Desktop Bat Sensitivity Analysis for the SKA Phase 1 Study Site

Compiled By:

Block G, Hurlingham Office Park
59 Woodlands Avenue
Hurlingham
Johannesburg
South Africa
2196
Tel: +27 (0) 11 285 0008
Mobile: +27 (0) 79 175 1758
Fax: +27 (0) 86 549 2322

Compiled For:

CSIR - Environmental Management Services
PO Box 320
Stellenbosch
7599
Tel: +27 (0) 21 888 2561
Fax: +27 (0) 21 888 2693

Reviewed and edited by:

Professor David Jacobs, SARCHI Research Chair in Animal Evolution & Systematics at the Department of Biological Sciences of the Univeristy of Cape Town; and
Patrick Morant, SACNASP Professional Natural Scientist (Reg. No. 401514/83)]

IWS Ref No: 3048_rev2 Date: October 2016

Table of Contents

List of Figures

List of Tables

Declaration of Independence

Inkululeko Wildlife Services (Pty) Ltd (IWS) is an independent consultancy. IWS has no legal or financial connection with the developer or the environmental assessment practitioner (EAP), except for fulfilling the tasks required for this assessment. Remuneration to IWS for conducting this assessment is not linked to the authorisation of the project by the competent authority. In addition, IWS has no interest or connection to any secondary or future development associated with the approval of this project. Kate MacEwan is the lead bat specialist on this project. She is registered with the South African Council for Natural Scientific Professions (SACNASP).

Signed: KMach

Kate MacEwan

for Inkululeko Wildlife Services (Pty) Ltd

1. Project Introduction

The Council for Scientific and Industrial Research (CSIR) is conducting strategic environmental assessment (SEA) process to identify potential environmental impacts and environmental principles and facilitate the environmental authorisation process for the construction of the Square Kilometre Array (SKA) Phase 1, near Carnarvon in the Northern Cape, South Africa. For the Integrated Management Plan (IMP), specialist studies are required to analyse potential environmental impacts and environmental principles, develop minimum requirements for various environmental features, as well as any potential monitoring or mitigation required. As such, the CSIR has appointed Inkululeko Wildlife Services (Pty) Ltd (IWS) to conduct a desktop bat sensitivity analysis for the SKA Phase 1 study site (**Figure 1**) and the greater Karoo Central Astronomy Advantage Area (KCAAA) area (**Figure 2**). **This study has been performed at a strategic desktop level only.** Should the initial desktop study reveal any potential major roost sites or bat flight paths or sensitive habitats, a field verification visit will be requested.

The SKA project is a radio telescope project that will be built in Australia and South Africa and will have a total collecting area of approximately one square kilometre. The SKA will be the world's largest and most sensitive radio telescope and will be powerful enough to sense radio waves from objects millions or even billions of light years away from Earth (DEA, 2015a).

The SKA Phase 1 study site covers approximately 268 000 hectares and includes the 64 MeerKAT antennas and 133 additional antennas for SKA Phase 1. The SKA will be made up of three different kinds of antennas (receivers) - designed to work at different frequencies (i) Dishes - looking more or less like a DSTV antenna, but much bigger - about 13 m in diameter and 19 m high, (ii) Huge, flat disk-shaped antennas - about 60 m wide, (iii) Small, upright radio antennas - about 1,5 m high. Once all phases are complete, the thousands of SKA dishes and other types of radio receivers will work together as one gigantic, virtual instrument.

The focus of this study is the **SKA Phase 1 study site,** consisting of the core (38 land parcels) and the spiral arms (131 land parcels). The greater KCAAA area is included in the study only to provide a high-level baseline description and review just to inform the regional setting.

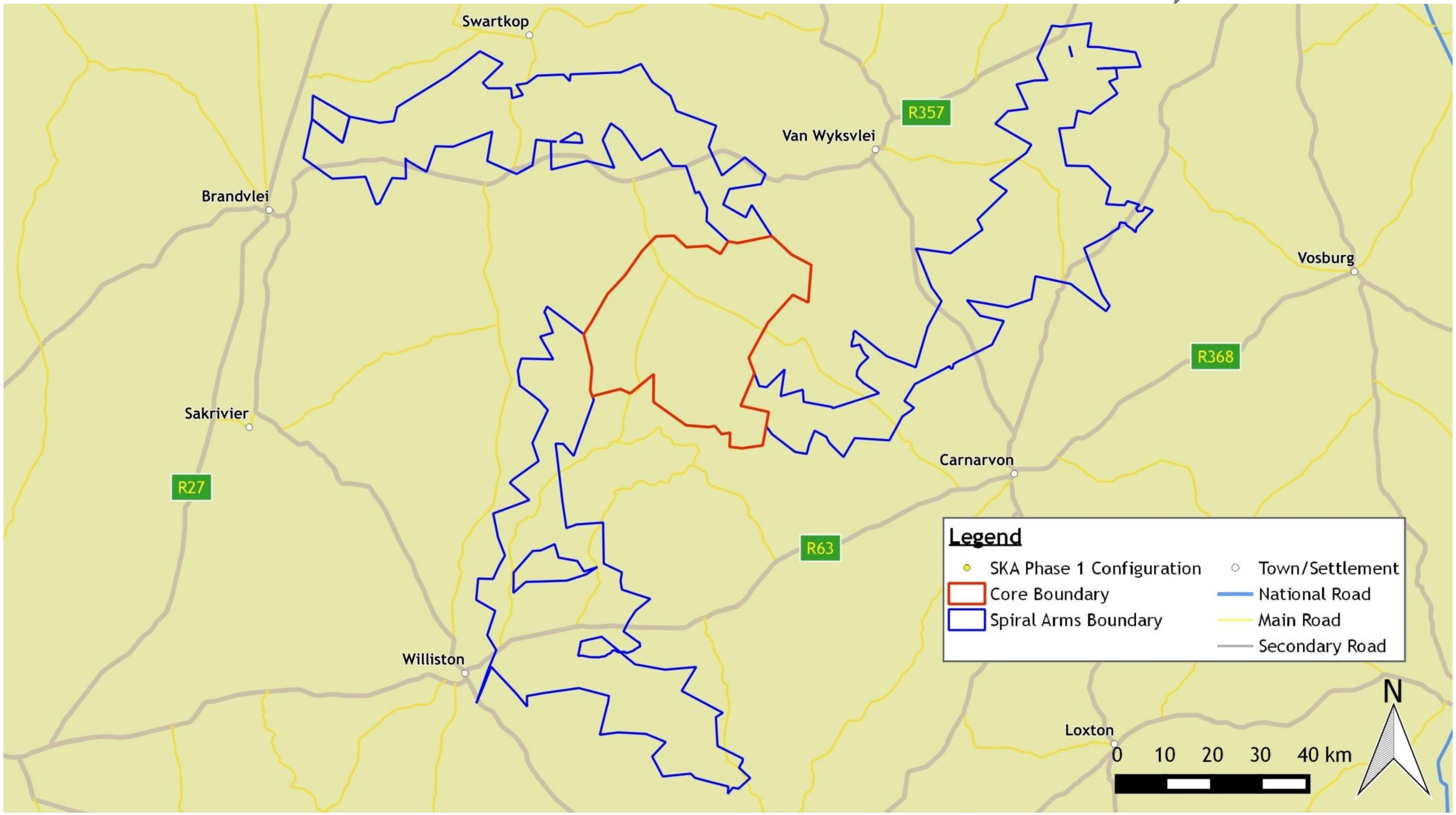

Figure 1 SKA Phase 1 Study Site

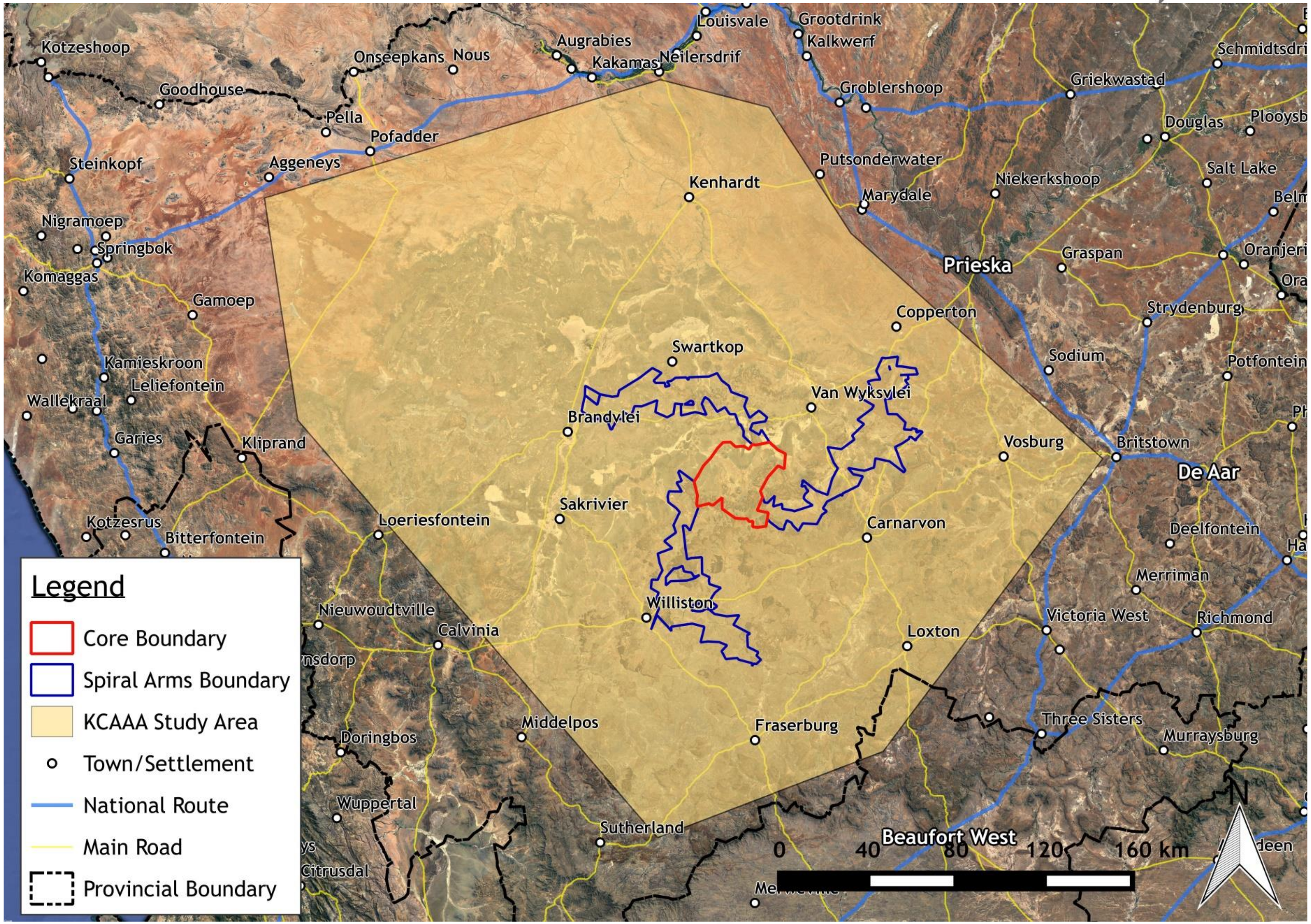

Figure 2 Greater KCAAA Area

2. Scope of Work

The scope of the bat sensitivity analysis is to:

- Identify sites/areas of (potential) high sensitivity within the SKA Phase 1 study site and greater KCAAA area such as:
  - Important bat roosting habitat/s
  - Important bat foraging habitat/s
  - Known large roosting sites
- Identify potential species of concern.
- Assess the potential impact on bats during construction activities.
- Assess that the development and operation of the power lines within the SKA Phase 1 study site does not impact on:
  - Important bat roosting habitat
  - Important bat foraging habitat
- Make recommendations that will avoid or mitigate the impacts, if significant impacts are identified, including possible ground-truthing/field work in the next phase.

3. Bat Assessment Team

The IWS team have conducted over 30 long-term pre-construction bat monitoring studies and have 7 current long-term operational bat monitoring studies for wind energy development in South Africa. The team members have also been involved in the bat sensitivity analysis for the SEA done for the Renewable Energy Development Zones (REDZs) in South Africa and numerous other bat specialist and inventory assessments for mines and protected areas. The team directly involved in the SKA assessment are described below.

3.1 Kate MacEwan

Kate MacEwan was a founding member of NSS over 12 years ago and has been the founding Director of IWS since September 2014. She is a SACNASP registered zoologist and environmental scientist and holds a BSc (Honours) in Zoology from Wits University. She has over 17 years of zoological and practical bat conservation experience. Kate is currently the chairperson for the South African Bat Assessment Association Panel (SABAAP), a contributing editor to the 3rd edition (Sowler and Stoffberg, 2014) and co-author of the 4th edition South African Good Practise Guidelines for Surveying Bats in Wind Farm Developments (Sowler *et al.*, 2016) and a co-author on the 1st edition South African Good Practice Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (Aronson *et al.*, 2014). In addition, she is Rope Access Level 1 certified and Fall Arrest and Rescue accredited.

3.2 Joshua Weiss

Joshua Weiss is a full-time Junior Zoologist with IWS. He has a BSc in Environmental Sciences and Geography and an Honours in Ecology & Conservation. He has keen interests in and experience in biodiversity (particularly avifauna), conservation planning and spatial analysis. In previous work positions, he has done data analysis, compiling carbon footprint reports, researching and had some involvement in the EIA process. Since joining IWS, he has been responsible for mapping and GIS analysis for all projects, data handling and since gaining his fall arrest certification has been involved in the field doing both active capture and setting up passive monitoring equipment. He is also a qualified Level 1 field guide and a member of BirdLifeSA, GNoRBIG and WESSA.

4. Background Regional Environmental Information

This section provides a brief environmental background at a regional level to the SKA Phase 1 study site only.

4.1 Regional Vegetation

The SKA Phase 1 study site is located in the Nama Karoo biome. This biome is arid and the climate is continental, with very little influence from oceans. The biome is characterised by short/dwarf shrubs, intermixed with grasses, succulents and geophytes. Trees are limited to drainage lines or areas where the climate is favourable to such, particularly in the eastern regions (Mucina and Rutherford, 2006).

Being spread across such a vast area, there are a number of vegetation types encompassed by the SKA Phase 1 spiral arms and core. The highest percentage of cover falls under Bushmanland Basin Shrubland. This unit is dominated by low shrubs (*Rhigozum sp., Salsola sp., Pentzia sp.* and *Eriocephalus sp.*), *Stipagrotstis sp.* grasses and annuals such as *Leysera sp.* and *Gazani sp.* (Mucina and Rutherford, 2006). Three endemic taxa occur in this unit. The Bushmanland Basin give rise to a number of endorheic pans or “vloere” as they are known locally, as well as non-perennial streams. These form the basis of another unit known as the Bushmanland Vloere. This comprises mostly salt pans which are devoid of vegetation and are very rarely filled with water. Other ‘major’ vegetation units include the Western Upper Karroo and Upper Karoo Hardeveld, while smaller areas of Bushmanland Sandy Grassland and Arid Grassland are also present in the Eastern Spiral Arm (**Figure 3**).

4.2 Regional Climate and Hydrology

The study area falls within the Karoo - an arid region of South Africa, with mean annual precipitation ranging from 100-200 mm (peaking in March), high evaporation and a highly continental climate (highly seasonal and rarely affected by coastal weather systems). The area experiences extreme seasonal temperature variation, with average maxima ranging from ±34°C in summer to ±16°C in winter, while minima range from ±14°C in summer to below freezing in the winter months (Mucina and Rutherford, 2006; SAExplorer, 2014). There are on average 30-55 days where frost occurs annually.

Due to the climate and topography of the region, there are no permanent natural waterbodies in the region. The large natural wetlands displayed in **Figure 4** are the Bushmanland Vloere previously mentioned, shallow salt pans which only fill up after intense rainstorms or unsual sustained rain. All of the rivers in the study site are considered either dry, non-perennial (episodic and periodic) and some of the minor rivers have not been assessed (Nel *et al*., 2011). They flow for less than a couple of months a year if at all but are highly susceptible to flash flooding. Because of the climate, many landowners have built artificial dams on their properties to sustain livestock, and much of this water is likely to be derived from deep boreholes rather than relying on surface water. Of the major rivers in the area (i.e. the Sakrivier), almost all are classified as being in a healthy or large natural ecological condition (Nel *et al.*, 2011), mostly due to the lack of human habitation and water abstraction in the region.

4.3 Geology and Lithology

The dominant geology of the SKA Phase 1 study site is shale (**Figure 5**)– an organic-rich clay- or mud-based sedimentary rock which is highly susceptible to fracturing. Other geology includes arenite and areas of dolerite, an igneous which forms many of the well-known Karoo ‘koppies’ or mesas **(Figure 5**). The lithology comprises mostly Karoo Dolerite Suite and Ecca Group rocks. Soils tend to be either strongly saline and shallow on hard or weathering rock (AGIS, 2006)

4.4 Land Use/Cover

According to the most recent land use data (DEA, 2015b), the majority of the site is either classified as natural 'low shrubland' (particularly the eastern spiral arm) or where vegetation is sparser, 'bare ground' [*](**Figure 6**). Percentage wise, areas of 'woodland/thicket', 'water' and 'commercial cultivation' are negligible within the SKA Phase 1 study site.

[*] In the case of 'bare ground' – this may be slightly exaggerated as satellite images used to generate the land cover map will classify a pixel as bare if most of the area is not vegetated. Thus areas with sparse, well-spaced vegetation are likely to be classified this way.

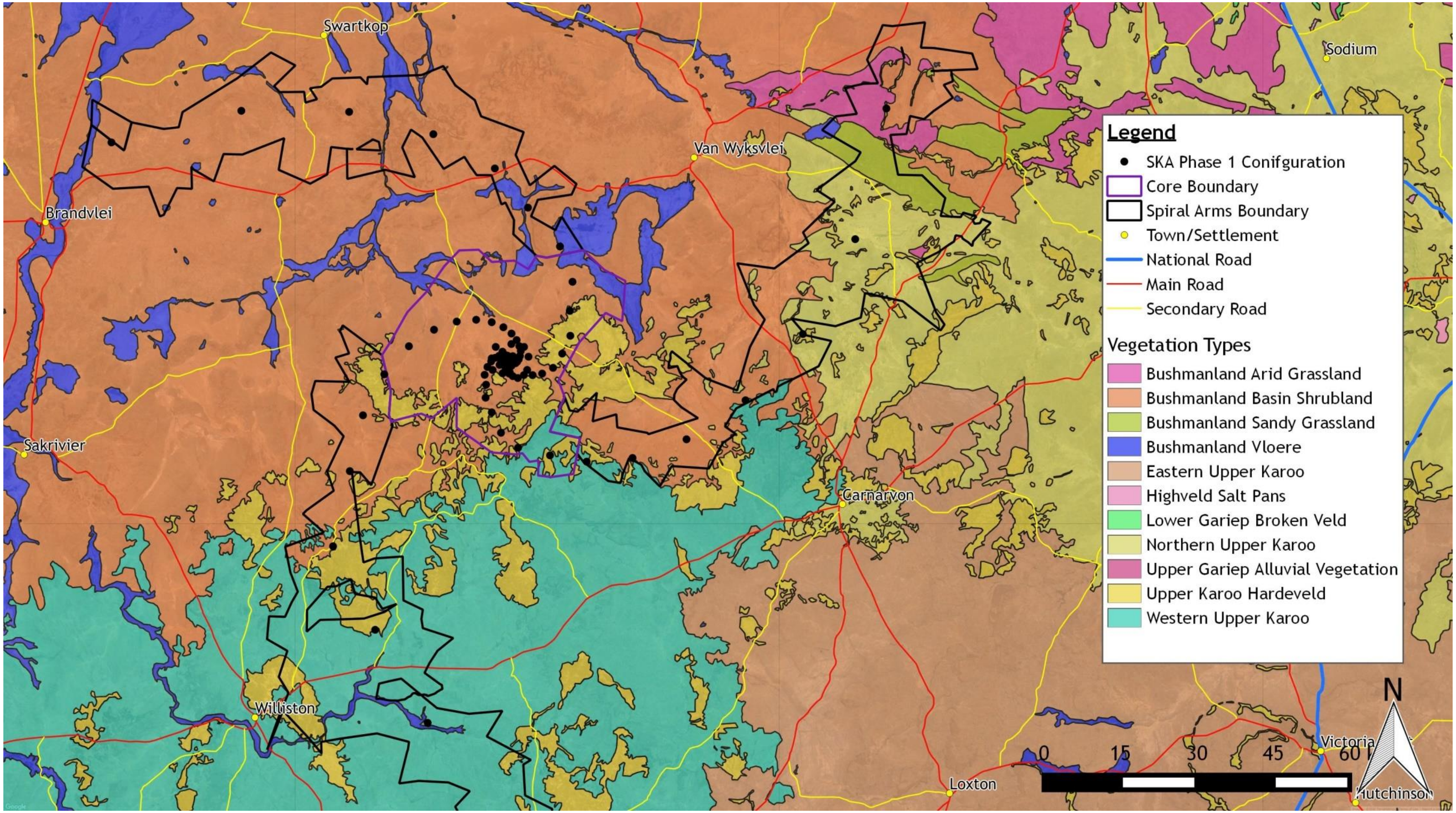

Figure 3 Regional Vegetation Units of the SKA Phase 1 study site and surrounds

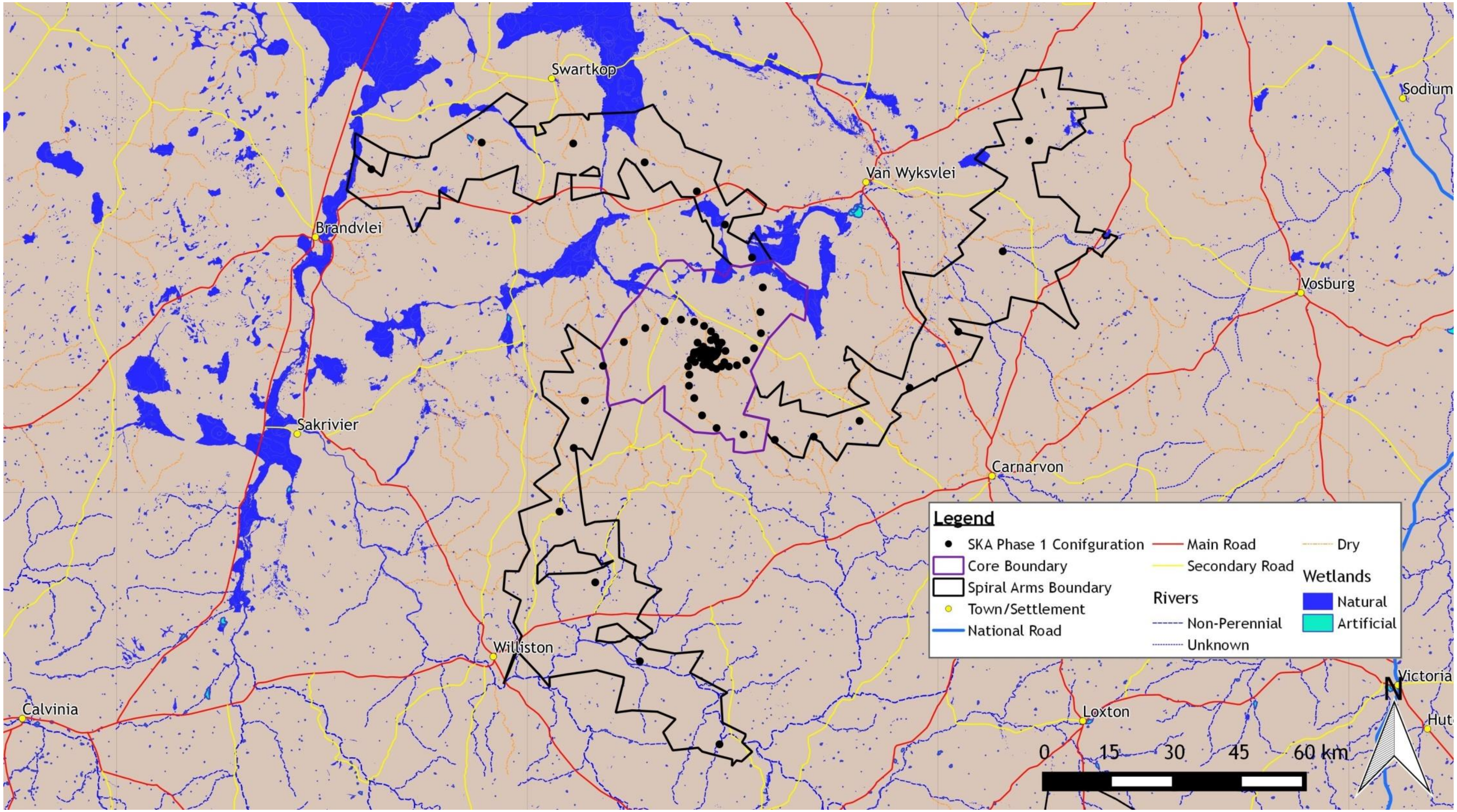

Figure 4 **Hydrology of the SKA Phase 1 study site and surrounds**

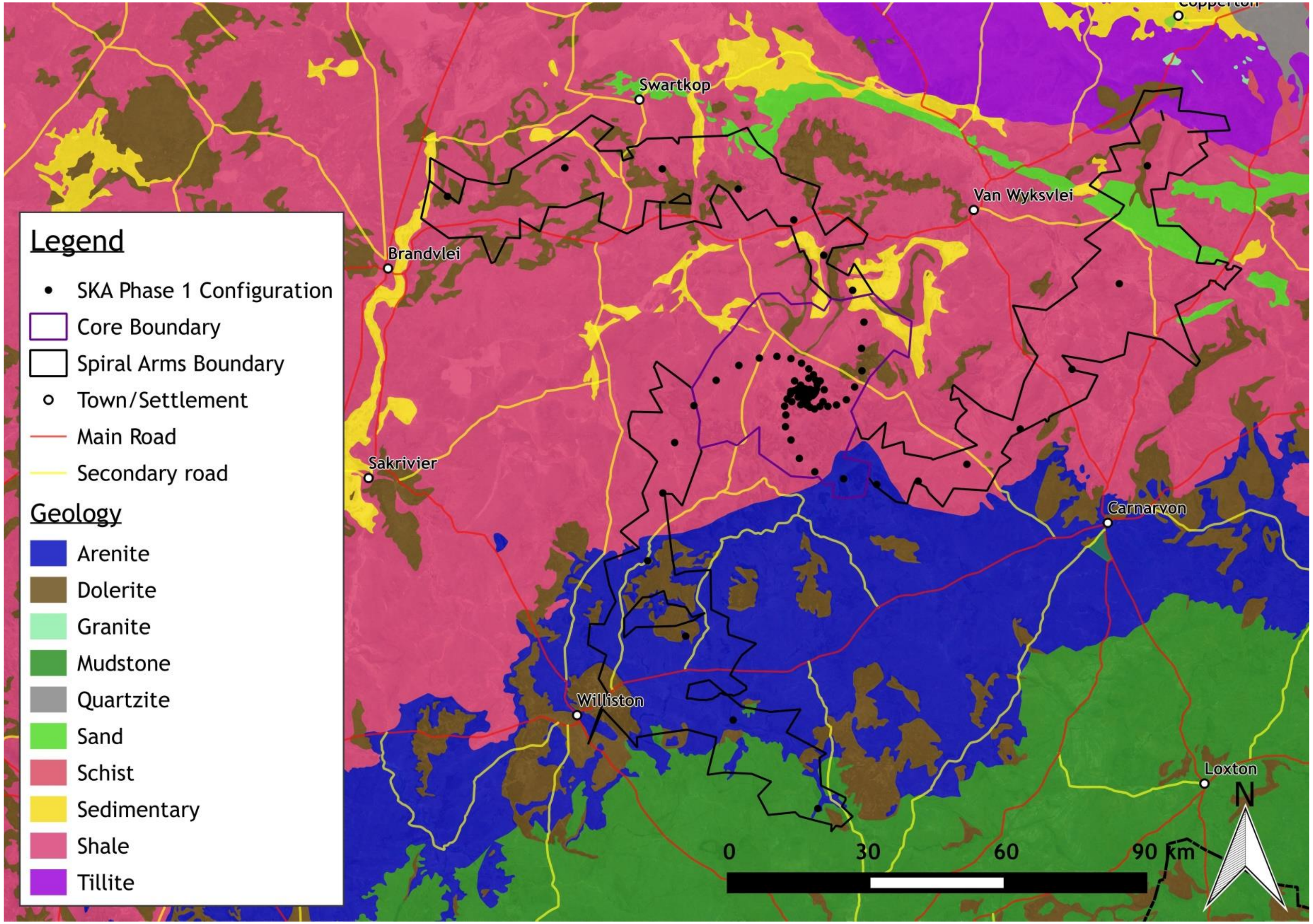

Figure 5 **Geology of the SKA Phase 1 study site and surrounds**

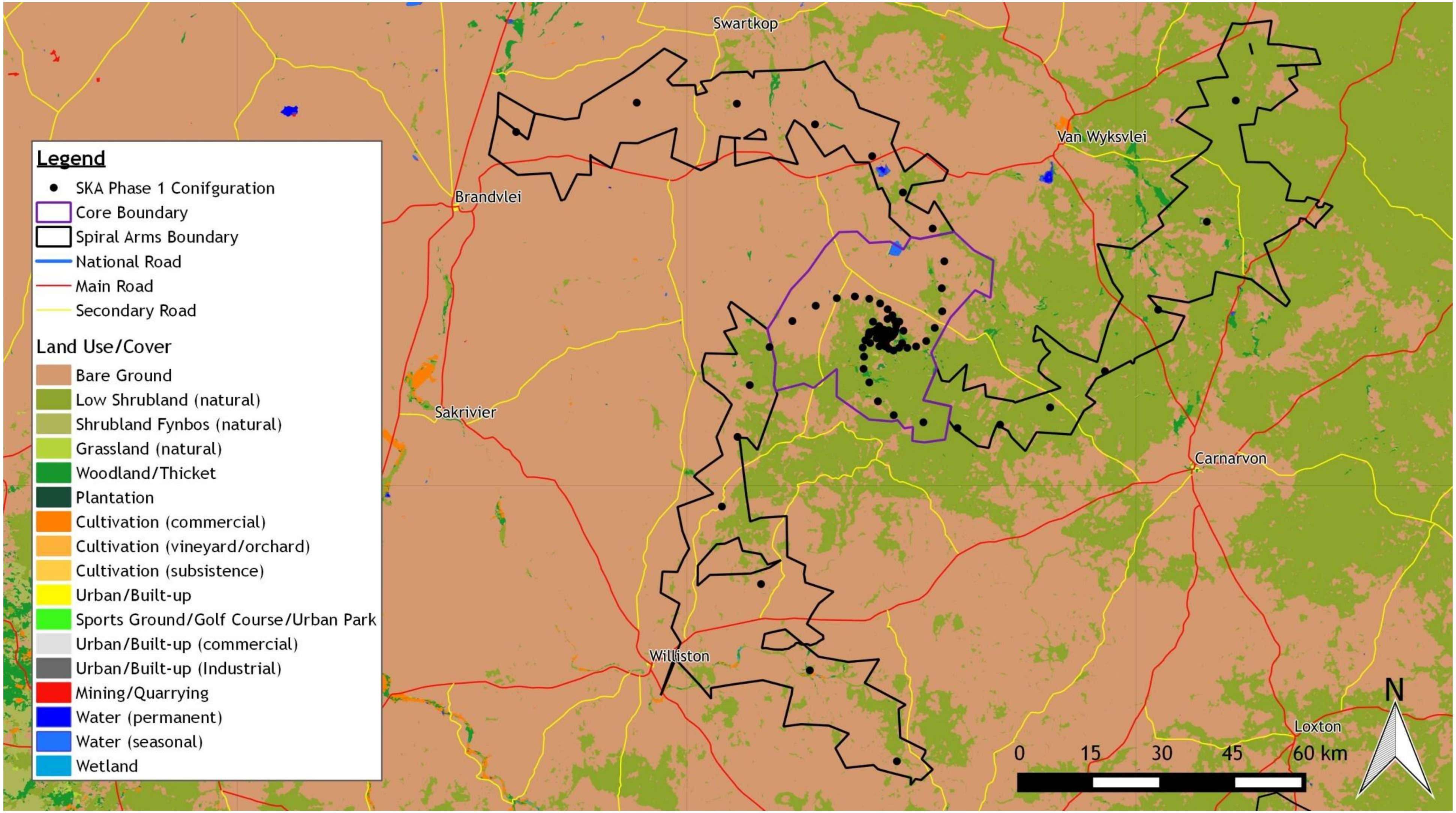

Figure 6 Land Use/Cover of the SKA Phase 1 study site and surrounds

5. Important Conservation Areas and Legislation

5.1 Protected Areas

According to the most recent DEA (2016) quarterly database of protected areas, there are no protected areas of any category[†] within the SKA Phase 1 study site. The nearest is Dr Appie van Heerden Nature Reserve (1 570 ha), roughly 60 km south-east of the core of the site (**Figure 7**). This is also the only protected area in the greater KCAAA area.

5.2 Conservation Focus Areas

There are three Important Bird and Biodiversity Area (IBAs)[‡] which fall partially within the north-western area of the greater KCAAA area. These aim to protect endemic Karoo avifauna and range-restricted species of South Africa's arid regions in addition to other taxa.

The SKA Land Management Plan states that there is an intention to declare the SKA Phase 1 study site (or parts thereof) a 130 000 ha protected area. This will go a long way to ensuring minimal disturbance, prohibiting certain activities and adequate statutory protection for the biodiversity of the Nama Karoo, currently South Africa's least conserved biome (SANBI, 2013).

5.3 Provincial Legislation

The overarching provincial environmental legislation is the Northern Cape Nature Conservation Act, 2009 Act No. 9 of 2009). The act is intended to ensure sustainable use and trade of wild fauna and flora, and to provide for the appointment of conservation officials to enforce and implement the provisions made in the Act. From a bat perspective, 58 species are listed as protected under the Act.

[†] Statutory protected areas - Biosphere Reserve, Botanical Garden, Forest Nature Reserve, Forest Wilderness area, Marine Protected Area, Mountain Catchment, National Park, Nature Reserve, Protected Environment, RAMSAR site, Special Nature Reserve or World Heritage Site. Conservancies excluded.

[‡] See http://www.birdlife.org.za/conservation/important-bird-areas/iba-directory#northern-cape-province . IBAs are not formally protected areas but are areas critical to the survival of local biodiversity, particularly avifauna. They may encompass existing recognised protected areas or conserve important habitats.

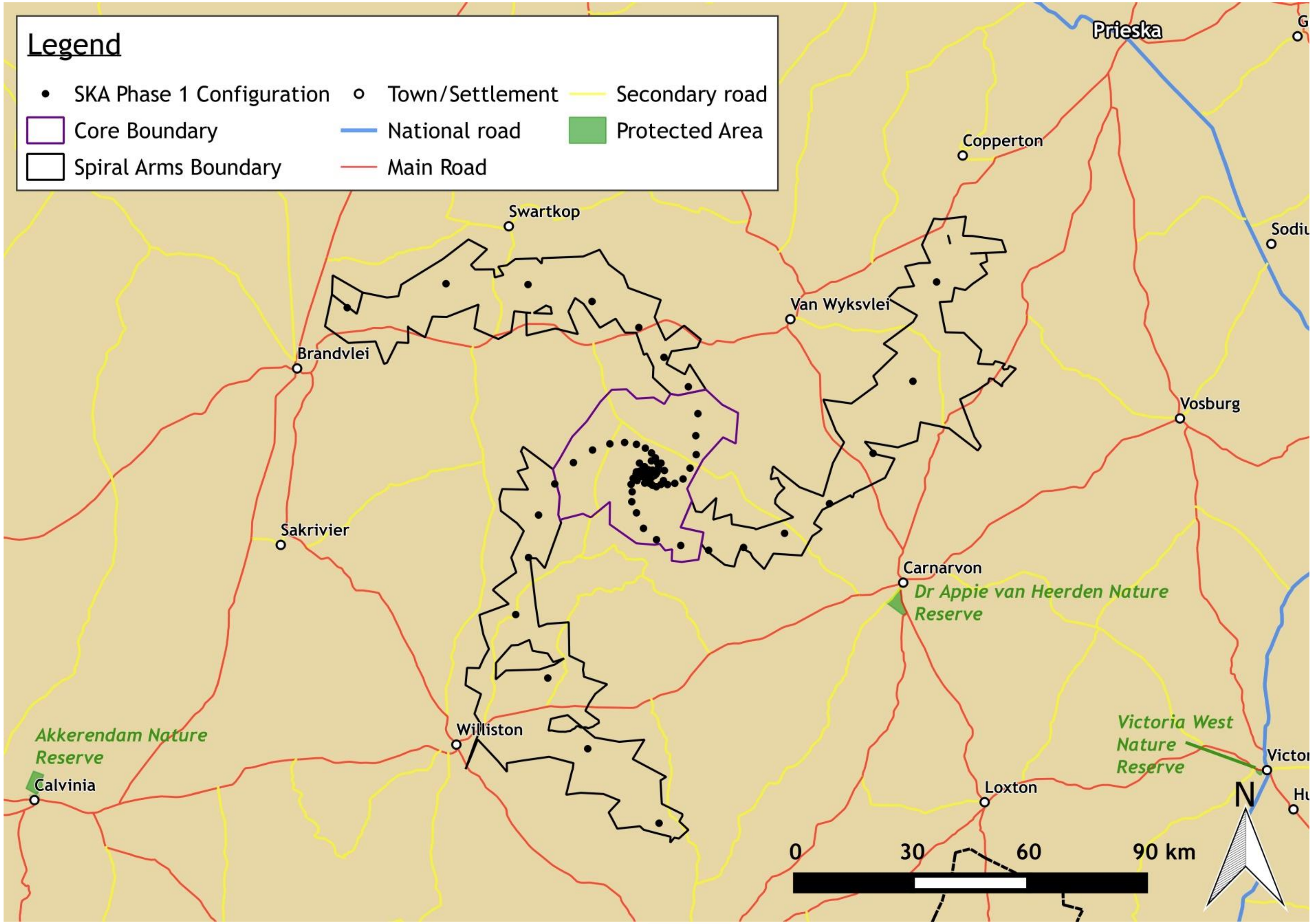

Figure 7 **Protected Areas in the vicinity of the SKA Phase 1 study site**

6. Methodology - Desktop

6.1 Species Likelihood of Occurrence

The Likelihood of Occurrence (LoO) was done according to the species distribution maps provided in Monadjem *et al*. (2010) and IWS's knowledge. The LoO was categorised as follows:

- If a species has been historically recorded on or near the site (<100 km), it was assigned a High LoO;
- If a species' range could include the site due to favourable environmental variables, the species was assigned a Moderate LoO;
- If the site is adjacent to an area where a species range extends, that species was assigned a Low LoO, and
- Species known to definitely not occur within the study area were not listed.

6.2 Literature, Spatial Data and Legislation Reviews

The background information documents, photographs, spatial data and other information supplied by the CSIR were reviewed and used in this assessment. In addition, IWS conducted a review of available literature, legislation and datasets, of which a list can be found under **Appendix 1** – Literature and Spatial Data References and Legislation Reviewed

6.3 Impact Assessment and Sensitivity Mapping

Based on the information provided, a crude impact assessment and sensitivity mapping exercise was performed and mitigation measures recommended. The sensitivity map was derived using IWS's knowledge and considering the following natural and artificial features: rivers and wetlands, geology (lithology), topography (relief), vegetation, buildings (visible on *Google Earth*), croplands (visible on *Google Earth* and from land use spatial data), confirmed and unconfirmed roosts.

7. Results

7.1 Likelihood of Species Occurrence

Based on historical and recent records and modelled distributions (Monadjem *et al.*, 2010; Babiker, 2012; Jacobs *et al*., 2013) and IWS's knowledge, 11 bats, presented in **Table 1,** have the potential to occur in the SKA Phase 1 study site and the greater KCAAA area. In terms of the Likelihood of Occurrence (LoO) of the various species, two are highly likely to occur – with confirmed records within a 50 km radius of the SKA Phase 1 study area. This area of the Northern Cape is not very well studied from a bat perspective. The widespread distribution of two of the species and the suitable habitat of rocky outcrops scattered around both the SKA Phase 1 study site and the greater KCAAA area, give the two said species moderate LoO (**Table 1**). The remaining seven species have a low but possible LoO due to their distribution ranges in Monadjem *et al.* (2010) and pockets of suitable climate habitat niches.

Table 1 Potential Species List

FAMILY	SPECIES	COMMON NAME	LoO	CONSERVATION STATUS National *	Global **	Provincial ***/****	ENDEMISM to SA*****
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat	High	LC	LC	PS/ PWA	
RHINOLOPHIDAE	*Rhinolophus damarensis*	Damara Horseshoe bat	High	NE	NE	¥	
MOLOSSIDAE	*Sauromys petrophilus*	Robert's flat-headed bat	Moderate	LC	LC	PS/ PWA	Endemic
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine bat	Moderate	LC	LC	PS/ PWA	
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered bat	Low	NT	LC	PS/ PWA	
NYCTERIDAE	*Nycteris thebaica*	Egyptian slit-faced bat	Low	LC	LC	PS/ PWA	
RHINOLOPHIDAE	*Rhinolophus capensis*	Cape horseshoe bat	Low	NT	LC	PS/ PWA	Endemic
RHINOLOPHIDAE	*Rhinolophus clivosus*	Geoffroy's horseshoe bat	Low	NT	LC	PS/ PWA	
VESPERTILIONIDAE	*Cistugo lesueuri*	Lesueur's wing-gland bat	Low	NT	LC	PS/ PWA	Endemic
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed serotine	Low	LC	LC	PS/ PWA	Endemic
VESPERTILIONIDAE	*Laephotis namibensis*	Yellow-bellied house bat	Low	NE	LC	PWA	Endemic

Legend: LC = Least Concern; NE = Not Evaluated; NT = Near Threatened; PS = Protected Species; *Friedman and Daly (2004) **IUCN (2016) *** Northern Cape Nature Conservation Act: Act 9 of 2009: Schedule 2 – Protected Species list **** Cape Nature Conservation Ordinance: No. 19 of 1974: Schedule 2 – Protected Wild Animals list ***** Monadjem *et al.* (2010) ¥ Species has only recently been described as a separate species by Jacobs *et al*. (2013) and thus has not been included on any provincial species lists.

7.2 Important Bat Habitats

Besides the lush and productive lands along the Orange River in the northern sections of the greater KCAAA area and some scattered bush and ephemeral drainage lines, most of the greater KCAAA area, including the SKA Phase 1 study site falls within arid habitat of the Nama Karoo biome (**Figure 3**), with a small portion of the western boundary of the greater KCAAA area falling within the Succulent Karoo biome. According to the most recent guidelines for surveying bats at potential wind energy facility (WEF) sites (Sowler *et al*., 2016), bat activity in the Succulent Karoo has been found to be substantially lower than other biomes/bioregions. Bat activity in Nama Karoo is higher than in the Succulent Karoo, but still low overall. Bat important habitats are limited to significant features in the landscape such as rock outcrops, buildings, any open water croplands, riparian vegetation and bush clumps.

7.2.1 Roosting Potential

Bats roost in various features and structures, mainly caves, rock crevices, buildings, trees and bush clumps. Whilst there are no large confirmed caves in the SKA Phase 1 study site, there are two known bat roosts (>500 bats each) within the greater KCAAA area – one approximately 40 km northeast of Carnarvon (D. Jacobs *pers. comm.*), and one approximately 55 km north-west of Kenhardt. The former roost is likely to be an important maternity roost for *R. damarensis* (D. Jacobs *pers. comm.*). These roost localities were supplied by a reliable academic source, however, other than the information supplied here, further characteristics and more recent information regarding the roosts are unknown to IWS and will need to be verified in the next phase of this project. Additionally, IWS can confirm two roosts further afield - large cave roosts (>60 000 bats) approximately 200 km to the west (Steenkampskraal Mine) and 300 km to the northeast (Koegelbeen Cave) of the SKA Phase 1 study site respectively which host important unique populations of *R. capensis* and *M. natalensis*. Refer to **Section 7.2.3**.

Besides potential large roosts, several small roosts are likely to occur in the rocky outcrops on the scattered rocky hills throughout the SKA Phase 1 study site (**Figure 8a**) and the topographical ridges, occurring more densely in the southern areas (**Figure 8b**). The town of Carnarvon and smaller farm homesteads are likely to provide many small potential roosts in the form of trees and buildings (**Figure 8c** and **Figure 8d**).

a. Rocky hills and outcrops in study site

b. Topographical ridges in the study site

c Buildings in the town of Carnivon

d. Buildings in the town of Carnivon

Figure 8 Roosting potential photographs (photos supplied by the CSIR)

7.2.2 Foraging Potential

It is only insect-eating bats that are likely to occur in the SKA Phase 1 study site and the greater KCAAA area. The foraging potential for these bats is low across most of these areas, due to the arid conditions. Foraging and drinking potential will be highest near water, in the form of permanent rivers and water bodies, ephemeral rivers and wetlands at certain times of the year (Sirami *et al.*, 2013), irrigated croplands and near homesteads with irrigated gardens and diverse vegetation, where flying insect numbers are higher. One of the bats that has the potential to occur (*Nycteris thebaica*) is a gleaning forager, i.e. it forages at very low heights amongst clutter and will pick up spiders, scorpions and grasshoppers from the ground, walls or rocks. This species is suited to such arid environments.

7.2.3 Migration Potential

There is evidence that migrant bats travel south-west from Koegelbeen Cave, near Griekwastad to hibernate at Steenkampskraal mine, near Vanrhynsdorp, 560 km away (Miller-Butterworth *et al*., 2003). Both cave type roosts contain thousands of bats (Monadjem *et al*., 2008; MacEwan *pers comm*). Furthermore, there could be connectivity in movement between the two roosts in the greater KCAAA area. Based on the assumption that bats will follow the shortest route on seasonal migrations, these bats will definitely fly through the greater KCAAA area and are likely to fly over sections of the SKA Phase 1 study site. Potential migration routes are shown in **Figure 9** in relation to the SKA Phase 1 study site and the greater KCAAA area. The assumed migration path is shown with a red dashed arrow.

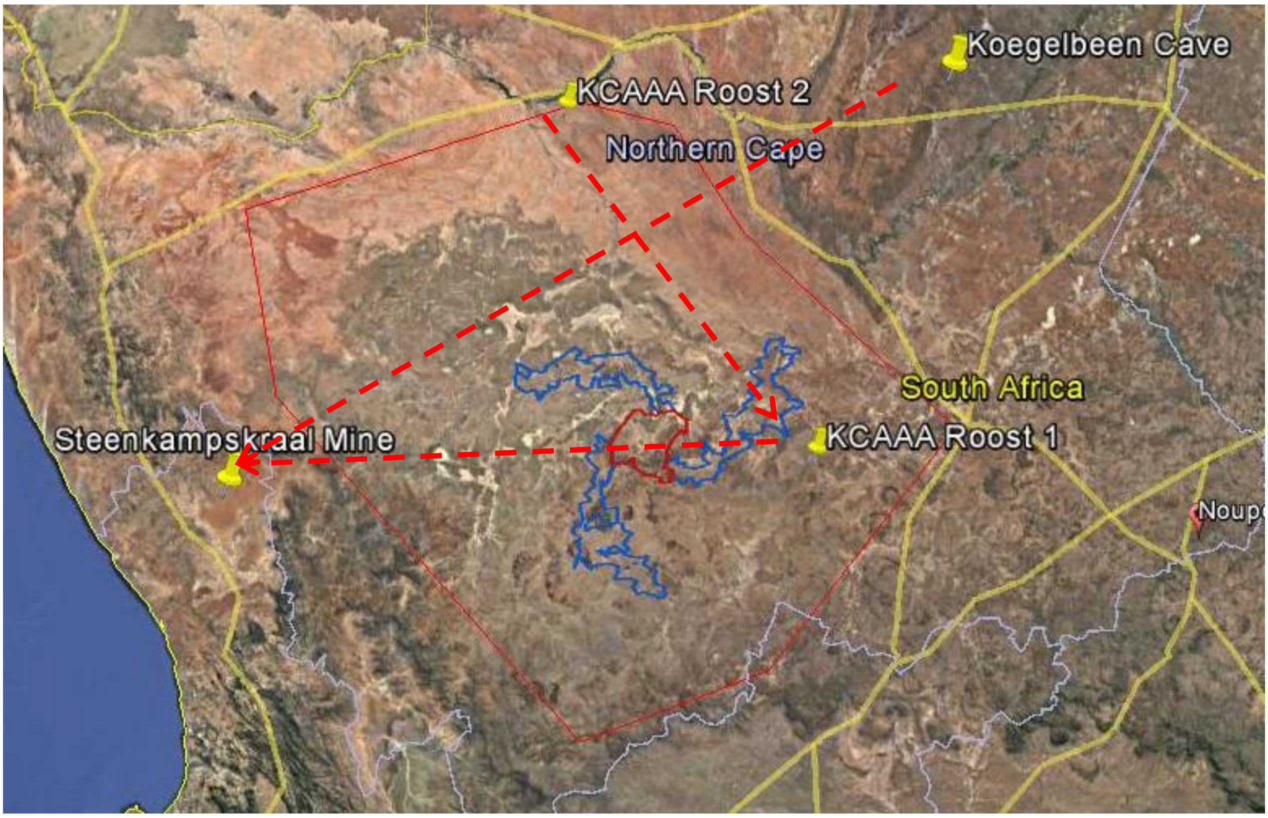

Figure 9 **Bat migration potential map**

8. Desktop Bat Sensitivity Map

As there are no guidelines available for the development of radio telescopes and bats, IWS has used the up-to-date recommendations in Sowler *et al*. (2016) as a guide in terms of identifying sensitive features and assigning buffer zones. The minimum buffers were used due to the assumption that radio telescopes have less of an impact during the operational phases, compared to that of wind turbines. However, we have also considered construction phase impacts and the fact that bats are protected in the Northern Cape Province. The sensitivity mapping was done mainly for the SKA Phase 1 study site, however, the two cave-type roosts in the greater KCAAA area were also buffered and shown in **Figure 10** and **Figure 11**. The desktop preliminary sensitivity maps (**Figure 10** - **Figure 15**) were compiled as follows:

- Potential Bat Sensitive Areas:
  - Rivers and wetlands[§] plus a 200 m buffer were assigned as potential bat sensitivity areas. There is strong support for the importance of rivers and riparian areas for bats (Serra-Cobo *et al*., 2000; Akasaka *et al*., 2009; Hagen and Sabo, 2012; Sirami *et al*, 2013). Sowler *et al*. (2016) prescribe 200 m as a minimum buffer for such features.
  - All dwellings (such as farm buildings, reservoirs, bridges) in the SKA Phase 1 study site that were visible on *Google Earth* plus a 500 m buffer.[**] Sowler *et al*. (2016) prescribe a buffer of 500 m for a colony of 1 – 50 Least Concern bats.
  - Cliffs and ridges plus a 500m buffer[††]. These areas are the most likely areas to contain small caves crevices and roosting sites for bats, considering the arid habitat and were thus ascribed a 500 m buffer as the Sowler *et al*. (2016) state this is the recommended buffer for a colony of 1-50 Least Concern or low-risk Conservation Important bats, and IWS believes that this number is likely if a number of small roosts occur along these cliffs.
  - Any significant bush/tree clumps, woodland vegetation (including alien species) plus a buffer of 200 m.[‡‡] Sowler *et al*. (2016) prescribe 200 m as a minimum buffer for such features.
  - Irrigated croplands (identified on *Google Earth* and DEA, 2015b) plus a 200 m buffer due to the foraging potential of insectivorous bats. Sowler *et al*. (2016) prescribe 200 m as a minimum buffer for such features.
  - Potential bat sensitivity areas should be areas where development is avoided. Only unavoidable linear cable or road crossings should be allowed. Where possible, all point structures, such as antennae/receptors and buildings should be constructed outside of these potential sensitivity areas.
- High Bat Sensitivity Areas
  - The two known roosts within the greater KCAAA area were assigned a 10 km buffer. While IWS has not verified the estimated population or species composition of these roosts, a reliable source has estimated the population of > 500 bats for each roost. Therefore, IWS assigned a 10km buffer to these based on Sowler *et al*. (2016) prescribing a buffer of 10 km for a colony of 500 - 2000 Medium-High Risk Conservation Important bats. Most cave-dwelling bats are Medium-High Risk and are Near-Threatened.
  - High bat sensitivity areas should be considered no-go areas for any future development until a bat specialist has verified the sites' population and species composition and makes a more informed recommendation.

[§] According to CSIR (2011); DEA (2015b) datasets.
[**] Where dwellings were found in very close proximity to one another, these were counted as one dwelling unit.
[††] These were identified by selecting all areas of steep topography (high proximity contour lines) from Chief Surveyor-General spatial data, within the SKA Phase 1 study area, and verifying these on *Google Earth*.
[‡‡] This was done by selecting all the areas classified under the DEA (2015b) 2013/14 Land Cover Dataset version 05 as a 'woodland', thicket' or 'open bush' and then buffering these by 200 m.

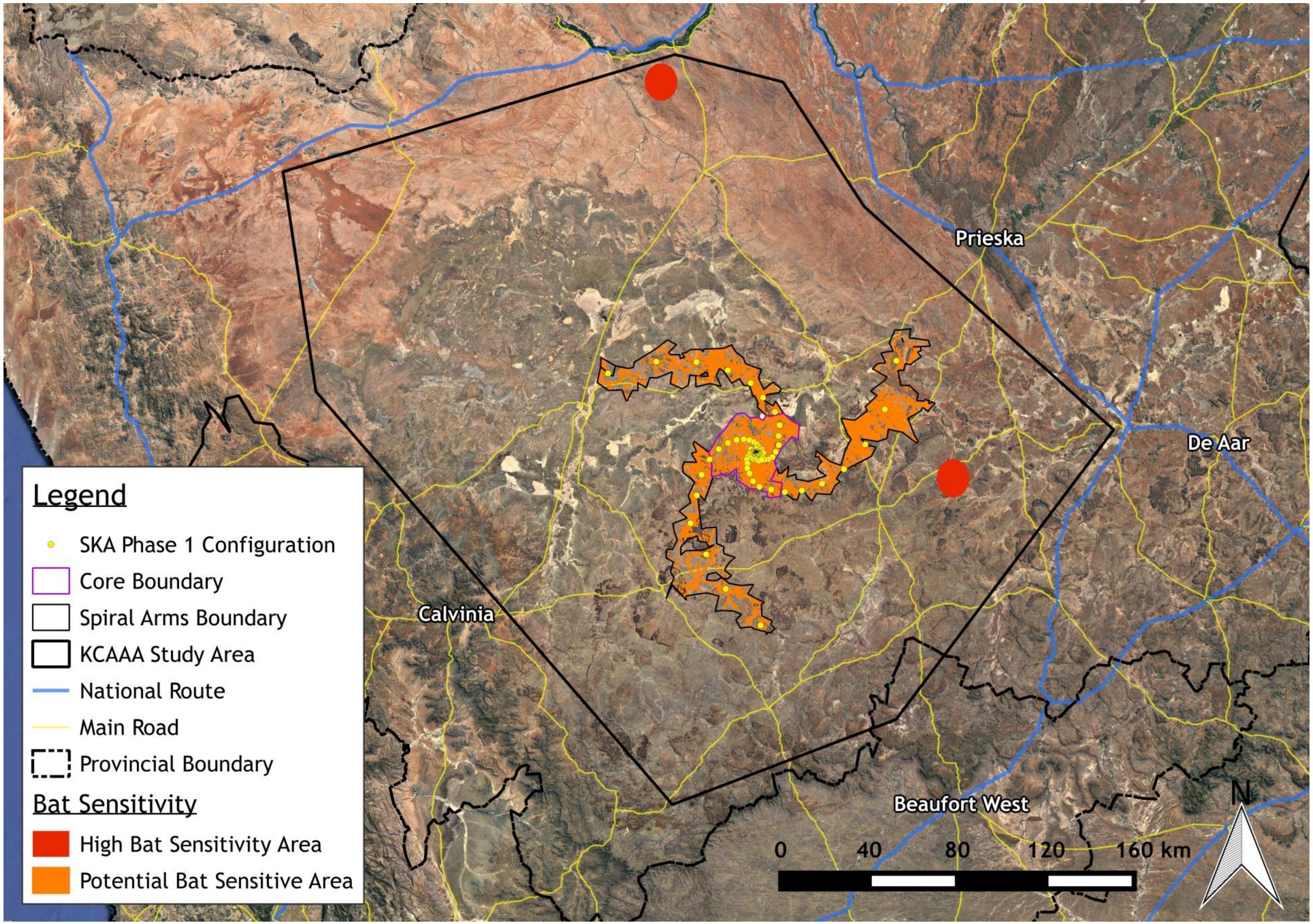

Figure 10 **Desktop bat sensitivity map for the SKA Phase 1 study site, including two roosts in the greater KCAAA area**

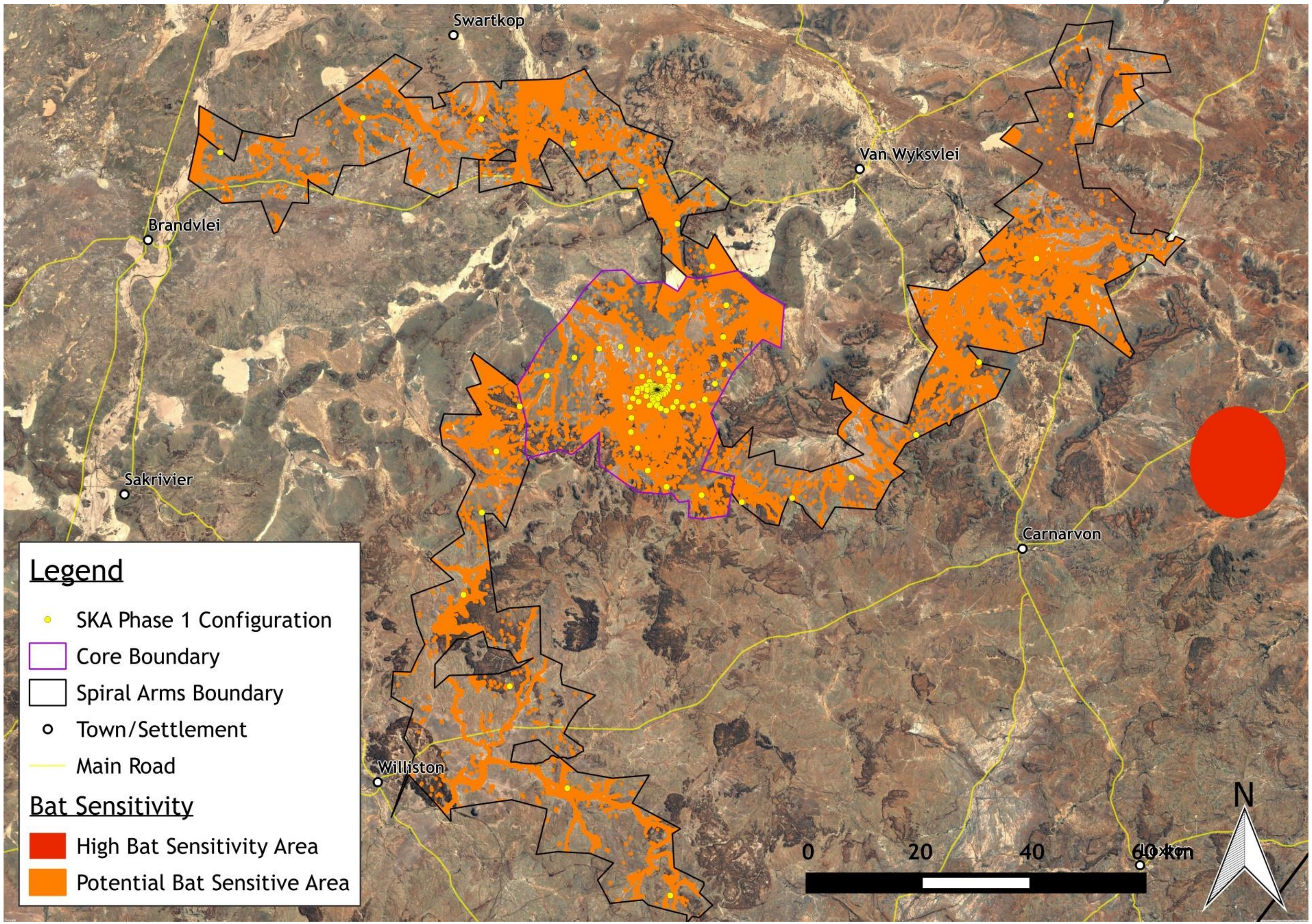

Figure 11 **Desktop bat sensitivity map for the SKA Phase 1 study site**

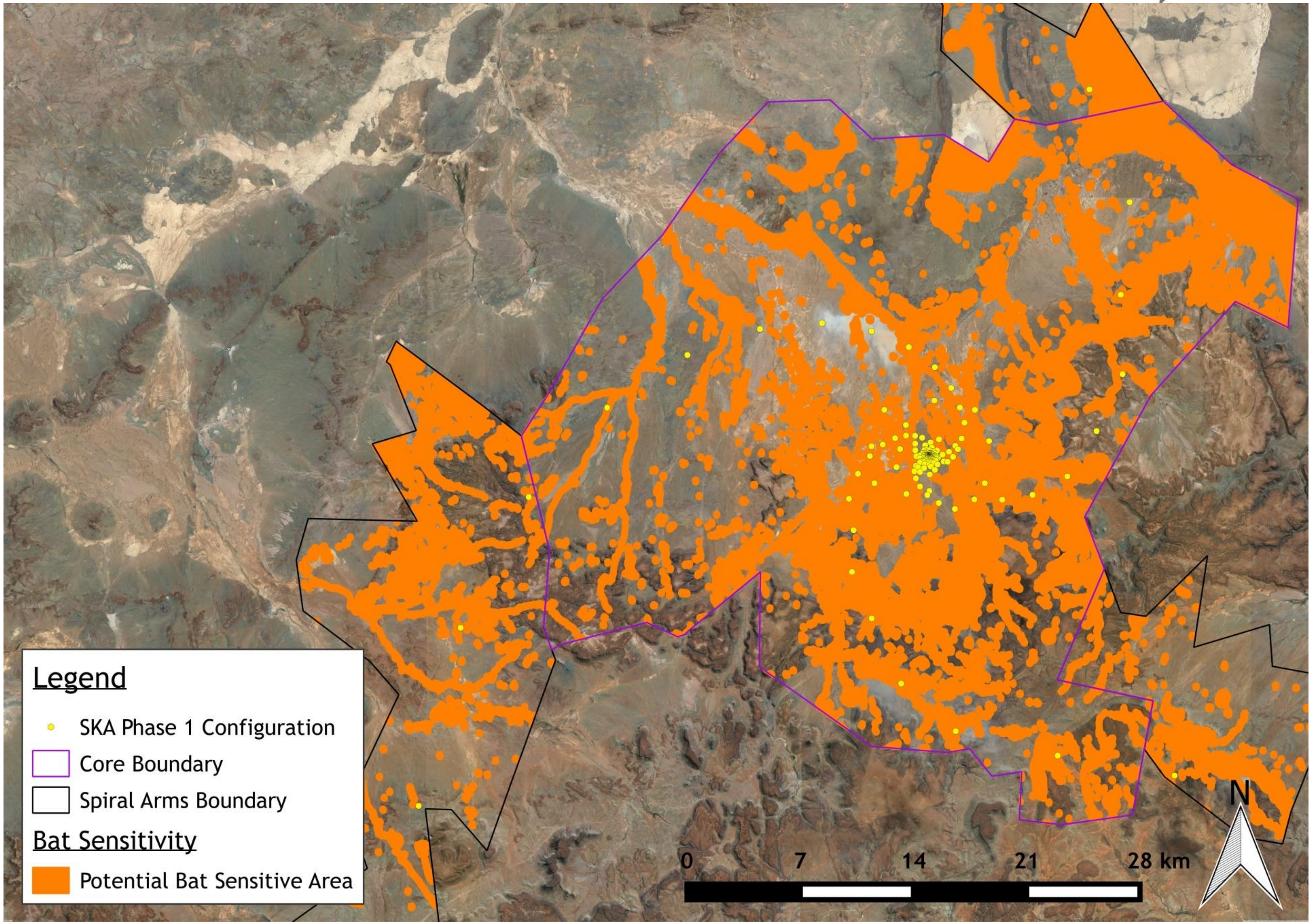

Figure 12 **Desktop bat sensitivity map for the core of the SKA Phase 1 study site**

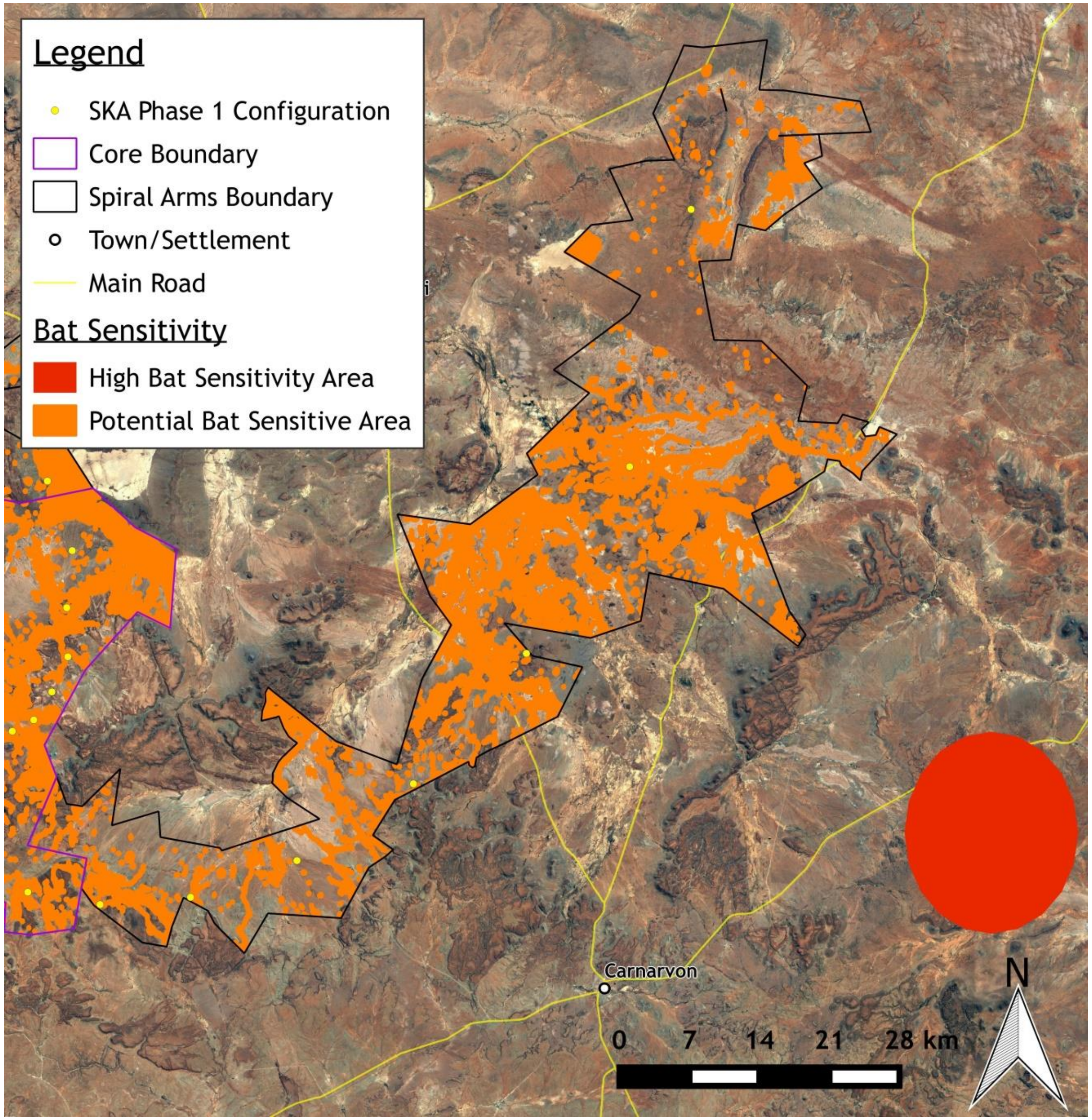

Figure 13 Desktop bat sensitivity map for the eastern spiral arm of the SKA Phase 1 study site

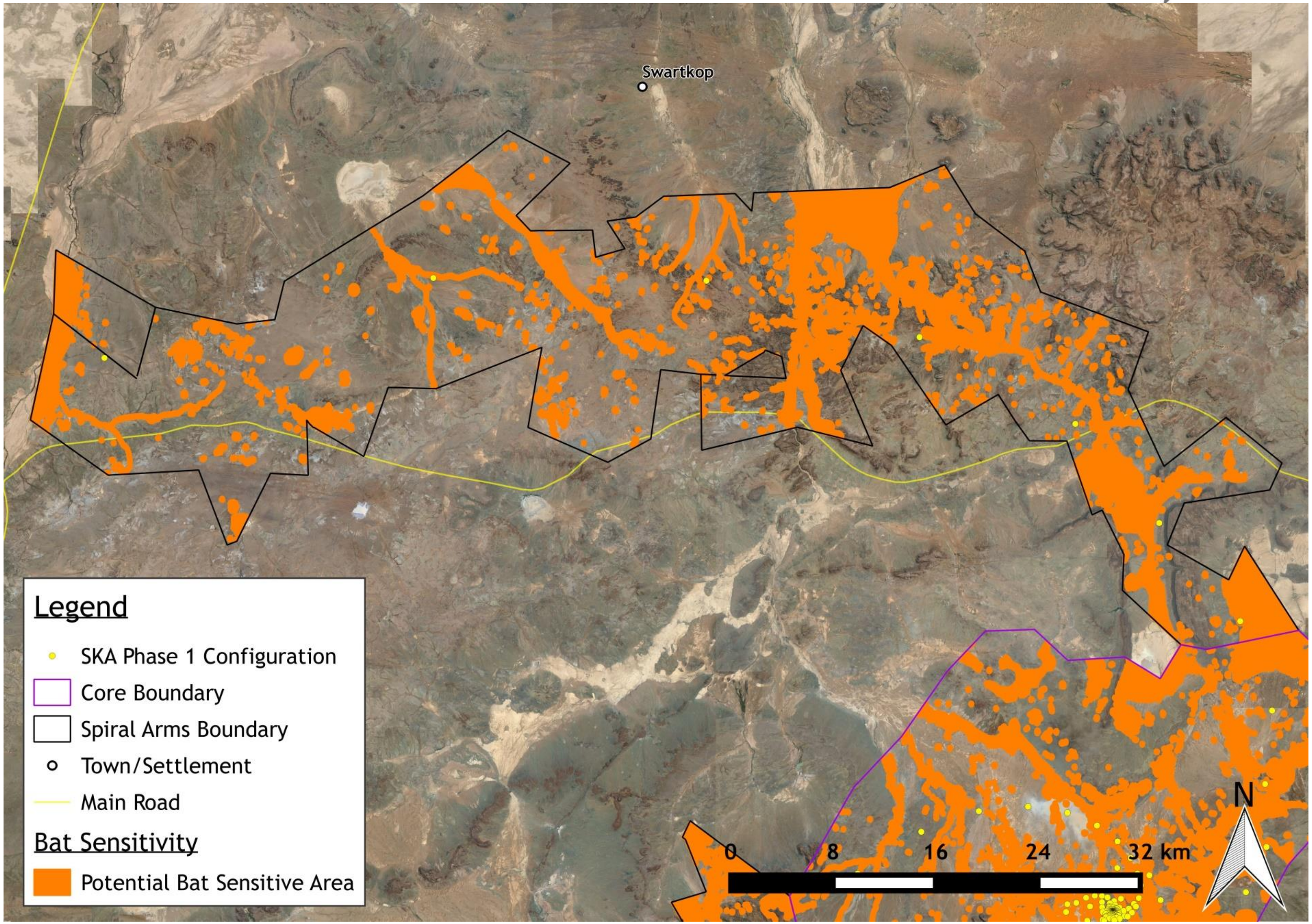

Figure 14 Desktop bat sensitivity map for the north-western spiral arm of the SKA Phase 1 study site

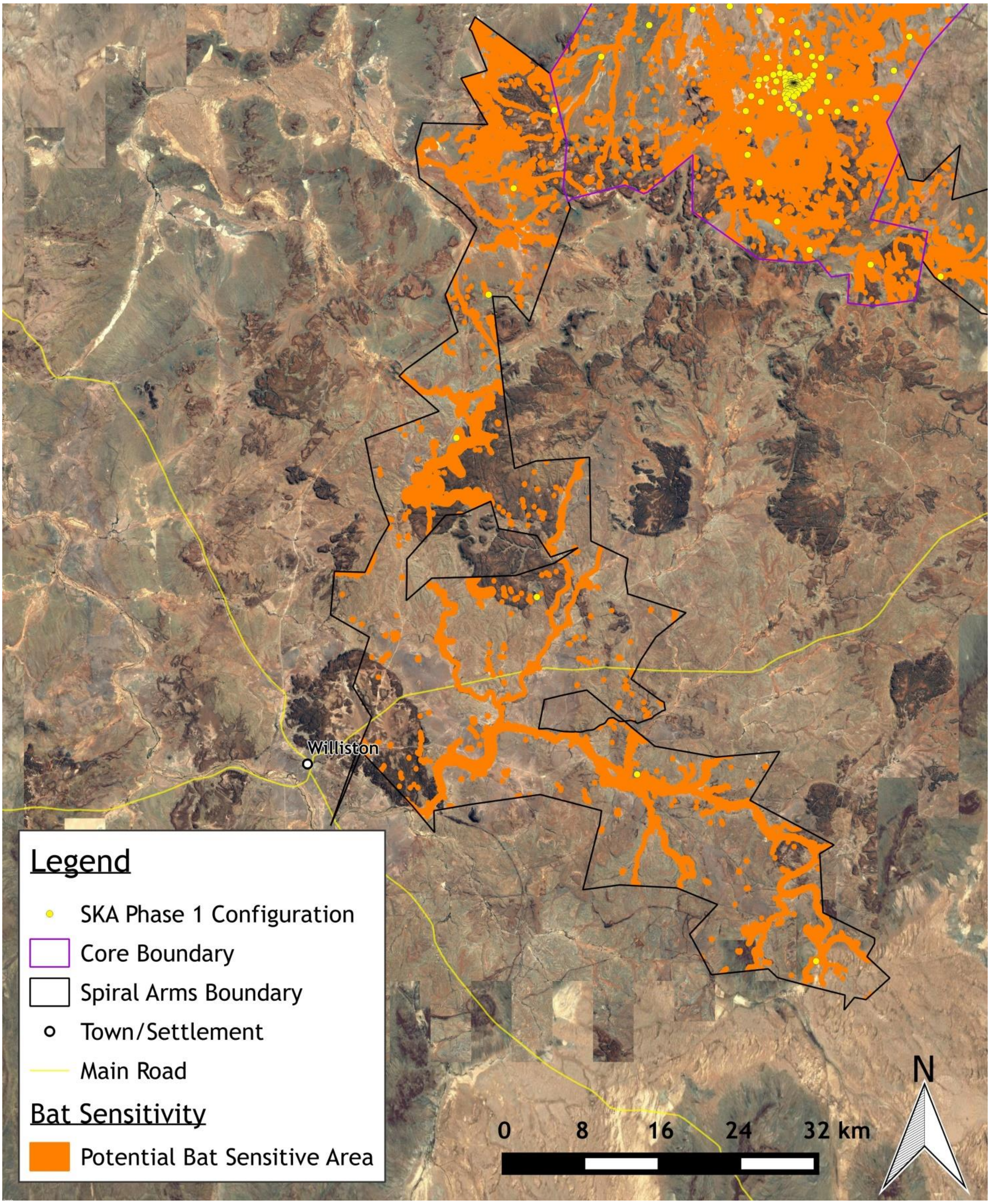

Figure 15 **Desktop bat sensitivity map for the southern spiral arm of the SKA Phase 1 study site**

9. Potential Impacts and Mitigation Recommendations

Very little is known about the impact of radio telescope technology on bats. However, IWS has compiled a draft impact assessment based on available information and their knowledge of bat biology. The impact assessment considers the construction and operational stages of the SKA Phase 1 project only.

9.1 Construction Phase

The construction stage will consist of the clearing of vegetation and rocks for the antennae foundations, road access and power line access. The power line cables will run underground and therefore some drilling and tunnelling will take place. Cars and heavy vehicles will be driving around the site. Offices and maintenance yards will be constructed and from the MeerKAT photographs, it appears that diesel will be stored on site. Some images of the construction stage from the currently in-construction MeerKAT project can be seen in **Figure 16**.

Figure 16 Construction phase photographs of the MeerKAT project (photos supplied by the CSIR)

Potential impacts and mitigation recommendations for this the construction phase are as follows:

9.1.1 Habitat Loss and Disturbance

Potential Impacts

Clearing of vegetation and rocks during construction will unlikely cause disturbance to any large bat roosts, but will cause a loss of and disturbance to bat foraging habitat. The loss, degradation and fragmentation of natural ecosystems are regarded as one of the key reasons for loss of biodiversity and extinction of species, globally and in South Africa (King *et al*., 2005; SANBI 2013). This is also true of bats, and as mentioned previously, species such as *Miniopterus natalensis* are particularly susceptible to changes in land cover due to major disruptions in their foraging and roosting ecology. However, the bat roosting and foraging potential on site is low and this impact is considered to have a low significance.

Mitigation Recommendations

Mitigation recommendations include:

- Construction activities for this project are to disturb as little natural vegetation, existing dwellings, rocky ridges, river beds and wetlands as possible.
- Development in potentially bat sensitive areas should be avoided where possible. See Section 8.
- Dust and noise control measures during construction should be employed.
- Vehicles and equipment should be well maintained to avoid diesel spillages resulting in land and water contamination.
- It is recommended that construction occurs during daylight hours only, avoiding the hours of highest bat activity during dusk, late evening and pre-dawn and that mitigation measures to minimise disturbances during construction are implemented and adhered to, for example, dust control
- Whilst the SKA Phase 1 study site does not encroach on any large known roosts or their buffer areas, there are two known roosts in the greater KCAAA area. These areas have been classified as high bat sensitivity areas and should be considered no-go areas for any future development until a bat specialist has verified the sites' population and species composition.
- Should the project proceed to further phases and into the greater KCAAA area, known roosts identified in this phase, should be verified for more recent information. High bat sensitivity areas should be considered no-go areas for any future development until a bat specialist has verified the sites' population and species composition and makes a more informed recommendation.
- Should any other definite roosts be discovered during construction, the bat specialist team should be consulted and if confirmed as a large roost (with >50 bats or containing bats of conservation importance), suitable mitigation measures will be recommended.

9.1.2 Sensory disturbance

Potential Impacts

Bats rely on sensory adaptations such as echolocation for movement and feeding. Noise has been shown to impact bats' feeding capabilities (Jones, 2008). Gleaning bats (those which take prey off objects) in particular rely on detecting the noises of prey around vegetation and are particularly susceptible to noise disturbances. Aerial-feeding bats are less vulnerable to noise disturbance as echolocation used by bats to detect prey has a higher frequency than most anthropogenic-induced noise (Jones, 2008). Dust and vibrations generated by machinery may also impair bats' mobility and feeding.

Mitigation Recommendations

It is recommended that:

- Construction occurs during daylight hours only, avoiding the hours of highest bat activity during dusk, late evening and pre-dawn, and that mitigation measures to minimise disturbances during construction are implemented and adhered to, for example, dust and noise control.
- Should any definite roosts be discovered during any stage of the project, the bat specialist team should be consulted and if confirmed as a large roost (with >50 bats or containing bats of conservation importance), suitable mitigation measures will be recommended.

9.2 Operational Phase

Once all of the antennae, offices and maintenance buildings are constructed, operational activities are anticipated to consist of minor electromagnetic radiation, rotation of the receptors and maintenance and scientific activities on site. Potential impacts and mitigation recommendations for this the operational stage is as follows:

9.2.1 Collision with Antennae/Receptors or Infrastructure

Potential Impacts

Depending of the angle of the receptor and whether certain section of the dish are flat enough, bats could mistake the dome receptors as water bodies and be attracted to them for drinking and collide with other vertical structures on the dish. Studies have shown bats to mistake mirror-like and smooth metal and plastic surfaces as water (Greif and Siemers, 2010; Russo *et al.* 2012). While not horizontal like a water surface, the smooth face of a dish may lead to echolocation pulses emitted by bats, being transmitted in a similar fashion to how their calls respond off of water surfaces (as they are acoustically smooth surfaces). These are called acoustic mirrors. Bats have evolved to drink from such surfaces in a natural setting and if bats do indeed perceive dishes as water, this may lead to collisions with the dish and/or related infrastructure. This is a similar impact to what is suspected to happen at solar energy facilities (Dr Dave Johnston *pers. comm.* 2 August 2016 – presentation at the International Bat Research Conference).

Mitigation Recommendations

Seeing that this is an unknown phenomenon, all wildlife fatalities observed or carcasses found, including bats, should be immediately reported to the below relevant organisations for the organisations to decide is action is required:

- For bats – the South African Bat Assessment Association (SABAA)
- For birds – BirdLife South Africa (BLSA)
- All other taxa – Endangered Wildlife Trust (EWT)

9.2.2 Electromagnetic Radiation and Habitat Fragmentation for Foraging and Migrating Bats

Potential Impacts

According to Black and Black (2008), electromagnetic radiation can cause serious harm to animals. The effect of electromagnetic field radiation depends on the dose and the time of exposure. Different doses may have different effects. Acute doses, especially at high voltages, may be instantly fatal, whereas prolonged exposure to low doses may have cumulative effects causing behavioural and physiological defects (Lai, 2005; Adey, 1997). Unfortunately, studies on the effects of electromagnetic radiation on wildlife are exceedingly rare. Among the studies which have been done, bird populations appear most well-studied. Physiological effects in birds range from plumage deterioration to movement problems, as well as albinism and melanism (Balmori, 2003). Other effects include decreases in sperm motility and the bird's response to photoperiod due to altered melatonin levels (Fernie, 1999). Electric fields have also been known to disrupt the chemical gradient and signals to embryo cells thereby resulting in malformation. Berman *et al*. (1990) add that malformation in the nervous system, the heart and delayed embryo growth have also been observed.

Based on lab experiments, electromagnetic radiation is also said to have behavioural effects on bats and rats. Nicholls and Racey (2007) state that the activity of bats is significantly reduced in areas where they are exposed to electromagnetic field strengths exceeding 2 volts / meter. Nicholls and Racey (2009) went further to say that pulsed electromagnetic radiation from a small, affordable and portable radar system can reduce bat activity within a given area.

Changes in muscle and nervous system functioning are observed in living tissues when electric current density reaches over 10mA/m2. Considering that the effects of electromagnetic radiation are inversely proportional to body size and age, smaller mammals such as bats are particularly prone to the negative effects of prolonged exposure (ICNIRP, 1998).

In a more recent publication by Nicholls and Racey (2012), they concluded that electromagnetic radiation exerts a deterrent effect on foraging bats, possibly due to thermal loading.

According to the radio frequency interference expert at SKA (Dr Adrian Tiplady *pers comm* 26 September 2016), the antenna do not transmit radio waves of any nature but receive radio waves passively only. These radio waves are emitted naturally from cosmic sources, are millions of times weaker than existing terrestrial transmissions from cell phones, television signals etc., and have been 'hitting' the earth for millions of years. There is no communications between the dishes, other than the measurement data, which is transmitted via fibre optic networks on conventional communication infrastructure. There is no electromagnetic radiation around the dishes (at least, nothing more than you would expect from a few pieces of industrial equipment to move the dish, and a couple computers to process the data).

Therefore, the potential impact of electromagnetic interference on bats due to the SKA Phase 1 project is considered very low to negligible.

Mitigation Recommendations

Considering that the electromagnetic radiation impact is considered to be of low significance, specific mitigation measures cannot be recommended for this. However, due to the lack of knowledge of bat species distributions and diversity in the Northern Cape, their protected status and increasing developments in these remote areas, e.g. renewable energy projects, satellite telescope projects and radio telescope projects, the below project is worth considering by research funders, such as the NRF and academic institutions:

- A long-term research programme to be undertaken to improve knowledge of bat species distribution, diversity and migration routes in the Northern Cape. This can be initiated by providing NRF bursaries/scholarships to postgraduate students at South African tertiary institutions to gather baseline data (i.e. species composition, distribution, movements and interactions with infrastructure). This data will be useful to input into the DEA/ SANBI bird and bat database and will assist in updating the sensitivity map of the study sites if required.

9.2.3 Habitat Protection

Potential Positive Impact

Whilst there are a few potentially negative impacts, a positive impact of the SKA phases is that the core SKA areas will be no-go areas for human activity, other than maintenance activities. The SKA Land Management Plan states that there is an intention to declare the SKA Phase 1 study site (or parts thereof) a 130 000 ha protected area. This will go a long way to ensuring minimal disturbance, prohibiting certain activities and adequate statutory protection for the biodiversity of the area, including bats from a habitat protection perspective only.

This is to avoid human noises and light pollution from interfering with the data received by the receptors. Hence, besides the already identified potential negative impacts due to the construction and operational of the facility, the remainder of the large area will remain untouched by humans and hence, areas where wildlife can thrive, assuming the electromagnetic radiation does not deter them or cause them harm.

10.Conclusions

- Ten species have the potential to occur within the SKA Phase 1 study site and the greater KCAAA area and current distribution records reflect that only three of these are likely.
- The Northern Cape Nature Conservation Act: Act 9 of 2009 recognises all bats as Protected Species in the Northern Cape.
- Two known large roosts occur within the greater KCAAA area, but these do not encroach on the SKA Phase 1 study site. For future phases of the project, these two roosts should be verified by a bat specialist due to the potential impact on migrating bats and for future phases of the project. Several small roosts are likely to occur in the rocky outcrops on the scattered rocky hills throughout the site and the topographical ridges, occurring more densely in the southern areas. The town of Carnarvon and smaller farm homesteads are likely to provide many small potential roosts in the form of trees and buildings.
- There is a strong possibility that the greater KCAAA area and the SKA Phase 1 study site are situated in migration routes of *Miniopterus natalensis*, a Near-threatened, cave-dwelling migratory bat.

- The foraging potential for bats is low across most of the site, due to the arid conditions. Foraging potential will be highest near water, in the form of permanent rivers and water bodies (including farm dams/reservoirs), ephemeral rivers and wetland at certain times of the year, irrigated croplands and near homesteads with irrigated gardens diverse vegetation where flying insect numbers are higher.
- The potential impacts identified for the construction stage are mainly associated with habitat disturbance and fragmentation and a few general mitigation measures relevant to most fauna have been recommended:
  - Construction activities for this project are to disturb as little natural vegetation, existing dwellings, rocky ridges, river beds and wetlands as possible.
  - Development in potentially bat sensitive areas should be avoided where possible. See Section 8.
  - Dust and noise control measures during construction should be employed.
  - Vehicles and equipment should be well maintained to avoid diesel spillages resulting in land and water contamination.
  - It is recommended that construction occurs during daylight hours only, avoiding the hours of highest bat activity during dusk, late evening and pre-dawn and that mitigation measures to minimise disturbances during construction are implemented and adhered to, for example, dust control
  - Whilst the SKA Phase 1 study site does not encroach on any large known roosts or their buffer areas, there are two known roosts in the greater KCAAA area. These areas have been classified as high bat sensitivity areas and should be considered no-go areas for any future development until a bat specialist has verified the sites' population and species composition.
  - Should the project proceed to further phases and into the greater KCAAA area, known roosts identified in this phase, should be verified for more recent information. High bat sensitivity areas should be considered no-go areas for any future development until a bat specialist has verified the sites' population and species composition and makes a more informed recommendation.
  - Should any other definite roosts be discovered during construction, the bat specialist team should be consulted and if confirmed as a large roost (with >50 bats or containing bats of conservation importance), suitable mitigation measures will be recommended.
- In the case of potential impacts due to collision with antennae or infrastructure, all wildlife fatalities observed or carcasses found, including bats, should be immediately reported to the below relevant organisations for the organisations to decide is action is required:
  - For bats – the South African Bat Assessment Association (SABAA)
  - For birds – Bird Life South Africa
  - All other taxa – Endangered Wildlife Trust (EWT)
- Considering that the electromagnetic radiation impact is considered to be of low significance, specific mitigation measures cannot be recommended for this. However, due to the lack of

knowledge of bat species distributions and diversity in the Northern Cape, their protected status and increasing developments in these remote areas, e.g. renewable energy projects, satellite telescope projects and radio telescope projects, the below project is worth considering by research funders, such as the National Research Foundation (NRF) and academic institutions:

- A long-term research programme to be undertaken to improve knowledge of bat species distribution, diversity and migration routes in the Northern Cape. This can be initiated by providing NRF bursaries/scholarships to postgraduate students at South African tertiary institutions to gather baseline data (i.e. species composition, distribution and movements). This data will be useful to input into the DEA/ SANBI bird and bat database.

11. Appendix 1 – Literature and Spatial Data References and Legislation Reviewed

11.1 Literature References

- Adey, W.R. 1997. Bioeffects of mobile communications fields; possible mechanisms of cumulative dose. In: Kuster N, Balzano Q, Lin J, eds., *Mobile Communications Safety*. New York: Chapman and Hall. pp. 103-139.
- Akasaka, T. Nakano, D. and Nakamura, F. (2009). Influence of prey variables, food supply, and river restoration on the foraging activity of Daubenton's bat (*Myotis daubentonii*) in the Shibetsu River, a large lowland river in Japan. *Biological Conservation 142: p1302–1310*.
- Aronson, J., Richardson, E., MacEwan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. & Hein, C. 2014. *South African Good Practise Guidelines for Operational Monitoring for Bats at Wind Energy Facilities*. *1st Edition*. Unpublished guidelines.
- Babiker, H. 2012. Environmental factors influencing the distribution of bats (Chiroptera) in South Africa. PhD thesis, University of Cape Town.
- Berman, E., Chacon, L., House, J.D., Koch, B.A., Koch, W.E., Leal, J., Lovtruup, S., Mantiply, E., Martin, A.H., Martucci, GI., Mild, K.H., Monahan, J.C., Sandstrom, M., Shamsaifar, K., Tell, R., Trillo, M.A., Ubeda, A. and Wagner, P. 1990. Development of chicken embryos in a pulsed magnetic field. *Bioelectromagnetics 11: p169-187*.
- Black, M and Black, D.R. 2008. *Assessment of potential effects of high voltage transmission lines on domestic animals*. Enviromedix Doc 4821 – Version 3 Final. Report for Contact Energy Ltd.
- DEA. 2015a. Background Information Document for the Strategic Environmental Assessment for the Square Kilometre Array (SKA) Phase 1 South Africa, Department of Environmental Affairs, Pretoria.
- DST. 2014. South Africa's MeerKAT Radio Telescope Technical Fact Sheet, Department of Science and Technology, Pretoria.
- Fernie, K.J. and Bird, D.M. 1999. Effect of electromagnetic fields on body mass and food intake of American Kestrel. *Condor 101: p616-621*.

- Friedmann, Y. & Daly, B. (eds.) 2004. *Red data book of the mammals of South Africa: A conservation assessment*. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN). Endangered Wildlife Trust, Johannesburg.
- Greif, S. & Siemers, BM. 2010. Innate recognition of water bodies in echolocating bats. *Nature Communications 1: 107*. DOI: 10.1038/ncomms1110.
- Hagen, E.M. and J.L. Sabo. (2012). Influence of river drying and insect availability on bat activity along the San Pedro River, Arizona (USA). *The Journal of Arid Environments 84: p1-8*.
- ICNIRP. 1998. ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic Fields. *Health Physics 74: p494-522*.
- IUCN 2014. IUCN Red List of Threatened Species. Version 2016.1. <www.iucnredlist.org>. Downloaded on 27 June 2016.
- Jacobs, D.S., Babiker, H., Bastian, A., Kearney, T., Van Eeden, R. & Bishop, J.M. 2013. Phenotypic convergence in genetically distinct lineages of a *Rhinolophus* species complex (Mammalia, Chiroptera). *PLoS ONE*, 8(12): e82614. doi:10.1371/journal.pone.0082614.
- Jones, G. 2008. Sensory Ecology: noise annoys foraging bats. *Current Biology 18:23*.
- King, N., Rosmarin, T., Friedmann, Y. and Reyers, B. 2005. National State of the Environment Project: Biodiversity and Ecosystem Health. Report for the Department of Environmental Affairs and Tourism, October 2005.
- Lai, H. and Singh, N.P. 2005. Interaction of microwaves and a temporally incoherent magnetic field on single and double DNA strand breaks in rat brain cells. *Electromagnetic Biology and Medicine 24: p23- 29*.
- Miller-Butterworth, C.M., Jacobs, D., & Harley, E.H., 2003. Strong population substructure is correlated with morphology and ecology in a migratory bat. *Nature 424: p187-191.*
- Monadjem, A., Higgins, N., Smith, T. & Herrmann, E. 2008. Bats Recorded from Koegelbeen Cave and Selected Other Sites in the Northern Cape, South Africa. *African Bat Conservation News 18: p2-4*.
- Monadjem, A., Taylor, P.J., Cotterill, F.P.D. & Schoeman M.C. 2010. Bats of southern and central Africa – A biogeographic and taxonomic synthesis. Wits University Press, Johannesburg.
- Mucina, L and Rutherford, M.C. (eds). 2006. *The vegetation of South Africa, Lesotho and Swaziland.* Strelitzia 19, South African National Biodiversity Institute, Pretoria.
- Nicholls, B. and Racey, P.A. 2009 The Aversive Effect of Electromagnetic Radiation on Foraging Bats—A Possible Means of Discouraging Bats from Approaching Wind Turbines. *PLoS ONE 4:7*: e6246. doi:10.1371/journal.pone.0006246
- Nicholls, B. and Racey, PA. 2007. Bats avoid radar installations. Could electromagnetic fields deter bats from colliding with wind turbines? *PLOS One 3 ed297*.
- Nicholls, B. and Racey, PA. 2012. Electromagnetic Radiation Effects on Foraging Bats. In, Recent Advances and Issues in Environmental Science. Ed. William Hunter III. Apple Academic Press, New York & Toronto

- SAExplorer. 2014. Carnarvon *Climate*. SAExplorer < http://saexplorer.co.za/south-africa/climate/carnarvon_climate.asp>. Last Accessed 4 July 2016.
- SANBI. 2013. Life: the state of South Africa's biodiversity 2012. South African National Biodiversity Institute, Pretoria.
- Serra-Cobo J., López-Roig M., Marquès-Lopez T., Lahuerta E. (2000). Rivers as possible landmarks in the orientation flight of *Miniopterus schreibersii*. *Acta Theriol. 45:3 p347-352*.
- Sirami, C., **Jacobs, D.S.** & Cumming, G.S. 2013. Artificial wetlands and surrounding habitats provide important foraging habitat for bats in agricultural landscapes in the Western Cape, South Africa. *Biological Conservation*, 164:30- 38.
- Sowler, S. & Stoffberg, S. 2014. South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments: Pre-construction. 3rd Edition. South African Bat Assessment Association Guidelines.
- Sowler, S., Stoffberg, S., MacEwan, K., Aronson, J., Ramalho, R., Forssman, K., Lötter, C. 2016. South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments - Pre-construction: 4th Edition. South African Bat Assessment Association Guidelines.

11.2 Spatial Dataset References/Sources

Dataset used	Reference/Source
SKA Phase 1 & KCAAA Data	Provided by CSIR
Aerial Imagery	NASA/TerraMetrics (Google Earth) (2016) web plugin for QGIS
	Google Earth. 2014. Central Karoo/Pixley ka Seme and Namakwa Districts, Digital Globe, AfriGIS (Pty) Ltd. *Google Earth* 8 April 2014. Accessed 1 July 2016.
Roads	South African National Biodiversity Institute. 2006. Vegetation Map: 2006.
Rivers	South African National Biodiversity Institute. 2006. Vegetation Map: 2006.
Hydrography	Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E., Smith-Adao, L.B. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources*. WRC Report No. TT 500/11, Water Research Commission, Pretoria.
	South African Rivers. 2012. Department of Water Affairs: Resource Quality Services Directorate. < https://www.dwa.gov.za/iwqs/gis_data/river/rivs500k.aspx>.
Land Use/Cover	DEA. 2015b. 2013-2014 South African Land Cover Dataset, Created by GeoterraImage SA, Feb 2015, Ver. 05 <https://www.environment.gov.za/mapsgraphics#national_landcover>, Department of Environmental Affairs, Pretoria.
Geology & Lithology	Council for Geoscience South Africa. Date unknown.
Soil	AGIS. 2006. AGIS Comprehensive Atlas. *Agricultural Geo-Referenced Information Systems* (http://www.agis.agric.za/agismap_atlas/AtlasViewer.jsp?MapService=agis_atlas2006&ProjectId=5&LId=0&OId=0&LayerIdVisList=none). Last Accessed 4 July 2016.

Protected Areas	■	DEA. 2016. South African Protected Areas Database, <http://egis.environment.gov.za/sapad_detail.aspx?m=73&amid=124>, Department of Environmental Affairs, Pretoria.

In addition to the specialist's knowledge, sensitivity mapping was based on the hydrography and land use/cover datasets and the Topographical 1:50 000, Topographical Series (GIS data), Department of Rural Development and Land Reform - Chief Surveyor-General: National Geo-Spatial Information Directorate, Cape Town, South Africa.

11.3 Software

- QGIS Development Team. 2016. QGIS Geographic Information System. Version 2.14.3 Open Source Geospatial Foundation Project. http://www.qgis.org/

11.4 Legislation

- Northern Cape Provincial Legislature. 2010. Northern Cape Nature Conservation Act, 2009 (Act No. 9 of 2009). 82pp.
- Provincial Council of the Province of the Cape of Good Hope. 1975. Nature Conservation Ordinance of 1974 as amended. 32pp.