigeria filifolia*	LC				x	x
Asteraceae	*Geigeria ornativa* subsp. *ornativa*	LC				x	x
Asteraceae	*Gerbera piloselloides*	LC				x	
Asteraceae	*Gnaphalium capense*	LC				x	
Asteraceae	*Gorteria alienata*	LC				x	
Asteraceae	*Helichrysum asperum* var. *appressifolium*	LC				x	cf
Asteraceae	*Helichrysum caespititium*	LC				x	
Asteraceae	*Helichrysum dregeanum*	LC				x	
Asteraceae	*Helichrysum hamulosum*	LC				x	
Asteraceae	*Helichrysum herniarioides*	LC				x	
Asteraceae	*Helichrysum lineare*	LC				x	
Asteraceae	*Helichrysum lucilioides*	LC				x	x

Asteraceae	*Helichrysum pentzioides*	LC				x
Asteraceae	*Helichrysum pumilio* subsp. *pumilio*	LC			x	x
Asteraceae	*Helichrysum rosum*	LC			x	
Asteraceae	*Helichrysum rosum* var. *arcuatum*	LC			x	
Asteraceae	*Helichrysum rugulosum*	LC			x	
Asteraceae	*Helichrysum scitulum*	LC			x	
Asteraceae	*Helichrysum* sp. 1	-				x
Asteraceae	*Helichrysum* sp. 2	-				x
Asteraceae	*Helichrysum trilineatum*	LC			x	
Asteraceae	*Helichrysum zeyheri*	LC			x	x
Asteraceae	*Ifloga* sp.	-				x
Asteraceae	*Hertia ciliata*	LC			x	
Asteraceae	*Hertia cluytiifolia*	LC	X		x	
Asteraceae	*Kleinia longiflora*	LC				x
Asteraceae	*Lactuca inermis*	LC			x	x
Asteraceae	*Lasiospermum poterioides*	LC			x	cf.
Asteraceae	*Leysera gnaphalodes*	LC			x	
Asteraceae	*Leysera tenella*	LC			x	x
Asteraceae	*Macledium spinosum*	LC			x	
Asteraceae	*Mantisalca salmantica*	NE		x	x	
Asteraceae	*Oedera glandulosa*	LC				x
Asteraceae	*Oedera humilis*	LC			x	x
Asteraceae	*Oedera oppositifolia*	LC			x	x
Asteraceae	*Oedera spinescens*	LC			x	x
Asteraceae	*Oncosiphon piluliferus*	LC			x	x
Asteraceae	*Osteospermum calendulaceum*	LC			x	
Asteraceae	*Osteospermum leptolobum*	LC			x	x
Asteraceae	*Osteospermum microphyllum*	LC			x	x
Asteraceae	*Osteospermum scariosum*	LC			x	x
Asteraceae	*Osteospermum sinuatum*	LC			x	x
Asteraceae	*Osteospermum* sp. 1	-				x
Asteraceae	*Osteospermum* sp. 2	-				x
Asteraceae	*Osteospermum spinescens*	LC			x	x
Asteraceae	*Othonna eriocarpa*	LC			x	
Asteraceae	*Othonna furcata*	LC			x	
Asteraceae	*Othonna pavonia*	LC			x	
Asteraceae	*Othonna* sp.	-				x
Asteraceae	*Pegolettia retrofracta*	LC			x	x
Asteraceae	*Pentzia calcarea*	LC			x	
Asteraceae	*Pentzia globosa*	LC			x	x
Asteraceae	*Pentzia incana*	LC			x	x
Asteraceae	*Pentzia lanata*	LC			x	x
Asteraceae	*Pentzia pinnatisecta*	LC			x	
Asteraceae	*Pentzia punctata*	LC			x	
Asteraceae	*Pentzia quinquefida*	LC			x	x
Asteraceae	*Pentzia spinescens*	LC				x
Asteraceae	*Phymaspermum aciculare*	LC			x	x
Asteraceae	*Phymaspermum parvifolium*				x	x
Asteraceae	*Phymaspermum thymelaeoides*	LC			x	
Asteraceae	*Pseudognaphalium luteoalbum*	LC			x	
Asteraceae	*Pseudognaphalium* sp.	-				x
Asteraceae	*Pseudognaphalium undulatum*	LC			x	
Asteraceae	*Pteronia acuminata*	LC			x	
Asteraceae	*Pteronia adenocarpa*	LC			x	
Asteraceae	*Pteronia aspalatha*	LC			x	
Asteraceae	*Pteronia bolusii*	LC			x	
Asteraceae	*Pteronia erythrochaeta*	LC			x	x
Asteraceae	*Pteronia glauca*	LC			x	x
Asteraceae	*Pteronia glaucescens*	LC			x	
Asteraceae	*Pteronia glomerata*	LC			x	x
Asteraceae	*Pteronia hutchinsoniana*	LC			x	
Asteraceae	*Pteronia membranacea*	LC			x	x
Asteraceae	*Pteronia sordida*	LC			x	x
Asteraceae	*Pteronia* sp.	-				x
Asteraceae	*Pteronia staehelinoides*	LC			x	x
Asteraceae	*Pteronia viscosa*	LC			x	x
Asteraceae	*Rhynchopsidium sessiliflorum*	LC			x	
Asteraceae	*Senecio achilleifolius*	LC			x	
Asteraceae	*Senecio angustifolius*	LC			x	
Asteraceae	*Senecio asperulus*	LC			x	x
Asteraceae	*Senecio burchellii*	LC			x	
Asteraceae	*Senecio cordifolius*	LC			x	

Asteraceae	*Senecio cotyledonis*	LC					x	
Asteraceae	*Senecio erysimoides*	DD					x	
Asteraceae	*Senecio hastatus*	LC					x	
Asteraceae	*Senecio inaequidens*	LC					x	x
Asteraceae	*Senecio incomptus*	LC					x	
Asteraceae	*Senecio madagascariensis*	LC					x	
Asteraceae	*Senecio niveus*	LC						x
Asteraceae	*Senecio pinnulatus*	LC					x	
Asteraceae	*Senecio sisymbriifolius*	LC					x	
Asteraceae	*Senecio* sp.	-						x
Asteraceae	*Senecio striatifolius*	LC					x	
Asteraceae	*Sonchus dregeanus*	LC					x	
Asteraceae	*Tarchonanthus minor*	LC					x	x
Asteraceae	*Tragopogon dubius*	NE				x	x	
Asteraceae	*Troglophyton capillaceum* subsp. *capillaceum*	LC					x	
Asteraceae	*Ursinia nana* subsp. *nana*	LC					x	x
Asteraceae	*Vellereophyton niveum*	LC		X			x	
Bignoniaceae	*Rhigozum obovatum*	LC					x	x
Bignoniaceae	*Rhigozum trichotomum*	LC					x	
Boraginaceae	*Anchusa capensis*	LC						x
Boraginaceae	*Anchusa riparia*	LC					x	
Boraginaceae	*Cynoglossum obtusicalyx*	LC					x	
Boraginaceae	*Ehretia rigida*	LC					x	x
Boraginaceae	*Heliotropium ciliatum*	LC					x	
Boraginaceae	*Lithospermum scabrum*	LC					x	
Boraginaceae	*Lobostemon stachydeus*	LC					x	x
Boraginaceae	*Myosotis arvensis*	NE				x	x	
Boraginaceae	*Trichodesma africanum*	LC					x	x
Brassicaceae	*Heliophila carnosa*	LC					x	
Brassicaceae	*Heliophila cornuta* var. *squamata*	LC					x	
Brassicaceae	*Heliophila crithmifolia*	LC					x	x
Brassicaceae	*Heliophila minima*	LC					x	
Brassicaceae	*Heliophila suavissima*	LC					x	
Brassicaceae	*Lepidium desertorum*	LC					x	x
Brassicaceae	*Sisymbrium burchellii* var. *burchellii*	LC					x	
Brassicaceae	*Sisymbrium capense*	LC					x	
Brassicaceae	*Sisymbrium orientale*	NE				x	x	
Cactaceae	*Cylindropuntia fulgida*	-			1b	x	x	
Cactaceae	*Cylindropuntia imbricata*	-			1b	x	x	
Cactaceae	*Opuntia ficus-indica*	-			1b	x	x	x
Cactaceae	*Opuntia microdasys*	-			1b	x	x	
Cactaceae	*Tephrocactus articulatus*	-			1a	x	x	
Campanulaceae	*Wahlenbergia androsacea*	LC					x	
Campanulaceae	*Wahlenbergia capillacea* subsp. *capillacea*	LC					x	
Campanulaceae	*Wahlenbergia cernua*	LC					x	
Campanulaceae	*Wahlenbergia nodosa*	LC					x	x
Campanulaceae	*Wahlenbergia tenella* var. *tenella*	LC					x	
Campanulaceae	*Wahlenbergia undulata*	LC					x	
Capparaceae	*Cadaba aphylla*	LC					x	x
Caryophyllaceae	*Cerastium capense*	LC					x	
Caryophyllaceae	*Dianthus micropetalus*	LC	x				x	x
Caryophyllaceae	*Pollichia campestris*	LC					x	
Caryophyllaceae	*Silene burchellii* subsp. *pilosellifolia*	LC					x	
Caryophyllaceae	*Silene burchellii* subsp. *modesta*	LC					x	
Caryophyllaceae	*Silene undulata* subsp. *undulata*	LC					x	
Celastraceae	*Gymnosporia szyszylowiczii*	-	x				x	x
Colchicaceae	*Colchicum albomarginatum*	LC					x	
Colchicaceae	*Colchicum melanthioides*	LC					x	
Colchicaceae	*Colchicum striatum*	LC	x				x	
Colchicaceae	*Colchicum volutare*	LC					x	
Colchicaceae	*Ornithoglossum vulgare*	LC					x	
Commelinaceae	*Commelina africana var. lancispatha*	LC					x	
Convolvulaceae	*Convolvulus dregeanus*	LC					x	
Convolvulaceae	*Convolvulus sagittatus*	LC					x	x
Convolvulaceae	*Cuscuta campestris*	NE			1b	x	x	
Crassulaceae	*Adromischus filicaulis subsp. marlothii*	LC	x				x	
Crassulaceae	*Adromischus humilis*	LC	x	X			x	
Crassulaceae	*Adromischus liebenbergii*	LC	x				x	
Crassulaceae	*Adromischus* sp.	-	x					x
Crassulaceae	*Cotyledon cuneata*	LC	x				x	
Crassulaceae	*Cotyledon orbiculata*	LC	x				x	x
Crassulaceae	*Cotyledon orbiculata var. oblonga*	LC	x				x	

Crassulaceae	*Cotyledon* sp.	-		x				x
Crassulaceae	*Cotyledon papillaris*	LC		x			x	
Crassulaceae	*Crassula barbata* subsp. *barbata*	LC		x			x	
Crassulaceae	*Crassula capitella* subsp. *thyrsiflora*	LC		x			x	
Crassulaceae	*Crassula corallina* subsp. *corallina*	LC		x			x	x
Crassulaceae	*Crassula corallina* subsp. *macrorrhiza*	LC		x			x	
Crassulaceae	*Crassula cotyledonis*	LC		x			x	cf.
Crassulaceae	*Crassula dependens*	LC		x			x	
Crassulaceae	*Crassula deltoidea*	LC		x				x
Crassulaceae	*Crassula ericoides*	LC		x				x
Crassulaceae	*Crassula exilis* subsp. *exilis*	LC		x			x	
Crassulaceae	*Crassula expansa* subsp. *expansa*	LC		x			x	
Crassulaceae	*Crassula montana* subsp. *quadrangularis*	LC		x			x	
Crassulaceae	*Crassula muscosa* var. *muscosa*	LC		x			x	x
Crassulaceae	*Crassula natans*	LC		x			x	
Crassulaceae	*Crassula pubescens* subsp. *pubescens*	LC		x			x	
Crassulaceae	*Crassula rogersii*	LC		x			x	
Crassulaceae	*Crassula rupestris*	LC		x			x	x
Crassulaceae	*Crassula socialis*	LC		x			x	
Crassulaceae	*Crassula subaphylla*	LC		x				cf.
Crassulaceae	*Crassula tetragona* subsp. *tetragona*	LC		x			x	x
Crassulaceae	*Crassula tomentosa* var. *tomentosa*	LC		x			x	
Crassulaceae	*Crassula vaillantii*	LC		x		x	x	x
Crassulaceae	*Tylecodon reticulatus* subsp. *reticulatus*	LC					x	
Crassulaceae	*Tylecodon wallichii* subsp. *wallichii*	LC					x	
Cucurbitaceae	*Cucumis africanus*	LC					x	
Cucurbitaceae	*Cucumis myriocarpus* subsp. *leptodermis*	LC					x	
Cucurbitaceae	*Kedrostis africana*	LC					x	
Cyperaceae	*Afroscirpoides dioeca*	LC					x	x
Cyperaceae	*Bulbostylis humilis*	LC					x	
Cyperaceae	*Carex burkei*	LC					x	
Cyperaceae	*Cyperus bellus*	LC					x	
Cyperaceae	*Cyperus indecorus* var. *namaquensis*	LC					x	
Cyperaceae	*Cyperus longus* var. *tenuiflorus*	LC					x	
Cyperaceae	*Cyperus marginatus*	LC					x	
Cyperaceae	*Cyperus squarrosus*	LC					x	
Cyperaceae	*Cyperus usitatus*	LC					x	
Cyperaceae	*Ficinia ramosissima*	LC					x	
Cyperaceae	*Kyllinga pulchella*	LC					x	
Cyperaceae	*Pseudoschoenus inanis*	LC					x	x
Cyperaceae	*Schoenoxiphium* sp.	-					x	
Dipsacaceae	*Scabiosa columbaria*	LC					x	
Ebenaceae	*Diospyros austro-africana* var. *austro-africana*	LC					x	x
Ebenaceae	*Diospyros austroafricana* var. *microphylla*	LC					x	
Ebenaceae	*Diospyros lycioides* subsp. *lycioides*	LC					x	x
Ebenaceae	*Euclea crispa* subsp. *ovata*	LC					x	x
Euphorbiaceae	*Euphorbia* cf. *caterviflora*	-		x	x			x
Euphorbiaceae	*Euphorbia* cf. *decepta*	-		x	x		x	x
Euphorbiaceae	*Euphorbia clavarioides*	LC		x	x		x	x
Euphorbiaceae	*Euphorbia hypogaea*	LC		x	x		x	
Euphorbiaceae	*Euphorbia inaequilatera*	LC		x			x	x
Euphorbiaceae	*Euphorbia mauritanica*	LC		x	x		x	x
Euphorbiaceae	*Euphorbia patula* subsp. *patula*			x	x		x	
Euphorbiaceae	*Euphorbia pillansii*	LC		x	x		x	
Euphorbiaceae	*Euphorbia rhombifolia*	LC		x	x		x	
Euphorbiaceae	*Euphorbia spartaria*	LC		x	x		x	
Euphorbiaceae	*Euphorbia stellispina*	LC		x	x		x	
Euphorbiaceae	*Euphorbia stolonifera*	LC		x	x		x	
Fabaceae	*Argyrolobium argenteum*	LC					x	
Fabaceae	*Aspalathus acicularis* subsp. *acicularis*	LC		x			x	
Fabaceae	*Aspalathus divaricata* subsp. *divaricata*	LC		x			x	
Fabaceae	*Calobota spinescens*	LC						x
Fabaceae	*Indigastrum argyraea*	LC						x
Fabaceae	*Indigofera alternans* var. *alternans*	LC					x	
Fabaceae	*Indigofera exigua*	LC					x	
Fabaceae	*Indigofera hantamensis*	LC					x	
Fabaceae	*Indigofera heterophylla*	LC					x	
Fabaceae	*Indigofera meyeriana*	LC					x	x
Fabaceae	*Indigofera sessilifolia*	LC					x	
Fabaceae	*Lessertia annularis*	LC	x				x	
Fabaceae	*Lessertia frutescens* subsp. *frutescens*	LC	x				x	x
Fabaceae	*Lessertia frutescens* subsp. *microphylla*	LC	x				x	

Fabaceae	*Lessertia inflata*	LC		x					x	x
Fabaceae	*Lessertia sneeuwbergensis*	LC		x					x	
Fabaceae	*Lotononis azureoides*	LC				X			x	
Fabaceae	*Lotononis caerulescens*	LC							x	
Fabaceae	*Lotononis carnosa* subsp. *carnosa*	LC							x	
Fabaceae	*Lotononis fruticoides*	LC							x	
Fabaceae	*Lotononis laxa*	LC							x	
Fabaceae	*Lotononis lenticula*	LC							x	
Fabaceae	*Lotononis pungens*	LC							x	
Fabaceae	*Lotononis* sp.	-								x
Fabaceae	*Medicago laciniata* var. *laciniata*	NE						x	x	
Fabaceae	*Medicago polymorpha*	NE						x	x	
Fabaceae	*Melolobium candicans*	LC							x	x
Fabaceae	*Melolobium canescens*	LC								x
Fabaceae	*Melolobium microphyllum*	LC							x	x
Fabaceae	*Prosopis chilensis*	NE						x	x	
Fabaceae	*Prosopis glandulosa* var. *torreyana*	NE					1b/3	x	x	
Fabaceae	*Prosopis glandulosa* var. *glandulosa*	NE					1b/3	x	x	x
Fabaceae	*Prosopis velutina*	NE					1b/3	x	x	
Fabaceae	*Trifolium africanum* var. *africanum*	LC							x	
Fabaceae	*Trifolium* sp.	-								x
Fabaceae	*Vachellia karroo*	LC							x	x
Frankeniaceae	*Frankenia pulverulenta*	LC							x	
Fumariaceae	*Cysticapnos pruinosa*	LC							x	
Gentianaceae	*Chironia palustris* subsp. *palustris*	LC							x	
Gentianaceae	*Sebaea pentandra* var. *pentandra*	LC							x	
Geraniaceae	*Erodium cicutarium*	NE						x	x	x
Geraniaceae	*Geranium dregei*	LC							x	
Geraniaceae	*Geranium harveyi*	LC							x	
Geraniaceae	*Monsonia camdeboensis*	LC							x	
Geraniaceae	*Monsonia crassicaulis*	LC							x	
Geraniaceae	*Monsonia salmoniflorum*	LC							x	x
Geraniaceae	*Pelargonium abrotanifolium*	LC		x					x	cf.
Geraniaceae	*Pelargonium althaeoides*	LC		x					x	
Geraniaceae	*Pelargonium aridum*	LC		x					x	x
Geraniaceae	*Pelargonium brevirostre*	LC		x					x	
Geraniaceae	*Pelargonium capituliforme*	LC		x					x	
Geraniaceae	*Pelargonium denticulatum*	LC		x					x	
Geraniaceae	*Pelargonium glutinosum*	LC		x					x	
Geraniaceae	*Pelargonium griseum*	LC		x					x	
Geraniaceae	*Pelargonium grossularioides*	LC		x					x	
Geraniaceae	*Pelargonium laxum* subsp. *laxum*	LC		x					x	
Geraniaceae	*Pelargonium malacoides*	-		x					x	
Geraniaceae	*Pelargonium minimum*	LC		x						x
Geraniaceae	*Pelargonium multicaule* subsp. *multicaule*	LC		x					x	
Geraniaceae	*Pelargonium myrrhifolium* var. *myrrhifolium*	LC		x					x	
Geraniaceae	*Pelargonium ramosissimum*	LC		x					x	
Geraniaceae	*Pelargonium ribifolium*	LC		x					x	
Geraniaceae	*Pelargonium sessiliflorum*	-		x					x	
Geraniaceae	*Pelargonium tetragonum*	LC		x					x	
Geraniaceae	*Pelargonium tragacanthoides*	LC		x					x	
Gisekiaceae	*Gisekia pharnaceoides* var. *pharnaceoides*	LC							x	
Grubbiaceae	*Grubbia rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia*	LC	x						x	
Hyacinthaceae	*Albuca exuviata*	LC							x	
Hyacinthaceae	*Albuca namaquensis*	LC							x	
Hyacinthaceae	*Albuca setosa*	LC							x	cf.
Hyacinthaceae	*Albuca* sp.	-								x
Hyacinthaceae	*Albuca suaveolens*	LC							x	
Hyacinthaceae	*Albuca virens* subsp. *arida*	LC							x	
Hyacinthaceae	*Dipcadi ciliare*	LC							x	x
Hyacinthaceae	*Dipcadi viride*	LC							x	
Hyacinthaceae	*Drimia anomala*	LC							x	
Hyacinthaceae	*Drimia intricata*	LC							x	
Hyacinthaceae	*Drimia physodes*	LC							x	
Hyacinthaceae	*Drimia platyphylla*	LC							x	
Hyacinthaceae	*Drimia* sp.	-								x
Hyacinthaceae	*Lachenalia aurioliae*	LC	x		x		X		x	
Hyacinthaceae	*Lachenalia campanulata*	LC	x		x				x	cf
Hyacinthaceae	*Ledebouria ensifolia*	LC							x	
Hyacinthaceae	*Massonia dentata*	LC							x	
Hyacinthaceae	*Massonia depressa*	LC							x	

Hyacinthaceae	*Massonia echinata*	LC						x	
Hyacinthaceae	*Ornithogalum comptonii*	LC		x				x	
Hyacinthaceae	*Ornithogalum flexuosum*	LC		x				x	
Hyacinthaceae	*Ornithogalum juncifolium* var. *juncifolium*	LC		x				x	
Hyacinthaceae	*Ornithogalum paludosum*	LC		x				x	
Hyacinthaceae	*Ornithogalum* sp.	-		x					x
Hyacinthaceae	*Veltheimia capensis*	LC	x	x				x	
Hypoxidaceae	*Empodium elongatum*	LC						x	
Hypoxidaceae	*Empodium flexile*	LC						x	
Hypoxidaceae	*Empodium gloriosum*	LC						x	
Iridaceae	*Babiana hypogaea*	LC	x	x					x
Iridaceae	*Babiana* sp.	-	x	x					x
Iridaceae	*Gladiolus permeabilis*	LC	x	x				x	x
Iridaceae	*Gladiolus* sp.	-	x	x					x
Iridaceae	*Hesperantha bachmannii*	LC	x	x				x	
Iridaceae	*Hesperantha cucullata*	LC	x	x					cf.
Iridaceae	*Ixia marginifolia*	LC	x	x				x	
Iridaceae	*Lapeirousia plicata* subsp. *foliosa*		x	x				x	
Iridaceae	*Moraea ciliata*	LC	x	x				x	
Iridaceae	*Moraea cookii*	LC	x	x				x	
Iridaceae	*Moraea crispa*	LC	x	x				x	
Iridaceae	*Moraea elliotii*	LC	x	x				x	
Iridaceae	*Moraea miniata*	LC	x	x				x	x
Iridaceae	*Moraea polystachya*	LC	x	x				x	
Iridaceae	*Moraea* sp.	-	x	x					x
Iridaceae	*Moraea speciosa*	LC	x	x				x	
Iridaceae	*Moraea unguiculata*	LC	x	x				x	
Iridaceae	*Romulea atrandra* var. *esterhuyseniae*	LC	x	x				x	
Iridaceae	*Syringodea concolor*	LC	x	x				x	
Juncaceae	*Juncus oxycarpus*	LC	x	x				x	
Juncaceae	*Juncus rigidus*	LC						x	
Kewaceae	*Kewa salsoloides*	LC						x	
Lamiaceae	*Ballota africana*	LC						x	x
Lamiaceae	*Salvia disermas*	LC						x	x
Lamiaceae	*Salvia stenophylla*	-						x	
Lamiaceae	*Salvia verbenaca*	LC					x	x	x
Lamiaceae	*Stachys cuneata*	LC						x	x
Lamiaceae	*Stachys dregeana*	LC						x	
Lamiaceae	*Stachys linearis*	LC						x	x
Lamiaceae	*Stachys rugosa*	LC						x	
Lamiaceae	*Teucrium trifidum*	LC						x	
Lentibulariaceae	*Utricularia bisquamata*	LC						x	
Limeaceae	*Limeum aethiopicum* var. *aethiopicum*	LC						x	x
Linaceae	*Linum adustum*	LC						x	
Linaceae	*Linum thunbergii*	LC						x	
Lobeliaceae	*Lobelia dregeana*	LC						x	
Lobeliaceae	*Lobelia thermalis*	LC						x	
Loranthaceae	*Moquiniella rubra*	LC						x	
Loranthaceae	*Septulina glauca*	LC						x	x
Lycopodiaceae	*Lycopodium clavatum*	LC						x	
Malvaceae	*Abutilon sonneratianum*	LC						x	
Malvaceae	*Anisodontea capensis*	LC						x	
Malvaceae	*Anisodontea malvastroides*	LC				X		x	
Malvaceae	*Anisodontea triloba*	LC						x	
Malvaceae	*Grewia robusta*	LC						x	x
Malvaceae	*Hermannia alnifolia*	LC						x	x
Malvaceae	*Hermannia althaeifolia*	LC						x	
Malvaceae	*Hermannia burkei*	LC						x	
Malvaceae	*Hermannia cernua*	LC						x	
Malvaceae	*Hermannia coccocarpa*	LC						x	x
Malvaceae	*Hermannia comosa*	LC						x	x
Malvaceae	*Hermannia cuneifolia* var. *cuneifolia*	LC						x	x
Malvaceae	*Hermannia cuneifolia* var. *glabrescens*	LC						x	
Malvaceae	*Hermannia desertorum*	LC						x	x
Malvaceae	*Hermannia filifolia* var. *filifolia*	LC						x	x
Malvaceae	*Hermannia filifolia* var. *grandicalyx*	LC						x	
Malvaceae	*Hermannia grandiflora*	LC						x	x
Malvaceae	*Hermannia linearifolia*	LC						x	
Malvaceae	*Hermannia paucifolia*	LC						x	
Malvaceae	*Hermannia pulchella*	LC						x	x
Malvaceae	*Hermannia* sp.	-							x
Malvaceae	*Hermannia spinosa*	LC						x	x

Malvaceae	*Hermannia stipulacea*	LC						x	
Malvaceae	*Hermannia stricta*	LC						x	
Malvaceae	*Hermannia vestita*	LC						x	x
Malvaceae	*Hibiscus pusillus*	LC						x	x
Malvaceae	*Malva pusilla*	NE					x	x	x
Malvaceae	*Radyera urens*	LC						x	x
Marsileaceae	*Marsilea burchellii*	LC						x	
Melianthaceae	*Melianthus comosus*	LC						x	x
Menispermaceae	*Cissampelos capensis*	LC							x
Neuradaceae	*Grielum sinuatum*	LC						x	
Nyctaginaceae	*Boerhavia cordobensis*	NE					x	x	
Myrtaceae	*Eucalyptus* sp.	-							x
Oleaceae	*Menodora juncea*	LC						x	x
Ophioglossaceae	*Ophioglossum polyphyllum* var. *polyphyllum*	LC						x	x
Orchidaceae	*Eulophia hians* var. *hians*	LC						x	
Orchidaceae	*Holothrix villosa* var. *villosa*	LC						x	
Orobanchaceae	*Harveya* sp.	LC	x		x			x	
Oxalidaceae	*Oxalis ambigua*	LC			x			x	
Oxalidaceae	*Oxalis lanata* var. *lanata*	LC			x			x	
Oxalidaceae	*Oxalis obtusa*	LC			x			x	
Oxalidaceae	*Oxalis psilopoda*	LC			x			x	
Papaveraceae	*Argemone ochroleuca*	NE				1b	x	x	x
Papaveraceae	*Papaver aculeatum*	LC						x	
Pedaliaceae	*Sesamum capense*	LC							x
Peraceae	*Clutia marginata*	LC						x	x
Peraceae	*Clutia thunbergii*	LC						x	
Plantaginaceae	*Veronica anagallis-aquatica*	LC						x	
Pinaceae	*Pinus* sp.	-				1b/2/3	x		x
Plantaginaceae	*Plantago lanceolata*	LC							x
Poaceae	*Agrostis lachnantha* var. *lachnantha*	LC						x	
Poaceae	*Aristida adscensionis*	LC						x	x
Poaceae	*Aristida congesta*	LC						x	x
Poaceae	*Aristida diffusa* subsp. *burkei*	LC						x	
Poaceae	*Aristida diffusa* subsp. *diffusa*	LC						x	x
Poaceae	*Brachypodium bolusii*	LC						x	
Poaceae	*Bromus catharticus*	NE					x	x	x
Poaceae	*Bromus pectinatus*	LC						x	
Poaceae	*Capeochloa arundinacea*	LC						x	
Poaceae	*Cenchrus ciliaris*	LC						x	x
Poaceae	*Chaetobromus involucratus* subsp. *dregeanus*	LC						x	
Poaceae	*Chloris virgata*	LC						x	x
Poaceae	*Cymbopogon dieterlenii*	LC						x	
Poaceae	*Cymbopogon nardus*	LC						x	
Poaceae	*Cymbopogon prolixus*	LC						x	x
Poaceae	*Cynodon dactylon*	LC						x	
Poaceae	*Cynodon incompletus*	LC						x	x
Poaceae	*Digitaria argyrograpta*	LC						x	x
Poaceae	*Digitaria eriantha*	LC						x	x
Poaceae	*Ehrharta calycina*	LC						x	x
Poaceae	*Ehrharta dura*	LC						x	
Poaceae	*Ehrharta erecta*	LC						x	
Poaceae	*Ehrharta longigluma*	LC						x	
Poaceae	*Ehrharta pusilla*	LC						x	
Poaceae	*Enneapogon desvauxii*	LC						x	x
Poaceae	*Enneapogon scaber*	LC						x	x
Poaceae	*Enneapogon scoparius*	LC						x	x
Poaceae	*Eragrostis annulata*	LC							x
Poaceae	*Eragrostis bergiana*	LC						x	x
Poaceae	*Eragrostis bicolor*	LC						x	x
Poaceae	*Eragrostis brizantha*	LC						x	
Poaceae	*Eragrostis chloromelas*	LC						x	x
Poaceae	*Eragrostis cilianensis*	LC						x	
Poaceae	*Eragrostis curvula*	LC						x	x
Poaceae	*Eragrostis cylindriflora*	LC						x	
Poaceae	*Eragrostis echinochloidea*	LC							x
Poaceae	*Eragrostis homomalla*	LC						x	
Poaceae	*Eragrostis lehmanniana*	LC						x	x
Poaceae	*Eragrostis obtusa*	LC						x	x
Poaceae	*Eragrostis procumbens*	LC						x	
Poaceae	*Eragrostis rotifer*	LC						x	x
Poaceae	*Festuca scabra*	LC						x	
Poaceae	*Fingerhuthia africana*	LC						x	x

Poaceae	*Fingerhuthia sesleriiformis*	LC				x	
Poaceae	*Helictotrichon hirtulum*	LC				x	
Poaceae	*Heteropogon contortus*	LC				x	x
Poaceae	*Hordeum capense*	LC				x	
Poaceae	*Hordeum murinum* subsp. *glaucum*	NE			x	x	
Poaceae	*Hordeum murinum* subsp. *leporinum*	NE			x	x	
Poaceae	*Hyparrhenia hirta*	LC				x	x
Poaceae	*Koeleria capensis*	LC				x	
Poaceae	*Leptochloa fusca*	LC				x	
Poaceae	*Lolium multiflorum*	NE			x	x	
Poaceae	*Melica decumbens*	LC				x	
Poaceae	*Melica racemosa*	LC				x	
Poaceae	*Oropetium capense*	LC					x
Poaceae	*Panicum coloratum*	LC				x	
Poaceae	*Panicum lanipes*	LC				x	
Poaceae	*Panicum maximum*	LC				x	
Poaceae	*Pennisetum setaceum*	NE		1b	x	x	x
Poaceae	*Pennisetum sphacelatum*	LC				x	
Poaceae	*Pentameris airoides* subsp. *airoides*	LC				x	x
Poaceae	*Pentameris airoides* subsp. *jugorum*	LC				x	
Poaceae	*Pentameris setifolia*	LC				x	x
Poaceae	*Phragmites australis*	LC				x	x
Poaceae	*Polypogon monspeliensis*	NE			x	x	
Poaceae	*Schismus barbatus*	LC					x
Poaceae	*Schmidtia kalahariense*	LC				x	x
Poaceae	*Setaria sphacelata* var. *torta*	LC				x	
Poaceae	*Setaria verticillata*	LC				x	x
Poaceae	*Sporobolus coromandelianus*	LC				x	
Poaceae	*Sporobolus fimbriatus*	LC				x	x
Poaceae	*Sporobolus ioclados*	LC				x	x
Poaceae	*Sporobolus tenellus*	LC				x	
Poaceae	*Stipagrostis ciliata*	LC				x	x
Poaceae	*Stipagrostis namaquensis*	LC					x
Poaceae	*Stipagrostis obtusa*	LC				x	x
Poaceae	*Stipagrostis uniplumis*	LC				x	x
Poaceae	*Tenaxia disticha*	LC				x	x
Poaceae	*Tenaxia dura*	LC				x	
Poaceae	*Tetrachne dregei*	LC				x	
Poaceae	*Themeda triandra*	LC				x	x
Poaceae	*Tragus berteronianus*	LC				x	x
Poaceae	*Tragus koelerioides*	LC				x	x
Poaceae	*Tragus racemosus*	LC				x	x
Poaceae	*Tribolium purpureum*	LC				x	
Poaceae	*Tricholaena capensis* subsp. *capensis*	LC				x	
Poaceae	*Urochloa* cf. *panicoides*	-					x
Poaceae	*Vulpia myuros*	NE			x	x	
Polygalaceae	*Muraltia macrocarpa*	LC				x	
Polygalaceae	*Polygala asbestina*	LC				x	
Polygalaceae	*Polygala ephedroides*	LC				x	x
Polygalaceae	*Polygala leptophylla* var. *leptophylla*	LC				x	x
Polygonaceae	*Rumex crispus*	NE			x	x	
Polygonaceae	*Rumex lanceolatus*	LC				x	
Polypodiaceae	*Polypodium vulgare*	LC				x	
Pteridaceae	*Cheilanthes contracta*	LC				x	
Pteridaceae	*Cheilanthes eckloniana*	LC				x	x
Pteridaceae	*Cheilanthes hirta var. hirta*	LC				x	
Pteridaceae	*Cheilanthes induta*	LC				x	
Pteridaceae	*Cheilanthus* sp.	-					x
Pteridaceae	*Pellaea calomelanos* var. *calomelanos*	LC				x	x
Pteridaceae	*Pellaea leucomelas*	LC				x	
Pteridaceae	*Pellaea rufa*	LC				x	
Ranunculaceae	*Clematis brachiata*	LC				x	x
Ranunculaceae	*Ranunculus multifidus*	LC				x	x
Ranunculaceae	*Ranunculus trichophyllus*	LC				x	
Rhamnaceae	*Phylica purpurea*	LC				x	
Rhamnaceae	*Rhamnus prinoides*	LC					x
Rosaceae	*Cliffortia arborea*	VU				x	
Rosaceae	*Rubus ludwigii* subsp. *ludwigii*	LC				x	x
Rubiaceae	*Anthospermum dregei* subsp. *dregei*	LC				x	
Rubiaceae	*Anthospermum rigidum* subsp. *pumilum*	LC				x	
Rubiaceae	*Anthospermum spathulatum* subsp. *spathulatum*	LC				x	
Rubiaceae	*Anthospermum* sp.	-					x

Rubiaceae	*Galium capense* subsp. *garipense*	LC						x		
Rubiaceae	*Galium capense* subsp. *capense*	LC						x		
Rubiaceae	*Kohautia cynanchica*	LC						x		
Rubiaceae	*Nenax microphylla*	LC						x	x	
Ruscaceae	*Eriospermum* sp.	-							x	
Salicaceae	*Populus alba*	NE				2	x		x	
Salicaceae	*Populus nigra* var. *italica*	NE					x	x		
Salicaceae	*Salix mucronata*	LC							x	
Santalaceae	*Lacomucinaea lineata*	LC						x	x	
Santalaceae	*Thesium gnidiaceum* var. *gnidiaceum*	LC						x		
Santalaceae	*Thesium hystricoides*	LC						x		
Santalaceae	*Thesium hystrix*	LC						x		
Santalaceae	*Thesium junceum* var. *junceum*	LC						x		
Santalaceae	*Thesium* sp.	-							x	
Santalaceae	*Thesium sonderianum*	DD						x		
Santalaceae	*Viscum continuum*	LC						x		
Santalaceae	*Viscum rotundifolium*	LC						x	x	
Scrophulariaceae	*Aptosimum indivisum*	LC						x	x	
Scrophulariaceae	*Aptosimum procumbens*	LC						x	x	
Scrophulariaceae	*Aptosimum spinescens*	LC						x	x	
Scrophulariaceae	*Buddleja glomerata*	LC						x	x	
Scrophulariaceae	*Buddleja salviifolia*	LC						x	x	
Scrophulariaceae	*Chaenostoma halimifolium*	LC						x		
Scrophulariaceae	*Chaenostoma macrosiphon*	LC						x		
Scrophulariaceae	*Chaenostoma pauciflorum*	LC						x		
Scrophulariaceae	*Cromidon confusum*	LC						x		
Scrophulariaceae	*Cromidon decumbens*	LC						x		
Scrophulariaceae	*Diascia alonsooides*	LC	x		x			x		
Scrophulariaceae	*Diascia capsularis*	LC	x		x			x		
Scrophulariaceae	*Gomphostigma incomptum*	LC						x		
Scrophulariaceae	*Hebenstretia parviflora*	LC						x		
Scrophulariaceae	*Hebenstretia robusta*	LC						x		
Scrophulariaceae	*Jamesbrittenia atropurpurea*	LC			x			x		
Scrophulariaceae	*Jamesbrittenia filicaulis*	LC			x			x		
Scrophulariaceae	*Jamesbrittenia tysonii*	LC			x			x	x	
Scrophulariaceae	*Limosella grandiflora*	LC						x		
Scrophulariaceae	*Manulea chrysantha*	LC						x		
Scrophulariaceae	*Manulea fragrans*	LC						x		
Scrophulariaceae	*Nemesia cynanchifolia*	LC			x			x	cf.	
Scrophulariaceae	*Nemesia floribunda*	LC			x			x		
Scrophulariaceae	*Nemesia fruticans*	LC			x			x		
Scrophulariaceae	*Nemesia linearis*	LC			x			x		
Scrophulariaceae	*Peliostomum leucorrhizum*	LC						x	x	
Scrophulariaceae	*Peliostomum virgatum*	LC							x	
Scrophulariaceae	*Selago acocksii*	LC						x		
Scrophulariaceae	*Selago albida*	LC						x		
Scrophulariaceae	*Selago centralis*	LC						x		
Scrophulariaceae	*Selago divaricata*	LC						x		
Scrophulariaceae	*Selago geniculata*	LC						x		
Scrophulariaceae	*Selago gracilis*	LC						x		
Scrophulariaceae	*Selago magnakarooica*	LC				X		x		
Scrophulariaceae	*Selago rigida*	LC						x		
Scrophulariaceae	*Selago saxatilis*	LC						x	x	
Scrophulariaceae	*Selago* sp. 1	-							x	
Scrophulariaceae	*Selago* sp. 2	-							x	
Scrophulariaceae	*Trieenea glutinosa*	LC						x		
Scrophulariaceae	*Zaluzianskya karrooica*	LC						x		
Scrophulariaceae	*Zaluzianskya peduncularis*	LC						x	x	
Scrophulariaceae	*Zaluzianskya venusta*	LC						x	x	
Solanaceae	*Lycium bosciifolium*	LC						x		
Solanaceae	*Lycium cinereum*	LC						x	x	
Solanaceae	*Lycium hirsutum*	LC						x		
Solanaceae	*Lycium horridum*	LC						x	x	
Solanaceae	*Lycium oxycarpum*	LC						x	x	
Solanaceae	*Lycium pumilum*	LC						x		
Solanaceae	*Lycium schizocalyx*	LC						x	x	
Solanaceae	*Solanum burchellii*	LC							x	
Solanaceae	*Solanum retroflexum*	LC						x		
Solanaceae	*Solanum tomentosum*							x		
Solanaceae	*Withania somnifera*	LC						x		
Thymelaeaceae	*Gnidia meyeri*	LC						x		
Thymelaeaceae	*Lasiosiphon deserticola*	LC						x		

Thymelaeaceae	*Lasiosiphon microphyllus*	LC		x	x
Thymelaeaceae	*Lasiosiphon polycephalus*	LC		x	x
Thymelaeaceae	*Passerina corymbosa*	LC		x	
Thymelaeaceae	*Passerina obtusifolia*	LC		x	
Urticaceae	*Forsskaolea candida*	LC		x	x
Urticaceae	*Urtica dioica*	NE	x	x	
Verbenaceae	*Chascanum garipense*	LC			x
Verbenaceae	*Chascanum pinnatifidum* var. *pinnatifidum*	LC		x	x
Verbenaceae	*Chascanum pumilum*	LC		x	x
Verbenaceae	*Lantana rugosa*	LC		x	
Zygophyllaceae	*Roepera incrustata*	LC		x	
Zygophyllaceae	*Roepera lichtensteiniana*	LC		x	x
Zygophyllaceae	*Tetraena microcarpa*	LC		x	x
Zygophyllaceae	*Tetraena simplex*	LC		x	
Zygophyllaceae	*Roepera microphyllum*	LC		x	
Zygophyllaceae	*Tetraena chrysopteron*	LC		x	x
Zygophyllaceae	*Tribulus terrestris*	LC		x	x

APPENDIX B

ANIMAL SPECIES CHECKLISTS (ADU DATABASE)

1. Mammals

[1]IUCN category
[2]Western Cape Nature and Environmental Conservation Ordinance (WCNECO)
[3]Northern Cape Nature Conservation Act (NCCA)
[4]Animals observed during September/October 2020 site visit
Prot = Protected

Family	Scientific name	Common name	IUCN RSA[1]	IUCN Global[1]	WCNECO[2] Sch 1 EWA	WCNECO[2] Sch 2 PWA	NCNCA[3] Sch 1 SPS	NCCA[3] Sch 2 PS	NCNCA[3] Sch 4	ToPS	CITES	CURRENT[4]
ORDER: Rodentia (Rodents)												
Bathyergidae	*Cryptomys hottentotus*	Southern African mole-rat	LC					x				
Gliridae	*Graphiurus ocularis*	Spectacled African dormouse	NT					x				
Hystricidae	*Hystrix africaeaustralis*	Cape porcupine	LC					x				x
Muridae	*Acomys subspinosus*	Cape spiny mouse	LC					x				
Muridae	*Aethomys granti*	Grant's rock mouse	LC					x				
Muridae	*Aethomys namaquensis*	Namaqua rock mouse	LC					x				
Muridae	*Desmodillus auricularis*	Cape short-tailed gerbil	LC					x				
Muridae	*Gerbilliscus paeba*	Paeba hairy-footed gerbil	LC					x				
Muridae	*Mastomys coucha*	Southern African mastomys	LC					x				
Muridae	*Mastomys natalensis*	Natal multimammate mouse	LC					x				
Muridae	*Mus (Nannomys) minutoides*	Southern African pygmy mouse	LC					x				
Muridae	*Myomyscus verreauxi*	Verreaux's mouse	LC					x				
Muridae	*Otomys irroratus*	Southern African vlei rat (Fynbos type)	LC					x				
Muridae	*Otomys unisulcatus*	Karoo bush rat	LC					x				
Muridae	*Parotomys brantsii*	Brants's whistling rat	LC					x				
Muridae	*Rhabdomys pumilio*	Xeric four-striped grass rat	LC					x				
Nesomyidae	*Malacothrix typica*	Large-eared African desert mouse	LC					x				
Nesomyidae	*Petromyscus collinus*	Pygmy rock mouse	LC					x				
Nesomyidae	*Saccostomus campestris*	Southern African pouched mouse	LC					x				
Nesomyidae	*Steatomys krebsii*	Kreb's African fat mouse	LC					x				
Pedetidae	*Pedetes capensis*	South African spring hare	LC					x				
Sciuridae	*Xerus inauris*	South African ground squirrel	LC					x				
ORDER: Artiodactyla												
Bovidae	*Aepyceros melampus*	Impala	LC			x		x				
Bovidae	*Alcelaphus buselaphus caama*	Red hartebeest	LC			x		x				
Bovidae	*Antidorcas marsupialis*	Springbok	LC			x		x				x
Bovidae	*Connochaetes gnou*	Black wildebeest	LC			x		x		Prot		
Bovidae	*Damaliscus pygargus phillipsi*	Blesbok	LC			x		x				
Bovidae	*Damaliscus pygargus pygargus*	Bontebok	VU			x		x		VU	App II	
Bovidae	*Hippotragus equinus*	Roan antelope	EN	LC				x		VU		
Bovidae	*Hippotragus niger niger*	Sable antelope	VU	LC				x				
Bovidae	*Oreotragus oreotragus*	Klipspringer	LC			x		x				
Bovidae	*Oryx gazella*	Gemsbok	LC			x		x				
Bovidae	*Pelea capreolus*	Grey rhebok	NT			x		x				x
Bovidae	*Raphicerus campestris*	Steenbok	LC			x		x				x
Bovidae	*Redunca arundinum*	Southern reedbuck	LC			x		x				
Bovidae	*Redunca fulvorufula*	Mountain reedbuck	EN	EN		x		x				
Bovidae	*Sylvicapra grimmia*	Bush duiker	LC			x		x				
Bovidae	*Syncerus caffer*	African buffalo	LC			x		x				

Bovidae	*Tragelaphus oryx*	Common eland	LC			x		x			
Bovidae	*Tragelaphus sylvaticus*	Southern bushbuck	LC			x		x			
Bovidae	*Tragelaphus strepsiceros*	Greater kudu	LC			x		x			
ORDER: Carnivora (Carnivores)											
Canidae	*Canis mesomelas*	Black-backed jackal	LC						x		
Canidae	*Otocyon megalotis*	Bat-eared fox	LC			x	x				
Canidae	*Vulpes chama*	Cape fox	LC			x	x			Prot	
Felidae	*Caracal caracal*	Caracal	LC						x		App II
Felidae	*Felis nigripes*	Black-footed cat	VU	VU		x	x			Prot	App I
Felidae	*Felis silvestris*	African wildcat	LC				x				App II
Felidae	*Panthera leo*	Lion	LC			x	x			VU	App II
Herpestidae	*Atilax paludinosus*	Water mongoose	LC					x			
Herpestidae	*Cynictis penicillata*	Yellow mongoose	LC					x			
Herpestidae	*Herpestes pulverulentus*	Cape Gray mongoose	LC								
Herpestidae	*Suricata suricatta*	Suricate meerkat	LC					x			
Hyaenidae	*Parahyaena brunnea*	Brown hyena	NT			x	x			Prot	
Hyaenidae	*Proteles cristata*	Aardwolf	LC			x	x				
Mustelidae	*Ictonyx striatus*	Striped polecat	LC				x				
Mustelidae	*Mellivora capensis*	Honey badger	LC			x	x			Prot	
Mustelidae	*Poecilogale albinucha*	African striped weasel	NT			x	x				
Viverridae	*Genetta genetta*	Small-spotted genet	LC					x			
Viverridae	*Genetta tigrina*	Cape genet	LC					x			
ORDER: Primates											
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet monkey	LC						x		x
Cercopithecidae	*Papio ursinus*	Chacma baboon	LC						x		x
ORDER: Afrosoricida (Golden moles)											
Chrysochloridae	*Chlorotalpa sclateri*	Sclater's golden gole	LC					x			
ORDER: Perissodactyla											
Equidae	*Equus quagga*	Plains zebra	LC					x			
Equidae	*Equus zebra zebra*	Cape Mountain zebra	LC		x		x			EN	App II
ORDER: Lagomorpha (Hares and rabbits)											
Leporidae	*Bunolagus monticularis*	Riverine rabbit	CR		x		x			CR	
Leporidae	*Lepus capensis*	Cape hare	LC					x			
Leporidae	*Lepus saxatilis*	Scrub hare	LC					x			x
Leporidae	*Pronolagus rupestris*	Smith's red rock rabbit	LC					x			
ORDER: Macroscelidea (Elephant shrews)											
Macroscelididae	*Elephantulus edwardii*	Cape rock sengi	LC					x			
Macroscelididae	*Elephantulus rupestris*	Western rock sengi	LC					x			
Macroscelididae	*Macroscelides proboscideus*	Karoo round-eared sengi	LC					x			
ORDER: Tubulidentata											
Orycteropodidae	*Orycteropus afer*	Aardvark	LC			x	x				x
ORDER: Hyracoidea (Hyraxes)											
Procaviidae	Procavia capensis	Rock hyrax	LC					x			x
ORDER: Eulipotyphla (Shrews)											
Soricidae	*Crocidura cyanea*	Reddish-grey musk shrew	LC					x			
Soricidae	*Crocidura flavescens*	Greater red musk shrew	LC					x			
Soricidae	*Myosorex varius*	Forest shrew	LC					x			
Erinaceidae	*Atelerix frontalis*	Southern African hedgehog	NT			x	x			Prot	
ORDER: Chiroptera											
Molossidae	*Tadarida aegyptiaca*	Egyptian free-tailed bat	LC			x		x			
Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's horseshoe bat	LC			x		x			
Vespertilionidae	*Miniopterus natalensis*	Natal long-fingered bat	LC			x					
Vespertilionidae	*Neoromicia capensis*	Cape serotine	LC			x		x			
ORDER: Proboscidea											
Elephantidae	*Loxodonta africana*	African savanna Eeephant	LC			x	x			Prot	App II

2. Reptiles

[1]IUCN category
[2]Western Cape Nature and Environmental Conservation Ordinance (WCNECO)
[3]Northern Cape Nature Conservation Act (NCCA)
[4]Animals observed during September/October 2020 site visit

Family	Scientific name	Common name	IUCN[1]	WCNECO[2] Sch 2 PWA	NCNCA[3] Sch 2 PS	ToPS	CITES	CURRENT[4]
ORDER: SQUAMATA								
SUB-ORDER: LACERTILIA (LIZARDS)								
Agamidae	*Agama aculeata aculeata*	Western ground agama	LC	x				
Agamidae	*Agama anchietae*	Anchieta's agama	LC	x				
Agamidae	*Agama atra*	Southern rock agama	LC	x				X
Chamaeleonidae	*Bradypodion ventrale*	Eastern Cape dwarf chameleon	LC	x			App II	
Cordylidae	*Cordylus cordylus*	Cape girdled lizard	LC	x			App II	
Cordylidae	*Karusasaurus polyzonus*	Southern karusa lizard	LC	x				
Cordylidae	*Pseudocordylus microlepidotus namaquensis*	Nuweveldberg crag lizard	LC	x				
Gekkonidae	*Chondrodactylus angulifer angulifer*	Common giant ground gecko	LC	x				
Gekkonidae	*Chondrodactylus bibronii*	Bibron's gecko	LC	x				
Gekkonidae	*Goggia braacki*	Braack's pygmy gecko	NT	x				
Gekkonidae	*Pachydactylus capensis*	Cape gecko	LC	x				
Gekkonidae	*Pachydactylus kladaroderma*	Thin-skinned Gecko	LC	x				
Gekkonidae	*Pachydactylus latirostris*	Quartz gecko	LC	x				
Gekkonidae	*Pachydactylus maculatus*	Spotted gecko	LC	x				
Gekkonidae	*Pachydactylus mariquensis*	Common banded gecko	LC	x				
Gekkonidae	*Pachydactylus oculatus*	Golden spotted gecko	LC	x				
Gekkonidae	*Pachydactylus purcelli*	Purcell's gecko	LC	x				
Gekkonidae	*Pachydactylus rugosus*	Common rough gecko	LC	x				
Gekkonidae	*Ptenopus garrulus maculatus*	Spotted barking gecko	LC	x				
Gerrhosauridae	*Cordylosaurus subtessellatus*	Dwarf plated lizard	LC	x				
Gerrhosauridae	*Tetradactylus tetradactylus*	Cape Long-tailed Seps	LC	x				
Lacertidae	*Meroles suborbitalis*	Spotted desert lizard	LC	x	x			
Lacertidae	*Nucras livida*	Karoo sandveld lizard	LC	x	x			
Lacertidae	*Pedioplanis burchelli*	Burchell's sand lizard	LC	x	x			
Lacertidae	*Pedioplanis laticeps*	Karoo sand lizard	LC	x	x			
Lacertidae	*Pedioplanis lineoocellata pulchella*	Common sand lizard	LC	x	x			
Lacertidae	*Pedioplanis namaquensis*	Namaqua sand lizard	LC	x	x			
Scincidae	*Acontias meleagris*	Cape legless skink	LC	x				
Scincidae	*Trachylepis capensis*	Cape skink	LC	x				
Scincidae	*Trachylepis homalocephala*	Red-sided Skink	LC	x				
Scincidae	*Trachylepis occidentalis*	Western three-striped skink	LC	x				
Scincidae	*Trachylepis sulcata sulcata*	Western rock skink	LC	x				X
Scincidae	*Trachylepis variegata*	Variegated skink	LC	x				
Varanidae	*Varanus albigularis albigularis*	Southern rock monitor	LC		x		App II	
SUB-ORDER: SERPENTES (SNAKES)								
Typhlopidae	*Rhinotyphlops lalandei*	Delalande's beaked blind snake	LC					
Typhlopidae	*Rhinotyphlops schinzi*	Schinz's beaked blind snake	LC					
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped snake	LC					
Colubridae	*Dasypeltis scabra*	Rhombic egg-eater	LC	x	x			
Colubridae	*Dipsina multimaculata*	Dwarf beaked snake	LC					
Lamprophiidae	*Boaedon capensis*	Common house snake	LC					
Lamprophiidae	*Homoroselaps lacteus*	Spotted harlequin snake	LC					
Lamprophiidae	*Lamprophis guttatus*	Spotted rock snake	LC	x	x			
Lamprophiidae	*Prosymna sundevallii*	Sundevall's shovel-snout	LC	x	x			
Lamprophiidae	*Psammophis notostictus*	Karoo sand snake	LC					
Lamprophiidae	*Psammophylax rhombeatus*	Spotted grass snake	LC					
Elapidae	*Aspidelaps lubricus lubricus*	Coral shield cobra	LC					
Elapidae	*Hemachatus haemachatus*	Rinkhals	LC					
Elapidae	*Naja nivea*	Cape cobra	LC					
Viperidae	*Bitis arietans arietans*	Puff adder	LC					
ORDER: TESTUDINATA (CHELONIANS)								
Testudinidae	*Chersina angulata*	Angulate tortoise	LC	x	x		App II	
Testudinidae	*Homopus femoralis*	Greater padloper	LC	x	x		App II	
Testudinidae	*Psammobates tentorius*	Tent tortoise	LC	x	x		App II	
Testudinidae	*Psammobates tentorius tentorius*	Karoo tent tortoise	-	x	x		App II	
Testudinidae	*Psammobates tentorius verroxii*	Verrox's tent tortoise	-	x	x		App II	
Testudinidae	*Stigmochelys pardalis*	Leopard tortoise	LC	x	x		App II	X
Testudinidae	*Chersobius boulengeri*	Karoo dwarf tortoise	EN					
Pelomedusidae	*Pelomedusa galeata*	South African helmeted terrapin	Not	x				

3. Frogs

[1]IUCN category
[2]Western Cape Nature and Environmental Conservation Ordinance (WCNECO)
[3]Northern Cape Nature Conservation Act (NCCA)

Family	Scientific name	Common name	IUCN category[1]	WCNECO[2] Sch 2 PWA	NCNCA[3] Sch 2 PS	ToPs
Bufonidae	Poyntonophrynus vertebralis	Southern pygmy toad	LC	x	x	
Bufonidae	Sclerophrys capensis	Raucous toad	LC	x	x	
Bufonidae	Vandijkophrynus gariepensis gariepensis	Karoo toad (subsp. gariepensis)	LC	x	x	
Hyperoliidae	Kassina senegalensis	Bubbling kassina	LC	x	x	
Pipidae	Xenopus laevis	Common platanna	LC	x	x	
Pyxicephalidae	Amietia fuscigula	Cape river frog	LC	x	x	
Pyxicephalidae	Amietia poyntoni	Poynton's river frog	LC	x	x	
Pyxicephalidae	Cacosternum boettgeri	Common caco	LC	x	x	
Pyxicephalidae	Cacosternum karooicum	Karoo caco	LC	x	x	
Pyxicephalidae	Pyxicephalus adspersus	Giant bull frog	NT	x	Sch 2 SPS	Prot
Pyxicephalidae	Strongylopus grayii	Clicking stream frog	LC	x	x	
Pyxicephalidae	Tomopterna cryptotis	Tremelo sand frog	LC	x	x	
Pyxicephalidae	Tomopterna delalandii	Cape sand frog	LC	x	x	
Pyxicephalidae	Tomopterna tandyi	Tandy's sand frog	LC	x	x	

4. Avifauna

[1]IUCN category
[2]Western Cape Nature and Environmental Conservation Ordinance (WCNECO)
[3]Northern Cape Nature Conservation Act (NCCA)
[4]Animals observed during September/October 2020 site visit

Family	Species	Common name	IUCN[1] (RSA, global)	WCNECO[2]	NCNCA[3] SCH 1 SPS	NCNCA[3] SCH 2 PS	ToPS	CITES	CURRENT[4]
Accipitridae	*Milvus aegyptius*	Yellow-billed Kite		x					
Accipitridae	*Polemaetus bellicosus*	Martial eagle	EN, VU	x	x		VU		
Accipitridae	*Polyboroides typus*	African harrier-hawk		x	x				
Acrocephalidae	*Acrocephalus baeticatus*	African reed-warbler		x		x			
Acrocephalidae	*Acrocephalus gracilirostris*	Lesser swamp-warbler		x		x			
Acrocephalidae	*Acrocephalus palustris*	Marsh warbler		x		x			
Alaudidae	*Calandrella cinerea*	Red-capped lark		x		x			
Alaudidae	*Certhilauda curvirostris*	Cape long-billed lark		x		x			
Alaudidae	*Certhilauda semitorquata*	Eastern long-billed lark		x		x			
Alaudidae	*Certhilauda subcoronata*	Karoo long-billed lark		x		x			
Alaudidae	*Chersomanes albofasciata*	Spike-heeled lark		x		x			
Alaudidae	*Eremopterix australis*	Black-eared sparrowlark		x		x			
Alaudidae	*Eremopterix verticalis*	Grey-backed sparrowlark		x		x			
Alaudidae	*Galerida magnirostris*	Large-billed lark		x		x			
Alaudidae	*Mirafra fasciolata*	Eastern clapper lark		x		x			
Alaudidae	*Spizocorys conirostris*	Pink-billed lark		x		x			
Alaudidae	*Spizocorys sclateri*	Sclater's lark	NT, NT	x	x				
Alcedinidae	*Alcedo cristata*	Malachite kingfisher		x		x			
Alcedinidae	*Ceryle rudis*	Pied kingfisher		x		x			
Alcedinidae	*Halcyon albiventris*	Brown-hooded Kingfisher		x		x			
Alcedinidae	*Megaceryle maximus*	Giant kingfisher		x		x			
Anatidae	*Alopochen aegyptiacus*	Egyptian goose		x		x			
Anatidae	*Anas capensis*	Cape teal		x		x			
Anatidae	*Anas erythrorhyncha*	Red-billed teal		x		x			
Anatidae	*Anas smithii*	Cape shoveler		x		x			
Anatidae	*Anas sparsa*	African black duck		x		x			
Anatidae	*Anas undulata*	Yellow-billed duck		x		x			
Anatidae	*Dendrocygna viduata*	White-faced duck		x		x			
Anatidae	*Netta erythrophthalma*	Southern pochard		x		x			
Anatidae	*Oxyura maccoa*	Maccoa duck	NT, VU	x		x			
Anatidae	*Plectropterus gambensis*	Spur-winged goose		x		x			
Anatidae	*Tadorna cana*	South African shelduck		x		x			
Anhingidae	*Anhinga rufa*	African darter		x		x			
Apodidae	*Apus affinis*	Little swift		x		x			
Apodidae	*Apus apus*	Common swift		x		x			
Apodidae	*Apus barbatus*	African black swift		x		x			
Apodidae	*Apus caffer*	White-rumped Swift		x		x			
Apodidae	*Cypsiurus parvus*	African palm-swift		x		x			
Apodidae	*Tachymarptis melba*	Alpine swift		x		x			
Ardeidae	*Ardea cinerea*	Grey heron		x		x			
Ardeidae	*Ardea melanocephala*	Black-headed heron		x		x			
Ardeidae	*Ardeola ralloides*	Squacco heron		x		x			
Ardeidae	*Bubulcus ibis*	Cattle egret		x		x			
Ardeidae	*Egretta garzetta*	Little egret		x		x			
Ardeidae	*Ixobrychus minutus*	Common little bittern		x		x			
Ardeidae	*Nycticorax nycticorax*	Black-crowned night-heron		x		x			
Bucerotidae	*Tockus leucomelas*	Southern yellow-billed hornbill		x		x			
Burhinidae	*Burhinus capensis*	Spotted thick-knee		x		x			
Burhinidae	*Burhinus vermiculatus*	Water thick-knee		x		x			
Alaudidae	*Calendulauda albescens*	Karoo lark		x		x			
Alaudidae	*Calendulauda sabota*	Sabota lark		x		x			
Charadriidae	*Charadrius hiaticula*	Common ringed plover		x		x			
Charadriidae	*Charadrius pecuarius*	Kittlitz's plover		x		x			
Charadriidae	*Charadrius tricollaris*	Three-banded plover		x		x			
Charadriidae	*Vanellus armatus*	Blacksmith lapwing		x		x			
Charadriidae	*Vanellus coronatus*	Crowned lapwing		x		x			
Charadriiformes	*Glareola nordmanni*	Black-winged pratincole	NT, NT	x	x				

Ciconiidae	*Ciconia ciconia*	White stork		x		x			
Ciconiidae	*Ciconia nigra*	Black stork	VU, LC	x	x		VU	App II	
Ciconiidae	*Leptoptilos crumeniferus*	Marabou stork	NT, LC	x	x				
Ciconiidae	*Mycteria ibis*	Yellow-billed stork	EN, LC	x	x				
Ciconiidae	*Phoenicopterus minor*	Lesser flamingo		x	x			App II	
Ciconiidae	*Phoenicopterus roseus*	Greater flamingo	NT, LC	x	x			App II	
Cisticolidae	*Apalis thoracica*	Bar-throated apalis		x		x			
Cisticolidae	*Cisticola aridulus*	Desert cisticola		x		x			
Cisticolidae	*Cisticola fulvicapilla*	Neddicky neddicky		x		x			
Cisticolidae	*Cisticola juncidis*	Zitting cisticola		x		x			
Cisticolidae	*Cisticola subruficapilla*	Grey-backed cisticola		x		x			
Cisticolidae	*Cisticola tinniens*	Levaillant's cisticola		x		x			
Cisticolidae	*Eremomela gregalis*	Karoo eremomela		x		x			
Cisticolidae	*Eremomela icteropygialis*	Yellow-bellied eremomela		x		x			
Cisticolidae	*Euryptila subcinnamomea*	Cinnamon-breasted warbler		x		x			
Cisticolidae	*Malcorus pectoralis*	Rufous-eared warbler		x		x			
Cisticolidae	*Phragmacia substriata*	Namaqua warbler		x		x			
Cisticolidae	*Prinia flavicans*	Black-chested prinia		x		x			
Cisticolidae	*Prinia maculosa*	Karoo prinia		x		x			
Coliidae	*Colius colius*	White-backed mousebird							
Coliidae	*Colius striatus*	Speckled mousebird							
Coliidae	*Urocolius indicus*	Red-faced mousebird							
Columbidae	*Columba guinea*	Speckled pigeon		x		x			x
Columbidae	*Columba livia*	Rock dove		x		x			
Columbidae	*Oena capensis*	Namaqua dove		x		x			
Columbidae	*Streptopelia capicola*	Cape turtle-dove		x		x			
Columbidae	*Streptopelia semitorquata*	Red-eyed dove		x		x			
Columbidae	*Streptopelia senegalensis*	Laughing dove		x		x			
Corvidae	*Corvus albicollis*	White-necked daven		x		x			
Corvidae	*Corvus albus*	Pied crow							X
Corvidae	*Corvus capensis*	Cape crow							
Cuculidae	*Chrysococcyx caprius*	Diderick cuckoo		x		x			
Cuculidae	*Clamator glandarius*	Great spotted cuckoo		x		x			
Dicruridae	*Dicrurus adsimilis*	Fork-tailed drongo		x		x			
Emberizidae	*Emberiza capensis*	Cape bunting		x		x			
Emberizidae	*Emberiza flaviventris*	Golden-breasted bunting		x		x			
Emberizidae	*Emberiza impetuani*	Lark-like bunting		x		x			
Emberizidae	*Emberiza tahapisi*	Cinnamon-breasted bunting		x		x			
Estrildidae	*Amadina erythrocephala*	Red-headed finch		x		x			
Estrildidae	*Estrilda astrild*	Common waxbill		x		x			
Estrildidae	*Lagonosticta rubricata*	African firefinch		x		x			
Estrildidae	*Lagonosticta senegala*	Red-billed firefinch		x		x			
Estrildidae	*Ortygospiza atricollis*	African quailfinch		x		x			
Falconiformis	*Accipiter melanoleucus*	Black sparrowhawk		x	x			App II	
Falconiformis	*Accipiter rufiventris*	Rufous-chested sparrowhawk		x	x			App II	
Falconiformis	*Aquila pennatus*	Booted eagle		x	x			App II	
Falconiformis	*Aquila verreauxii*	Verreaux's eagle	VU, LC	x	x			App II	
Falconiformis	*Buteo rufofuscus*	Jackal buzzard		x	x			App II	
Falconiformis	*Buteo vulpinus*	Steppe buzzard		x	x			App II	
Falconiformis	*Circaetus cinereus*	Brown snake-eagle		x	x			App II	
Falconiformis	*Circaetus pectoralis*	Black-chested snake-eagle		x	x			App II	
Falconiformis	*Circus maurus*	Black harrier	EN, EN	x	x			App II	
Falconiformis	*Elanus caeruleus*	Black-shouldered kite		x	x			App II	
Falconiformis	*Falco amurensis*	Amur falcon		x	x			App II	
Falconiformis	*Falco biarmicus*	Lanner falcon	VU, LC	x	x			App II	
Falconiformis	*Falco naumanni*	Lesser kestrel		x	x		VU	App II	X
Falconiformis	*Falco peregrinus*	Peregrine falcon		x	x		VU	App I	
Falconiformis	*Falco rupicoloides*	Greater kestrel		x	x			App II	
Falconiformis	*Falco rupicolus*	Rock kestrel		x	x			App II	
Falconiformis	*Falco subbuteo*	Eurasian hobby		x	x			App II	
Falconiformis	*Haliaeetus vocifer*	African fish-eagle		x	x			App II	
Falconiformis	*Melierax canorus*	Southern pale chanting goshawk		x	x			App II	X
Falconiformis	*Melierax gabar*	Gabar goshawk		x	x			App II	
Fringillidae	*Crithagra albogularis*	White-throated canary		x		x			
Fringillidae	*Crithagra atrogularis*	Black-throated canary		x		x			
Fringillidae	*Crithagra flaviventris*	Yellow canary		x		x			
Fringillidae	*Crithagra gularis*	Streaky-headed seedeater		x		x			
Fringillidae	*Serinus alario*	Black-headed canary		x		x			
Fringillidae	*Serinus canicollis*	Cape canary		x		x			
Glareolidae	*Cursorius rufus*	Burchell's courser	VU, LC	x		x			
Glareolidae	*Cursorius temminckii*	Temminck's courser		x		x			

Glareolidae	*Rhinoptilus africanus*	Double-banded courser		x		x			
Gruidae	*Grus paradisea*	Blue crane	NT, VU	x			EN	App II	
Hirundinidae	*Delichon urbicum*	Common house-martin		x		x			
Hirundinidae	*Hirundo albigularis*	White-throated swallow		x		x			
Hirundinidae	*Hirundo cucullata*	Greater striped swallow		x		x			
Hirundinidae	*Hirundo dimidiata*	Pearl-breasted swallow		x		x			
Hirundinidae	*Hirundo fuligula*	Rock martin		x		x			
Hirundinidae	*Hirundo rustica*	Barn swallow		x		x			
Hirundinidae	*Hirundo spilodera*	South African cliff-swallow		x		x			
Hirundinidae	*Riparia cincta*	Banded martin		x		x			
Hirundinidae	*Riparia paludicola*	Brown-throated martin		x		x			
Indicatoridae	*Indicator indicator*	Greater honeyguide		x		x			
Indicatoridae	*Indicator minor*	Lesser honeyguide		x		x			
Laniidae	*Lanius collaris*	Common fiscal		x		x			
Laniidae	*Lanius collurio*	Red-backed shrike		x		x			
Laridae	*Chlidonias hybrida*	Whiskered tern		x		x			
Laridae	*Chlidonias leucopterus*	White-winged tern		x		x			
Laridae	*Larus cirrocephalus*	Grey-headed gull		x		x			
Locustellidae	*Bradypterus baboecala*	Little rush-warbler		x		x			
Lybiidae	*Tricholaema leucomelas*	Acacia pied barbet		x		x			
Macrosphenidae	*Sylvietta rufescens*	Long-billed crombec		x		x			
Malaconotidae	*Laniarius ferrugineus*	Southern boubou		x		x			
Malaconotidae	*Tchagra tchagra*	Southern tchagra		x		x			
Malaconotidae	*Telophorus zeylonus*	Bokmakierie		x		x			
Meropidae	*Merops apiaster*	European bee-eater		x		x			
Meropidae	*Merops bullockoides*	White-fronted bee-eater		x		x			
Monarchidae	*Terpsiphone viridis*	African paradise-flycatcher		x		x			
Motacillidae	*Anthus cinnamomeus*	African pipit		x		x			
Motacillidae	*Anthus crenatus*	African rock pipit	NT, LC	x		x			
Motacillidae	*Anthus leucophrys*	Plain-backed pipit		x		x			
Motacillidae	*Anthus similis*	Nicholson's pipit		x		x			
Motacillidae	*Anthus similis*	Long-billed pipit		x		x			
Motacillidae	*Anthus vaalensis*	Buffy pipit		x		x			
Motacillidae	*Motacilla capensis*	Cape wagtail		x		x			
Muscicapidae	*Bradornis infuscatus*	Chat flycatcher		x		x			
Muscicapidae	*Cercotrichas coryphoeus*	Karoo scrub-robin		x		x			
Muscicapidae	*Cossypha caffra*	Cape robin-chat		x		x			
Muscicapidae	*Monticola brevipes*	Short-toed rock-thrush		x		x			
Muscicapidae	*Monticola rupestris*	Cape rock-thrush		x		x			
Muscicapidae	*Muscicapa striata*	Spotted flycatcher		x		x			
Muscicapidae	*Myrmecocichla formicivora*	Southern anteating chat		x		x			
Muscicapidae	*Oenanthe monticola*	Mountain wheatear		x		x			
Muscicapidae	*Oenanthe pileata*	Capped wheatear		x		x			
Muscicapidae	*Saxicola torquatus*	African stonechat		x		x			
Muscicapidae	*Sigelus silens*	Fiscal flycatcher		x		x			
Muscicapidae.	*Cercomela familiaris*	Familiar chat		x		x			
Muscicapidae.	*Cercomela schlegelii*	Karoo chat		x		x			
Muscicapidae.	*Cercomela sinuata*	Sickle-winged chat		x		x			
Muscicapidae.	*Cercomela tractrac*	Tractrac chat		x		x			
Nectariniidae	*Anthobaphes violacea*	Orange-breasted sunbird		x		x			
Nectariniidae	*Cinnyris chalybeus*	Southern double-collared sunbird		x		x			
Nectariniidae	*Cinnyris fuscus*	Dusky sunbird		x		x			
Nectariniidae	*Cinnyris talatala*	White-bellied sunbird		x		x			
Nectariniidae	*Nectarinia famosa*	Malachite sunbird		x		x			
Numididae	*Numida meleagris*	Helmeted guineafowl		x		x			
Oriolidae	*Oriolus oriolus*	Eurasian golden oriole		x		x			
Otididae	*Afrotis afra*	Southern black korhaan	VU, VU	x		x			
Otididae	*Afrotis afraoides*	Northern black korhaan		x		x			
Otididae	*Ardeotis kori*	Kori bustard	NT, NT	x			VU	App II	
Otididae	*Eupodotis vigorsii*	Karoo korhaan	NT, LC	x		x			
Otididae	*Neotis ludwigii*	Ludwig's bustard	EN, EN	x	x		VU		X
Paridae	*Melaniparus afer*	Grey tit		x		x			
Passeridae	*Passer diffusus*	Southern grey-headed sparrow		x		x			
Passeridae	*Passer domesticus*	House sparrow							
Passeridae	*Passer melanurus*	Cape sparrow							
Phalacrocoracidae	*Phalacrocorax africanus*	Reed cormorant		x		x			
Phalacrocoracidae	*Phalacrocorax carbo*	White-breasted cormorant		x		x			
Phasianidae	*Coturnix coturnix*	Common quail		x		x			
Phasianidae	*Pavo cristatus*	Indian peafowl		x		x			
Phasianidae	*Pternistis capensis*	Cape spurfowl		x		x			
Phasianidae	*Scleroptila africanus*	Grey-winged francolin		x		x			

Phoeniculidae	*Phoeniculus purpureus*	Green wood-hoopoe		x		x		
Phylloscopidae	*Phylloscopus trochilus*	Willow warbler		x		x		
Picidae	*Dendropicos fuscescens*	Cardinal woodpecker		x		x		
Picidae	*Geocolaptes olivaceus*	Ground woodpecker	LC, NT	x		x		
Platysteiridae	*Batis pririt*	Pririt batis		x		x		
Ploceidae	*Euplectes afer*	Yellow-crowned bishop		x		x		
Ploceidae	*Euplectes orix*	Southern red bishop				x		
Ploceidae	*Philetairus socius*	Sociable weaver		x		x		
Ploceidae	*Ploceus capensis*	Cape weaver						
Ploceidae	*Ploceus velatus*	Southern masked-weaver						
Ploceidae	*Quelea quelea*	Red-billed quelea						
Ploceidae	*Sporopipes squamifrons*	Scaly-feathered finch		x		x		
Podicipedidae	*Podiceps cristatus*	Great crested grebe		x		x		
Podicipedidae	*Podiceps nigricollis*	Black-necked grebe		x		x		
Podicipedidae	*Tachybaptus ruficollis*	Little grebe		x		x		
Pteroclidae	*Pterocles namaqua*	Namaqua sandgrouse		x		x		X
Pycnonotidae	*Pycnonotus nigricans*	African red-eyed bulbul						
Rallidae	*Crecopsis egregia*	African crake		x		x		
Rallidae	*Fulica cristata*	Red-knobbed coot		x		x		
Rallidae	*Gallinula chloropus*	Common moorhen		x		x		
Recurvirostridae	*Himantopus himantopus*	Black-winged stilt		x		x		
Recurvirostridae	*Recurvirostra avosetta*	Pied avocet		x		x		
Remizidae	*Anthoscopus minutus*	Cape penduline-tit		x		x		
Sagittariidae	*Sagittarius serpentarius*	Secretarybird	VU, VU	x	x			
Scolopacidae	*Actitis hypoleucos*	Common sandpiper		x		x		
Scolopacidae	*Arenaria interpres*	Ruddy turnstone		x		x		
Scolopacidae	*Calidris ferruginea*	Curlew sandpiper	LC, NT	x		x		
Scolopacidae	*Calidris minuta*	Little stint		x		x		
Scolopacidae	*Gallinago nigripennis*	African snipe		x		x		
Scolopacidae	*Philomachus pugnax*	Ruff ruff		x		x		
Scolopacidae	*Tringa glareola*	Wood sandpiper		x		x		
Scolopacidae	*Tringa nebularia*	Common greenshank		x		x		
Scolopacidae	*Tringa stagnatilis*	Marsh sandpiper		x		x		
Scopidae	*Scopus umbretta*	Hamerkop		x		x		X
Stenostiridae	*Stenostira scita*	Fairy flycatcher		x		x		
Strigiformes	*Caprimulgus pectoralis*	Fiery-necked ightjar		x	x		App II	
Strigiformes	*Caprimulgus rufigena*	Rufous-cheeked nightjar		x	x		App II	
Strigiformes	*Caprimulgus tristigma*	Freckled nightjar		x	x		App II	
Strigiformes	*Tyto alba*	Barn owl		x	x		App II	
Strigiformis	*Bubo africanus*	Spotted eagle-owl		x	x		App II	
Strigiformis	*Bubo capensis*	Cape eagle-owl		x	x		App II	
Strigiformis	*Glaucidium perlatum*	Pearl-spotted owlet		x	x		App II	
Struthionidae	*Struthio camelus*	Common ostrich		x		x		
Sturnidae	*Creatophora cinerea*	Wattled starling		x		x		
Sturnidae	*Lamprotornis nitens*	Cape starling		x		x		
Sturnidae	*Onychognathus morio*	Red-winged starling						
Sturnidae	*Onychognathus nabouroup*	Pale-winged starling		x		x		
Sturnidae	*Spreo bicolor*	Pied starling		x		x		
Sturnidae	*Sturnus vulgaris*	Common starling						
Sylviidae	*Parisoma layardi*	Layard's tit-babbler		x		x		
Sylviidae	*Parisoma subcaeruleum*	Chestnut-vented tit-babbler		x		x		
Sylviidae	*Sylvia borin*	Garden warbler		x		x		
Threskiornithidae	*Bostrychia hagedash*	Hadeda ibis		x		x		
Threskiornithidae	*Platalea alba*	African spoonbill		x		x		
Threskiornithidae	*Plegadis falcinellus*	Glossy ibis		x		x		
Threskiornithidae	*Threskiornis aethiopicus*	African sacred ibis		x		x		
Turdidae	*Turdus smithi*	Karoo thrush		x		x		
Upupidae	*Upupa africana*	African hoopoe		x		x		
Viduidae	*Vidua chalybeata*	Village indigobird		x		x		
Viduidae	*Vidua macroura*	Pin-tailed whydah		x		x		
Viduidae	*Vidua paradisaea*	Long-tailed paradise-whydah		x		x		
Zosteropidae	*Zosterops pallidus*	Orange river white-eye		x		x		
Zosteropidae	*Zosterops virens*	Cape white-eye		x		x		

5. Scorpions

Family	Scientific name	NCNCA
BUTHIDAE	*Parabuthus capensis*	
BUTHIDAE	*Parabuthus granulatus*	
BUTHIDAE	*Parabuthus laevifrons*	
BUTHIDAE	*Parabuthus nanus*	
BUTHIDAE	*Parabuthus schlechteri*	
BUTHIDAE	*Uroplectes sp.*	
BUTHIDAE	*Uroplectes carinatus*	
BUTHIDAE	*Uroplectes gracilior*	
BUTHIDAE	*Uroplectes schlechteri*	
HORMURIDAE	*Hadogenes* sp.	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus austerus*	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus carinatus*	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus crassimanus*	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus karrooensis*	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus lornae*	Sch 2 PS
SCORPIONIDAE	*Opistophthalmus pictus*	Sch 2 PS

6. Spiders

Family	Scientific name	Common name	NCNCA
Araneidae	*Argiope sp.*	Garden orb-web spiders	Sch 3
Araneidae	*Argiope australis*	Common garden orb-web spiders	Sch 3
Araneidae	*Nemoscolus sp.*	Stone nest spiders	Sch 3
Araneidae	*Neoscona sp.*	Neoscona hairy field spiders	Sch 3
Caponiidae	*Caponia sp.*	Eight-eyed orange lungless spiders	Sch 3
Eresidae	*Seothyra sp.*	Buckspoor or bokspoor spiders	Sch 3
Eresidae	*Stegodyphus sp.*	Community nest spiders	Sch 3
Eresidae	*Stegodyphus mimosarum*	Bush-legged stegodyphus	Sch 3
Eresidae	*Stegodyphus tentoriicola*	Pale stegodyphus	Sch 3
Eutichuridae	*Cheiracanthium sp.*	Sac spiders	Sch 3
Gnaphosidae	*Drassodes sp.*	Dark-face ground spiders	Sch 3
Lycosidae	*Hogna sp.*	Burrowing wolf spiders	Sch 3
Nemesiidae	*Hermacha sp.*		Sch 3
Oecobiidae	*Oecobius sp.*	Dwarf round headed spiders	Sch 3
Oecobiidae	*Oecobius navus*	House ant-eating spiders	Sch 3
Palpimanidae	*Palpimanus namaquensis*	Namaqua palp-footed spiders	Sch 3
Philodromidae	*Thanatus sp.*	running spiders	Sch 3
Pisauridae	*Rothus sp.*	Crowned pisaurids	Sch 3
Salticidae	*Mexcala elegans*	Elegant mexcala ant-like jumping spiders	Sch 3
Salticidae	*Mexcala rufa*	Scaly mexcala ant-like jumping spiders	Sch 3
Sparassidae	*Olios sp.*	huntsman spiders	Sch 3
Sparassidae	*Palystes sp.*	Rain spiders	Sch 3
Theraphosidae	*Harpactira baviana*	Baboon spiders	Sch 1 SPS
Theraphosidae	*Harpactira namaquensis*	Baboon spiders	Sch 1 SPS
Theraphosidae	*Harpactirella sp.*	Baboon spiders	Sch 3
Theridiidae	*Latrodectus geometricus*	Common brown button spiders	Sch 3
Thomisidae	*Xysticus sp.*	crab spiders	Sch 3
Zodariidae	*Cicynethus sp.*	burrowing zodariids & ant-eating spiders	Sch 3
Zodariidae	*Psammorygma sp.*	Tunnelling zodariids	Sch 3

7. Dung beetles

Family	Scientific name
Scarabaeidae	Digitonthophagus sp.
Scarabaeidae	Gymnopleurus humanus
Scarabaeidae	Metacatharsius marani
Scarabaeidae	Onthophagus fritschi
Scarabaeidae	Scarabaeus basuto
Scarabaeidae	Scarabaeus bohemani
Scarabaeidae	Scarabaeus fritschi
Scarabaeidae	Scarabaeus megaparvulus
Scarabaeidae	Scarabaeus parvulus
Scarabaeidae	Scarabaeus satyrus
Scarabaeidae	Scarabaeus viator

8. Lacewings (Neuroptera)

Family	Scientific name
Ascalaphidae	Melambrotus papio
Ascalaphidae	Melambrotus simia
Ascalaphidae	Proctolyra brincki
Chrysopidae	Chrysemosa jeanneli
Chrysopidae	Chrysoperla sp.
Chrysopidae	Dichochrysa karooensis
Chrysopidae	Dichochrysa rubicunda
Chrysopidae	Dichochrysa tacta
Chrysopidae	Italochrysa neurodes
Coniopterygidae	Aleuropteryx ohmi
Myrmeleontidae	Centroclisis maligna
Myrmeleontidae	Centroclisis mendax
Myrmeleontidae	Crambomorphus sinuatus
Myrmeleontidae	Creoleon sp.
Myrmeleontidae	Creoleon africanus
Myrmeleontidae	Creoleon mortifer
Myrmeleontidae	Cueta infima
Myrmeleontidae	Cueta trivirgata
Myrmeleontidae	Cymothales illustris
Myrmeleontidae	Furgella damarinus
Myrmeleontidae	Golafrus oneili
Myrmeleontidae	Myrmeleon alcestris
Myrmeleontidae	Myrmeleon doralice
Myrmeleontidae	Myrmeleon obscurus
Myrmeleontidae	Nannoleon michaelseni
Myrmeleontidae	Nemoleon delicatus
Myrmeleontidae	Nesoleon boschimanus
Myrmeleontidae	Nesoleon braunsi
Myrmeleontidae	Neuroleon chloranthe
Myrmeleontidae	Obus capensis
Myrmeleontidae	Obus elizabethae
Myrmeleontidae	Palparellus dubiosus
Myrmeleontidae	Palparellus pulchellus
Myrmeleontidae	Palpares elegantulus
Myrmeleontidae	Palpares immensus
Myrmeleontidae	Palpares karrooanus
Myrmeleontidae	Palpares speciosus
Myrmeleontidae	Palparidius capicola
Myrmeleontidae	Pamexis karoo
Nemopteridae	Laurhervasia setacea
Nemopteridae	Nemia karrooa
Nemopteridae	Nemopterella sp.
Nemopteridae	Nemopterella peringueyi
Psychopsidae	Silveira jordani

9. Butterflies (Lepidoptera)

Family	Scientific name	IUCN category	NCNCA
CRAMBIDAE	Bocchoris inspersalis	Not listed	
CRAMBIDAE	Loxostege frustalis	Not listed	
ELACHISTIDAE	Ethmia sp.		
EREBIDAE	Achaea catella	Not listed	
EREBIDAE	Amata alicia		
EREBIDAE	Bracharoa quadripunctata	Not listed	
EREBIDAE	Cerocala vermiculosa	Not listed	
EREBIDAE	Cyligramma latona	Not listed	
EREBIDAE	Eilema sanguicosta	Not listed	
EREBIDAE	Eublemma seminivea	Not listed	
EREBIDAE	Grammodes stolida	Not listed	
EREBIDAE	Leucaloa eugraphica	Not listed	
EREBIDAE	Ophiusa mejanesi	Not listed	
EREBIDAE	Ophiusa tirhaca		
EREBIDAE	Sozusa scutellata	Not listed	
EREBIDAE	Sphingomorpha chlorea	Not listed	
EREBIDAE	Tytroca metaxantha	Not listed	
EREBIDAE	Utetheisa pulchella	Not listed	
GEOMETRIDAE	Acanthovalva focularia	NT	
GEOMETRIDAE	Anthemoctena textilis	NT	
GEOMETRIDAE	Chiasmia subcurvaria	Not listed	
GEOMETRIDAE	Drepanogynis sp.		
GEOMETRIDAE	Drepanogynis bifasciata	NT	
GEOMETRIDAE	Drepanogynis tripartita	NT	
GEOMETRIDAE	Eulycia sp.		
GEOMETRIDAE	Eulycia grisea grisea	NT	
GEOMETRIDAE	Eupithecia sp.		
GEOMETRIDAE	Isturgia catalaunaria		
GEOMETRIDAE	Isturgia deerraria	NT	
GEOMETRIDAE	Prasinocyma sp.		
GEOMETRIDAE	Rhodometra participata	NT	
GEOMETRIDAE	Rhodometra sacraria	NT	
GEOMETRIDAE	Scopula sp.		
HESPERIIDAE	Alenia sandaster	LC	Sch 2 PS
HESPERIIDAE	Borbo fatuellus fatuellus	LC	Sch 2 PS
HESPERIIDAE	Coeliades pisistratus	LC	Sch 2 PS
HESPERIIDAE	Gomalia elma elma	LC	Sch 2 PS
HESPERIIDAE	Sarangesa phidyle	LC	Sch 2 PS
HESPERIIDAE	Spialia agylla agylla	LC	Sch 2 PS
HESPERIIDAE	Spialia ferax	LC	Sch 2 PS
HESPERIIDAE	Spialia nanus	LC	Sch 2 PS
HESPERIIDAE	Spialia sataspes	LC	Sch 2 PS
HESPERIIDAE	Spialia spio	LC	Sch 2 PS
HESPERIIDAE	Tagiades flesus	LC	Sch 2 PS
LASIOCAMPIDAE	Streblote sp.		
LYCAENIDAE	Aloeides caledoni	LC	Sch 2 PS
LYCAENIDAE	Aloeides damarensis damarensis	LC	Sch 2 PS
LYCAENIDAE	Aloeides depicta	LC	Sch 2 PS
LYCAENIDAE	Aloeides kaplani	LC	Sch 2 PS
LYCAENIDAE	Aloeides macmasteri	LC	Sch 2 PS
LYCAENIDAE	Aloeides pallida pallida	LC	Sch 2 PS
LYCAENIDAE	Aloeides pierus	LC	Sch 2 PS
LYCAENIDAE	Aloeides vansoni	LC	Sch 2 PS
LYCAENIDAE	Anthene amarah amarah	LC	Sch 2 PS
LYCAENIDAE	Argyraspodes argyraspis	LC	Sch 2 PS
LYCAENIDAE	Azanus jesous	LC	Sch 2 PS
LYCAENIDAE	Azanus moriqua	LC	Sch 2 PS
LYCAENIDAE	Azanus ubaldus	LC	Sch 2 PS
LYCAENIDAE	Brephidium metophis	LC	Sch 2 PS
LYCAENIDAE	Cacyreus fracta fracta	LC	Sch 2 PS
LYCAENIDAE	Cacyreus marshalli	LC	Sch 2 PS
LYCAENIDAE	Chilades trochylus	LC	Sch 2 PS
LYCAENIDAE	Chrysoritis beaufortia beaufortia	LC	Sch 2 PS

LYCAENIDAE	Chrysoritis chrysantas	LC	Sch 2 PS
LYCAENIDAE	Chrysoritis chrysaor	LC	Sch 2 PS
LYCAENIDAE	Chrysoritis midas	LC	Sch 2 PS
LYCAENIDAE	Chrysoritis pan lysander	LC	Sch 2 PS
LYCAENIDAE	Crudaria leroma	LC	Sch 2 PS
LYCAENIDAE	Cupidopsis jobates jobates	LC	Sch 2 PS
LYCAENIDAE	Deudorix antalus	LC	Sch 2 PS
LYCAENIDAE	Eicochrysops messapus messapus	LC	Sch 2 PS
LYCAENIDAE	Harpendyreus notoba	LC	Sch 2 PS
LYCAENIDAE	Hypolycaena philippus philippus	LC	Sch 2 PS
LYCAENIDAE	Lampides boeticus	LC	Sch 2 PS
LYCAENIDAE	Leptomyrina lara	LC	Sch 2 PS
LYCAENIDAE	Leptotes pirithous pirithous	LC	Sch 2 PS
LYCAENIDAE	Lycaena clarki	LC	Sch 2 PS
LYCAENIDAE	Oraidium barberae	LC	Sch 2 PS
LYCAENIDAE	Stugeta bowkeri bowkeri	LC	Sch 2 PS
LYCAENIDAE	Thestor protumnus aridus	LC	Sch 2 PS
LYCAENIDAE	Trimenia macmasteri macmasteri	LC	Sch 2 PS
LYCAENIDAE	Trimenia wykehami	LC	Sch 2 PS
LYCAENIDAE	Tuxentius melaena melaena	LC	Sch 2 PS
LYCAENIDAE	Tylopaedia sardonyx sardonyx	LC	Sch 2 PS
LYCAENIDAE	Zizeeria knysna knysna	LC	Sch 2 PS
LYCAENIDAE	Zizula hylax	LC	Sch 2 PS
NOCTUIDAE	Helicoverpa armigera armigera	Not listed	
NOCTUIDAE	Heliothis scutuligera	Not listed	
NOCTUIDAE	Ozarba hemiochra hemiochra	Not listed	
NOCTUIDAE	Proschaliphora albida	Not listed	
NOCTUIDAE	Proschaliphora butti	Not listed	
NOCTUIDAE	Pseudozarba opella	Not listed	
NYMPHALIDAE	Acraea horta	LC	Sch 2 PS
NYMPHALIDAE	Acraea natalica	LC	Sch 2 PS
NYMPHALIDAE	Acraea neobule neobule	LC	Sch 2 PS
NYMPHALIDAE	Acraea trimeni	LC	Sch 2 PS
NYMPHALIDAE	Bicyclus anynana anynana	LC	Sch 2 PS
NYMPHALIDAE	Byblia ilithyia	LC	Sch 2 PS
NYMPHALIDAE	Cassionympha detecta	LC	Sch 2 PS
NYMPHALIDAE	Charaxes zoolina	LC	Sch 2 PS
NYMPHALIDAE	Coenyropsis bera		Sch 2 PS
NYMPHALIDAE	Danaus chrysippus orientis	LC	Sch 2 PS
NYMPHALIDAE	Hypolimnas anthedon wahlbergi	LC	Sch 2 PS
NYMPHALIDAE	Hypolimnas misippus	LC	Sch 2 PS
NYMPHALIDAE	Junonia hierta cebrene	LC	Sch 2 PS
NYMPHALIDAE	Junonia oenone oenone	LC	Sch 2 PS
NYMPHALIDAE	Melampias huebneri huebneri	LC	Sch 2 PS
NYMPHALIDAE	Melanitis leda	LC	Sch 2 PS
NYMPHALIDAE	Protogoniomorpha parhassus	LC	Sch 2 PS
NYMPHALIDAE	Pseudonympha southeyi wykehami	LC	Sch 2 PS
NYMPHALIDAE	Pseudonympha trimenii nieuwveldensis	LC	Sch 2 PS
NYMPHALIDAE	Sevenia boisduvali boisduvali	LC	Sch 2 PS
NYMPHALIDAE	Sevenia natalensis	LC	Sch 2 PS
NYMPHALIDAE	Stygionympha irrorata	LC	Sch 2 PS
NYMPHALIDAE	Stygionympha robertsoni	LC	Sch 2 PS
NYMPHALIDAE	Tarsocera fulvina	LC	Sch 2 PS
NYMPHALIDAE	Telchinia serena	LC	Sch 2 PS
NYMPHALIDAE	Torynesis magna	LC	Sch 2 PS
NYMPHALIDAE	Vanessa cardui	LC	Sch 2 PS
NYMPHALIDAE	Ypthima asterope hereroica	LC	Sch 2 PS
PAPILIONIDAE	Papilio dardanus cenea	LC	
PAPILIONIDAE	Papilio demodocus demodocus	LC	
PIERIDAE	Belenois aurota	LC	
PIERIDAE	Belenois creona severina	LC	
PIERIDAE	Catopsilia florella	LC	
PIERIDAE	Colias electo electo	LC	
PIERIDAE	Colotis antevippe gavisa	LC	
PIERIDAE	Colotis auxo auxo	LC	
PIERIDAE	Colotis euippe omphale	LC	
PIERIDAE	Colotis evenina evenina	LC	
PIERIDAE	Eurema brigitta brigitta	LC	
PIERIDAE	Pinacopteryx eriphia eriphia	LC	
PIERIDAE	Pontia helice helice	LC	
PIERIDAE	Teracolus subfasciatus	LC	

PYRALIDAE	Hypotia bolinalis	Not listed	
SATURNIIDAE	Heniocha apollonia	Not listed	Sch 2 PS
SPHINGIDAE	Agrius convolvuli		
SPHINGIDAE	Hyles livornica	Not listed	
SPHINGIDAE	Nephele comma	Not listed	

10. Odonata

Family	Scientific name	Common name	Red list
Aeshnidae	*Anax ephippiger*	Vagrant Emperor	LC
Aeshnidae	*Anax imperator*	Blue Emperor	LC
Aeshnidae	*Zosteraeschna minuscula*	Friendly Hawker	LC
Coenagrionidae	*Africallagma glaucum*	Swamp Bluet	LC
Coenagrionidae	*Ischnura senegalensis*	Tropical Bluetail	LC
Coenagrionidae	*Pseudagrion citricola*	Yellow-faced Sprite	LC
Libellulidae	*Crocothemis erythraea*	Broad Scarlet	LC
Libellulidae	*Orthetrum caffrum*	Two-striped Skimmer	LC
Libellulidae	*Orthetrum chrysostigma*	Epaulet Skimmer	LC
Libellulidae	*Orthetrum trinacria*	Long Skimmer	LC
Libellulidae	*Pantala flavescens*	Wandering Glider	LC
Libellulidae	*Rhyothemis semihyalina*	Phantom Flutterer	LC
Libellulidae	*Sympetrum fonscolombii*	Red-veined Darter or Nomad	LC
Libellulidae	*Tholymis tillarga*	Twister	LC
Libellulidae	*Tramea limbata*	Ferruginous Glider	LC
Libellulidae	*Trithemis arteriosa*	Red-veined Dropwing	LC
Libellulidae	*Trithemis dorsalis*	Highland Dropwing	LC
Libellulidae	*Trithemis kirbyi*	Orange-winged Dropwing	LC
Libellulidae	*Urothemis assignata*	Red Basker	LC
Libellulidae	*Zygonyx torridus*	Ringed Cascader	LC
Macromiidae	*Phyllomacromia picta*	Darting Cruiser	LC
Synlestidae	*Chlorolestes fasciatus*	Mountain Malachite	LC

APPENDIX C
Table of species encountered per habitat

NKu1 = Western Upper Karoo; NKu2 = Upper Karoo Hardeveld; NKu3 = Northern Upper Karoo; NKu4 = Eastern Upper Karoo; NKl1 = Gamka Karoo
B = Bottomlands; FS = footslopes; H = low hills; MS = midslope; M = mountain; P = plain; Pl = plateau; V = valley
c = species common; d = species dominant; x = species present

Species	NKu 1	NKu 1	NKu 1	NKu 3	NKu 4	NKu 4	NKu 4	NKu 4	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	Nku 2	NKl 1	NKl 1	NKl 1
	Fs	**H**	**P**	**P**	**B**	**Fs**	**H**	**P**	**Fs**	**H**	**M**	**MS**	**Pl**	**P**	**V**	**Fs**	**H**	**P**
Asparagus tuberosus	x																	
Cotula sp. 1			x															
Galenia meziana			x															
Sporobolus ioclados			x															
Gonialoe variegata	x		x					c										
Calobota spinescens				c														
Trifolium sp.					x													
Aloe claviflora						x												
Eragrostis annularis						x												
Tetraena lichtensteiniana						x												
Anacampseros ustulata							x											
Asparagus sp.							x											
Atriplex semibaccata							x											
Chascanum pinnatifidum							x											
Clutia thunbergii							x											
Eriospermum sp.							x											
Ifloga sp.							x											
Oropetium capense							x											
Osteospermum sinuatum							x											
Polygala leptophylla							x											
Schlechteranthus spinescens							x											
Stapelia grandiflora							x											
Tetragonia sp.							x											
Zaluzianskya venusta							x											
Afroscirpoides dioeca								x										
Anchusa riparia								x										
Mesembryanthemum noctiflorum								x										
Aristaloe aristata								x										
Asparagus exuvialis								x										
Cephalophyllum sp.								x										
Chrysocoma sp.								x										
Cotula sp. 2								x										
Crassula subaphylla								x										
Crassula vaillantii								x										
Eragrostis rotifer								x										
Eucalyptus sp.								x										
Euphorbia clavarioides								x										
Gazania rigida								x										
Gazania tenuifolia								x										
Hereroa sp.								x										
Helichrysum cf. *asperum*								x										
Helichrysum pentzioides								x										
Helichrysum sp. 1								x										
Hermannia spinosa								x										
Hesperantha cf. *cucullata*								x										
Indigastrum argyraea								x										
Lasiosiphon microcephalus								x										
Malva pusilla								x										
Pelargonium aridum								x										
Plantago lanceolata								x										
Pteronia sp.								x										
Selago saxatilis								x										
Senecio asperulus								x										
Tetraena chrysopteron								x										
Atriplex vestita					x			c										
Berkheya carlinifolia					x			c										
Eragrostis bergiana					x			c										
Heliophila crithmifolia							x	x										
Crassula corallina							x	x										
Crassula deltoidea							x	x										
Dianthus micropetalus							c	c										
Felicia hirsuta							x	x										
Ornithogalum sp.							x	x										
Pelargonium minimum							x	x										
Radyera urens							x	x										
Oedera glandulosa							x	x										
Oedera spinescens						x		x										
Lasiopogon muscoides						x	x											
Ruschia cradockensis					x		c	c										

Mesembryanthemum articulatum					x			c										
Pteronia erythrochaeta					x			x										
Schmidtia kalahariense					x			x										
Amphiglossa triflora							x	x										x
Jamesbrittenia tysonii							x	c		x								
Dicoma capensis							x	x										x
Boophone disticha							x	c			x							
Opuntia ficus-indica							x	x			x							
Peliostomum virgatum							x	x									x	
Bromus pectinatus					x			c						x				
Wahlenbergia nodosa							x	x				x						
Crassula muscosa							c	c	x									x
Osteospermum spinescens			x				d	d										
Osteospermum leptolobum			x				x	x										
Eragrostis bicolor			x		x			c										x
Euryops oligoglossus		x					x	c						x				
Helichrysum pumilio							c	x						x			x	
Indigofera meyeriana	x		x		c			c										
Ruschia intricata		x	x				d	d										
Sarcocaulon cf. *salmoniflorum*							c	c									x	x
Senecio niveus				x	c		c	c										
Euphorbia mauritanica						x	x	x	x									
Oedera humilis			c		d		c	c										
Trichodiadema sp.					x	x	x	c										
Stipagrostis ciliata				c	c		x	c									x	c
Stipagrostis obtusa				c	c	c	c	d										d
Stomatium sp.		x					x	x						x				
Tragus koelerioides			x			x	x	c										
Pteronia staehelinoides	x					c	d	d										
Albuca sp. 1			x				x	x										
Mesembryanthemum crystallinum	x		x		x	x	c	c						x				
Mesembryanthemum geniculiflorum	x		x			x	x	c	c					x				
Mesembryanthemum grossum		x	x			x	x	c										
Lessertia inflata			x	x	x	x	x	c										
Pentzia spinescens			d		x	x	c	d						c				
Ruschia spinosa			x			x	c	c	x								d	
Stachys cuneata					x	x	x	c	x		x							
Salsola spp.					x	x	c	c										x
Selago sp.				x	x		x	x				x						
Salvia verbenaca			x	x	c	x	c	c			x							
Babiana hypogaea									x									
Drimia sp.									x									
Pteronia membranacea									x									
Amphiglossa sp.											x							
Ballota africana											x							
Carissa bispinosa											x							
Clematis brachiata											x							
Cussonia paniculata											x							
Cymbopogon prolixus											x							
Eragrostis curvula											x							
Hermannia filifolia											x							
Heteromorpha arborea											x							
Pelargonium cf. *abrotanifolium*											x							
Pseudoschoenus inanus											x							
Salix capense											x							
Adromischus sp.												x						
Aizoon rigidum												x						
Asparagus laricinus												x						
Babiana sp.												x						
Chascanum garipense												x						
Crassula rupestris												x						
Delosperma sp.												x						
Enneapogon scoparius												x						
Euclea crispa												x						
Gladiolus permeabilis							x					x						
Helichrysum zeyheri								x				x						
Hermannia pulchella												x						
Kiggelaria africana												x						
Lasiopogon micropoides												x						
Lobostemon stachydeus												x						
Nenax microphylla												x						
Pachypodium succulentum												x						
Pellaea calomelanos												x						
Pentameris setifolia												x						
Senecio inaequidens												x						
Tetraena cf. microcarpa												x						
Crassula sp. 1													x					
Hermannia sp.													x					
Osteospermum sp.													x					
Dipcadi cf. *ciliare*														x				
Euphorbia inaequilatera														x				
Huernia barbata														x				
Crassothonna sp.														x				
Tetragonia spicata															x			
Ehretia rigida											x	x						
Hibiscus pusillus											x	x						
Menodora juncea											x	x						
Carissa haematocarpa											x	d						

Cheilanthus eckloniana											x	x						
Lotononis sp.											x	x						
Cissampelos capensis											x	x						
Buddleja salviifolia											x	x						
Crassula ericoides												x	x					
Mesembryanthemum cf. *granulicaule*											x		x					
Tarchonanthus minor											c	c						
Artemisia afra											x	x	x					
Gymnosporia szyszylowiczii											x	d	d					
Themeda triandra											x	c	x					
Ophioglossum sp.												x		x				
Euryops imbricatus									x			x						
Buddleja glomerata											c				x			
Asparagus retrofractus									x		c			x	d	c		
Searsia burchellii									x		d	x	c		x	c		
Vachellia karroo									x		c	c	c		d	d		x
Forsskaolea candida											x	x					x	
Grewia robusta											x	d	x			d		
Euryops abrotanifolius												x			x			x
Nemesia cf. cynanchifolia								x			x	x						
Berkheya spinosa								x			x	x						
Asparagus capensis							x				c	x	c					
Cotyledon orbiculata								c			x	c	c					
Crassula tetragona								x				x	x					
Helichrysum lucilioides								x				c	x					
Moraea sp.								x			x		x					
Dimorphotheca cuneata	x						x				x		x					
Pentameris airoides								c					x	x				
Lycium oxycarpum							x		x						c			
Arctotheca calendula								x				x	x		x			
Hermannia comosa								x		x	c				x			
Drosanthemum lique								x			x	x		x				
Eriocephalus brevifolius								d				x	x	c				
Merxmuellera disticha								c			c	x	c					
Pegolettia retrofracta							x				x	x	x					
Pentzia quinquefida							x				c	c			x			
Stachys linearis							x				c	c	x					
Phymaspermum parvifolium								x			x	x	x					
Aloe broomii							x		x		x	x	x					
Polygala ephedroides								x			x			x				
Digitaria eriantha						x			x	x	d	d	d	x				
Cadaba aphylla								x			x	x	x	x				
Crassula sp. 2								x			x	x	x	x				
Euryops sp.							x	c			x	x	x					
Melianthus comosus							x		x		d	x			d			
Hermannia coccocarpa							x	c		x		x		c				
Lepidium sp.						x	x	x			x					x		
Leysera tenella							x	c				x		x				x
Aristida diffusa						x	d	d	d		d	d	c	x				
Euryops lateriflorus							x	d	x		c		x	x				
Dicerothamnus rhinocerotis							x	d	x		c	c	c	x				
Hermannia vestita						x	x	x			c	c	x		x			
Cynodon incompletus	x				x			x	x				x					
Erodium cicutarium			x		c			c					x	x				
Melolobium canescens			x					x	x		x			x				
Moraea miniata			x				c	c	x	x	x			x				
Pteronia glomerata			x					c	x	x				x				
Septulina glauca	x		x				x	c						x				
Galenia namaensis	c		c	x	c	x	c	c	c					c				
Gazania krebsiana	x	x	c		x	c	c	c	x	x								
Oedera oppositifolia	d		d		x		d	d	v	x	x			d				
Pteronia sordida	d	x	d		c	x	d	d	c			x		x				
Asparagus suaveolens			x		d	d	d	d	x	x	x	x	x	x	x			
Chrysocoma ciliata	x	x	x		c	d	c	d	x	x	x	x	x	c				
Melolobium microphyllum	x		x		x	x	x	x	x		x	x	c	x				
Eragrostis obtusa	c	x	d		c		d	c	x			x	c	c				
Diospyros austro-africana			c				x	c	x		d	d	c	x				
Eriocephalus decussata	c		c	d	c	x		d	c					x				
Eriocephalus spinescens		c	c	d	d		c	d	c					x				
Lessertia frutescens	x	x	c			x		c			x	c			x			
Pteronia glauca		c	c	x		x	c	c	x									
Drosanthemum karrooense		c	x		x	x	c	c	c									
Tragus berteronianus			x		x		c	c				x						
Ursinia nana		x	x				x	c				x						
Felicia filifolia		x	x				x	x			c	c	d					
Ehrharta calycina		x	x				x	c					x	x				
Hermannia cuneifolia			x				c	d			x	x		x				
Melolobium candicans			x				x	x	x			x		x				
Aptosimum procumbens			x				x	x	x			x	x		x			
Stipagrostis namaquensis		x		x	x	x		c			x			x				
Conyza sp.																x		
Panicum sp.																x		
Solanum burchellii																x		
Anacampseros cf. *lanceolata*																	x	
Astroloba foliolosa																	x	
Digitaria argyrograpta																	x	
Euryops multifidus																	x	
Hermannia alnifolia																	x	

Blepharis sp. 1																							x
Chascanum pumilum																							x
Crassula cf. *subaphylla*																							x
Eragrostis echinochloidea																							x
Euphorbia cf. *decepta*																							x
Gazania lichtensteinii																							c
Kleinia longiflora																							x
Monechma sp.																							x
Prosopis glandulosa																							x
Stipagrostis uniplumis																							x
Urochloa cf. panicoides																							x
Blepharis mitrata																						x	x
Sericocoma avolans																						c	c
Trichodesma africanum																						x	x
Monechma incanum													x									x	x
Pennisetum setaceum														x						c			x
Arctotis leiocarpa				x				c												x	x	c	
Cenchrus ciliaris														x				x		x	x	x	
Rhigozum obovatum									x					d	c					d	c	c	
Heteropogon contortus													c	c	c						c	c	
Hyparrrhenia hirta													x	x							x	x	
Lacomucinaea lineata							x			x		x	c	x	x	x	x				x	d	
Aristida congesta					x		x	c						x	x						x	x	
Hermannia desertorum						c	x	d					x	x			c				x		
Limeum aethiopicum							c	c					x	c	x						x	x	
Searsia lancea								d	x			x	x	x				d		d			
Trichodiadema setuliferum						x	x	x						x			x				x	x	
Osteospermum scariosum							x	c	x			x	x	x	x					x	c	c	
Hermannia grandiflora						c	d	c	x					x								x	
Salsola kali					c		c	c	x			x	x				x			x			x
Aristida adscensionis	x			x	x	x	x	x	x	x				x			x			x	x	x	
Eriocephalus ericoides	d	d		d	d	c	d	d	d	x		c	x	x		d					x		
Felicia muricata	x			c	c	c	c	d	c			x	c	x	x	x	x				c	c	
Pentzia incana	d	x		x	d	c	d	d	c	x		x	c	c	c	c				c			
Sporobolus fimbriatus	d	d		d	c		x	d	d	x		d	d	d	d	x							d
Lycium cinereum	d	d		d	d	c	d	d	d	x		d	d	x	d	x							d
Euphorbia cf. *caterviflora*				x			c	c				x	x	x	x	x				x			c
Aptosimum indivisum	x				x	x	x	x	x	x			x		x						x	x	
Enneapogon desvauxii		x		x	d	d	d	d						x	x					c	c	c	
Mesembryanthemum coriarium				c	c	x	c	c	x					x	c						d	c	
Fingerhuthia africana	x				d	c	d	d					d	c			x			c	x	c	
Drosanthemum hispidum		c		d	c	x	c	d					c		c						d		
Eragrostis lehmanniana	c			c	c		d	d				x	x				x					c	
Argemone ochroleuca				x	x			c												x		c	
Chloris virgata				c				c								x				x		x	
Enneapogon scaber		c				x	c	x													c	x	
Galenia cf. *papulosa*				x			x	c				x					x				x		
Lycium horridum				x	c	x		c										x					c
Mesembryanthemum tetragonum		x		x	c		x	c															x
Pentzia globosa				x	d		x	c						x							d	c	
Albuca sp. 2				x						x													
Anacampseros albidiflora														x							x		
Anthospermum sp.		x											x										
Bulbine abyssinica							x									x							
Convolvulus sagitatus								x												x			
Curio radicans								c													x		
Deverra denudata								x	x														
Diospyros lycioides																		c		x			
Lycium schizocalyx				x				c															
Geigeria filifolia								x															x
Gethyllis sp.				x			x																
Gomphocarpus fruticosus								x						x									
Lachenalia sp.	x						x																
Lasiosiphon polycephala				x			x																
Monechma spartioides														x						x			
Pentzia lanata								x													x		
Crassula sp. 3								x	x														
Ruschia sp.						x		x						x									
Mesembryanthemum emarcidum							x							c									
Schismus barbatus				x				x															
Suaeda fruticosa								x									x						
Tetragonia acanthocarpa						x							x										
Tetragonia sarcophylla								x									x						
Tragus racemosus																	x			x			
Viscum rotundifolium														x						x			
Zaluzianskya pedunculata								x									x						
Amaranthus sp.					x													x		x			
Thesium sp.				x		x											x						
Asparagus striatus							x							x									x
Aptosimum spinescens								x						x									x

APPENDIX D
SITE SENSITIVITY VERIFICATION

Prior to commencing with the Terrestrial Biodiversity Specialist Assessment in accordance with the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity (Government Notice 320, dated 20 March 2020), a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).

The details of the site sensitivity verification are noted below:

Date of site visit	29 September 2020 to 2 October 2020
Specialist name	N. van Rooyen; M.W van Rooyen
Professional registration number	401430/83 Botanical Science (NvR); 400509/14 Ecological Science (MvR)
Specialist affiliation / company	Ekotrust cc

The site sensitivity verification was undertaken using the following means:

- desk top analysis using satellite imagery;
- consulting geological, land type, vegetation type maps of the region;
- consulting provincial datasets on the latest versions of the mapping of CBAs, ESAs, ONAs, NPAES and PAs;
- liasing with SANBI on the identify of the plant species referred to by number;
- checking distribution ranges of IUCN red listed species and species highlighted by the screening tool;
- compiling plant and animal species checklist for the region; and
- preliminary on-site inspection.

To verify the site sensitivity of the screening tool along the 181 km route, Google satellite images were studied beforehand and the route stratified into relatively homogenous physiographic-physionomic units or habitats. The first level of stratification was the six vegetation types of the region and within each of them the different habitat types represented the second level of stratification. Sites were then selected along the route to represent these habitats. During the field survey, 157 sites were surveyed along the route. This gave an average of one survey site every 1.2 km.

Animal Theme

Screening tool: The screening tool rated the sensitivity of the Animal Species Theme as **High.**
Site verification:

Mammals:

- Our background study concurred with the presence of the riverine rabbit (Collins *et al*. 2016) and the mountain reedbuck (Taylor *et al.* 2016) in the region. The presence of the riverine rabbit was furthermore confirmed by one of the landowners (Mr Johan Moolman) of the farm Dunedin and the notice board of the Endangered Wildlife Trust at Slangfontein. Although it is unlikely that the elusive riverine rabbit will be encountered by the construction teams, special mitigation measures need to be applied to ensure minimum impact on the riverine rabbit population.
- The background study also listed the presence of the black-footed cat in the region.
- The screening tool listed the mountain reedbuck for the area. It is however, believed that the mountain reedbuck was introduced in the Karoo National Park and is unlikely to be encountered free-roaming in the

road reserve. This will also be the case for the other red listed species introduced in the region (see Appendix B).

Reptiles:

- Our background study confirmed the presence of the Karoo dwarf tortoise.

Birds:

- The presence of two red listed bird species was singled out by the screening tool although our background study revealed the presence of 10 red listed species.
- Additionally, Ludwig's bustard was sighted during the site survey.

Plant Theme

Screening tool: The screening tool rated the sensitivity of the Plant Species Theme as **Medium.**
Site verification:

- Our background study corresponded with the screening tool on the possible presence of *Cliffortia arborea* along the route, however sensitive species 704 was not listed for the region on the NewPosa database. Neither of these species were encountered during the site visit. *Cliffortia arborea* is a conspicuous species in the high mountains and would have been spotted easily if it had been present. Sensitive species 704, on the other hand, is a small, cryptic species, preferring quartz patches. Along the fibre-optic cable route quartz patches were not noted and thus it can be assumed that the species would not occur along the route.
- Two other red listed species were listed on the NewPosa database for the region. However, these species seem to be beyond their known distribution range and could thus either be wrong identifications or specimens grown in collections.
- Based solely on the presence of red listed species which were not found along the route, we would suggest to downgrade the rating of the Plant Species Theme to Low. However, many provincially protected/specially protected and CITES II listed species were recorded which could imply a Medium rating.

Relative Terrestrial Biodiversity Theme

Screening tool: The screening tool rated the sensitivity of the Relative Terrestrial Biodiversity theme as **Very High**.
Site verification:

- This theme considers the presence of protected areas, National Protected Area Expansion Strategy (NPAES), CBA, ESA and National Freshwater Ecosystem Priority Area (NFEPA). Our background study concurred with the findings of the screening tool on the presence of these features.
- However, since the development will take place in the road reserve it will have no impact on existing protected areas (Karoo National Park and Dr Appie van Heerden Nature Reserve) and it will also not affect the NPAES. These features are thus irrelevant when considering the construction of the fibre-optic cable between Beaufort West and Carnarvon.
- Furthermore, the classification of the road reserve as CBA is questionable from a vegetation standpoint, although it might still be marginal riverine rabbit habitat (however, this species did not appear listed under the reasons for the CBA in the Western Cape).
    - The definition of a CBA1 is: 'Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas' (SANBI 2018b). **The road reserve by no means complies with these conditions.**
    - The definition of a CBA2 is: 'Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses'. **Road reserves are not the best option to meet biodiversity targets.**

- In the Western Cape NFEPA was considered in delineating CBAs, however in the Northern Cape a relative long stretch between Loxton and Carnarvon was identified as a NFEPA that was not incorporated into the delineation of the CBAs.

Outcome of the site sensitivity verification:

- We confirm the Animal Theme's site sensitivity as being High.
- Based solely on the presence of red listed species (highlighted by the screening tool), which were not found along the route, we would suggest to downgrade the rating of the Plant Species Theme to Low. However, many provincially protected/specially protected and CITES II listed species were recorded which could imply a Medium rating.
- We dispute the site sensitivity of the Relative Terrestrial Biodiversity **in the road reserve** as being Very high and suggest a downscaling to Low.

Figure Appendix D: (a) A road cutting along the optic-fibre route indicating the remnants of road building activities; (b) Water run-off may increase plant cover and change the vegetation composition in the road reserve; (c) & (d) changed species composition in the road reserve as a result of road building and road maintenance activities.

APPENDIX E
COMPLIANCE WITH THE TERRESTRIAL BIODIVERSITY PROTOCOL (GN 320, 20 MARCH 2020)

Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity	***Section where this has been addressed in the Specialist Report***
The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects: *2.3.1. a description of the ecological drivers or processes of the system and how the proposed development will impact these;*	*Chapter 4 (pp. 10-18);* *Section 8.5, p. 48*
2.3.2. ecological functioning and ecological processes (e.g. fire, migration, pollination, etc.) that operate within the preferred site;	*Section 8.5, p. 48*
2.3.3. the ecological corridors that the proposed development would impede including migration and movement of flora and fauna;	*Section 8.5, p. 48*
2.3.4. the description of any significant terrestrial landscape features (including rare or important flora- faunal associations, presence of strategic water source areas (SWSAs) or freshwater ecosystem priority area (FEPA) sub catchments;	*Sections 8.5 to 8.8 (pp. 48 – 49)*
2.3.5. a description of terrestrial biodiversity and ecosystems on the preferred site, including: *a) main vegetation types;* *b) threatened ecosystems, including listed ecosystems as well as locally important habitat types identified;* *c) ecological connectivity, habitat fragmentation, ecological processes and fine-scale habitats; and* *d) species, distribution, important habitats (e.g. feeding grounds, nesting sites, etc.) and movement patterns identified;*	*(a) Chapter 5; Section 5.2 (pp. 19 – 24)* *(b) Chapter 5; Section 5.2 (pp. 19 – 24); Section 8.3 (p.46)* *(c) Chapter 5; Section 8.5, p. 48* *(d) Chapter 5; Chapter 6; Chapter 7; Appendix A; Appendix B; Appendix C*
2.3.6. the assessment must identify any alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification; and	*Alternative assessed by CSIR (2020) and found to have a higher impact than current choice.*
2.3.7. the assessment must be based on the results of a site inspection undertaken on the preferred site and must identify: *a) terrestrial critical biodiversity areas (CBAs), including:* *a) the reasons why an area has been identified as a CBA;* *b) an indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation;* *c) the impact on species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s);* *d) the impact on ecosystem threat status;* *e) the impact on explicit subtypes in the vegetation;* *f) the impact on overall species and ecosystem diversity of the site; and* *g) the impact on any changes to threat status of populations of species of conservation concern in the CBA;*	*(a) Section 8.4.1 (pp. 46 – 47)* *(b) Section 8.4.1 (pp. 46 – 47)* *(c) p.25; Section 8.4.1 (pp. 46 – 47)* *(d) Chapter 14 (pp. 93 – 95)* *(e) no recognised subtypes* *(f) Chapter 14 (pp. 93 – 95)* *(g) Chapter 14 (pp. 93 – 95)*
b) terrestrial ecological support areas (ESAs), including: *a) the impact on the ecological processes that operate within or across the site;* *b) the extent the proposed development will impact on the functionality of the ESA; and* *c) loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna;*	*(a) Section 8.4.2 (pp. 47 – 48)* *(b) Section 8.4.2 (pp. 47 – 48)* *(c) Chapter 8, (p. 47 – 48)*
c) protected areas as defined by the National Environmental Management: Protected Areas Act, 2004 including- *a) an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and the zoning as per the protected area management plan;*	*Chapter 8 (p. 45)*
d) priority areas for protected area expansion, including- *a) the way in which in which the proposed development will compromise or contribute to the expansion of the protected area network;*	*Chapter 8 (p. 45)*

Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity	***Section where this has been addressed in the Specialist Report***
e) SWSAs including: *a) the impact(s) on the terrestrial habitat of a SWSA; and* *b) the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses);*	*n.a. – no SWSAs present*
f) FEPA subcatchments, including- *3.1.1.1. the impacts of the proposed development on habitat condition and species in the FEPA sub catchment;*	*Chapter 8.8 (p. 49); Chapter 9 (p63)*
g) indigenous forests, including: • *impact on the ecological integrity of the forest; and* • *percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.*	*n.a. – no indigenous forest present*
○ *The Terrestrial Biodiversity Specialist Assessment Report must contain, as a minimum, the following information:*	
▪ *contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;*	*p. xvi; Appendix F*
▪ *a signed statement of independence by the specialist;*	*p. xv*
▪ *a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;*	*Chapter 2 (p 3)*
▪ *a description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant;*	*Chapter 2 (pp. 3 – 4)*
▪ *a description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;*	*p. xix*
▪ *a location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant);*	*Depicted in Section 9.3; Sensitivity.kmz file*
▪ *additional environmental impacts expected from the proposed development;*	*n.a.*
▪ *any direct, indirect and cumulative impacts of the proposed development;*	*Chapter 10; Chapter 11*
▪ *the degree to which impacts and risks can be mitigated;*	*Chapter 11*
▪ *the degree to which the impacts and risks can be reversed;*	*Chapter 11*
▪ *the degree to which the impacts and risks can cause loss of irreplaceable resources;*	*Chapter 11*
▪ *proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr);*	*Chapter 13*
▪ *a motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a "low" terrestrial biodiversity sensitivity and that were not considered appropriate;*	*n.a.*
▪ *a substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not; and*	*Chapter 14;*
▪ *any conditions to which this statement is subjected.*	*Chapter 14*
○ *The findings of the Terrestrial Biodiversity Specialist Assessment must be incorporated into the Basic Assessment Report or the Environmental Impact Assessment Report including the mitigation and monitoring measures as identified, which must be incorporated into the EMPr, where relevant.*	*For EAP to incorporate*
▪ *A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.*	*For EAP to append*

APPENDIX F

Curriculum vitae: DR NOEL VAN ROOYEN

1. Biographical information

Surname	**Van Rooyen**
First names	**Noel**
ID number	**501225 5034 084**
Citizenship	**South African**
Business address	**Ekotrust CC** **7 St George Street** **Lionviham 7130** **Somerset West** **South Africa**
Mobile	**082 882 0886**
e-mail	**noel@ekotrust.co.za**
Current position	**Member of Ekotrust cc**
Professional registration	**Botanical Scientist : Pr.Sci.Nat; Reg no. 401430/83**

Academic qualifications include BSc (Agric), BSc (Honours), MSc (1978) and DSc degrees (1984) in Plant Ecology at the University of Pretoria, South Africa. Until 1999 I was Professor in Plant Ecology at the University of Pretoria and at present I am a member of Ekotrust cc.

2. Publications

I am the author/co-author of 128 peer reviewed research publications in national and international scientific journals and was supervisor or co-supervisor of 9 PhD and 33 MSc students. More than 350 projects were undertaken by Ekotrust cc as consultant over a period of more than 40 years.

Books

VAN ROOYEN, N. 2001. ***Flowering plants of the Kalahari dunes***. Ekotrust CC, Pretoria. (In collaboration with H. Bezuidenhout & E. de Kock).

VAN ROOYEN, N. & VAN ROOYEN, M.W. 2019. ***Flowering plants of the southern Kalahari***. Somerset West.

Author / co-author of various chapters on the Savanna and Grassland Biomes in:

LOW, B. & REBELO, A.R. 1996. ***Vegetation types of South Africa, Lesotho and Swaziland*****,** Department of Environmental Affairs and Tourism, Pretoria.

KNOBEL, J. (Ed.) 1999, 2006. ***The Magnificent Natural Heritage of South Africa*****.** (Chapters on the Kalahari and Lowveld).

VAN DER WALT, P.T. 2010. **Bushveld.** Briza, Pretoria. (Chapter on Sour Bushveld).

Contributed to chapters on vegetation, habitat evaluation and veld management in the book:

BOTHMA, J. du P. & DU TOIT, J.G. (Eds). 2016**.** ***Game Ranch Management*****.** 5th edition**.** Van Schaik, Pretoria.

Co-editor of the book:

BOTHMA, J. du P. & VAN ROOYEN, N**.** (eds). 2005**.** ***Intensive wildlife production in southern Africa.*** Van Schaik, Pretoria.

3. Ekotrust CC: Core Services

Ekotrust CC specializes in vegetation surveys, classification and mapping, wildlife management, wildlife production and economic assessments, vegetation ecology, veld condition assessment, carrying capacity, biodiversity assessments, rare species assessments, carbon pool assessments and alien plant management.

4. Examples of projects previously undertaken

Numerous vegetation surveys and vegetation impact assessments for Baseline, Scoping and Environmental Impact Assessments (BAs & EIA's) were made both locally and internationally.

Numerous projects have been undertaken in game ranches and conservation areas covering aspects such as vegetation surveys, range condition assessments and wildlife management. Of note is the Kgalagadi Transfrontier Park; iSimangaliso Wetland Park, Ithala Game Reserve, Phinda Private Game Reserve, Mabula Game Reserve, Tswalu Kalahari Desert Reserve, Maremani Nature Reserve and Associate Private Nature Reserve (previously Timbavati, Klaserie & Umbabat Private Game Reserve).

Involvement in various research programmes: vegetation of the northern Kruger National Park, Savanna Ecosystem Project at Nylsvley, Limpopo; Kuiseb River Project (Namibia); Grassland Biome Project; Namaqualand and Kruger Park Rivers Ecosystem research programme.

5. Selected references of other projects done by Ekotrust CC

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6. Selected peer-reviewed research publications

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Curriculum vitae: GRETEL VAN ROOYEN

1. Biographical information

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Current position	**Honorary Professor in Plant Ecology Scientific advisor - Ekotrust**		
Academic qualifications	**BSc; BSc (Hons), HNOD, MSc (Botany), PhD (Plant ecology)**		

2. Publications

I am author / co-author of more than 100 peer reviewed research publications and have presented / co-presented more than 100 posters or papers at international and national conferences. Five PhD-students and 29 Masters students have completed their studies under my supervision / co-supervision. I have co-authored a book as part of a series on the Adaptations of Desert Organisms by Springer Verlag (Van Rheede van Oudtshoorn, K. & Van Rooyen, M.W. 1999. ***Dispersal biology of desert plants.*** Springer Verlag, Berlin) and two wildflower guides (Van Rooyen, G., Steyn, H. & De Villiers, R. 1999. ***Cederberg, Clanwilliam and Biedouw Valley*****.** Wild Flower Guide of South Africa no 10. Botanical Society of South Africa, Kirstenbosch, and Van der Merwe, H. & Van Rooyen, G. **Wild flowers of the Roggeveld and Tanqua**). I have also contributed to six chapters in the following books: (i) Dean, W.R.J. & Milton, S.J. (Eds) *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge. pp. 107-122; (ii) Knobel, J. (ed.) *The magnificent heritage of South Africa.* Sunbird Publishing, Llandudno. pp. 94-107; (iii)Hoffman, M.T., Schmiedel, U., Jürgens, N. [Eds]: *Biodiversity in southern Africa. Vol. 3: Implications for landuse and management*: pp. 109–150, Klaus Hess Publishers, Göttingen & Windhoek; (iv) Schmiedel, U., Jürgens, N. [Eds]: *Biodiversity in southern Africa. Vol. 2: Patterns and processes at regional scale: pp.* 222-232, Klaus Hess Publishers, Göttingen & Windhoek; (v) Stoffberg, H., Hindes, C. & Muller, L. South African Landscape Architecture: A Compendium and A Reader. Chapter 10, pp. 129 – 140; and (vi) Stoffberg, H., Hindes, C. & Muller, L. South African Landscape Architecture: A Compendium and A Reader. Chapter 11, pp. 141 – 146.

3. Research interests

My primary research interests lie in population biology and vegetation dynamics. The main aim of the research is to gain an understanding of ecosystem dynamics and to use this understanding to develop strategies to conserve, manage, use sustainably or restore ecosystems. Geographically the focus of the studies has been primarily in Namaqualand (Northern Cape Province, South Africa; classified as Succulent Karoo) and the Kalahari although several studies were conducted in Maputaland (Northern KwaZulu-Natal) and Namibia.

4. Selected project references

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5. Selected research publications

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