Environmental Impact Assessment for the proposed Concentrated Solar Thermal Power Plant on the farm Sanddraai 391, Northern Cape – EIR Phase Visual Impact Assessment Study for the Parabolic Trough Component

Solafrica Thermal Energy (Pty) Ltd

January 2016

Royal HaskoningDHV
Enhancing Society Together

Visual Impact Assessment Study

Client:

Solafrica Thermal Energy (Pty) Ltd

Project Name:

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Compiled by:

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Approval: Malcolm Roods

Signature

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Glossary of Terms

Anthropogenic	Human related, as opposed to natural
Band	In a visual assessment context a band is a contrasting linear form with two roughly parallel edges dividing an area in two.
Calcrete	A type of rock cemented together by calcareous material, formed in soils in semi-arid conditions. This near surface, terrestrial, accumulation of predominantly calcium carbonate, which occurs in a variety of forms from powdery to nodular to highly indurated.
Episodic Watercourse	Watercourses typically located within arid or semi-arid environments that only carry flow in response to isolated rainfall events
Glare	The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility
Glint	Glint is a brief flash of light.
Micro-topography	Small scale variations in the height and roughness of the ground surface; in the context of this report the definition includes structures such as buildings and larger-sized vegetation that can restrict views
Riparian Zone / Area	the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas
Sense of Place	“Sense of Place” is usually is defined as an overarching impression encompassing the general ways in which people feel about places, senses it, and assign concepts and values to it (Najafi, et al, 2011).
Viewshed	A viewshed is an area of land, water, or other environmental element that is visible to the human eye from a fixed vantage point
Visual Envelope	= a viewshed

1 INTRODUCTION

Solafrica Thermal Energy (Pty) Ltd has appointed Royal HaskoningDHV to undertake an environmental impact assessment (EIA) study for a proposed Concentrated Solar Thermal Power Plant on the farm Sanddraai 391, near Groblershoop in the Northern Cape Province. As part of the undertaking of the environmental studies for the proposed development, a visual impact assessment study has been identified as one of the studies that are required to be undertaken. A visual impact scoping study was undertaken in late 2014, and this report investigates the affected visual environment and the potential impacts associated with the proposed development in greater detail. This report assesses the visual impacts associated with the *Parabolic Trough* component of the proposed solar power plant (a separate report assesses the visual impacts associated with the Central Receiver component of the proposed development).

1.1 Aims of the Study (Project Terms of Reference)

The aims of the study are to:

- Assess the potential impacts visual impacts associated with the central receiver component of the proposed development, taking into account the existing visual environment and location of visual sensitive receptors.
- Assess the potential visual impacts associated with the associated infrastructure.
- Identify suitable mitigation measures to ameliorate or avoid the impacts from occurring.
- Comparatively assess the location / alignment alternatives presented and present a recommended option from a visual impact assessment perspective.

1.2 Assumptions and Limitations

It should be noted that the 'experiencing' of visual impacts is subjective and largely based on the perception of the viewer or receptor. The presence of a receptor in an area potentially affected by the proposed housing development does not thus necessarily mean that a visual impact would be experienced.

The Photovoltaic (PV) component of the proposed solar power plant development has been removed from the scope of works and has not been assessed in this report.

The Kalahari Oryx Game Reserve has not been assessed in spite of being potentially affected by the proposed development. As no information regarding the location of the Game Reserve and associated accommodation facility is publically available, an attempt was made by the EIA project manager to contact the management to arrange access when the EIR-phase visual impact assessment field visit was undertaken in December 2015. This proved unsuccessful, and subsequent requests by the EIA for information regarding the lodge's location also proved unsuccessful. The potential impact of the proposed development on the lodge (as raised in the scoping phase public participation phase on the project) has accordingly not able to be investigated. Should information be forthcoming and access to the said property provided, a subsequent draft of this report will be able to investigate the impact of the proposed development on this receptor location.

2 PROJECT DESCRIPTION

2.1 Project Technical Description

2.1.1 Power Generation Components

Solafrica Energy (Pty) Ltd (Solafrica) is currently assessing the feasibility of constructing a Concentrated Solar Plant with a maximum generation capacity of 150 MW based on Central Receiver technology including all associated infrastructure with a maximum generation capacity of 150 MW on the farm Sanddraai 391. The proposed plant is required to be sited on a technically and environmentally feasible site and to this end, Solafrica has considered land availability, land use capability, fuel availability and costs, grid connection proximity, capacity and strengthening, and other aspects related to the feasibility of solar power sites.

The CSP plant using central receiver technology will consist of the following components:

- A solar collection field of heliostats;
- A heat transfer fluid system with thermal storage option; and
- A power block (incl. steam cycle, steam generator, cooling system).

The footprint of the proposed plant is approximately 700ha in total. The facility will also include ancillary infrastructure in support of the power plants including water abstraction systems, waste management systems, power lines, roads, storage facilities, administration and operation buildings, construction laydown areas and temporary housing facilities.

The fundamental principle of CSP technologies is to collect the energy carried by sunrays, allowing a heat transfer fluid (HTF) to absorb the collected energy and thereby converting the thermal energy into further useful forms such as electricity (refer to Figure 1).

The process of energy conversion in a CSP plant is illustrated in Figure 2. Since a thermal intermediary is always involved, a conventional steam power turbine generator can be coupled for power generation. Energy storage is possible either in thermal form (e.g.: steam, molten salt) or as electrical energy (e.g. batteries). Losses occur throughout the energy conversion process.

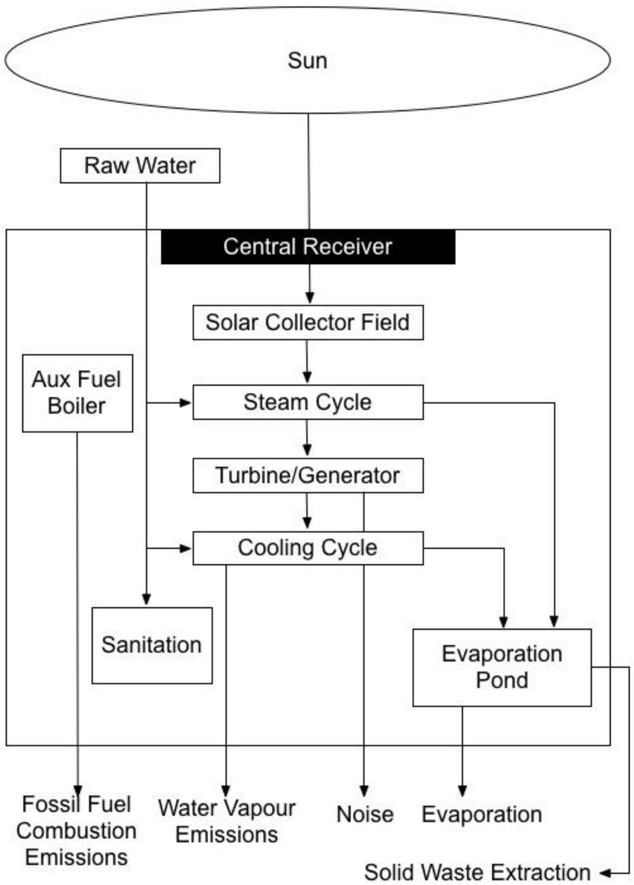

Figure 1 - Overview of the central receiver technology

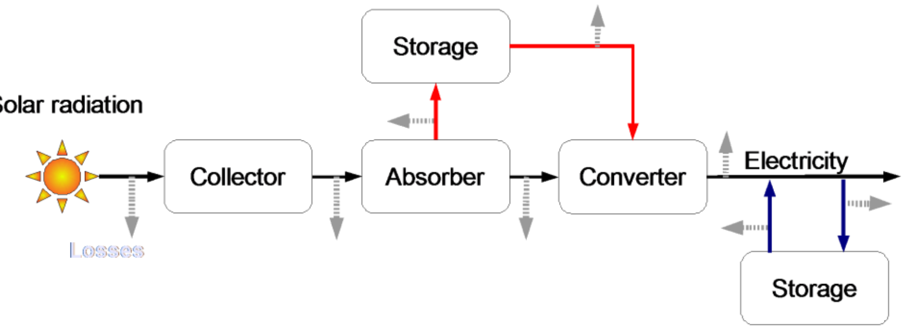

Figure 2 - Schematic of the energy conversion in a CSP plant. Storage is optional (Red – thermal energy; Blue – electrical energy; Grey - losses)

CSP technologies can be categorised by two concentrating methods according to the receiver types where sunrays are reflected to a point as in central receiver (Figure 3), a line receiver as in parabolic trough (Figure 4) or linear fresnel (Figure 5) technology.

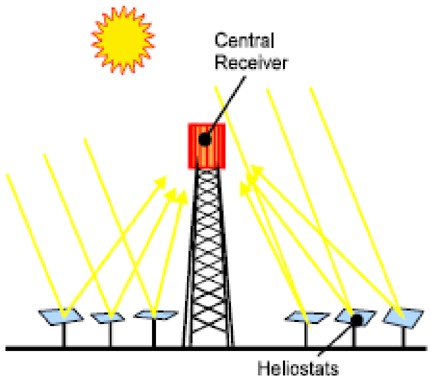

Figure 3 - Central Receiver

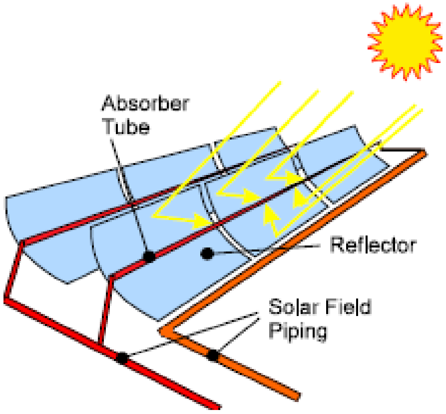

Figure 4 - Parabolic trough system

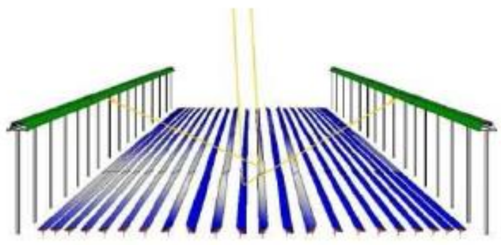

Figure 5 - Linear Fresnel

The HTF may be thermal oil (parabolic trough), molten salt (parabolic trough/central receiver/linear fresnel) or direct steam (parabolic trough/central receiver/linear fresnel) for the transportation of thermal energy. A thermal oil application is more commonly found in existing parabolic trough plants, molten salt and direct steam solutions are used in existing central receiver plants, and direct steam is used in existing linear fresnel plants although molten salt examples are emerging. The receivers, reflectors, HTF and the associated supporting structures make up the solar field. The design of the solar field is the core to the CSP technology. It is also the differentiator amongst the vendor designs.

It is important to note that the current report assesses the visual aspects associated with the parabolic trough component of the proposed development; the central receiver component is addressed in a separate report. Two alternative sites for the parabolic trough component have been provided, as indicated in Figure 7 below.

2.1.2 Ancillary Infrastructure

2.1.2.1 Water Supply Pipelines

A water supply pipeline will supply water abstracted from the Orange River (located on the southern boundary of the site) to the power generation plant. This pipeline will run from the abstraction point north-eastwards to where it splits into two alignment alternatives, aligned along the eastern or western cadastral (property) boundaries of the Sanddraai 391 property (the development site) respectively. The water pipeline will be buried, but no technical details of the pipeline have been provided by the applicant at this time.

It is important to note that the access road (alternatives) is aligned along the exact same route as the water pipeline and the road and pipeline would run in parallel. The distribution power line linking the plant to the existing 132kV power lines that cross the site would also be aligned along a portion of either the eastern or western boundary of the Sanddraai property, thereby creating a linear infrastructure corridor. The alignment of all linear infrastructure components is indicated in Figure 7 below.

2.1.2.2 Access Roads

An access road will run from the water abstraction point on the Orange River (located on the southern boundary of the site) to the power generation plant. This access will run from the abstraction point north-eastwards to where it splits into two alignment alternatives, aligned along the eastern or western cadastral (property) boundaries of the Sanddraai 391 property (the development site) respectively. No technical details of the road have been provided by the applicant at this time. The alignment of all linear infrastructure components is indicated in Figure 7 below.

It is important to note that the access road (alternatives) is aligned along the exact same route and the road and pipeline would run in parallel. The distribution power line linking the plant to the existing 132kV power lines that cross the site would also be aligned along a portion of either the eastern or western boundary of the Sanddraai property, thereby creating a linear infrastructure corridor.

2.1.2.3 Distribution Lines

A power line will need to transport electricity generated at the plant to the power distribution network. Accordingly a new 132kV distribution power line will be aligned from the plant to the existing 132kV distribution line that crosses the development site. Two alternatives alignments have been provided for the new power line on the eastern and western boundary of the site respectively. The alignment of the power line alternatives is indicated in Figure 7 below.

It is important to note that the power line (alternatives) is aligned along the exact same alignment as that of the portion of the road and pipeline (running in parallel) that would be aligned along the boundaries of the development site, thereby creating a linear infrastructure corridor.

2.2 Site Location and Description

The Study Site is located within the central part of the Northern Cape Province, being located to the north-west of the town of Groblershoop and to the south-east of Upington in the !Kheis Local Municipality. The development site is rural in nature, with intensive cultivation occurring in a narrow strip alongside the Orange River. The remainder of the development site and surrounding area comprises of rangeland (used for rearing of livestock (sheep and cattle) and game that consists of sparse natural semi-desert vegetation.

The development site is uninhabited, with the only permanent human habitation being located along the Orange River corridor and its immediate surrounds, concentrated around the Sanddraai Farmstead. The Bokpoort Solar Power Plant is located to the east of the site (refer to Figure 7 below), and represents a very large-scale power generation development that is resulting in development of large-scale industrial infrastructure over a large footprint and the concomitant transformation of the affected area from a natural state.

A number of linear infrastructure features are located in the vicinity of the development site; a district road – the Gariep Road – that runs from the N8 highway (located to the south of the development site), running east of the Orange River to the N14 highway bisects the south-western part of the development site. This road provides local access to properties on the eastern bank of the Orange River as it flows northwards towards Upington. The Sishen-Saldanha Iron Railway runs through part of the development site, crossing the Orange River close to the Sanddraai Farmstead. Lastly a 132kV power line bisects the southern part of the development site, running in an east-west orientation. The Study area is indicated in Figure 6 below.

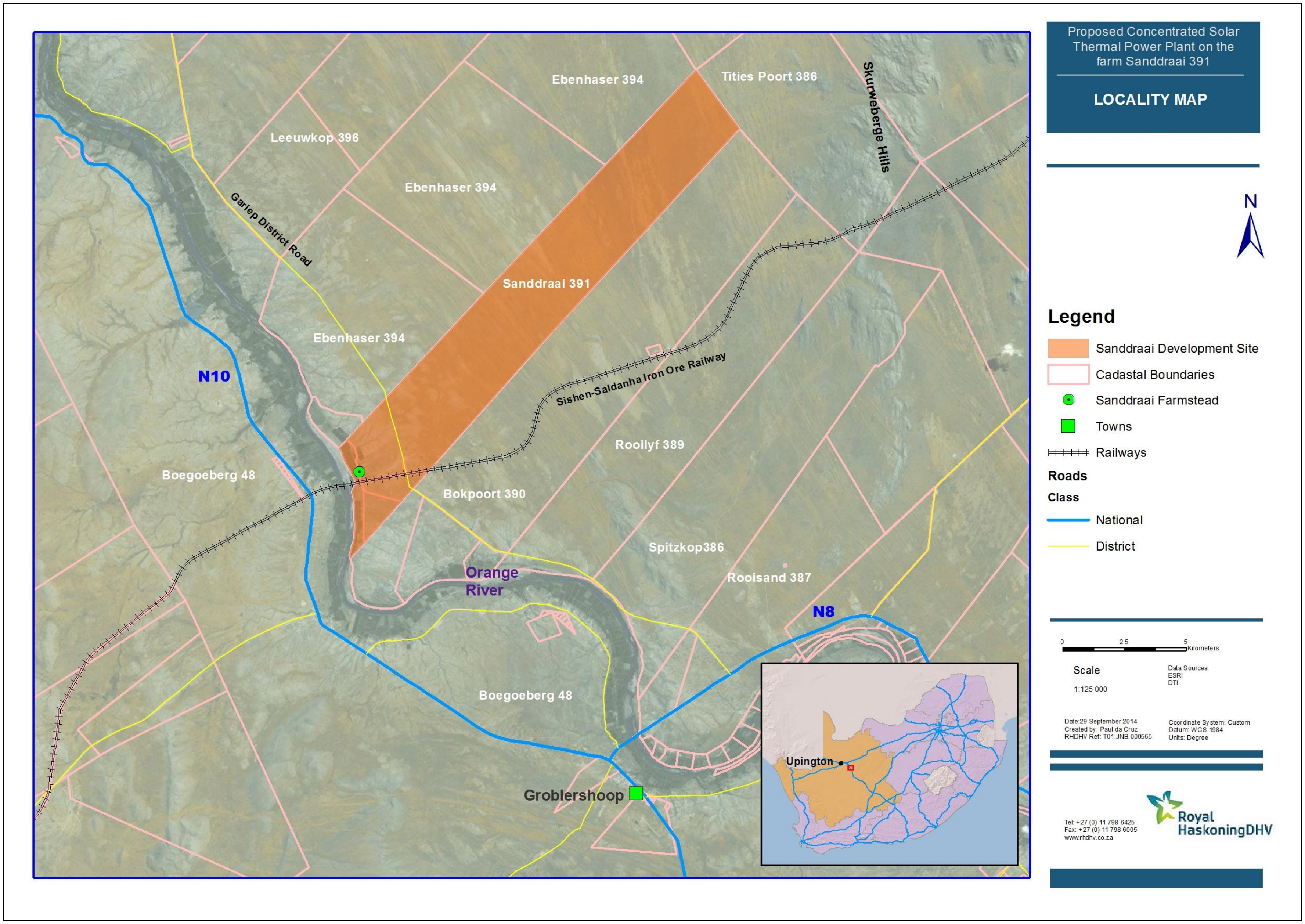

Figure 6 – Study Area Map showing the location of the development site

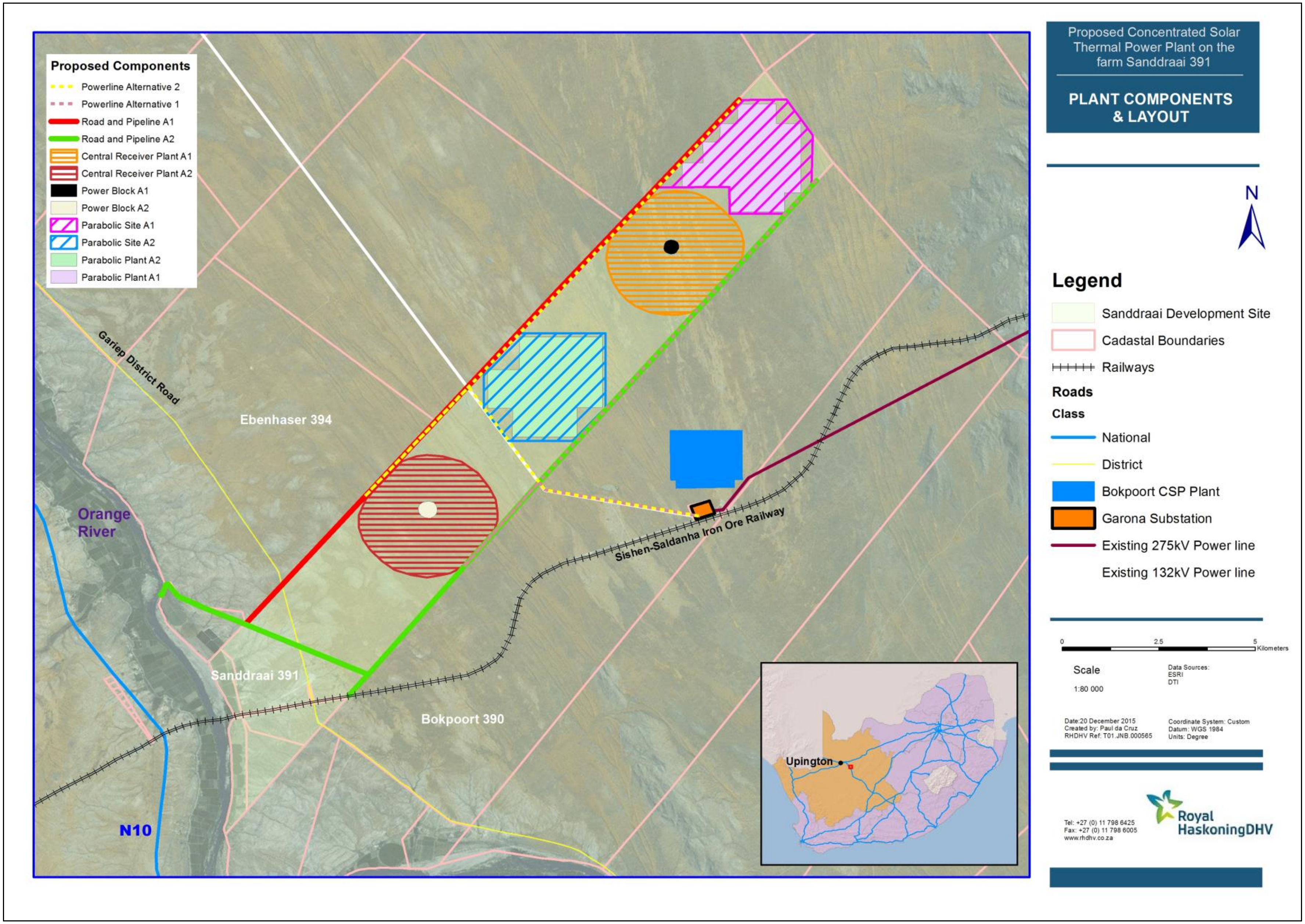

Figure 7 – Proposed Development Component Alternatives

3 STUDY AREA VISUAL ENVIRONMENT

It is important to characterise the visual environment surrounding the site in terms of its physical components and landuse in order to understand its visual character and associated visual sensitivity of the wider area. This is undertaken below.

3.1 Landscape Structural Components, Topography, Visual Character, and Visual Sensitivity of the study area.

3.1.1 Topography – Slope and Aspect

The development site borders the Orange River which comprises its south-western boundary. The Orange River is a significant river in a South African context, draining a very large part of the interior of South Africa, and is thus a large mature river as it flows north through the study area. The river is thus an important topographical feature on the site, having formed a wide, shallow valley that is flanked by distant higher lying ground on either side.

Figure 8 – Rugged, moderately undulating terrain on the development site between the Orange River valley bottom and the Gariep District Road

The terrain on the site on the site rises away from the Orange River and an alluvial terrace adjacent to the channel of the river on which irrigated fields and orchards have been established. The terrain on the footslopes of the wider valley is gently undulating to slightly undulating, with localised areas of higher ground (low ridges) formed by areas of resistant bedrock (see Figure 8). A number of small episodic watercourses drain this area. This area of higher ground extends to the Gariep District Road that runs roughly parallel to the river. The terrain changes from the incised and more steeply-sloping terrain closer to the river valley to much flatter terrain that is characterised by two prominent landforms – flat calcrete plains (Figure 9) and sandy duneveld (Figure 10). The duneveld occupies large parts of the central and north-eastern parts of the site, and is comprised of sand of wind-blown (aeolian) origin. A number of parallel-running longitudinal dunes that are aligned in a north-south orientation are encountered as one moves onto the site away from the river and the Gariep District Road. The dunes on the site were typically observed to be relatively low in height, varying between 2-10m. The dunes are typically well-vegetated, with shrubs and grasses located on the dunes themselves and the flat intervening areas between dunes being well grassed. It should be noted that a localised area of higher-lying topography occurs in the central part of the site in the form of a ridge that outcrops from the surrounding duneveld in the vicinity of the power lines that cross the site.

Figure 9 – Calcrete plains in the central part of the development site

The duneveld extends to the north-eastern-most end of the site. To the east and north-east of the site boundary the terrain rises up to a series of hills – the Skurweberge (refer to Figure 6 above) – that are a distant, but prominent visual feature within the environment of the area that frame the viewshed from the site.

Figure 10 – Typical duneveld in the northern part of the development site with intervening grassy area and dune in the background; note the Skurweberge hills in the background

3.1.2 Implications of slope and aspect for the experiencing of views

Slope and aspect are very important in the context of views as these can perform an important role in limiting views or 'focussing' views in a certain direction. Viewers located within an enclosed valley would have a limited visual envelope or viewshed, as the rising topography around them would preclude wider views of the surrounding terrain. Similarly an object placed lower down in such an enclosed valley would have a limited viewshed, being shielded or partly shielded by the terrain surrounding it. As described below, most of the receptor locations are situated close to, or within the Orange River corridor. Those on the eastern side of the river are located on gently sloping terrain with a west-facing aspect – thus away from most of the development site which is screened from view by higher-lying topography to the east that slopes up from the valley bottom. This has important implications for the viewing of the parabolic troughs on the site, as intervening topography will block part or all of the troughs from view (as indicated by the viewsheds of the parabolic trough alternatives – refer to section 4.3 below). However receptors on the western side of the river, especially those located on higher-lying ground away from the river (and thus with a wider vista) are located on ground with an eastward-facing aspect, towards the development site.

3.1.3 Landuse and Landcover

The climate of the study area is arid, with very low annual rainfall. This has affected the structure and cover of the natural vegetation on the site, except where increased moisture levels related to the Orange River are available. The entire development site, with the exception of a narrow strip along the Orange River is comprised of natural vegetation, except for limited areas where the presence of linear infrastructure or farming infrastructure has altered the vegetative composition. Natural vegetation has largely been retained as the arid nature of the climate in the areas away from the Orange River corridor has precluded the practicing of any agricultural activities other than livestock farming in the context of this rural area.

The more rocky, rugged parts of the site are characterised by a sparse cover of vegetation predominated by hardy, wiry grasses, with the presence of low shrubs along dry watercourses. The majority of the area of the site that is duneveld is characterised by a sparse coverage of shrubs and grasses on the dunes themselves, with generally well-grassed flats between the dunes. Mature trees are isolated and do not occur in any significant density on the site, being largely limited to the larger episodic watercourses and in isolated locations within the duneveld. Where they occur, calcrete plains are sparsely vegetated with wiry hardy grasses.

Under natural conditions, vegetation of larger structure and greater coverage occurs in a narrow strip along the Orange River. The riparian zone of the river is naturally characterised by the presence of a narrow but dense strip of large trees and shrubs. However historically parts of the riparian zone and the flat terrace behind the macro channel bank of the river have been transformed from a natural vegetative state, to establish intense irrigated cultivation as well as orchards and vineyards in places. In some parts of the site along the Orange River the natural riparian thickets still remain in a narrow strip along the channel. In certain places, in particular around the Sanddraai Farmstead, other mature trees including eucalyptus trees and date palms have been planted around homesteads.

The nature of the climate and corresponding land use which entails that stocking densities are low has resulted in relatively large farm properties across the area. Thus the area has a very low density of rural settlement, with only a handful of scattered farmsteads occurring across the parts of the study area located away from the Orange River corridor. No permanent areas of settlement are located on the development site with the exception of the part of the site that falls within the Orange River corridor, with most households (farm owner's household and farm workers dwellings) being located close to the river and associated cultivated areas to the north of the Sishen-Saldanha iron ore railway bridge over the Orange River at the Sanddraai Farmstead.

It should be noted that this pattern of landcover and human settlement is repeated on the neighbouring properties, with most permanent settlement being limited to the Orange River corridor, and livestock rearing occurring in the areas away from the river. Built form in the parts of the study area where livestock rearing occurs is thus limited to isolated farmsteads, gravel access roads, ancillary farm buildings, telephone lines, fences and the remnants of old workers' dwellings, as well as the iron ore railway. However an important change in landuse and landcover has recently occurred close to the site of the proposed development, on the Bokpoort 390 property on which a new the new Bokpoort Solar Power Plant has been developed. This solar power plant occupies a very large footprint with the development of extensive 'fields' of parabolic troughs and associated building infrastructure currently underway. This development constitutes a significant alteration of the current pattern of landuse and landcover in part of the study area. It is important to note however, that the location of the power plant results in it not being generally visible (or part of the day-time visual environment) from the Orange River / N10 corridor in which most of the receptor locations are situated.

3.1.4 Implications of land use and land cover (vegetation) for the experiencing of views

The sparse and low height of the natural vegetation on most of the site and the surrounds would perform an insignificant role in blocking any views towards the site, and in shielding infrastructure placed on the site. Only in the narrow Orange River corridor does vegetation of significant height and density occur that could perform this role, however the landscape position of this part of the site and surrounds is located low down in a valley bottom, thus topography is likely to perform a greater role in restricting viewsheds than vegetation would.

The patterns of human settlement on the site and in the surrounding area (as explored in more detail in section 3.2 below) have implications for the degree of visual exposure of the proposed development to receptor locations.

3.1.5 Visual Character and Visual Sensitivity of the area

3.1.5.1 Visual Character

The above structural and natural features of the environment engender the study area with a certain visual character. As has been explained above, the topographical and land use-related characteristics of the study area contribute to its visual character. Visual character is also influenced by the presence of built infrastructure such as buildings, roads and other objects such as electrical infrastructure. Visual character can be defined based on the level of change or transformation from a completely natural setting, which would represent a visual baseline in which there is little evidence of human transformation of the landscape. This is not to say that landscapes transformed by man are necessarily visually degraded, as many landscapes and visual settings around the world are a product of hundreds or even thousands of years of human influence, and thus represent a perceived 'natural visual baseline'. Varying degrees of human transformation of a landscape would engender differing visual characteristics to that landscape, with a highly modified urban or industrial landscape being very different to a largely natural undisturbed landscape. It should be noted that visual character is also related to aesthetic features of the environment, feeding into the related, but different concept of 'aesthetic quality' of the environment. Aesthetic quality is based on the existence of internal and built features in the landscape that are perceived to have aesthetically pleasing qualities, and the degree to which these are present or absent.

Due to the topographical and vegetative characteristics of the area, a viewer in the study area will have a general impression of a natural, rural landscape where there are wide-ranging vistas over the flat to moderately undulating terrain (with higher-lying ground in the distance in both the eastern and western fields of view) that are constrained very little by the vegetation. The generally low degree of human habitation and obvious impact at the landscape level thus engenders the area with a largely natural, rural feel. Anthropogenic structural features in the landscape are limited in spatial extent, and many of the linear structural features (such as the iron ore railway and 132kV power lines) are located away from corridors of human movement (i.e. public roads), thus enhancing the natural feel of the area. The Bokpoort Solar Power Plant is located relatively far away from the nearest public road, the Gariep District Road (approximately 10km distant) and is currently not visible from this road, as one travels along it. Construction traffic along the Gariep District Road (the presence of numerous large trucks ferrying construction material to and from the site) indicates the presence of a construction site somewhere in the vicinity, however this is an 'impact' that will be temporary, only lasting for the duration of the construction phase of the project. Rural infrastructure and landuse features are visible in certain parts of the area (especially along the Orange River corridor) and thus introduces a more rural aspect to the landscape.

Due to these factors the wider area in which the development is located displays a largely natural visual character with strong rural influences, particularly where human settlement and agricultural activity is concentrated along the Orange River corridor.

3.1.5.2 The importance of the Karoo / Kalahari Cultural Landscape

As explained above, the low density of human settlement and associated low level of change to the natural environment engenders the area with a largely natural visual character with rural influences. The visual context can be contextualised further by examining its location within a South African sub-regional context; the greater study area can thus be considered to be typical of a Karoo / Kalahari or "platteland" landscape that would typically be encountered across the high-lying dry western and central interior of South Africa. The study area is located in a transitional area between the Karoo and the Kalahari region. The Great Karoo (as distinct from the Little Karoo located in the Western Cape Province) can be described as the semi-arid part of the high-lying plateau in the western part of the South African interior that is located inland of the Great Escarpment. The Great Karoo occupies much of the Northern Cape and western Free State Provinces, as well as small parts of the Eastern Cape and Western Cape Provinces. The Kalahari is a semi desert region that extends over parts of South Africa, Namibia and Botswana. It is typically defined as the area covered by deep sandy deposits of wind-blown origin typically characterised by arid savannah with the presence of vegetated, stable sand dunes. The study area displays landscape characteristics of both sub-regions and is thus considered to be in the transitional area between the two sub-regions.

Much of South Africa's dry Karoo and Kalahari interior consists of wide open, uninhabited spaces sparsely punctuated by widely scattered farmsteads and small towns. Traditionally the Karoo has been perceived by many as a dull, lifeless part of the country that was to be crossed as quickly as possible en route between the major inland centres and the Cape coast, or between the Cape and Namibia. However in the last couple of decades such perceptions have been changing, with the launching of tourism routes within the Karoo and Kalahari, and the promotion of tourism in this hitherto little visited, but large part of South Africa. In a context of increasing urbanisation in South Africa's major centres, both the Karoo and Kalahari are being marketed as an undisturbed getaway, especially as a stop on a longer journey from the northern parts of South Africa to the Western and Eastern Cape coasts (in the case of the Karoo), or as a destination as its own, in the case of the Kalahari. Examples of this may be found in the relatively recently published "Getaway Guide to Karoo, Namaqualand and Kalahari" (Moseley and Naude-Moseley, 2008), and in the "Green Kalahari", as marketed by the Northern Cape Tourism Authority (see: http://experiencenortherncape.com/visitor/explore-the-northern-cape/regions/green-kalahari). The exposure of the Karoo in the national press during 2011 and subsequently as part of the debate around the potential for fracking (hydraulic fracturing) mining activities has brought the natural resources, land use and lifestyle of the Karoo into sharp focus, with many potential objectors stressing the need to preserve environment of the Karoo, as well as preserving the 'Karoo Way of Life', i.e. the stock farming practices which are highly dependent on the use of abstracted ground water (e.g. refer to the Treasure Karoo Action Group website http://treasurethekaroo.co.za/).

These examples of how the Karoo and Kalahari are valued provide a good example of how the typical Karoo and Kalahari landscapes can be considered valuable 'cultural landscapes' in a South African context. Cultural landscapes are becoming increasingly important concepts in terms of the preservation and management of rural and urban settings across the world; the concept of 'cultural landscape' is a way of looking at place that focuses on the relationship between human activity and the biophysical environment (Breedlove, 2002). The cultural landscape concept is a relatively new one in the heritage conservation movement across the world. In 1992 the World Heritage Committee adopted a definition for cultural landscapes:

Cultural landscapes represent the combined worlds of nature and of man illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal

Cultural Landscapes can fall into three categories (according to the Committee's Operational Guidelines):

- "a landscape designed and created intentionally by man";
- an "organically evolved landscape" which may be a "relict (or fossil) landscape" or a "continuing landscape";
- an "associative cultural landscape" which may be valued because of the "religious, artistic or cultural associations of the natural element"

The typical Karoo landscape of wide open plains, and isolated relief, interspersed with isolated farmsteads as well as windmills and stock holding pens, along with the Kalahari landscape of deep ochre sands, sand dunes and camel thorn trees, similarly interspersed with isolated farmsteads and stock rearing infrastructure are important parts of the cultural matrix of the South African environment. The presence of the Karoo / Kalahari farmstead, as well as the ubiquitous windmill, fence line and herds of sheep or cattle is an important representation of how the harsh, arid nature of the environment of this part of the country has shaped patterns of human habitation and interaction with the environment in the form of the predominant land use and economic activity practiced in the area over decades of human habitation. The presence of, and spatial orientation of small towns, such as those that occur in the wider area - Groblershoop, Kenhardt or Griekwastad, engulfed by an otherwise rural environment, form an integral part of the wider Karoo and Kalahari landscapes. As such the Karoo and Kalahari landscapes as they exist today have value as cultural landscapes in a South African context having been shaped by the physical limitations and the patterns of landuse and human habitation that have developed as a result. In the context of the types of cultural landscape listed above, the Karoo and Kalahari cultural landscapes would fall into the second category, that of an organically evolved, “continuing” landscape.

In the context of the study area, the various landscapes, as visible to the viewer, present excellent examples of such a Karoo cultural landscape, with more limited exposure to the Kalahari landscape, as the prominent dunes typical of the Kalahari landscape are not particularly visible from public human movement corridors,. In addition to the features noted above, there are two other physical characteristics found in the study area that are unique to the dry west of the country; the impressive sociable weavers’ nests that are found along roads on telephone poles or on power line towers, as well as the camel thorn tree or ‘Kameeldoring’ that is emblematic of the Kalahari. The presence of the Orange River that flows throught this highly arid context, providing a band greenery and intensive cultivation that is surrounded by largely empty uninhabited natural landscapes forms part of this cultural landscape.

The roads through the study area present good examples of these typical landscapes to the river. The area is not a significant hub for leisure tourism trips, although the wider Groblershoop area is visited for the Boegoeberg Dam and the Thuru Lodge, and as part of the N10 route linking the Eastern Cape and the Southern Cape with Upington and Namibia and as part of the access route to the Witsand Nature Reserve), however the aesthetic quality of the landscape is nonetheless important, considering the study area’s location in a wider context of proximity to the N10 highway route and the aforementioned tourism attractions. A significant change to this landscape has the potential to degrade its aesthetic quality and to threaten the conservation or preservation imperatives of the particular cultural landscape in a local context (refer to the discussion of environmental impacts of landscape change in the next section). In this context the significant potential visual intrusion posed by the proposed solar power plant may have implications for the aesthetic quality and degradation of the visual character and thus the cultural landscape context within the study area; although it is recognised that cultural landscapes are not necessarily static, but can be evolving. The potential for impact of the proposed solar power facility in the context of the Karoo / Kalahari cultural landscape in a local context is explored in more detail below (refer to section 4.3 below).

3.1.5.3 Amenity values related to landscapes

It is important to note that the more recent concept of landscape has shifted from its physical meaning to an emphasis on landscape as an intrinsic part of the human landscape (Skřivanová and Kalivoda, 2010). In humankind's recent past (especially since the industrial revolution) landscape change due to human action has been greatly accelerated; landscape has in many places been devastated in the name of development with the wastage and destruction of natural goods, including landscape (Skřivanová and Kalivoda, 2010). As explored below landscape is a very important part of the human psyche and cultural orientation, and has significant value (e.g. beautiful landscape is the keystone of tourism all over the world – Ewald, 2001). In this context the need for the consideration of landscape is an important environmental issue, especially if insufficient regard is paid to it (Skřivanová and Kalivoda, 2010).

The presence of natural / perceived natural and rural elements or areas within the landscape as viewed from the surrounds of the site can engender perceptions of aesthetic quality or value to the landscape. Many studies of landscape conservation have highlighted the value placed by people in rural or natural landscapes. In this context it is worthwhile to briefly explore how landscape, and particularly largely natural or rural landscapes, are valued in order to contextualise and understand responses to proposed developments that are associated with significant landscape change.

A rural landscape can be defined as an area where an interaction between humans and nature over time has led to the development of a landscape that has its own characteristics, and which is a middle ground between an urban landscape and wilderness, consisting of human activities that are related to the natural environment, such as agriculture and pastoral activities (Mazehan et al, 2013).

Placing value in a landscape is a psychological and cultural practice; values and meanings are not intrinsic to the landscape, but rather they are phenomena created by humans through their cultural practices (Pun, 2004). It is thus important to note that perceptions of landscape may not be universally shared and different individuals or groups of people may perceive or treat the same landscape differently, in turn ascribing different values and meanings to it (Pun, 2004). Values and meanings ascribed by local people may not be evident to an outsider. Indeed, differing values may be in competition among themselves (Pun, 2004).

There are different types of values that can be placed on a landscape; i.e. economic values (e.g. the relevancy of the landscape for business enterprises, or the market possibility of products from landscape), amenity values (values related to the non-material benefits associated with it) and security values (Pun, 2004). Amenity values can be subdivided into different sub-categories; "intrinsic" ecological value, scientific and educational value, aesthetical and recreational value, and orientational and identity value. Landscapes and the viewing of landscapes has also been shown to have positive psychological and health benefits; Velarde et al (2007), have shown through an examination of various environmental psychology studies that visual exposure to natural landscapes (e.g. by means of viewing natural landscapes during a walk, or viewing from a window) generally has a beneficial impact on human health (e.g. reduced stress, facilitating recovery from illness, and behavioural changes that improve mood and general well-being). Landscape as a source of beauty is prevalent within the arts, is strong draw card for recreational activities. In addition, landscape is an element in the ability of people to orient themselves, and is strongly related to people's cultural identity and sense of place. It is in this context that value is placed in natural or rural landscapes.

The above values can be interlinked, but can also be conflicting, e.g. amenity values associated with a landscape held by a certain group of people as described above may conflict with economic values associated with the market or development possibility of the landscape that are held by others. It is in this context that visual impact associated with a potential development often arises as an issue in environmental impact assessments.

The latter three sub-categories of amenity value described above – aesthetic, identity and psychological health value are typically involved in the perception of visual impact, as development within a landscape can change the landscape to the degree to which the amenity value associated with a landscape is degraded or no present.

3.1.5.4 Visual Sensitivity

The above cultural landscape context and the context of the potential amenity values placed in the landscape feed into the visual sensitivity of the area.

Value may be placed in the natural elements of the landscape as currently visible, indicating a sensitivity to change within the landscape that may be caused by development of significant infrastructure (such as a solar power plant) in the area as proposed. This perception would form a central basis for the visual sensitivity of the area, if it existed. This degree of visual sensitivity may not be universally shared by all inhabitants, as those not exposed to such views of the landscape may not share these perceptions. Perception of visual impacts is a complex multi-faceted phenomenon that relates to value judgments; a new development may not be perceived to be a visual impact if the inhabitants do not associate it with degradation of the landscape or if the new development is perceived to be uplifting the area in terms of job creation or advancement of the area. In addition if human receptors are not visually exposed to the new development such a development would be less likely to be perceived as a visual impact. This factor is explored in section 4.3 below.

In order to gain an idea of whether visual issues were perceived to be important in the area, the public participation process for the relatively recently completed Bokpoort Solar Power Plant EIA located in the same area, as well as the scoping phase public participation process for the current proposed development can be scrutinised; the Issues Trail for the EIA Public Participation Process only lists one response made as part of the public participation process that raises the issue of the visibility of a power tower component[1]. In the scoping phase of the public participation process a query from a nearby landowner related to the nature of the visual impact on his wild life and hunting business (the Kalahari Oryx Game Reserve), as the generation of his yearly income is dependent on giving a real live “African” experience to hunters from overseas, with these tourists being unlikely to visit his farm if they are able to see structures that remind them of the city[2]. This comment, and the presence of the Kalahari Oryx Game Reserve suggests that there are economic and amenity values placed in the landscape in which this property is located, and on which hunting operations are practiced (refer to section 3.1.5.3 above). The concern raised confirms the visual sensitivity of part of the wider study area (from which the proposed development would be visible). It should be noted that these comments do not necessarily indicate that this degree of visual sensitivity is shared across the entire study area.

3.2 Location of Visual Receptors

Visual Impact is related to the presence of human receptors / viewers, thus visual impact is typically experienced from locations inhabited or occupied by humans. Accordingly an understanding of the areas inhabited / occupied by humans (even transiently) is important in the classification of potential visual impacts. Sites of human habitation (e.g. residential areas, farmsteads and homesteads) typically make up the bulk of the receptor locations within an area. However lodges and other accommodation facilities, as well as recreational sites are other static locations that are typically considered receptor locations. However not only ‘static’ locations can be termed as

[1] It should be cautioned that due to renewable energy, and solar power generation being a very recent phenomenon in a South African context, public awareness of the potential (perceived) negative aspects of solar power generation in a visual or aesthetic context may be limited or not fully developed, as would be the case in countries with a longer history of renewable energy and solar power development.

[2] Comment raised by Johan Maritz at the Public Participation Meeting held on the 20th of July 2015.

receptor areas; areas or routes of human movement such as roads can also be considered to be receptor locations, as well as wider areas in which certain activities that would be considered visually sensitive are practiced. This could include areas where tourism activities such as hiking trails or 4X4 routes, or hunting are practiced.

In order to identify receptor locations in the study area, a radius of 5km beyond the boundaries of the site has been used. This radius has been utilised, as beyond 5km, even a large structure would be difficult to differentiate from the surrounding landscape (see section 4.1 below).

As can be seen in Figure 11 below, a cluster of receptor locations exists in the south-western part of the study area. The static receptor locations are typically located around farmsteads, with the presence of two small residential settlements of clustered housing being present within the 5km radius of the site. The receptors are located around the following farmsteads and locations:

- Saalskop Farmstead (west of the Orange River)
- Gannaput Farmstead (west of the Orange River)
- Sanddraai Farmstead (east of the Orange River on the development site)
- Bokpoort Farmstead *South* (close to the Orange River corridor, east of the river)
- Farmsteads along the Opwag (farm access) Road (west of the Orange river)
- Wegdraai Settlement
- Saalskop Settlement
- Bokpoort Farmstead *North* (located away from the Orange River corridor)
- Ebenhaeser Farmstead (located away from the Orange River corridor)

Three public access 'right of ways' are present in the area:

- The Gariep District Road that bisects the development site
- The Opwag (farm access) Road within the Orange River corridor
- The N10 national road west of the Orange River

It is important to note that apart from the Bokpoort North and Ebenhaeser Farmsteads that are located to the north, away from the Orange River corridor, all receptor locations are either located within the Orange River Corridor, or to the west of the river. North-east of the Sanddraai Farmstead cluster of receptors and the Gariep District Road, *no receptors are located on the development site.* This has important implications for visual exposure of receptors to the proposed development as explored in section 4.3 below.

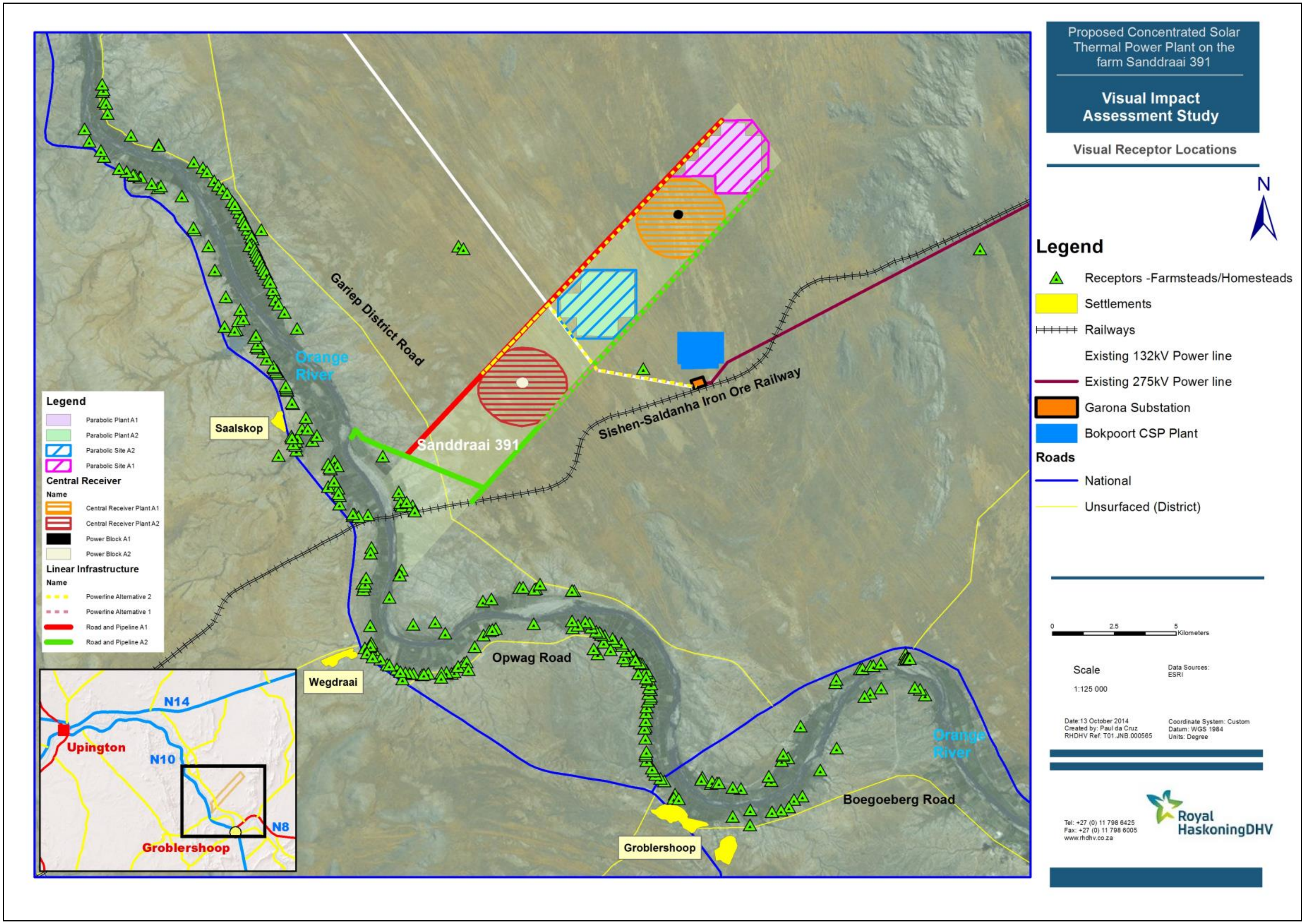

Figure 11 – Receptor locations within the study area

4 ASSESSMENT OF VISUAL IMPACTS

4.1 Generic aspects of visual impacts associated with developments and structures

Before exploring the site-specific impacts associated with the proposed development, it is necessary to explore some generic aspects of visual impact as associated with new developments such as the proposed solar power development.

- Size and footprint of an object/ development

Size of a new object / series of objects placed into a landscape is an important determinant in terms of visibility. The larger a structural feature, the more it is likely to be visible. Spatial footprint is also an important factor, as the larger the spatial footprint of a development, the more it will be likely to occupy a large portion of a landscape, thus having a greater potential to alter the visual character of the landscape.

- Viewing distance

The distance of the viewer / receptor location away from an object is the most important factor in the context of the experiencing of visual impacts. Beyond a certain distance, even large structural features tend to be much less visible, and are difficult to differentiate from the surrounding landscape. The visibility of an object is likely to decrease exponentially with increasing distance away from the object, with maximum impact being exerted on receptors at a distance of 500m or less. The impact decreases exponentially as one moves away from the source of impact, with the impact at 1000m being a quarter of the impact at 500m away (see Figure 12 below). At 5000m away or more, the impact would be negligible.

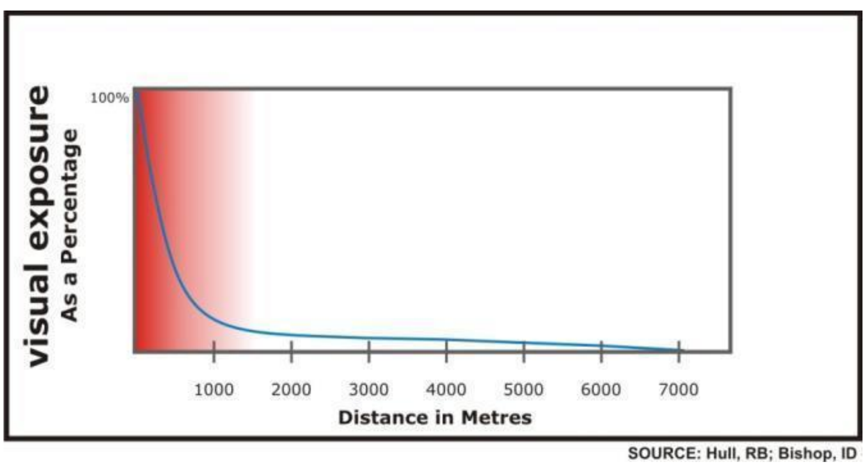

Figure 12 - Diagram Illustrating Diminishing Visual Exposure over Distance

- Presence of receptors

It is important to note that visual impacts are only experienced when there are receptors present to experience the impact; thus in a context where there are no human receptors or viewers present there are not likely to be any visual impacts experienced.

- Viewer perception

As described above, value can be placed in a landscape in terms of its aesthetic quality, or in terms of its sense of identity or sense of place with which it is associated. If no such values are held with respect to a landscape, there is less likely to a perception of visual impact if the landscape is visually altered. Development within a landscape may not be perceived negatively at all if the development is associated with progress or upliftment of the human condition. The perception of visual impacts is thus highly subjective and thus involves 'value judgements' on behalf of the receptor. The context of the landscape character, the scenic / aesthetic value of an area, and the types of land use practiced tend to affect the perception of whether new developments are considered to be an unwelcome intrusion. Sensitivity to visual impacts is typically most pronounced in areas set aside for the conservation of the natural environment (such as protected natural areas or conservancies), or in areas in which the natural character or scenic beauty of the area acts as a draw card for visitors (tourists) to visit an area, and accordingly where amenity and utilitarian ecological values are associated with the landscape.

When landscapes have a highly natural or scenic character, amenity values are typically associated with such a landscape. Structural features such as industrial / power generation developments and related infrastructure are not a feature of the natural environment, but are rather representative of human (anthropogenic) change to a landscape. Thus when placed in a largely natural landscape, such structural features can be perceived to be highly incongruous in the context of the setting, especially if they affect or change the visual quality of a landscape. It is in this context of incongruity with a natural setting that new developments are often perceived to be a source of visual impact.

- Landform (topographical) and micro-topographical context

The landform context of the environment in which the object is placed is an important factor. The location of the feature within the landform setting – i.e. in a valley bottom or on a ridge top is important in determining the relative visibility of the feature. In the latter case, the feature would be much more visible and would 'break' the horizon, if a viewer was located 'inferior' (lower than) to the object in the topographical context. Similarly the landform context in which the viewer is located is important in that topography can inherently block views towards an object if the viewer is located in a setting such as a steep-sided valley or on an aspect facing away from the object.

The micro-topography within the landscape setting in which the viewer and object are located is also important; the presence of micro-topographical features and objects such as buildings or vegetation that would screen views from a receptor position to an object can remove any visual impact factor associated with it.

- Landscape development context

The presence / existence of other anthropogenic objects associated with the built environment may influence the perception of whether a new development is associated with a visual impact. Where buildings and other infrastructure exists, the visual environment could be considered to be already altered from a natural context and thus the introduction of a new structural feature into this setting may be considered to be less of a visual impact than if there was no existing built infrastructure visible.

- Receptor type and nature of the view

Visual impacts can be experienced by different types of receptors, such as people driving along roads, or people living / working in the area in which the structural feature is visible. The receptor type in turn affects the nature of the typical 'view' of a potential source of visual impact, with views being permanent in the case of a residence or other place of human habitation, or transient in the case of vehicles moving along a road. The nature of the view experienced affects the intensity of the visual impact experienced.

- Weather and visibility

Meteorological factors, such as weather conditions (presence of haze, or heavy mist) which would affect visibility can impact the nature and intensity of a potential visual impact associated with a structural feature.

4.2 Visual Impact Issues related to Solar Power Plants

4.2.1 Generic Features common to all types of solar power

It is important to note that the development and associated environmental assessment of solar power plants in South Africa is relatively new, and thus it is valuable to draw on international experience. Thus this section of the report draws on international literature and web material to describe the generic impacts associated with solar power.

In general, solar power generating facilities need to occupy a very large area in comparison to other types of power generation facilities relative to the level of power output generated (Sullivan *et al*, 2012). This is an important component of the visual aspect of solar power plants as they can occupy large parts of a landscape, especially when viewed from an elevated position.

The large size, strong regular geometry of solar facilities, and the use of mirrors or glass panels with metal supporting structures, may result in high visual contrast being created that is visible for long distances in many instances (Sullivan *et al,* 2012). In favourable viewing conditions, large facilities can be visible from a distance of 16km or greater; it should be noted however that viewed from such long distances, the facilities may not be recognisable as solar facilities (Sullivan, *et al*, 2012). Built structures associated with solar power facilities would introduce complex, rectilinear geometric forms and lines and artificial looking textures and colours into the landscape; these would typically contrast markedly with natural appearing landscapes (US Department of Interior, 2013).

Previous studies have indicated that the ancillary infrastructure (in addition to the arrays of panels or mirrors) such as power blocks, substations, or cooling towers are also important in contributing towards observed visual contrasts and visual intrusion, particularly in the case of concentrating solar facilities (Sullivan *et al*, 2012). The visual impacts associated with this ancillary infrastructure is most pronounced in the case of views towards facilities from a low angle or low elevation, where the viewer is on the same, or lower horizontal plane as the facility. From low viewing angles, taller structures such as cooling towers extend far above the much lower collector arrays, creating a vertical contrast, and being particularly prominent if they extend above the horizon. If metallic (or containing metallic components), these can also be associated with glinting or glare.

A commonly expressed concern is whether glint or glare would negatively affect aircraft flying above the facility. It should be noted that in recent times several large scale solar projects have been completed and constructed at or near certain major airports in the USA (such as Denver International Airport or the Oakland FedEx International Airport Hub) without any reports of such problems (Power Engineers, 2010). It should be noted however that the solar power facilities at these airports are solar panel facilities that are typically low in reflectivity.

As most solar power plants tend to be located in vacant or uninhabited areas due to space availability, the landscape context is often natural; in this context the solar field could be considered to be a visual intrusion that possibly acts to alter the visual environment, especially if the pre-development visual context is natural. The level of visual exposure to the power plant (and potential visual intrusion of the facility) is dependent on the location of the solar fields in relation to receptor locations.

4.2.2 Parabolic Troughs

Parabolic troughs differ from photovoltaic panels in that these are curved and reflective, directing light onto a central receiver. These structures rotate on an axis and can reach a height of 8m above the ground (approximate in height to 2½-storeys of a building). The low profiles of these solar collector arrays of PV and parabolic trough facilities entail that these are typically able to be fully or partially screened by desert vegetation in flat landscapes where viewpoints are not elevated (U.S Department of the Interior, 2013). Parabolic trough facilities however require very flat terrain and the solar field for these facilities is typically completely cleared and levelled (US Department of Interior, 2013); this relates to the clearing of vegetation as discussed below in section 4.2.5.

As discussed above for PV facilities, parabolic trough facilities can create visual contrast and increased visibility through geometric patterns of reflected light. In the case of parabolic troughs this could emanate from regularly spaced metal surfaces in the collector array. It should be noted that these may not necessarily cause discomfort to the viewer and may change dramatically as the observer moves (Sullivan *et al,* 2012).

Glare has been noted to be associated with parabolic troughs; a study of solar facilities in the south-western part of the USA identified glare sufficient to cause annoyance or discomfort during extended viewing, for some observers at a parabolic trough facility in Nevada (Sullivan *et al*, 2012). Glare was observed from the front, sides, and tops of the parabolic trough arrays in this instant and was observed from viewpoints approximately level with the facilities as well as from elevated viewpoints, creating strong glare "spots". Glare sources in this instance were associated with reflections from heat transfer fluid tubes and/or associated components attached to the tubes. Glare can also be associated with control buildings, stream turbine generators, and associated facilities (US Department of the Interior, 2013). Glare would become significant if a solar facility were to cause unusually intense or prolonged glare that exceeded the amount of glare commonly encountered in the existing environment (e.g. from corrugated iron roofs or structures such as windmills).

Even if glint or glare are not experienced, the presence of a very large number of mirrored surfaces (parabolic mirrors or heliostats) can reflect the sky, clouds or at certain angles even the ground or surrounding vegetation. If the colour or reflection differs greatly from the surrounding colours in the natural landscape (e.g. if the blue sky is reflected thus giving the concentration of mirrors a blue colour), this could create a significant area of colour contrast in the natural landscape, thus enhancing the visibility to the facility

It should be noted that glare and colour differential (reflection of surrounding surfaces) may be transiently experienced if the observer moves, and especially if the observer is in a moving vehicle.

Figure 13 – Picture of a 'glare spot' at a parabolic trough facility in Nevada (Sullivan et al, 2012)

Plumes from gas boilers and cooling towers may also contribute substantially to observed visual contrasts in some situations if wet cooling was to be used, especially as it would tend to rise vertically, being visible against a natural landscape. Dry cooling technology may be used at some facilities, which would not result in a vapour plume (US Department of Interior, 2013).

Buildings and other structures such as tanks would be of sufficient height to protrude above collector arrays as viewed from outside the facility and would likely contrast with the collector arrays in terms of form, line, and colour (US Department of the Interior, 2013).

4.2.3 Vegetation clearing

One of the important potential indirect impacts of a solar power development relates to the clearing of natural vegetation. Clearing of vegetation could result in the potential loss of vegetative screening, which would result in the opening of views. Importantly in a visual contrast context the clearing of vegetation could result in the exposure of soils which could contrast with the colour of surrounding natural vegetation as well as potentially creating significant changes in form, line, colour, and texture for viewers close to the solar field. Lastly (especially in arid settings in which solar power plants are often developed) vegetation removal could result in windblown dust which could constitute an indirect visual impact (US Department of the Interior, 2013).

All of the above components of the proposed development will require the clearing of vegetation, to differing degrees. This clearing will be most intensive for CSP plants as the land will need to be graded and terraced where necessary, in order to provide a level surface for foundations. This practice of clearing vegetation will intensify the visibility of the solar energy facility, particularly in locations where natural woody vegetation would exist, but to a lesser degree when the proposed facility is located on land where woody vegetation does not occur.

4.2.4 Lighting

Due to the nature of solar power plants which would primarily be operational during sunlit (daylight) hours, lighting (at night) is not a major operational component of such facilities. However solar power generation facilities would include exterior lighting around buildings, parking areas, and other work areas, as well as security and other lighting around and on support structures (e.g., the control building) (US department of the Interior, 2013). In the context of a natural setting in which there would be little to no lighting, visible lighting at solar power generation facilities could constitute light pollution, especially in settings where landuses and activities (e.g. ecotourism establishments) which value the absence of lighting in a natural setting. Maintenance activities conducted at night, such as mirror or panel washing might require vehicle-mounted lights, which could also contribute to light pollution (US department of the Interior, 2013). Light pollution impacts associated with utility-scale solar facilities include sky glow, light trespass, and glare (US department of the Interior, 2013).

4.2.5 Access Roads

Roads can be associated with visual impacts, especially in the context of a road being constructed into a natural / rural visual context where there is no existing infrastructure. Viewed from a distance, roads can be responsible for creating an artificial "band" (a contrasting linear form with two roughly parallel edges dividing an area in two) in the landscape which draws the viewer's attention and which may create a new visual contrast in the landscape. The traffic along the road could heighten the perceived visual impact, especially if traffic volumes along the road are high, if heavy vehicles travelling on a road create large amounts of dust which rise into the air and which can be highly visible, and if vehicles travel along the road at night when lighting may create visual intrusion and light pollution in an otherwise dark rural night-time context.

Although the road is proposed to be constructed into a largely natural context in which there is little existing infrastructure, the 'banding' effect of the road may not be associated with a significant visual intrusion factor, as the road may be shielded by surrounding vegetation, and as much of the road would not be visible from areas of human access / habitation in the study area.

4.3 Analysis of degree of visual intrusion caused by the parabolic trough arrays at receptor locations in the study area

In the impact section, each of the proposed components of the solar power plant are assessed separately. The most intensive and greatest magnitude impacts of the proposed development will be associated with the central receiver tower component of the development, but that it addressed in a separate report. This section analyses the likely degree of visual intrusion related to the parabolic trough array components.

The visual phase scoping study undertook an analysis of potential visual exposure of the proposed solar power facility based on a number of zones of differing visual exposure (from high to marginal / negligible) visual exposure, based on the proposed location of the proposed solar facility development area (as provided by the applicant), and based on the typical degree of visibility of an object with distance (refer to Figure 12 section 4.1 above).

Moving into the EIR-phase of the development, the proposed development footprint has been enlarged, with proposed development areas for both central receiver and parabolic trough components set out by the applicant (refer to Figure 7 above). The alteration of the proposed development footprint has implications for the degree of visual intrusion on the receptor locations, as assessed in the scoping phase visual study.

In order to assess the potential visual impacts of the parabaolic tough arrays at the two alternative sites, viewsheds have been generated for both alternative sites. The viewshed for each site was based on a number of points within each alternative site, and the viewshed thus represents the parts of the study area which can view any part of the uppermost part of the heliostats (which are 15m high). The viewshed thus represents a worst-case scenario.

The Alternative 1 site is located in the far north-eastern part of the development site, and is thus the part of the site that is located furthest from the majority of the receptor locations in the study area that are located along the Orange River, at a distance of approximately 18km from the river. This is a significant distance, and a distance within which topography would be able to screen the site and the objects developed on the site from view. A low ridge than runs over part of the site is located between the plant and the receptor locations and would partly block the arrays from view for certain of the receptors. As can be seen from Figure 15 below, the vast majority of the receptor locations in the study are would not be able to view the parabolic trough array at all, and this part of the solar power plant would effectively not be visible, taking into account the distance factor which would render it very difficult for viewers at these receptor locations ti discern the presence of the plant against the surrounding wider landscape. The level of visual intrusion associated with the parabolic trough array would thus effectively be nil.

The only receptor locations that will be exposed to a view of the plant are two receptor locations that are situated away from the Orange River valley and closer to the proposed Alternative 1 site. These are the Bokpoort Farmstead and the Ebenhaeser Farmstead to the south and north of the development site respectively. The Bokpoort Farmstead is located on a hill with an aspect towards the development site and will have a full view of the Alternative 1 site by virtue of its position. The visual environment at this location is however modified from the rural baseline due to the presence of the Bokpoort Solar Power Plant that is located very close to this receptor location, thus the development of the Sanddraai Solar Power Plant would be adding to this view.

The Alternative 2 site is located somewhat closer to the Orange River valley and the majority of the receptor locations, being located approximately 11km from the receptor locations on the western side of the river. This shorter distance is still significant making it difficult for viewers to easily pick out objects at this distance. The plant is similarly to Alternative 1 located to the north-east of the low ridge on the site that would assist in shielding the plant from view from certain receptor locations. The viewshed for the Alternative 2 (Figure 16) site indicates that a slightly greater number of receptor locations within the Orange River valley would be able to view the upper parts of the heliostats, including a number around the settlement of Saalskop and certain receptors along the Opwag local road in the vicinity of the Wegdraai Settlement. The distance factor would still render the heliostat array difficult to discern against the surrounding landscape from the distant receptor locations, and the degree of visual intrusion of the array is likely to be low. The two closer receptor locations (the Bokpoort Farmstead and Ebenheaser Farmstead) would be able to view the heliostats at the Alternative 2 site due to their closer proximity to the site.

For the certain receptor locations in the Saalskop area there would be a possibility that any potential visual impacts associated with the Alternative 2 *parabolic trough* site would be obviated by the shielding effect and visual intrusion factor of the central receiver component (if developed – please refer to the non-development recommendation in the central receiver component visual report), if the central receiver component were to be developed at the Central Receiver Alternative 2 site that is located closer to the Orange River valley than the parabolic trough site. For the receptors in the Saalskop area the development components would line up behind each other, and the heliostats of the central receiver component (being of similar height to the those of the parabolic heliostats and being located closer) are likely to shield part or all of the parabolic trough arrays. For receptors to the north and south of the Saalskop area, the components would appear to be located adjacent to one another and not behind one another. However the high visual intrusion effect of the central receiver tower could easily dwarf any visual impact associated with the parabolic troughs at these locations.

Overall, the degree of visual intrusion associated with the parabolic trough arrays at both alternative sites is likely to be low at worst, with the distance between most of the receptor locations and the alternative sites being the greatest contributing factor. The plants are thus very unlikely to result in the creation of a visual impact, or perceptions of visual impact by residents and other viewers in the Orange River valley, especially if the Alternative 1 site is selected for development. The potential for colour contrast as caused by the parabolic trough arrays (as detailed in section 4.2.2 above) is also likely to be negligible due to the distance of the bulk of receptor locations that are able to view it from the Alternative 2 site. This potential impact is not applicable to the Alternative 1 site as the vast majority of receptor locations will not be able to view the plant at this site. The potential glint and glare-related impact is explored below.

Figure 14 – view from the Slypsteen Guest Farm over the Orange River valley and towards the development site.

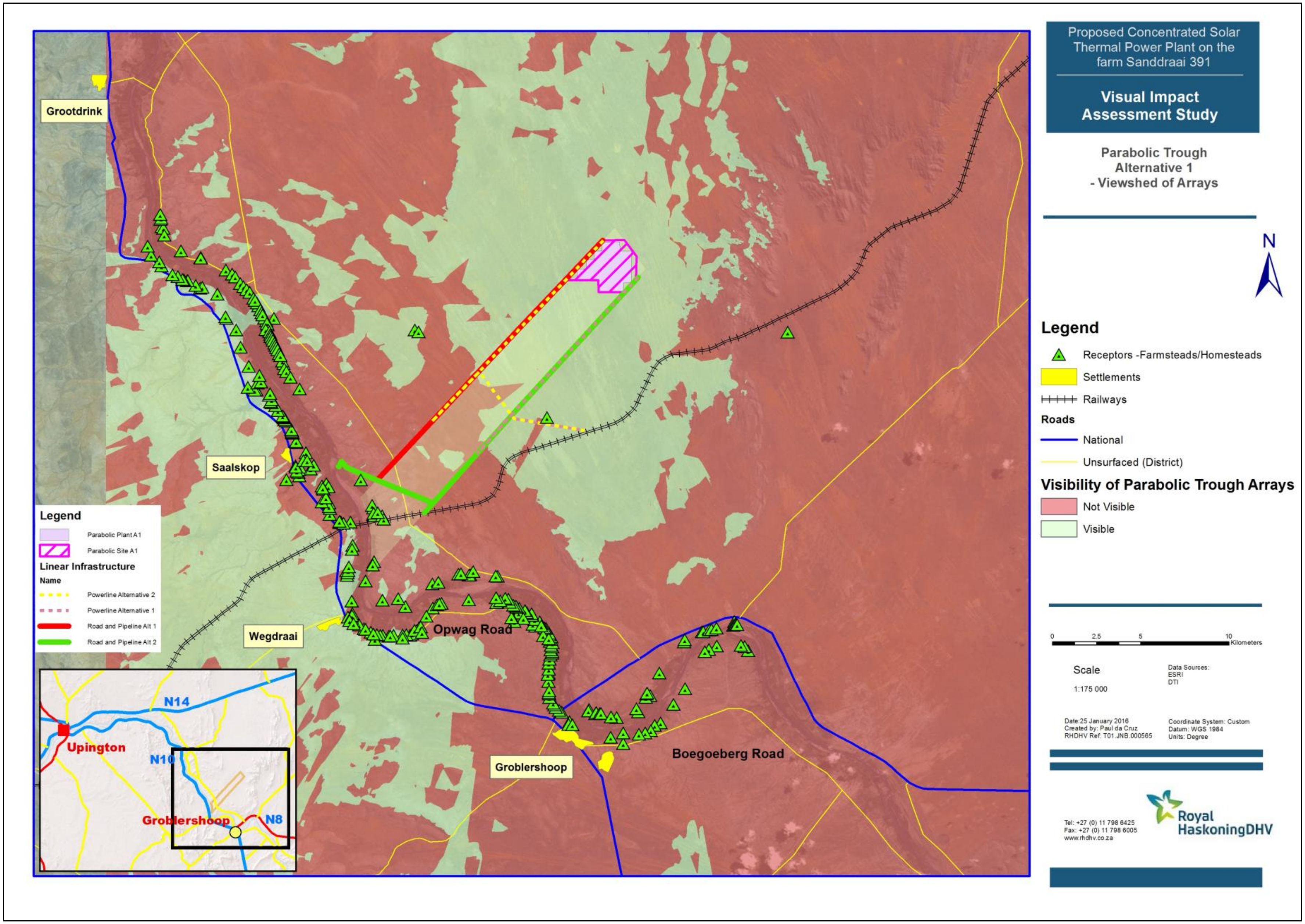

Figure 15 Viewshed of the upper part of the parabolic trough heliostats at the Alternative 1 site

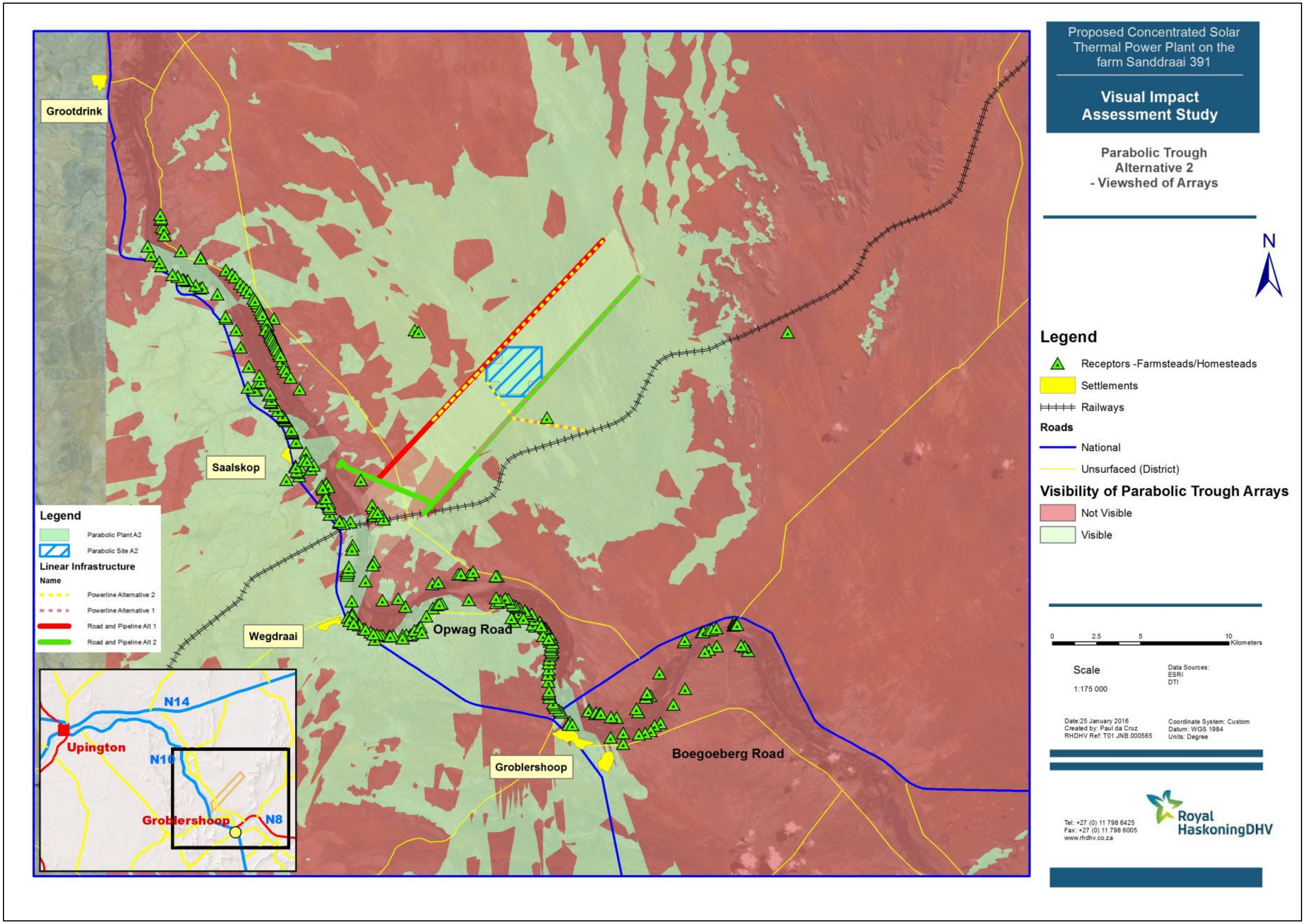

Figure 16 - Viewshed of the upper part of the parabolic trough heliostats at the Alternative 2 site

4.3.1 Glint and Glare analysis of the Parabolic Trough components

As described in section 4.2.2 above, glint and glare can become problematic aspects of the heliostats associated with the parabolic trough component of a solar power plant. As evident in Figure 15 above, the Alternative 2 parabolic trough will not be visible to the vast majority of receptor locations in the study area and thus will not create any glint or glare impacts. Site Alternative 1 is located closer to the Orange River valley and thus would be able to be viewed by certain higher-lying receptor locations. Glint from the sun reflected in the absorber tubes or from helistats could be visible. This glint over a wide area could make the parabolic troughs more visible and more easily identified within the wider landscape. However the distance of the majority of the receptor locations from the plant (a minimum of 11km) would result in any glint or glare generated being rendered relatively non-invasive, especially when atmospheric conditions such as haze or pollution from smoke is considered. In addition the shielding effect and great visual intrusion capacity of the central receiver component discussed above would be likely to further obviate any glint or glare-related impacts. Thus for the majority of the receptor locations, glint and glare associated with either of the parabolic site alternatives is unlikely to be a factor.

4.3.2 Assessment of lighting impacts associated with the Parabolic Trough Component

In order to assess the impact of lighting at the proposed solar power station facility, it is necessary to explore the nature of the night-time environment in the study area.

Most parts of the study area are highly rural in nature with a very low density of human settlement. Accordingly the night-time environment within the wider area is thus characterised by few sources of artificial lighting. Where these occur, these are highly localised. The location of the viewer is important as viewers located in low-lying terrain settings (such as in the Orange River valley) would not be able to view the lights in the surrounding area. However viewers in higher lying settings, such as certain of the receptor locations on higher-lying ground closer to the N10 national road west of the Orange River valley would be able to see a greater area, and thus see the light sources in this area.

The primary sources of lighting are floodlights that illuminate on a permanent (nightly) basis in a number of the small settlements located along the N10 including Wegdraai, Saalskop and Grootdrink to the north as well as in certain parts of Groblershoop and the settlement of Boegoeberg to the south. A number of these very tall floodlights provide general illumination for these respective settlements in the absence of (lower) street lighting. The height of these lights makes them highly visible in an otherwise dark night-time context. When viewed from a high point the effect is of ‘islands of light’ in an otherwise very dark, unlit night-time context.

The Bokpoort Solar Power Plant has introduced a further set of lights into this dark environment, and is the only really visible source of light on the eastern side of the Orange River (when viewed from afar). The Bokpoort Solar Power Plant is located relatively far from the Orange River and cannot be discerned from the higher points on the western side of the Orange River during the day. However a set of lights at the power plant is visible from higher-lying terrain to the west of the river. A collection of lights is visible at the plant’s location. These lights are likely to be tall, floodlight-type lights in order to be viewed from the higher lying areas to the west of the river. This set of lights adds to the few sources of lighting visible in the wider area.

It should be noted that it is not known what type of lighting is planned at the proposed facility. However if similar type of lighting was developed at the proposed facility, the relative proximity of the proposed facility to the Bokpoort Solar Power Plant when viewed from the area to the west would effectively add to the cluster of lighting that is already visible in this part of the study area. The number of lights as visible could more than double, especially if lighting was placed at both the parabolic and central receiver sites. The degree of visibility of lighting would depend on the height of the lights, the degree of illumination (strength) and their orientation. It is important to note that lighting at the proposed plant may not become a permanent feature of the light time environment if it is not operated on a permanent (nightly) basis, and only used in case of emergency maintenance requirements.

4.4 Visual impact of ancillary (linear) infrastructure

4.4.1 Roads and Pipeline

As described in section 2.1.2 above the road and pipeline will run in parallel, from the abstraction point along the Orange River along one of two alternative alignments to the northernmost component of the solar development, running along the boundary of the Sanddraai property. As the road and pipeline will run in parallel, these new features could form a visible linear 'band' in the landscape, especially as the alignment along the boundary is a straight alignment for a considerable distance.

As described elsewhere in this report, most of the Sanddraai site and the area to the east of the Orange River *away from the river valley bottom corridor* is uninhabited, and thus there will be few receptor points within this area away from, and to the east of the river. The other pertinent factor in a visual assessment context is the height of the road and pipeline, which are not raised features, and unlike other components of the development would not be visible over a greater area by virtue of their height.

Accordingly the most likely nature of visual impact potentially associated with the proposed road is the creation of a visible linear band in the landscape to the east of the Orange River, as viewed from receptor locations to the west of the river. The road would either be tarred or unsurfaced, creating a black or white surface respectively. The pipeline servitude running in parallel would be kept free of naturally-occurring woody vegetation and would thus be a different colour (matching the colour of the substrate) from the surrounding areas of sparse acacia thicket.

The portions of the respective alignments that are aligned along the Sanddraai property boundary, and which run up (and roughly parallel) away from the Orange River valley bottom are most likely to be visible from the receptor locations to the west. The nature of the terrain, however, would block much of the road and pipe alignments along the farm boundary, especially the majority of the alignment that is located within the flatter dunefields north-east of an area of locally-high lying topography immediately to the north-east of the Gariep District Road. The shielding effect of topography for most of the receptor locations along the Orange River corridor and N10 corridor is evidenced by the viewshed analysis undertaken for the parabolic trough sites that indicates that these areas will not able to be viewed by receptors within the Orange River valley and those located to the west of the valley.

Beyond the localised high ground immediately north-east of the Gariep District Road the road and pipeline servitude *along Alternative A1* would be visible from the receptor locations west of the Orange River as it crosses the low ridge along which the existing 132kV power lines are aligned, however this ridge is located at a sufficient distance from these receptor locations (approximately 10.5km) to make it very hard for the viewer to discern these features in the context of the surrounding landscape.

For the portions of the road that are visible, and which are located between the Gariep District Road and the Orange River, the presence of vehicles moving along the road *if it were unsurfaced* thus creating a dust cloud, would be the feature of the road that would be most visible, drawing attention to the road. This visual aspect is valid for the Gariep District Road, which is currently unsurfaced.

4.4.2 Power line

A new power line is proposed to run from the existing 132kV power line (that bisects the development site (Sanddraai property) to the north-east of the Gariep District Road) along either of the longitudinal boundaries of the Sanddraai property to link up with solar power plant components located to the north-east or-south-west of it. The exact alignment and length of the proposed power line will depend on which solar power generation component alternatives are selected, and on which of the respective alignment alternatives along the boundaries are ultimately selected.

Visual impacts associated with power lines typically relate to two factors – firstly that the towers are large structural objects and thus highly visible, and secondly that power lines are often perceived to be incongruous in the context of a natural setting.

The cluster of receptor locations concentrated along the Orange River, in particular those to the west of the river on higher-lying ground will be the closest receptor locations which would be potentially exposed to a view of these new power lines. There is a sizeable distance however between the closest receptors on the western side of the river to the closest point of the proposed power line alternatives (at the point at which the power line alternatives would link into the central receiver array Alternative 2) – approximately 7km for power line Alternate 2 and 8.5km for power line Alternative 1[3]. This distance factor would render the closest part of the line very difficult to discern from the surrounding landscape (and would be dwarfed by the central receiver tower if it was developed on Site Alternative 2). The existing 132kV power lines are impossible to discern with the naked eye from the western side of the valley and accordingly the majority of the alignment of the power lines along either of the alignments would exert little to no visual impact on the majority of the receptor locations in the study area.

There are two sets of receptor locations situated closer to the road alignment - the Bokpoort Farmstead and the Ebenhaeser Farmstead that are located 2km and 3.7km from the closest visible point of the lines respectively. However these receptor locations are both located in an area from which the solar power station components (including that of the Bokpoort Solar Power Plant in the case of the Bokpoort Farmstead) would be highly prominent. The associated power lines would arguably be insignificant in the context of the scale and area of the solar power plant components, and thus unlikely to affect these two receptor locations in a context of these structural features.

4.5 Proposed mitigation measures for identified visual impacts

4.5.1 Selection of preferred alternatives

As discussed in section 5 below, it is strongly recommended that the preferred alternatives (where a preference has been expressed from a visual perspective) be selected for development. Due to effective non-visibility of Site Alternative 1 to the majority of receptor locations in the study area, the development of the parabolic trough component on this site is strongly recommended.

[3] The power lines would not be visible from the Sanddraai Farmstead which is located closer to the end point of the power line alignment than the receptor locations on the western side of the river due to its location low down within the Orange River valley bottom.

4.5.2 Lighting-related mitigation measures

- Lighting at the plant could potentially exert a visual impact, especially if floodlight-type lighting was to be developed at the plant. Accordingly the following mitigation measures should be implemented with regards to lighting:
- Lighting of the plant at night should be limited to security lighting (where this is necessary). It is acknowledged that emergency operational lighting may be required, but this should not be permanently lit, only being lit when such emergency operational lighting is required.
- The height of any lights should be limited; more lights of lower height should be installed rather than fewer floodlights that would be visible from a wider area.
- All lighting should be downward, and inward facing (towards the plant), to avoid light spill into surrounding areas.

4.5.3 Other visual mitigation measures

- The consolidation of linear services should be considered, in order to reduce the creation of multiple 'bands' of cleared (woody) vegetation on the development site (as would occur within pipeline and power line servitudes).
- Within linear servitudes, all cleared areas during the construction phase that will not form part of the plant footprint, including power line and pipeline servitudes should be rehabilitated and replanted with grass or low shrubs with non-invasive root systems, in order to avoid the creation of areas devoid of vegetation that may be visible from receptor locations.
- It is recommended that the monopole power line tower be used (as opposed to the steel lattice tower) in order to reduce the visibility of power line towers. Wooden power line tower poles are also preferable to steel lattice tower types.
- During construction, dust suppression should be applied to areas cleared of vegetation to avoid the creation of dust clouds.
- It is recommended that the proposed access road be tarred and not left unsurfaced, in order to avoid the creation of dust clouds from vehicles moving along the road that would draw the attention of the viewer to the road in the distant landscape.
- The Gariep District Road will be utilised as the access route to the construction site for materials. It is recommended that this road be upgraded to a tarred road in order to prevent the creation of large clouds of dust by fast-moving heavy vehicles (especially trucks and busses) that would travel in high numbers along the road.

5 COMPARATIVE ASSESSMENT OF ALTERNATIVES

5.1.1 Parabolic Trough Component

In Section 4.3.the likely degree of visual intrusion and visual impact associated with each of the two parabolic trough alternative locations have been addressed in detail. The analysis of the respective viewsheds of each of the alternative sites has revealed that the Alternative 1 site will not be visible for the vast majority of receptor locations. Although the Alternative 2 site has been assessed to be associated with a low degree of visual intrusion, the non-visibility of the Alternative 1 site means that this site is strongly preferred as it would not be associated with any degree of visual impact for the majority of the study area.

5.1.2 Road and Water Pipeline

Two alternative alignments have been provided for the road and pipeline that would run in parallel. Due to the distance of the road and the respective alignments from the Orange River valley in which most of the receptor locations are located, large parts of the road and pipeline (at ground level) would not be able to be viewed (refer to Section 4.4.1) and the distance factor would render the sections of road able to be viewed difficult to discern. There is thus no preference for the two road / pipeline alignment alternatives.

5.1.3 Power Lines

Two alternative alignments have been provided for the power, running on the northern and southern boundaries of the development site respectively. Due to the distance of the power line alignment under the respective alignments from the Orange River valley in which most of the receptor locations are located, large parts of the power line would be very difficult to discern within the wider landscape context (refer to Section 4.4.2). There is thus no preference for the two power line alignment alternatives.

6 IMPACT RATING MATRIX

6.1 Parabolic Trough Component

6.1.1 Alternative 1

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
Construction	• The total clearing of the site would be conducive to the creation of large clouds of dust that with the movement of machinery that would be visible from a wide area. • Heavy vehicles traveling to the site along the Gariep District Road will create large dust clouds that will be able to be viewed from a relatively great distance.	**Extent:** Local (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Very Likely (-4) **Significance: High (-16)**	• Avoid complete clearing of the construction site, and only clear vegetation in a phased manner. • It is recommended that the Gariep District Road be tarred to avoid the creation of excessive dust by large numbers of construction vehicles.	**Extent:** Site (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Likely (-3) **Significance: Medium to High (-15)**
Operations	• The parabolic trough heliostats would not be visible to the vast majority of the receptor locations in the study area, and thus would not cause any visual impact for the majority of the study area.	**Extent:** Local (-2) **Duration:** Long-term (-4) **Frequency:** Very Rare (-1) **Intensity:** Very Low (-1) **Probability:** Improbable (-1) **Significance: Medium (-9)**	• Development of the Site Alternative 1 is recommended.	**Extent:** Local (-2) **Duration:** Long-term (-4) **Frequency:** Very Rare (-1) **Intensity:** Very Low (-1) **Probability:** Improbable (-1) **Significance: Medium (-9)**
Decom-missioning		**Extent:** Local (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5)		**Extent:** Site (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5)

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
		Intensity: Low (-2) **Probability:** Very Likely (-4) **Significance: High (-16)**		**Intensity:** Low (-2) **Probability:** Likely (-3) **Significance: Medium to High (-15)**
Cumulative	• The part of the study area (area to the east of the Orange River, north of Groblershoop) us largely natural as viewed from the area to the west (Orange River valley and N10 corridor), thus the parabolic trough component will not create any cumulative impacts.	**N/A**	N/A	**N/A**

6.1.2 Alternative 2

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
Construction	• The total clearing of the site would be conducive to the creation of large clouds of dust that with the movement of machinery that would be visible from a wide area. • Heavy vehicles traveling to the site along the Gariep District Road will create large dust clouds that will be able to be viewed from a relatively great distance.	**Extent:** Local (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Very Likely (-4) **Significance: High (-16)**	• Avoid complete clearing of the construction site, and only clear vegetation in a phased manner. • It is recommended that the Gariep District Road be tarred to avoid the creation of excessive dust by large numbers of construction vehicles.	**Extent:** Site (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Likely (-3) **Significance: Medium to High (-15)**
Operations	• The parabolic trough heliostats would be visible to a low number of receptor locations in the higher lying parts of thr Orange River corridor. However the distance factor (>11km) would result in a low degree of visual impact for the	**Extent:** Local (-2) **Duration:** Long-term (-4) **Frequency:** Very Frequent (-4) **Intensity:** Low (-2)	• Development of the Site Alternative 1 is recommended.	**Extent:** Local (-2) **Duration:** Long-term (-4) **Frequency:** Very Frequent (-4) **Intensity:** Low (-2)

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
	majority of the study area.	**Probability:** Probable (-2) **Significance: Medium to High (-14)**		**Probability:** Probable (-2) **Significance: Medium to High (-14)**
Decom-missioning		**Extent:** Local (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Very Likely (-4) **Significance: High (-16)**		**Extent:** Site (-2) **Duration:** Medium-term (-3) **Frequency:** Continuous (-5) **Intensity:** Low (-2) **Probability:** Likely (-3) **Significance: Medium to High (-15)**
Cumulative	• The part of the study area (area to the east of the Orange River, north of Groblershoop) us largely natural as viewed from the area to the west (Orange River valley and N10 corridor), thus the parabolic trough component will not create any cumulative impacts.	**N/A**	N/A	**N/A**

7 CONCLUSIONS

The proposed Sanddraai Solar Power Plant has a number of different power generation components, including a parabolic trough component and a central receiver component. The power plant is proposed in an area of low human habitation to the east of the Orange River, and thus most of the receptor locations in the study area are located within the Orange River valley, away from the development components.

Two alternative sites have been provided for the parabolic trough component. Site Alternative 1 is situated further from the Orange River valley than Site Alternative 2, and thus is located further from the bulk of the receptors in the study area, located in the Orange River valley. Analysis of the viewshed of the site alternatives reveals that the Site Alternative 1 would not be visible from the vast majority of the receptor locations in the study area and thus would not be associated with any visual impact on most of the study area.

Site Alternative 2 would be visible to a greater number of receptor locations that are situated on higher-lying ground in the Orange River valley. However due to the distance factor (most receptors are located at least greater than 11km from the site) the degree of visual intrusion and visual impact would be low.

Due to the absence of visual impacts associated with the Alternative 1 site, it is recommended that this site be selected for development.

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