SKA Phase 1 South Africa SEA Specialist Report: Visual Assessment

Includes Addendum with A3 maps and plates

Specialist names:	Bernard Oberholzer and Quinton Lawson
Company names:	BOLA Landscape Architect and MLB Architects
Date of submission:	Draft 23 March 2016 Revised 11 April 2016 Revised June 2016

Specialist Short CV

Bernard Oberholzer (BOLA Landscape Architect)

Principal, Bernard Oberholzer Landscape Architect / Environmental Planner
Professional Landscape Architect, B.Arch (UCT), MLA (Pennsylvania)
Professional Member of the SA Council for the Landscape Architectural
Profession (SACLAP) Reg. No. 87018
Fellow of the Institute of Landscape Architects of SA (ILASA)
Advisor to the Stanford Heritage Committee

Experience:

Has worked on numerous large scale landscape projects and land use suitability studies since 1976.
Has lectured at UCT, mainly on terrain analysis, and produced a book on *Reading the Landscape*, including landscape classification and mapping.
Has specialist expertise in landscape assessments and visual impact assessments, including those for wind energy farms, solar PV and CSP energy facilities.
Prepared the *Guideline for Involving Visual and Aesthetic Specialists in EIA Processes*, with the CSIR for the Provincial Government of the W. Cape.
Prepared a landscape and scenic resource survey of the W. Cape for the Provincial Government of the W. Cape, and a landscape heritage survey for the Overstrand Municipality, working in association with heritage specialists.

In association with:

Quinton Lawson (MLB Architects)

Partner, MLB Architects and Urban Designers
Professional Architect, B.Arch (Natal)
Professional Member of the SA Council for the Architectural Profession
(SACAP) Reg. No. 3686
Member of the Cape Institute for Architects (CIA)
Member of the Impact Assessment Review Committee, Heritage Western Cape

Experience:

Worked on large scale architectural and urban design projects since 1978.
Lectured at UCT on computer and visual assessment techniques.
Specialist expertise in visual modeling, viewshed mapping and photographic montages.
Worked in association with BOLA on numerous visual impact assessments, including wind energy farms, as well as solar PV and CSP energy facilities across several provinces.

Bernard Oberholzer and Quinton Lawson have jointly been involved in visual specialist studies for the CSIR on the National Wind and Solar PV SEA in 2014, the Electrical Grid Infrastructure SEA in 2015, and the Shale Gas Exploration SEA in 2016.

Specialist Declaration

We, Bernard Oberholzer and Quinton Lawson, as the appointed independent specialists hereby declare that we:

- act/ed as the independent specialists in this application;
- regard the information contained in this report as it relates to our specialist input/study to be true and correct;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed any material information that have or may have the potential to influence the objectivity of any report or decisions base thereon; and
- are aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Signatures of the specialists:

Name of company:	BOLA Landscape Arcitect / MLB Architects, in association
Professional Registration (incl number):	SACLAP 87018 SACAP 3686
Date:	20 June 2016

Contents

Abbreviations and Acronyms

CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEM	Digital Elevation Model
ECO	Environmental Control Officer
EMP	Environmental Management Plan
KAPB	Karoo Array Processor Building
KRAO	Karoo Radio Astronomy Observatory
NEMA	National Environmental Management Act
NGI	National Geospatial Information
NHRA	National Heritage Resources Act
SAPAD	South African Protected Areas Database
SEA	Strategic Environmental Assessment
SKA	Square Kilometre Array
VIA	Visual impact assessment

1 Scope and Methodology

1.1 Purpose of the assessment

This Landscape Assessment is one of a series of specialist studies, which form part of a Strategic Environmental Assessment (SEA) to assess the potential impacts of the planned SKA facility. The SEA, which is being conducted by the CSIR, aims to establish a baseline against which the potential impacts of the SKA can be measured.

1.2 Study methodology

Scope of visual study: The visual assessment broadly includes visual, scenic, aesthetic and amenity values, which contribute to the area's overall 'sense of place', and which encompass both natural and cultural landscape characteristics. The methodology for the visual assessment can be divided into 2 broad stages as follows:

Landscape Description (baseline study): The description involves the identification of landscape types and characteristics together with scenic significance. Given the large geographical scale of the project and the sparse vegetation, geomorphology tends to be a major factor in determining landscape character and scenic resources. Cultural landscapes and heritage sites form part of a separate heritage assessment as part of the SEA.

Landscape Sensitivity (landscape interpretation): Sensitivity is determined through the interpretation of natural and scenic resources, which have aesthetic and economic value to the local community and the region. Resources include features of topographic, geological or cultural interest, which contribute to the area's overall 'sense of place'. Protected landscapes and heritage sites tend to increase the value and therefore the sensitivity of landscapes.

Sensitivity is further determined by receptors within settlements, as well as along arterial and scenic routes, and at tourist destinations, such as guest farms and resorts.

1.3 Site visit and field work

The location and context of the study area are indicated in Figure 1. A site visit was carried out on the 10 and 11 March 2016, during which a brief meeting was held with Dawie Fourie at the SKA offices on Meysdam Farm. The route of the field trip is indicated in Figure 2. Several public gravel roads were travelled to get an idea of the terrain in which the proposed dish antennae would be located within the various spirals. Photographs were also taken from key viewpoints representing potential receptors. The late summer season of the site visit did not have a bearing on the visual assessment.

1.4 Data sources

A description of data sources on which the visual assessment was based, is given in Table 1 below.

Table 1 Data Sources

Data title	Source and date of publication	Data Description
1:1 000 000 Geological Map of SA	Geological Survey, 1984.	Geological information, particularly dolerite landscape features.
1:500 000 topographical maps of South Africa	Surveys and Mapping (several sheets with various dates).	Topographical and cadastral information.
Water resources, land cover, vegetation types	South African National Biodiversity Institute (SANBI BGIS).	Shape files.
Topographic data set v3 (viewshed mapping)	NASA SRTM (Shuttle Radar Topographic Mission).	Topographic data with resolution of 30x30m and vertical accuracy 10m.

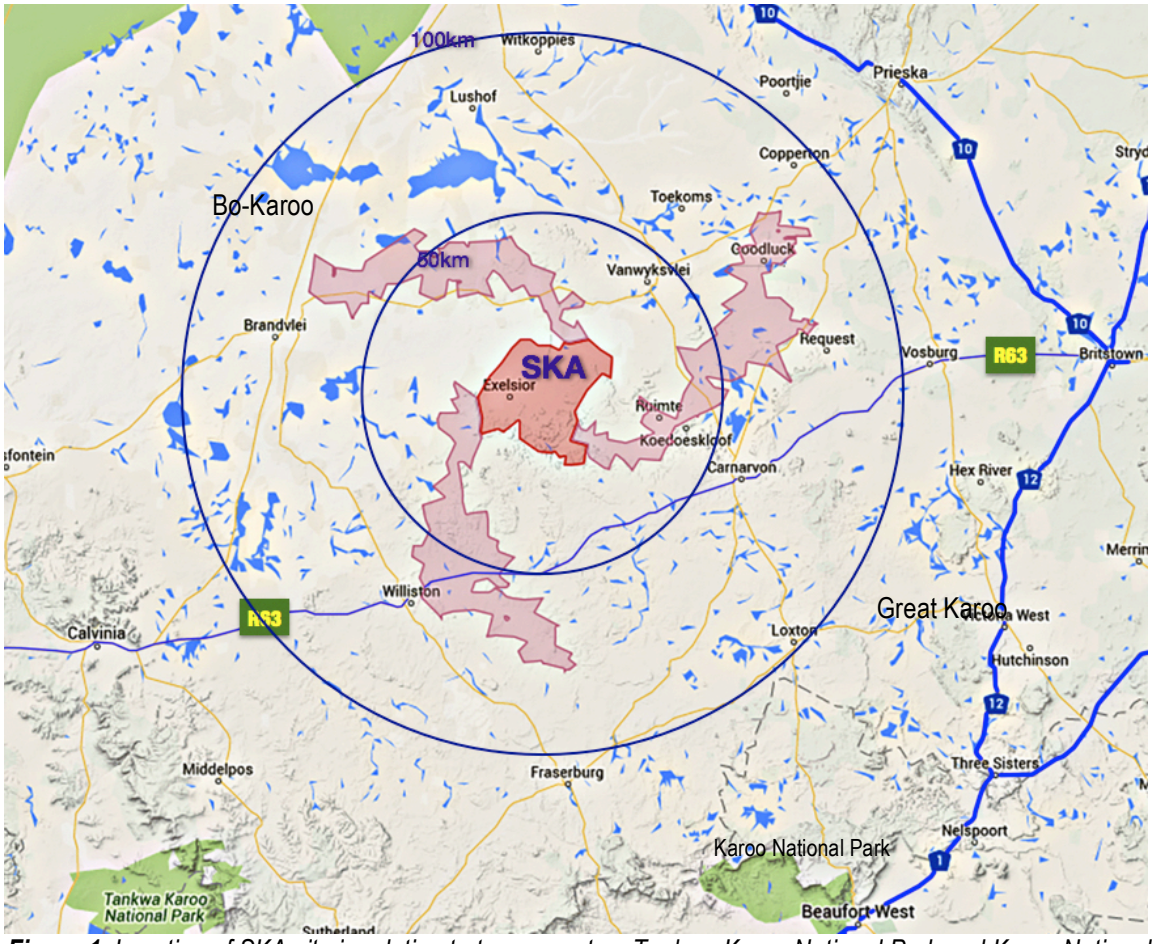


***Figure 1**: Location of SKA site in relation to towns, routes, Tankwa Karoo National Park and Karoo National Park*

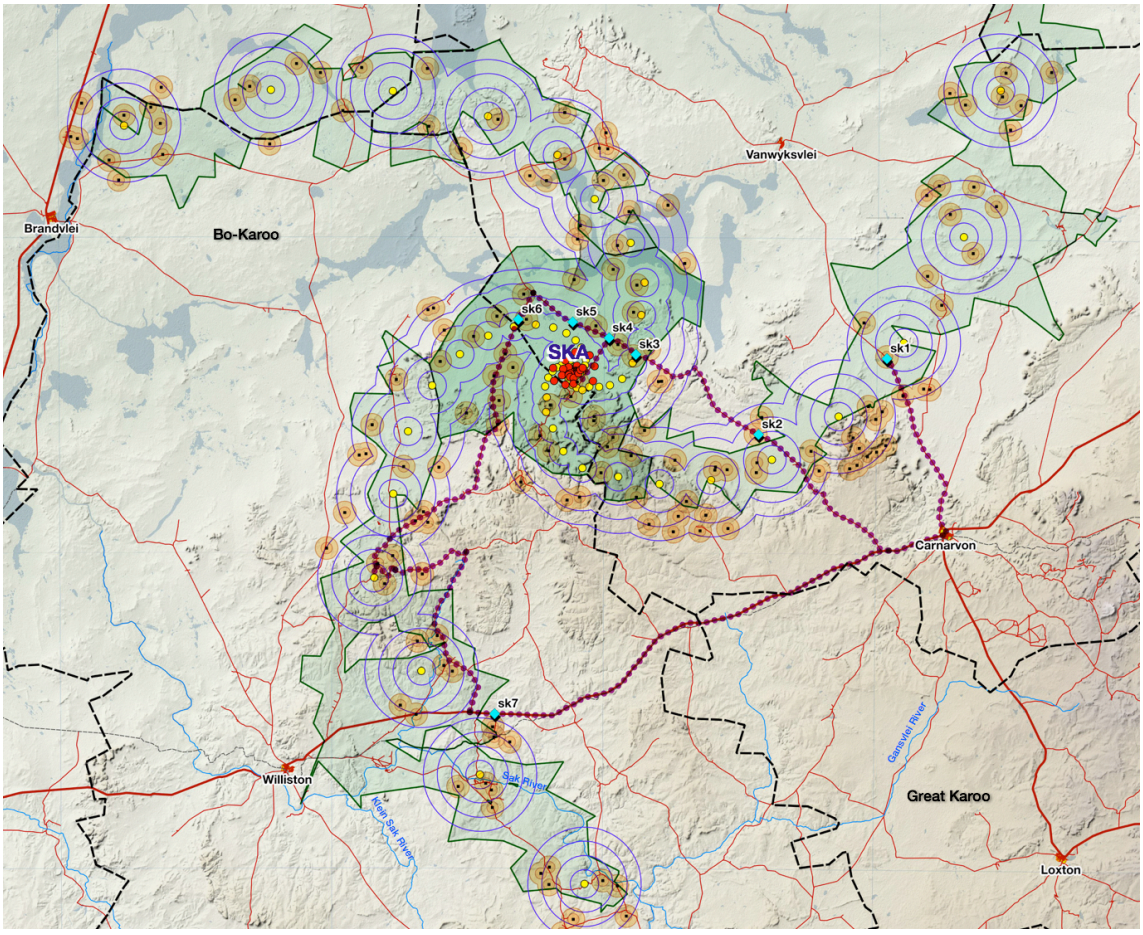


***Figure 2**: Proposed SKA 1 dish antennae (yellow dots), MeerKAT (red dots), the field trip route (dotted line) and viewpoints (light blue). Farmsteads indicated as black dots within orange circles.*

1.5 Assumptions and Limitations

Being strategic in nature, and covering a large study area, the visual study makes use of broad-scale baseline information, resulting in a number of assumptions and limitations listed in Table 2 Below.

Table 2 Visual Study Assumptions and Limitations

Limitation	Included in the scope of this study	Excluded from the scope of this study	Assumption
Level of mapping detail	1: 500 000 topographical maps, and 1:1 000 000 geological survey maps.	1:50 000 topographical maps.	1:500 000 mapping was adequate for the large-scale study area.
Information on cultural landscapes		Separate study by Heritage Specialist	Heritage assessment would be required in terms of the NHRA.
Information on game/ guest farms and resorts.	No information.	Detailed survey of private reserves / game farms.	Assumed no private reserves or game farms affected.
Electrical sub-stations	Existing and proposed powerlines.		Only mini-substations and kiosks are required.

2 Relevant regulatory instruments

Unlike the legal protection of heritage resources, there is no legislation in South Africa at present to specifically protect scenic resources. The result is that scenic landscapes are often, but not always, considered in heritage assessments, given that they form part of the country's natural heritage or so-called 'national estate'. Some protection of scenic resources is provided by the legislation listed in Table 3 below.

Table 3 Visual Regulatory Framework

Instrument	Key objective
National Instrument	
National Environmental Management Act (NEMA) (Act 107 0f 1998: Regulations in terms of Ch. 5. National Heritage Resources Act (Act 25 of 1999 NHRA) Protected Areas Act (PAA) (Act 57 of 2003, Section 17)	Activities requiring authorisation and the procedure to be followed, including proposed engineering and infrastructure projects. Includes protection of national and provincial heritage sites, as well as areas of environmental or cultural value, and proclaimed scenic routes. Includes protection of natural landscapes.
Provincial Instrument	
Land Use Planning Ordinance (LUPO)	Local authority zoning schemes can be used to protect natural and cultural heritage resources through 'Conservation Areas', 'Heritage Overlay Zones' and 'Scenic Overlay Zones' including scenic routes.

3 Description of the SKA facilities

Visually significant components of the SKA facilities that could have a visual effect on scenic resources or receptors within the study area are listed in Table 4 below.

Table 4 SKA 1 (Phase 1) components

Activity / facility	Footprint	Height	Visual implications and comments
Total project area	approx. 154 x 137 km	n/a	Core area and 3 spiral arms.
Total no. dish antennae (Phase 1)	Meerkat: 64 dishes SKA 1: 133 dishes		Meerkat: (red on map) SKA 1: (yellow on map)
Dish antenna size	13.5 diam.	19.5m	Platform 5 x 5m Fenced area 100 x 100m (1ha)
Access roads	6 - 8m wide	n/a	Gravel roads.
33kV powerline to construction camps, KAPB. 22kV powerlines to the 3 spiral arms and core area	9m wide servitudes over private property.	15m	Underground cables in the core area. Steel pylons 5-30km from core. Twin wooden poles 30km outwards. Powerlines underground within 500m of dish antenna.
Electrical substations and distribution kiosks.	Type B mini substations. ±3m^2	± 1.5m	21 existing mini substations at MeerKAT.
3 Construction camps in the core area	Footprints not known		Bergsig, Swartfontein, Losberg and Meysdam farms

***Figures 3a and 3b**: Illustration of Meerkat dish antenna. Height 19.5m and dish 13.5m diameter.*

Source: South Africa's MeerKAT Radio Telescope, Technical Fact Sheet, March 2014.

4 Visual baseline of the SKA study area

4.1 Visual characteristics of the study area

The study area falls within a region known as the Bo-Karoo (Upper Karoo), which in turn is a part of the Great Karoo, a vast semi-arid area of the Northern Cape Province.

Given the large scale of the study area, (approx. 154 by 137 km), landforms are the dominant feature in terms of scenic resources, the character of the landscape being largely determined by the geology.The generally low, sparse vegetation results in the landforms and rock formations being more pronounced.

Using a geomorphological approach, 3 broad landscape types can be identified within the study area, each with its own scenic characteristics, as described in Table 5 below, and in Figures 4, 5 and 6.

Table 5 Study area landscape types

Landscape Type	Characteristics	Significant Visual Features
A. Southern plain: Beaufort Group, Adelaide Formation mudstones, sandstones and shales.	Broad plain intruded in places by dolerites, and incised in the southwest corner of the study area by the Sak River and the Brak River. The elevation varies from 1100 to 1400m.	Generally dry river courses and minor dolerite koppies. Koppies are visually sensitive, and the plains visually exposed. Travellers on the R63 Route and a number of farmsteads are the main visual receptors.
B. Mountainous terrain: Ecca Group, Canarvon Formation sandstones and shales with dolerite intrusions.	The harder, more weather-resistant sandstones and dolerites are responsible for the koppies and ridges, including the Kareeberge, with elevations ranging from 1300 to 1500m. This is the most scenic part of the study area.	Scenic dolerite ridges and koppies, with a few small poorts. The ridge skylines are visually sensitive, while the varied topography is more visually absorptive than the plains. There are a small number of farmsteads, mainly in the more fertile valleys near sources of water.
C. Northern plain: Ecca Group, Tierberg Formation shales.	A broad, largely featureless plain at an elevation of 1000m, with some dolerite outcrops and several pans. Patches of alluvium, sand and calcrete occur to the north.	Fairly featureless, except for minor dolerite koppies and a series of linked pans, and dry river courses. Visually exposed. A number of farmsteads, are widely spread in the area.

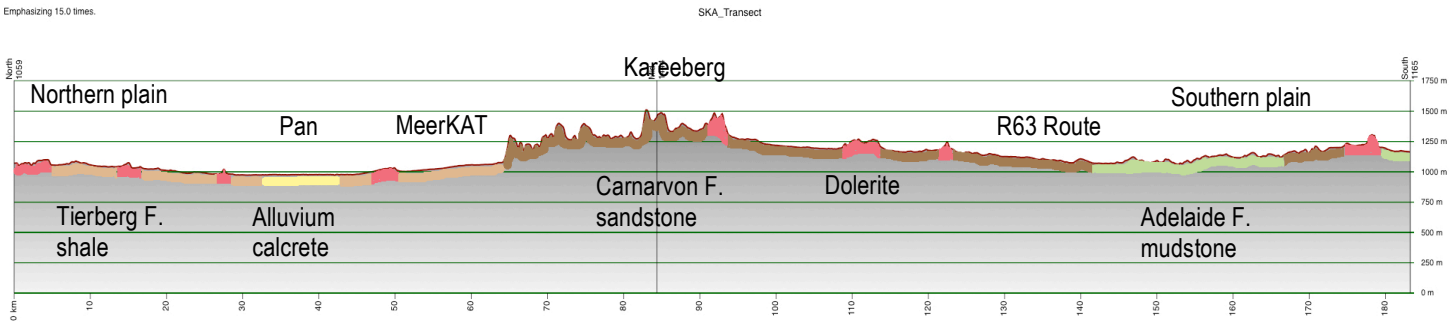


***Figure 4**: Typical transect through the SKA site indicating correlation between geology and scenic landscape types*

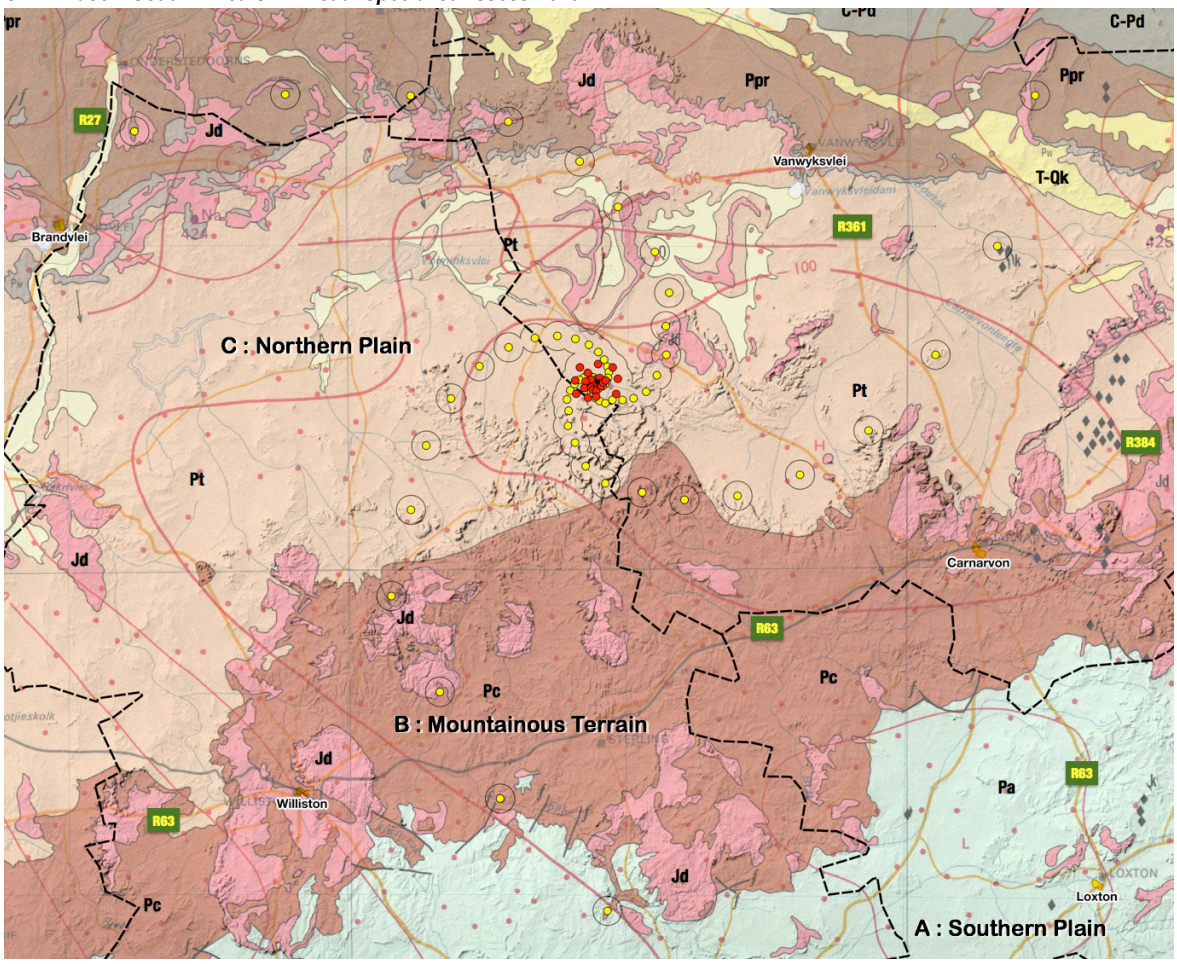


***Figure 5**: Geology and Landscape Types of the study area, with the dolerites indicated in pink.*

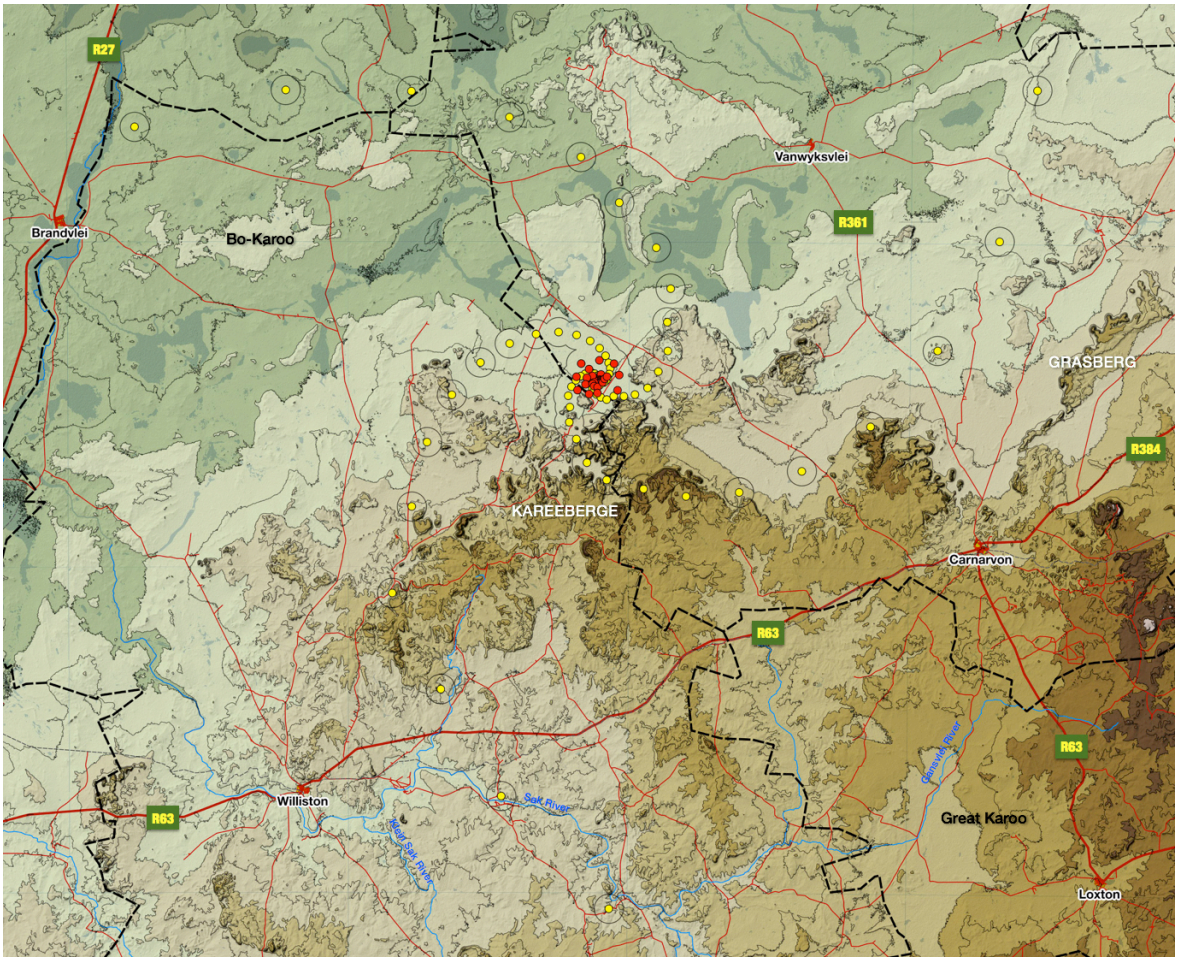


***Figure 6**: Physiography of the study area with high elevations in brown and low-lying areas in green.*

4.2 Scenic resources and sensitive receptors

In order to determine visual sensitivity, potentially vulnerable *scenic resources* and *sensitive receptors* have been identified, as listed in Table 6 below, together with notes on the factors that influence their visual significance. Scenic resources and sensitive receptors are indicated on Figures 7a and 7b including recommended visual buffers. Some of the proposed dishes are within these buffer areas. (See Addendum for more detailed maps, which are also available as shape files).

Heritage sites have not been included here as they form part of a separate specialist study, although they can be seen as visually sensitive.

Table 6 Scenic resources and sensitive receptors

Scenic Resource	**Contributing Factors**
Topographic features	Visual features that provide interest or contrast in the Karoo landscape such as mountain peaks, ridges, steep cliffs, and dolerite rock outcrops (visually sensitive skylines), within the study area.
River courses and pans	Water courses and pans, even when dry, provide interest in a generally featureless landscape.
Cultural landscapes	Cultivated land, often along rivers, provide rural scenic value and may have historical or cultural significance. These include farmsteads and the corbelled houses. (See Heritage study).
Sensitive Receptors	(includes residents, commuters, visitors and tourists)
Protected landscapes	There are no known protected landscapes within the study area. (These would be sensitive to visual intrusions).
Private reserves, game farms, resorts	No information available for the study area. (These would be sensitive to visual intrusions).
Human settlements	Includes towns, villages and farmsteads. Canarvon, Williston, Brandvlei and van Wyksvlei are too far away to be visually affected by the SKA. However farmsteads would be visually affected.
Provincial and district roads	Arterial routes, which serve local and regional users for commuting, recreation and tourism, could be visually sensitive within their view corridors.
Scenic routes and passes	A number of small passes and *poorts* in the study area may have historical, recreational and tourism vaue.
Passenger rail lines	Serve both commuting and tourism functions and are potentially sensitive to visual intrusions along view corridors. The rail line between Carnarvon and Williston does not appear to be in use.

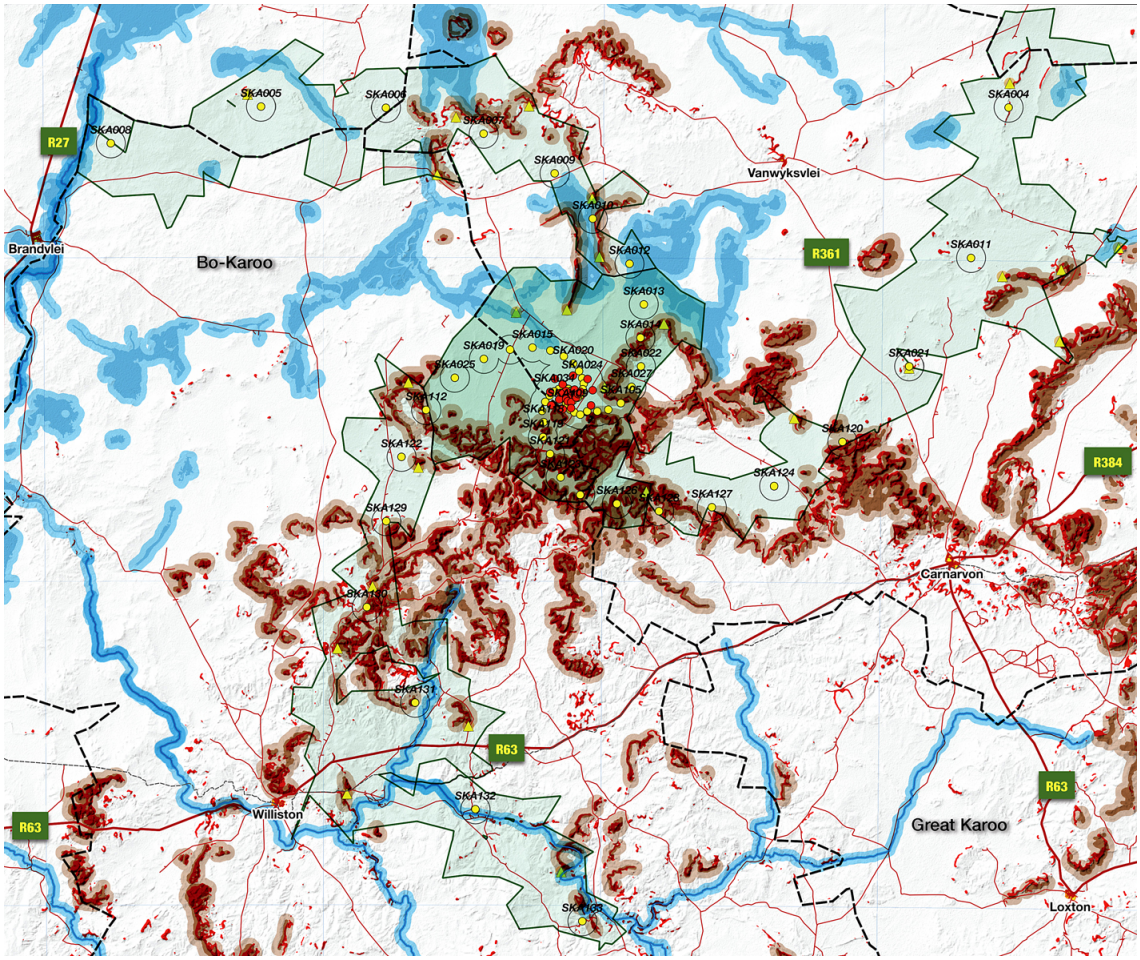


***Figure 7a**: Topographic features (brown),peaks (orange), steep slopes (red), stream corridors and pans (blue.*

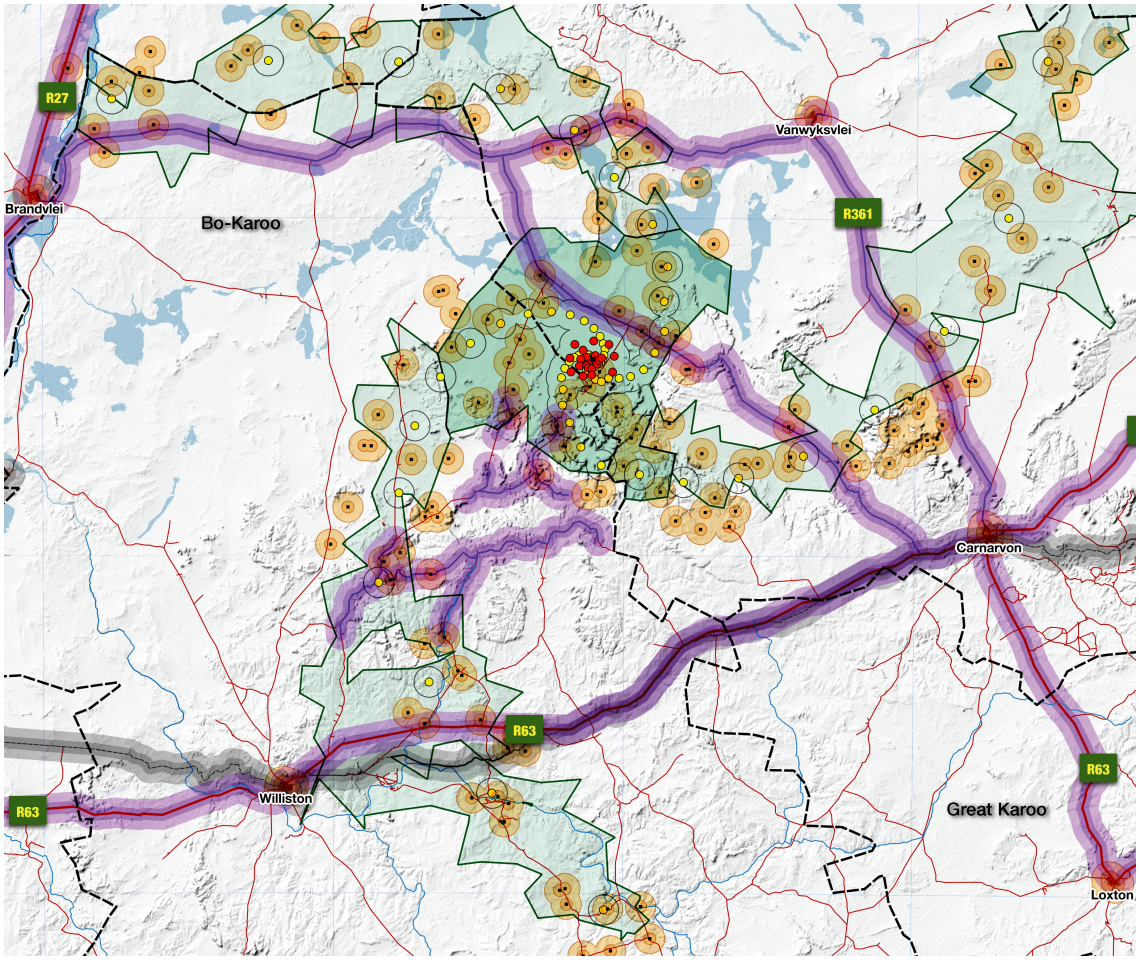


***Figure 7b:** Sensitive receptors including routes (purple) and farmsteads (orange), with buffers.*

5 Potential visual impacts of SKA

5.1 Visual sensitivity criteria

Visibility

Visibility is determined by distance between the proposed facilities and the viewer. Distance radii are used to quantify visibility of the proposed facilities. Based on fieldwork photographs and the visual model of the dish antenna in Figure 3, possible degrees of visibility are listed below.

High visibility:	Prominent feature within the observer's viewframe 0 - 500m
Mod-high visibility:	Relatively prominent within observer's viewframe 500m - 1km
Moderate visibility:	Noticeable within observer's viewframe 1 - 2.5km
Marginal visibility:	Visible within the broader landscape 2.5 - 5km

Potential visibility of the proposed SKA facility from selected viewpoints is given in Table 7 below, which indicates that the visibility of the SKA facilities would be generally moderate or marginal as seen from the viewpoints on the reconnaissance field trip. However, this represents only a random sample of viewpoints as all the potentially affected farmsteads could not be visited in the limited time available. The authors noted on the field trip that some of the farmsteads are vacant or abandoned. These should be recorded as potential visual impact would be less significant for these particular farmsteads.

An indication of the scale of a typical dish antenna, seen at a range of viewing distances, is given in Figure 8 below. This provides some idea of the visibility of the dish, which in turn informs visual sensitivity mapping. The visibility of internal access roads and powerlines would be less significant, but could add to the overall industrial-type visual effect in a rural landscape.

Table 7: Viewpoints and Potential Visibility

View-point	Location	Co-ordinates	Distance	Visibility of dish antennae
SK1	R361 Route near Garskolk farm	30.689S, 22.018E	4.0km	Not visible beyond ridge
SK2a	R295 from Carnarvon to SKA site, at Skietkolk Farm	30.811S, 21.784E	5.0km	Not visible beyond ridge
SK2b	R295 from Carnarvon to SKA site, at Skietkolk Farm	30.811S, 21.784E	11.6km	Marginally visible in distance
SK3a	R295 near Swartfontein Farm	30.685S, 21.558E	2.3km	Not visible beyond ridge
SK3b	R295 near Swartfontein Farm	30.685S, 21.558E	1.6km	Moderately visible in middle distance
SK4	R295 at Meysdam access road	30.659S, 21.509E	4.5km	Marginally visible in middle distance
SK5	R295 looking towards MeerKAT	30.634S, 21.442E	2.3km	Moderately visible in middle distance
SK6	R308 near Excelsior Farm	30.630S, 21.342E	1.5km	Moderately visible in middle distance
SK7	R63 near Elandfontein Farm	31.255S, 21.301E	10.9km	Not visible beyond ridge

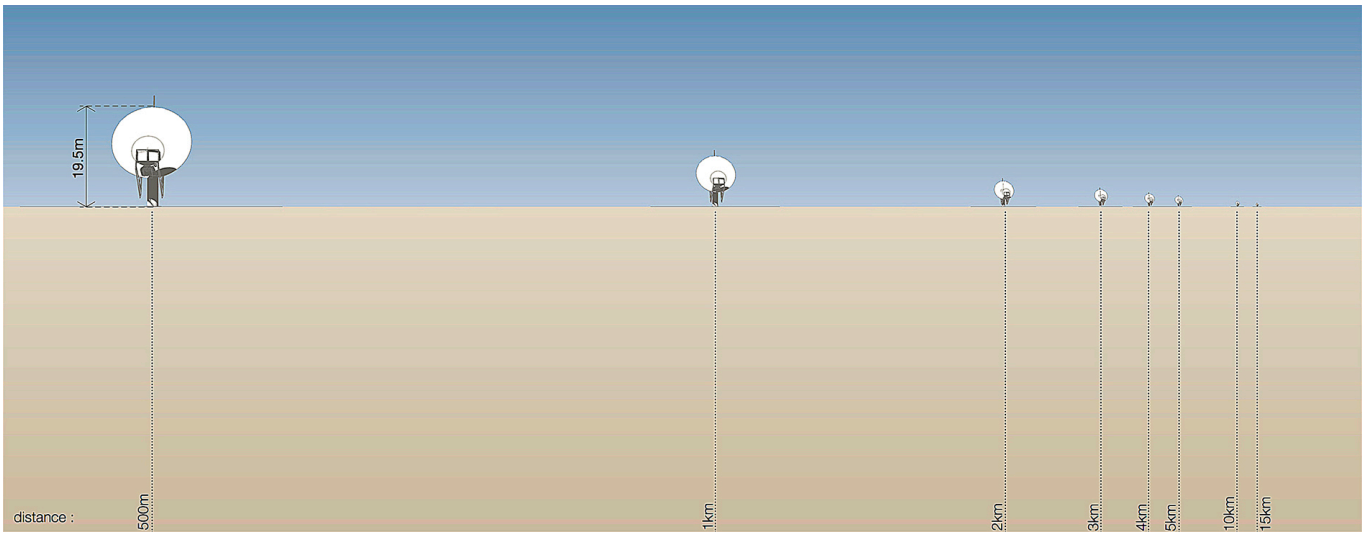


***Figure 8**: Visibility of dish antennae at a range of distances. The dishes would be only marginally visible beyond 5km*

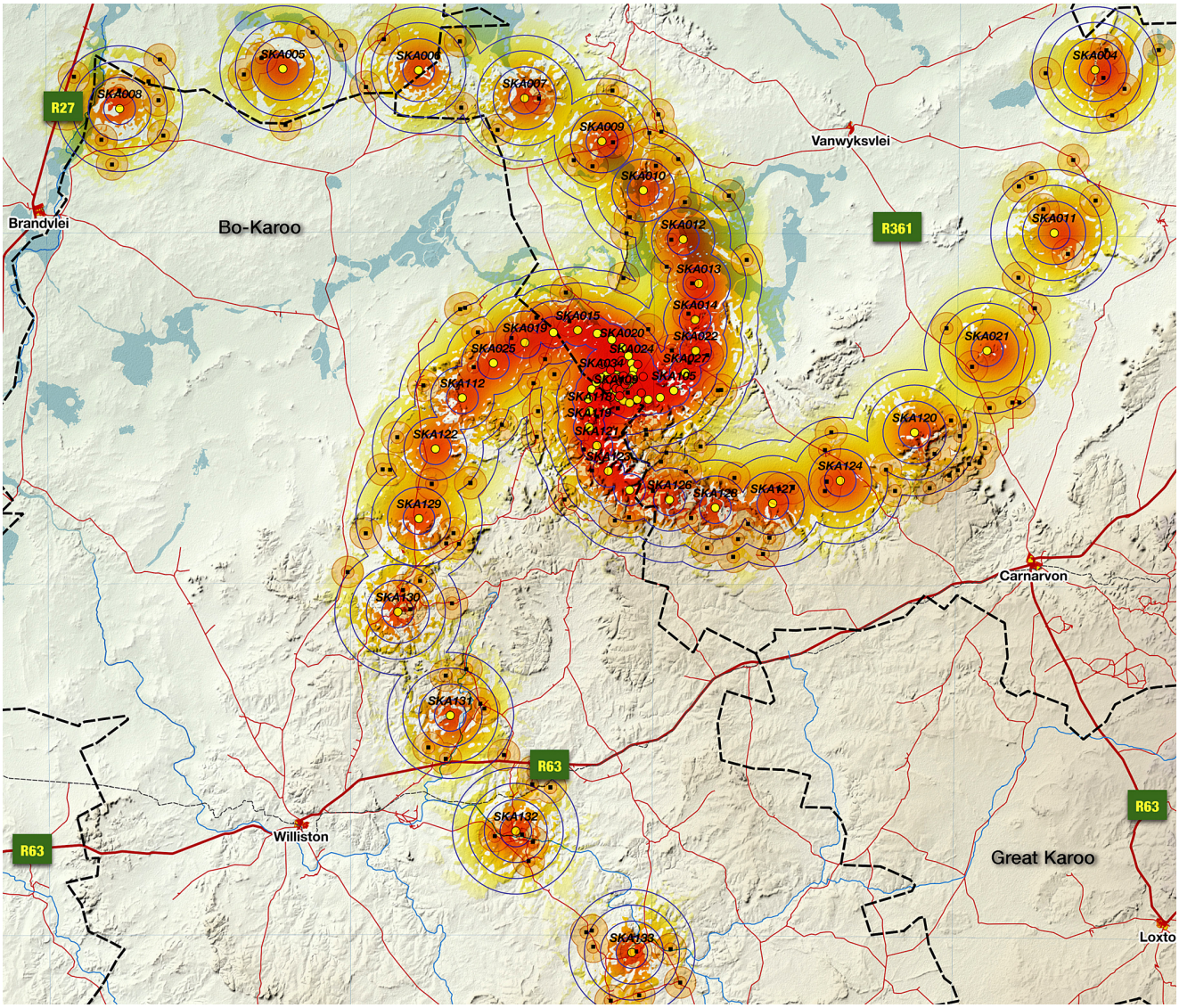


***Figure 9**: Viewshed of the dish antennae, from red indicating high visual exposure to yellow for low visual exposure. The rings represent 2.5km distance radii from the dish antennae. A number of sensitive receptors, including farmsteads (shown as black dots with orange circles), are within 10km of the proposed dish antennae.*

Visual exposure
Visual exposure is determined by the viewshed, being the geographic area within which the project would be visible, the boundary tending to follow ridgelines in the landscape. Some areas within the viewshed fall within a view shadow, and would therefore not be affected by the proposed SKA facilities. Given the size of the dish antenna, (which are significantly smaller than say wind turbines) the viewshed is fairly limited, as indicated in Figure 9. Some farmsteads, shown as black dots with orange circles, would however be affected.

Visual absorption capacity
This is the potential of the landscape to screen the project. The plains of the study area are generally open and visually exposed, although parts of the spiral arms are in more mountainous terrain, which provides some visual enclosure and screening. The Karoo grassland and shrubland vegetation provide little in the way of visual screening.

Landscape integrity
Visual quality is dependent on the scenic or rural quality and intactness of the landscape, as well as absence of other visual intrusions. The study area has a distinctly wilderness / rural character, particularly in the areas containing the proposed spiral arms. The existing MeerKAT installation and powerlines have partly altered the landscape character at the centre of the SKA.

Cultural landscapes
Cultural landscapes include the presence of palaeontological or archaeological sites, heritage sites, historical farmsteads, gravesites and cultivated lands. These features form part of a separate study, but could increase overall visual sensitivity.

Sense of place
Sense of place is difficult to measure, but has value in terms of the Karoo's legendary vastness, serenity, quietness and dark skies at night. Although quiteness is required for the SKA facility, the dish antennae and related infrastructure will add visual 'clutter' to the Karoo landscape. The construction phase will increase disturbance in the short term.

5.2 Visual sensitivity

The potential visual impacts on sentive receptors relates mainly to farmsteads in the proposed spiral arms of the SKA. These can be determined to some extent from Figure 7b and the viewshed mapping in Figure 9. However not all the spiral arms were visited and therefore the visibility of dishes from each of the farmsteads could not be finally determined. As a general guideline, the visual effect of those dishes within 1km of a farmstead could be significant, while those beyond 5km would be marginal, depending on whether the farmsteads fall wthin the viewshed of the dishes.

Identified scenic resources and visually sensitive receptors within the study area, within high, moderate and low visual sensitivity zones, are given in Table 8 below. The levels of sensitivity are defined by distance radii from the feature or the receptor, where these are within the same viewshed. The sensitivity zones are indicated in Figure 10, where it can be seen that a number of farmsteads in the proposed spiral arms will be affected.

The buffers indicated in Table 8 were based mainly on the visual model of the dish antennae in Figure 3, and from the authors' experience with infrastructure projects elsewhere (Lawson and Oberholzer 2014, 2015)[1].

[1] Lawson and Oberholzer, 2014. National Wind and Solar PV SEA Specialist Report: Landscape Assessment, with CSIR for DEA. Lawson and Oberholzer, 2015. National Electricity Grid Infrastructure SEA: Visual Specialist Report, with CSIR for DEA.

Table 8: Visual sensitivity mapping

Scenic Resources	High visual sensitivity	Mod. visual sensitivity	Low visual sensitivity	Criteria
Topographic features (mountains, scarps, steep slopes, geological features)	feature	within 1km radius	beyond 1km radius	Special landscape features, particularly skylines. Peaks include a 500m radius.
River courses, vleis, dams, pans	feature	within 1km radius	beyond 1km radius	Scenic / environmental value in an arid landscape. Rivers include a 500m corridor.
Cultural landscapes (incl. cultivated lands)	feature	within 1km radius	beyond 1km radius	Rural scenic value and possible historical or heritage value.
Sensitive Receptors				
Private reserves incl. game farms, guest accommo-dation	within 1km radius	within 2.5km radius	beyond 2.5km radius	Wilderness and scenic value. Sensitive visitor receptors. Important for local tourism industry.
Settlements incl. towns, villages, farmsteads	within 1km radius	within 2.5km radius	beyond 2.5km radius	Visually sensitive residents and visitors, as well as effect on property values.
Provincial roads and scenic routes	within 1km radius	within 2.5km radius	beyond 2.5km radius	Visually sensitive residents and visitors within view corridor. Subject to viewshed mapping.

Note: The distance radii are visual mapping categories and not setbacks or exclusion areas.

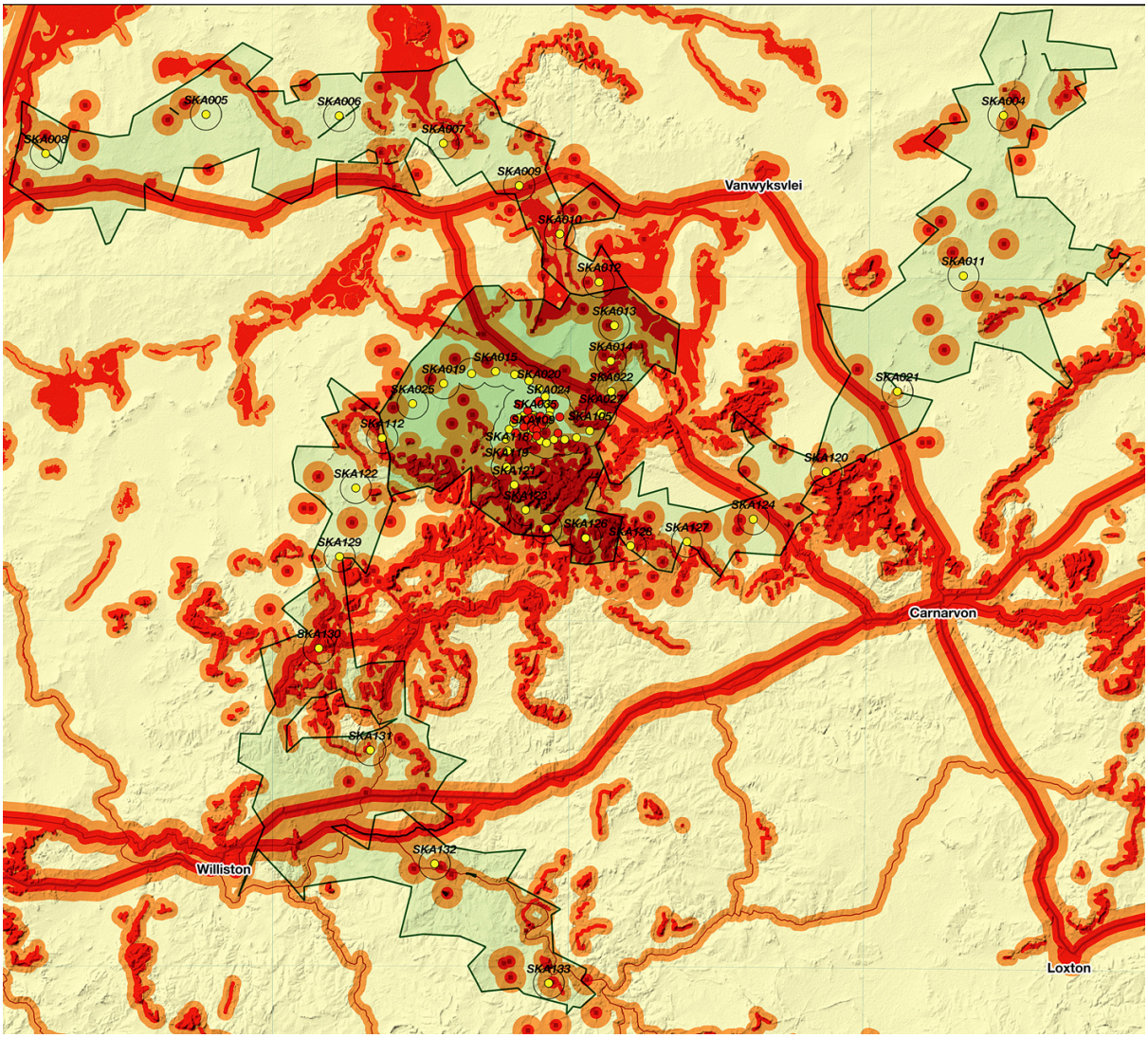
5.3 Potential visual impacts on scenic resources and sensitive receptors

Based on the visual criteria in 5.1 and visual sensitivity levels in 5.2 above, the potential degree of visual impacts in relation to location, extent, time scale and overall intensity can be determined, (see Table 9 below). Table 10 provides further detail on secondary visual effects, along with options for mitigation.

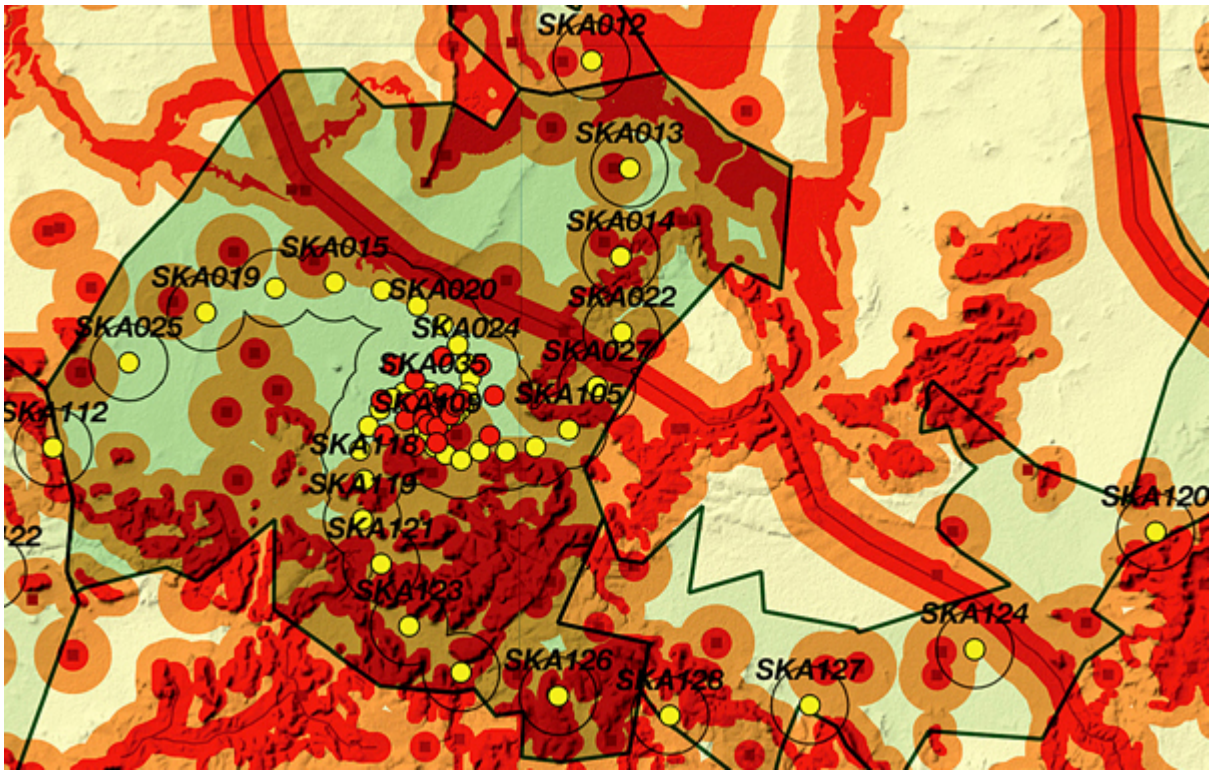
The potential visual impacts on scenic resources and sensitve receptors can be determined from Figures 10a and 10b. Except for a few dishes in the mountainous central area and some river courses in the south, along with a number of farmsteads, it appears that the effects would not be significant and could be mitigated through careful siting of the dish antennae.

Table 9: Potential visual impacts for SKA Phase 1 (See also Figure 10)

Visual Impact (See also Table 9)	**Visual sensitivity zone**	**Scenario**	**Extent**	**Timescale**	**Intensity** (consequence)
Visual intrusion of industrial-type facilities on the landscape, altering the rural / wilderness character of the Karoo, and affecting sensitive receptors (residents and visitors).	High visual sensitivity zone	Dish antennae	Local	Long term	Substantial
		Access roads, powerlines, substations	Local	Long term	Mod-substantial
		Construction phase	Local	Short term	Mod-substantial
	Moderate visual sensitivity zone	Dish antennae	Local	Long term	Mod-substantial
		Access roads, powerlines, substations	Local	Long term	Moderate
		Construction phase	Local	Short term	Slight
	Low visual sensitivity zone	Dish antennae	Local	Long term	Moderate
		Access roads, powerlines, substations	Local	Long term	Slight
		Construction phase	Local	Short term	Slight



***Figures 10a and 10b**: Synthesis map indicating visual sensitivity levels ranging from high visual sensitivity (red), moderate (orange) and low (yellow). Proposed dish antennae are indicated as yellow dots, several of which occur in the high visual sensitivity area based on the current layout. Detail of core area shown below. (See Addendum for detailed maps, which are also available as shape files).*



6 Management of potential visual impacts

6.1 Strategies for management of potential visual impacts

Strategies can be divided into 3 possible approaches namely, avoidance, mitigation and offsets.

Avoidance involves minimising visual impacts at the early landscape planning stage. Even though the siting of dish antennae is determined by technical considerations, micro-siting is possible at the implementation phase where measures can be taken to avoid sensitive landscape or scenic features.

Mitigation involves reducing the effects of the SKA activities, and minimising visual intrusion on sensitive scenic resources or receptors at the construction and operational stages of the project, (see Table 10 below).

Offsets could take many forms. For example a feature or amenity lost through the SKA activities could be offset by achieving other conservation objectives. The 'Astronomical Advantage Area' provides an opportunity to create protected areas, or linkages between these areas, for biodiversity and geodiversity, including the Kareeberg, pans and drainage corridors. Palaeontological remains, rock art sites and other heritage features could be included although the Heritage Specialists have reservations.

Table 10: Possible visual effects and options for mitigation

Possible visual effects	Options for mitigation of impacts
Fragmentation and industrialisation of wilderness and rural areas.	Consider the creation of a protected area for geodiversity and scenic conservation as an offset.
Transformation of rural / wilderness character, serenity and sense of place, including dark skies at night, by SKA infrastructure.	Cluster operation and maintenance buildings where feasible and minimise footprints. Use previously disturbed areas in preference to pristine landscapes as far as possible.
Visual intrusion on topographic features / scenic resources, including visual effects on the skyline.	Consider siting adjustments to dish numbers SKA004, SKA009, SKA126, SKA130, SKA132 to minimise intrusion on topographic features. (See Figure 10).
Effect on neighbouring farms incl. visual clutter created by dish antennae, fences, access roads, powerlines and substations.	Consider setbacks from farm settlements. Use planted berms to screen substations and maintenance yards. Keep access roads as narrow as feasible.
Visual intrusion of cleared areas for construction of dish antennae and roads.	Limit cleared areas to only that which is essential. Retain specimen trees where possible within the cleared areas. Protect surrounding veld from construction activities with temporary fencing.
Visual intrusion of construction camps, stockpiles, materials storage and litter during construction.	Locate construction camps, stockpiles and storage areas out of sight of public roads and farmsteads. Include litter control and education in the Environmental Management Plan (EMP), monitored by an Environmental Control Officer (ECO).
Dust and noise created by trucks and machinery along gravel roads during construction.	Upgrade and stabilise existing public roads and minimise new roads as far as possible.
Loss of dark skies at night from lighting at maintenance buildings and other installations.	Avoid high-mast lighting. Use reflectors to shade light sources. Use shades on windows of buildings.
Visual impacts from infrastructure related to the SKA development.	Avoid powerlines on visually exposed ridges or crossing district routes. Limit signage to only that which is absolutely necessary. Prohibit billboards or self-illuminated signs because of their visual intrusion, including signs by contractors.

6.2 Visual Risk Assessment

A risk assessment matrix is provided in Table 11 below, including risk levels 'without' and 'with' mitigation. The table is based on the description of the SKA arrays and the identification of visually sensitive zones in the previous sections. These are combined with the potential intensity of the visual impacts (derived from Table 9), and the likelihood (probability) of the impact occurring, to provide an overall risk evaluation.

The dish antennae require an uninterupted exposure to the horizon and their locations are based on technical requirements. As the dish antennae cannot easily be visually screened, mitigation is limited and confined to micro-siting.

The related infrastructure (access roads, powerlines and substations) would have a lower risk than the dish antennae because of their smaller size visually. The construction phase would also have a lower risk because it is short term, but could continue with future phases of the SKA.

Table 11: Visual Risk assessment matrix

			Without mitigation			With mitigation		
Impact	**Visual zone**	**Scenario**	**Intensity level**	**Likelihood**	**Risk**	**Intensity level**	**Likelihood**	**Risk**
Potential visual intrusion of industrial-type facilities on the landscape, altering the rural / wilderness character of the Karoo, or affecting sensitive receptors	High visual sensitivity zone	Dish antennae	Substantial	very likely	**high**	Substantial	likely	**mod-high**
		Related infrastructure	Moderate-substantial	very likely	**mod-high**	Moderate	likely	**moderate**
		Construction phase	Moderate-substantial	very likely	**moderate**	Moderate	likely	**low-mod**
	Moderate visual sensitivity zone	Dish antennae	Moderate-substantial	very likely	**mod-high**	Moderate	likely	**moderate**
		Related infrastructure	Moderate	very likely	**moderate**	Slight	likely	**low-mod**
		Construction phase	Slight	very likely	**low-mod**	Slight	likely	**low**
	Low visual sensitivity zone	Dish antennae	Moderate	very likely	**moderate**	Slight	likely	**low-mod**
		Related infrastructure	Slight	very likely	**low-mod**	Slight	likely	**low**
		Construction phase	Slight	very likely	**low**	Slight	likely	**low**

6.3 Cumulative Visual Impacts

Potential cumulative visual impacts could result from a combination of MeerKAT and SKA Phases 1 and 2 over time. Proposals for future phases of the SKA are not known at this stage and would need to be assessed for possible cumulative visual impacts as part of the rollout of the SKA.

Related infrastructure to the SKA project include the access roads and powerlines to each of the dish antennae, which seen together could result in additional cumulative visual impacts representing an industrialised landscape.

7 Visual Management Actions

Visual management actions for inclusion in the Environmental Management Programme report (EMPr) are outlined in Table 12 below. The table format indicates the links between the objectives, actions, monitoring requirements and responsibilities.

Table 12: Visual Management Actions

Impact	Mitigation Objectives	Mitigation measures and management actions	Monitoring		
			Methodology	**Frequency**	**Responsibility**
Potential visual intrusion of industrial-type facilities on the landscape, altering the rural / wilderness character of the Karoo, affecting the area's sense of place and sensitive receptors.	Minimise visual impact on the wilderness / rural character of the Karoo. Minimise visual impact on sensitive receptors, including the effect of dust and noise.	Locate borrow pits, construction camps and material stocpiles out of sight of arterial or district roads and sensitive receptors. Contain construction activities within clearly defined areas to avoid unnecessary damage to the surrounding landscape. Use existing roads and previously disturbed areas as far as possible, in preference to pristine areas. Rehabilitate disturbed areas as soon as possible on an on-going basis as the project proceeds. Use locally-occuring plant species for restoration to blend with the existing landscape. Minimise proliferation and size of construction signage, to avoid visual clutter in the landscape. Control dust and litter from construction activities and construction vehicles, especially near sensitive receptors (farmsteads).	Include visual mitigation measures in the EMPr. Conduct on-going monitoring of the EMP by the ECO on a weekly basis. Review construction work methods on an on-going basis to ensure that visual mitigations have been included. Educate construction personnel on issues such as littering. Engage with sensitive receptors (e.g. local farmers) to deal with issues such as dust and noise.	Daily supervision Weekly monitoring Monthly reporting	Contractor and Resident Engineer ECO ECO and SKA Environmental Team

8 Permit requirements

No specific permits in terms of visual considerations are required, but normal permits in terms of NEMA, NHRA and borrow pits are required. In particular, the visual findings should be seen in conjunction with the Heritage Report, as the scenic resources form part of the National Estate.

Figure 11 below indicates the connections between the various aspects of the visual assessment, including the relationship with other environmental, social and economic issues. It is recommended that the visual sensitivity ratings be included with those of the heritage study.

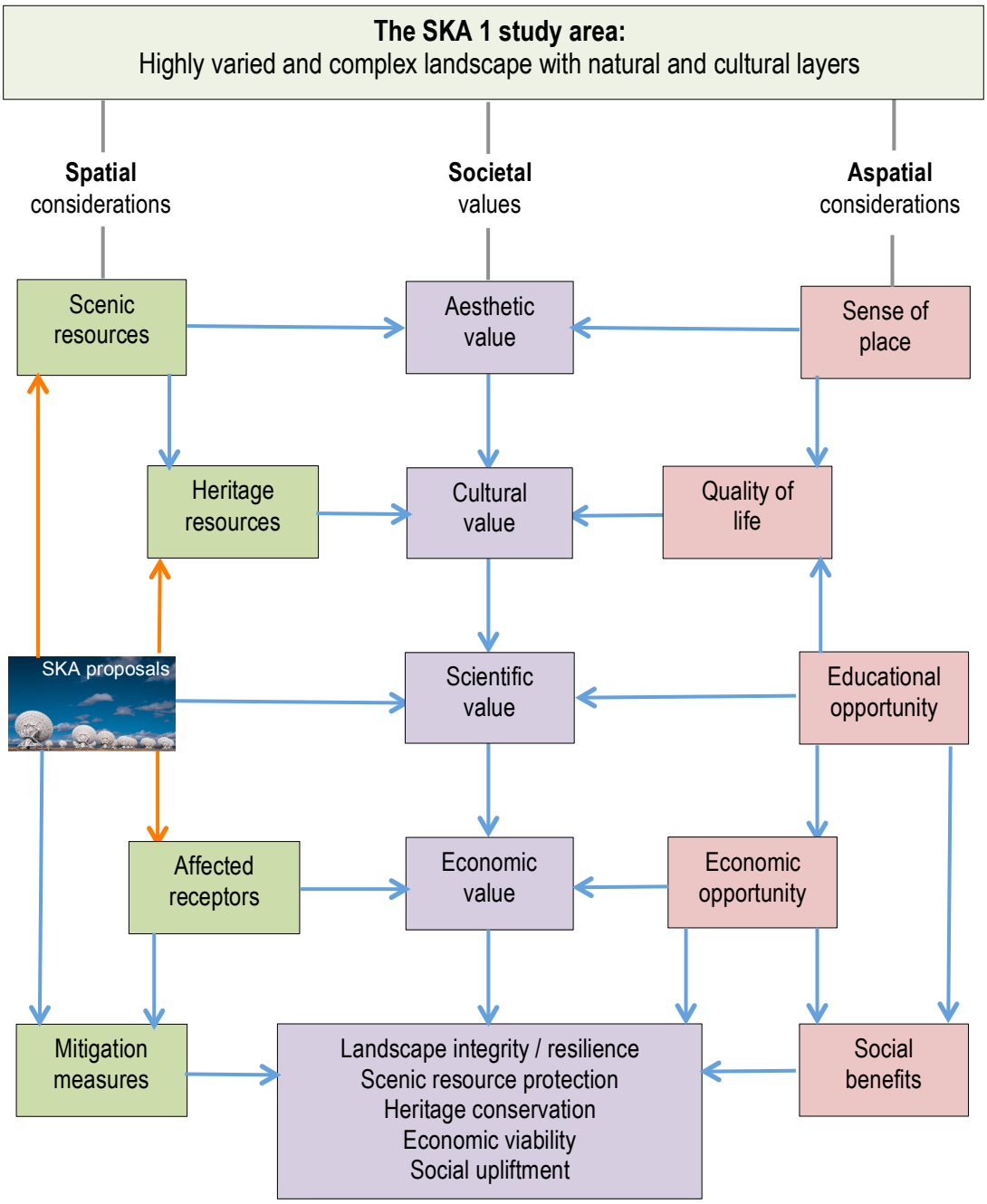


***Figure 11**: Causal loop diagram for the visual assessment indicating variables and connections, as well as relationships with other components, such as those relating to heritage, social and economics. Blue arrow indicates reinforcement of change, and the orange arrow, diminished change.*

9 Conclusions and Recommendations

Based on the stategic visual assessment carried out for the SKA Phase 1, the conclusions and recommendations are as follows:

1. Based on a reconnaissance field trip carried out over two days, the general nature of the terrain for the proposed project, scenic resources and a number of potential sensitive receptors were identified.
2. The general location selected for the SKA 1 consists largely of flat plains, with some low sandstone and doleritic mountains in a sparsely populated area (mainly farmsteads).
3. The main scenic resources are concentrated in the mountainous terrain across the middle of the study area, where peaks, ridgelines, scarp edges, steep side slopes and dolerite rock outcrops are potentially visually sensitive, particularly in terms of structures on the skyline.
4. The proposed dish antennae, including those in the spiral arms, cover a relatively large area of approximately 154 by 137 km, some of the dishes being located in more mountainous terrain. The exposed nature of the landscape suggests that the dishes could be highly visible up to 1km, but only marginally visible beyond 5km.
5. There are no major settlements or roads, (except for the R63), in the study area, and the farmsteads are spread relatively far apart. Some of the farmsteads affected by the SKA appear to not be permanently inhabited.
6. The composite visual sensitivity map, (Figure 10), indicates that high and moderately high visual sensitivity zones tend to be concentrated in the more mountainous terrain and near farmsteads. A number of the proposed dish antennae, and related infrastructure, are within these sensitivity zones. (See also Map 10 in the Addendum).
7. Given that the position of the dish antennae are determined by technical criteria, re-siting of the dishes may be limited. In cases where the proposed location of dishes coincides with visually sensitive landscape features or sensitive receptors, this can be partly overcome through micro-siting the dishes.
8. Particular attention needs to be paid to those dish antennae that are within 1 to 2.5km of farmsteads, mainly in the proposed spiral arms, as highlighted in Figure 9. These should be subject to a more detailed visual assessment, including photomontages, once a final layout has been prepared.
9. The cumulative visual impacts of the Meerkat and SKA Phase 1 have been considered, but given the nature of the landscape, careful siting of the dishes and the minimal sensitive receptors, the overall project should not represent a fatal flaw in visual terms after mitigation.
10. A number of mitigation measures have been recommended, which could help to reduce the potential visual impacts relating to the project. Mitigations relating to the construction phase, including the location of the construction camps, should be included in the EMPr.

Potential proclamation of the KCAAA1 as a protected area

The concept of having the SKA Phase 1 study area proclaimed a protected area has been mooted. This could help to conserve scenic and heritage resources, biodiversity and geodiversity, as indicated in Section 6.1 on offsets above. (The Heritage Specialist Study has indicated that there may be disadvantages to creating such a protected area).

Opportunities for the public, particularly tourists, to have controlled access to the protected area are apparently not feasible, and therefore the educational and public relations benefits of a protected area may be limited.

The town of Carnarvon represents a potentially important gateway to the SKA project, particularly for visitors to the area, and it is recommended that a major social, environmental and landscaping programme be implemented to uplift the presently degaded portions of the townscape. It is recognised that that some programmes have already been initiated, but that more needs to be done for the image of the town in consultation with the Municipality, the business community and NGOs.