Proposed Tshwane Strengthening Project – Phase 1

Apollo-Verwoerdburg Substation Extension and 400kV Turn-in Transmission Power Lines

Visual Impact Assessment

Draft EIR (EIA reference number 12/12/20/1470)

January 2010

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Professional Declaration

Stephen Townshend from MetroGIS (Pty) Ltd undertook the visual assessment in his capacity as a visual assessment and Geographic Information Systems specialist. Stephen holds a Bachelor of Science (Geography) degree and has three years of practical knowledge in spatial analysis, digital mapping and graphic rendering, and applies this knowledge in various scientific fields and disciplines. His GIS expertise are utilised in specialist contributions to Environmental Impact Assessments, State of the Environment Reports and Environmental Management Plans.

Savannah Environmental (Pty) Ltd appointed MetroGIS (Pty) Ltd as an independent specialist consultant for the visual assessment. Neither the author, nor MetroGIS will benefit from the outcome of the project decision-making.

1. Introduction and Background

Eskom Holdings Limited intends to upgrade the existing Verwoerdburg substation in the Rietvlei area and construct two 400kV loop-in power lines of approximately 4km in length that connect the existing Apollo-Pluto transmission line with the Verwoerdburg substation.

The study area for the Apollo-Verwoerdburg line lies immediately south of Centurion (Tshwane Municipality) and is adjacent to the Rietvlei Dam Nature Reserve. Major roads in the area include the R21, M18, and M57 running north-south roughly through the middle, The Olifantspruit River and some of its tributaries account for the most prominent hydrological features of the area flowing roughly south to north through the middle of the study area. Land uses include mostly agricultural holdings. The topography of the area is described as undulating hills.

The natural landcover has been extensively altered by urbanisation and agriculture over most of the study area. However, the Rietvlei Nature Reserves and other smaller protected areas are found either within or in close proximity to the proposed Tshwane strengthening Project Phase 1.

2. Scope of Work

The scope of work includes the determination of the potential visual impacts in terms of nature, extent, duration, magnitude, probability and significance of the proposed infrastructure. In this regard specific issues related to the visual impact were identified during a site visit to the affected environment. Issues related to the proposed Apollo-Verwoerdburg Transmission Line Project include:

- Visual distance/observer proximity to the proposed infrastructure (apply the principle of reduced impact over distance)
- Viewer incidence/viewer perception (identify areas with high viewer incidence and negative viewer perception)
- Landscape character/land use character (identify conflict areas in terms of existing and proposed land use)
- Visually sensitive features (scenic features or attractions)
- General visual quality of the affected area
- Visual absorption capacity of the natural vegetation
- Potential mitigation measures

3. Alignment Alternatives

Two alternatives have been carried over from the scoping phase as well as an additional alternative suggested by specialists during the site visit. The locality map below details these proposed alignments.

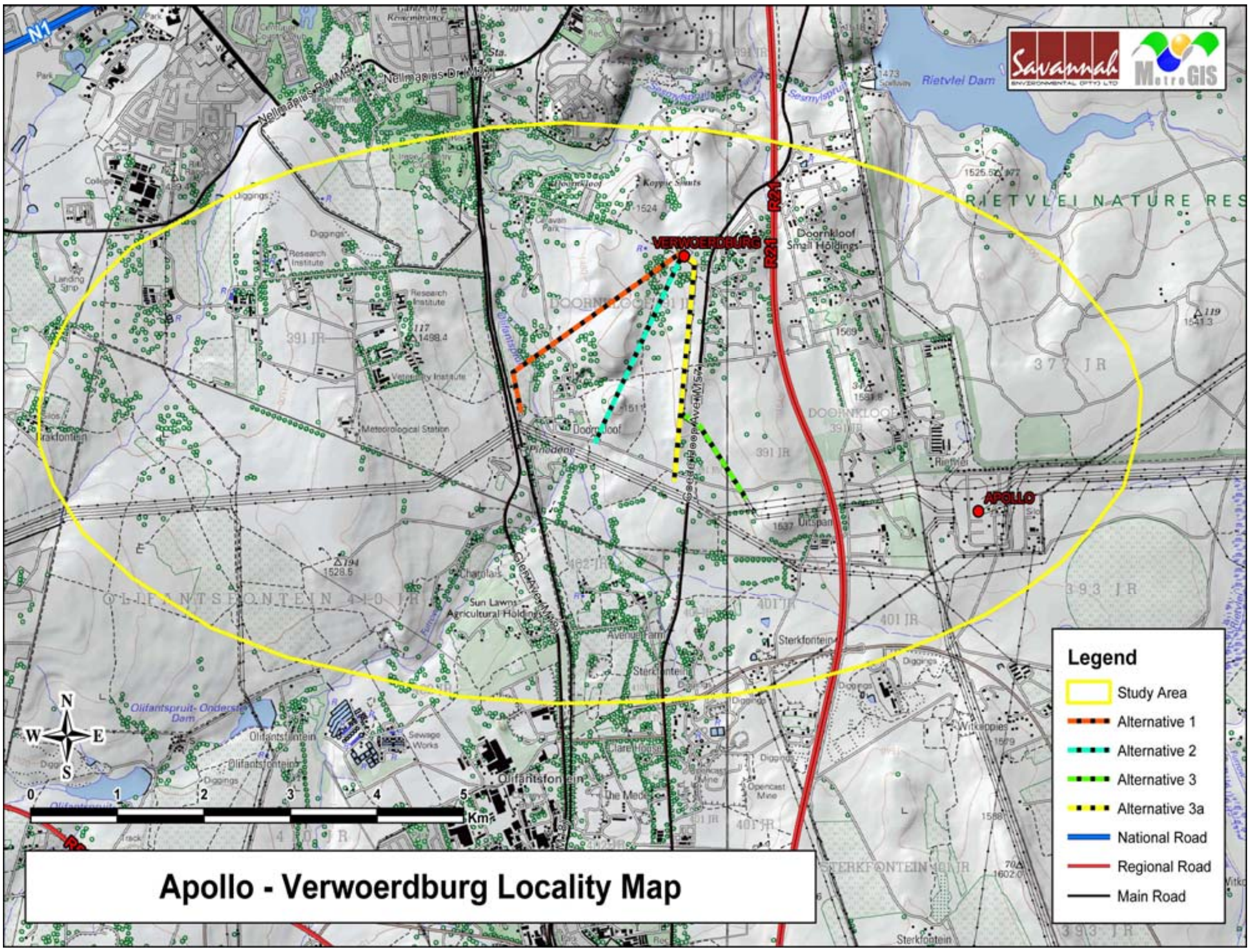

Figure 1. Apollo-Verwoerdberg Locality Map

3.1 Description of Affected Environment

Most of the land within the study area for the Apollo-Verwoerdberg alignment has been either permanently altered by agriculture or is degraded due to urban encroachment in the region with the exception of the Rietvlei Nature Reserve to the east. Most of the area is covered by agricultural holdings and no major industrial centres occur within the study area, although the Clayville Industrial area is not far to the south. Existing power lines traverse the area substantially due to the proximity and size of the Apollo substation, and already extensively mar the essential visual quality of the landscape.

3.2 Description of Issues Identified in the Scoping Phase

The preliminary viewshed analyses done (on a DTM generated from 20m interval contours) for the Scoping Phase established that there was little difference in visual exposure between the original two proposed alternatives as the length of each was comparatively short. The third suggested alignment would be modelled in the EIA phase using an identical methodology to the original two options. Visual receptors are sparse with the exception of the increased visual incidence frequency associated with the R21 main road. The issues this raised in the scoping phase were as follows:

- Visual receptors from **main roads**.
- Visual receptors from surrounding **residential areas**.
- Cumulative impact of the Verwoerdburg **substation upgrade**.

3.3 Methodology

3.3.1 General

The study was undertaken using Geographic Information Systems (GIS) software as a tool to generate viewshed analyses and to apply relevant spatial criteria to the proposed infrastructure. A detailed Digital Terrain Model (DTM) for the study area was created from 5m interval contours supplied by the Surveyor General.

Site visits were undertaken to source information regarding land use, vegetation cover, topography and general visual quality of the affected environment. It further served the purpose of verifying the results of the spatial analyses and to identify other possible mitigating/aggravating circumstances related to the potential visual impact.

The methodology utilised to identify issues related to the visual impact included the following activities:

- The creation of a detailed digital terrain model of the potentially affected environment.
- The sourcing of relevant spatial data. This included cadastral features, vegetation types, land use activities, topographical features, site placement, etc.
- The identification of sensitive environments upon which the proposed infrastructure could have a potential impact.
- The creation of viewshed analyses from the proposed development area in order to determine the visual exposure and the topography's potential to absorb the potential visual impact. The viewshed analyses take into account the dimensions of the proposed structures.

3.3.2 Potential visual exposure

The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed infrastructure, or evidence thereof, weren't visible, no impact would occur.

Viewshed analyses of the proposed infrastructure, based on a 20m contour interval (or 5m if available) digital terrain model of the study area, indicate the potential visual exposure (i.e. areas from where the infrastructure could theoretically be visible). The visibility analyses are undertaken at an offset of 20m above average ground level for the substation and at 33m for the transmission line alternatives in order to simulate a worst-case scenario. The viewshed analyses do not include the visual absorption capacity of natural vegetation in the study area. The visual absorption capacity of the vegetation is, however, addressed as a separate issue within this report and does form part of the visual impact assessment criteria.

As the viewshed analyses done for the scoping phase report indicating potential visual exposure form a component of the overall sensitivity analyses presented in section 4 of this report, the results are not duplicated here.

3.3.3 Visual Sensitivity Analysis

The sensitivity analysis comprises an indexed combination of three different data sets. Firstly, the landuse dataset for the study area is either acquired from an external source or captured from aerial photography or satellite imagery. Landuse types are then categorised and subcategorised depending on visual sensitivity and assigned an index value accordingly. A suitable range of proximity buffers from each alternative is also generated and assigned a similar index value since visual impact decreases with increasing distance. The landuse index is combined with the proximity index to give an overall sensitivity value, which then indicates areas where high sensitivity landuses coincide with the areas of high visual impact. Areas where the features are not visible are then clipped out using the viewshed analysis since no visual impact will occur where the features are not visible. This methodology models any potential visual receptor standing anywhere in the study area and provides a broader estimate of the potential visual intrusion rather than picking out each individual visual receptor and estimating sensitivity for each.

3.4 Assumptions

It is understood that the type of tower structure used will vary depending on what type of terrain the alignment traverses, implying that different types may be used on the same alignment. The tower types available range in height from between 30m and 36m above ground level. For the purposes of the viewshed analyses this difference is negligible so an average of 33m was used in all analyses.

4. Findings and Implications

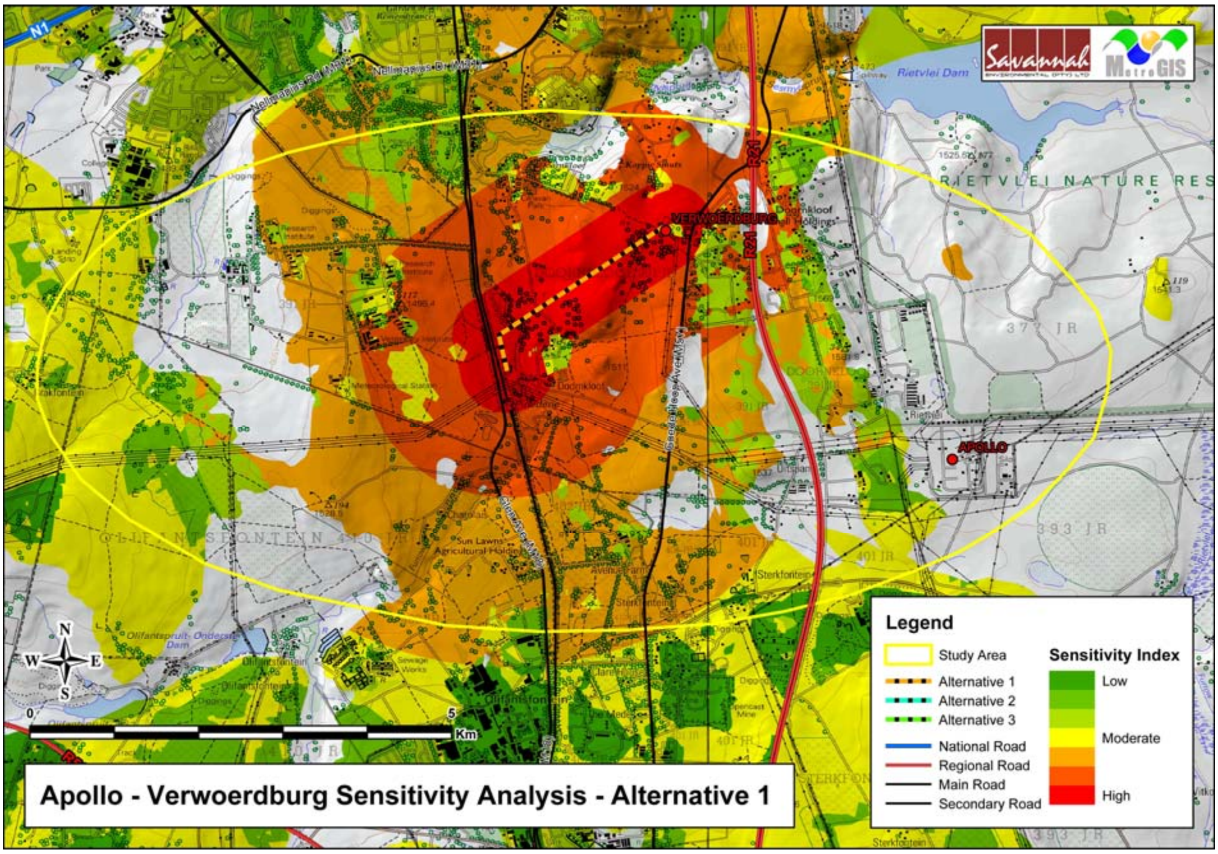

Figure 2. Sensitivity Index of Alternative 1

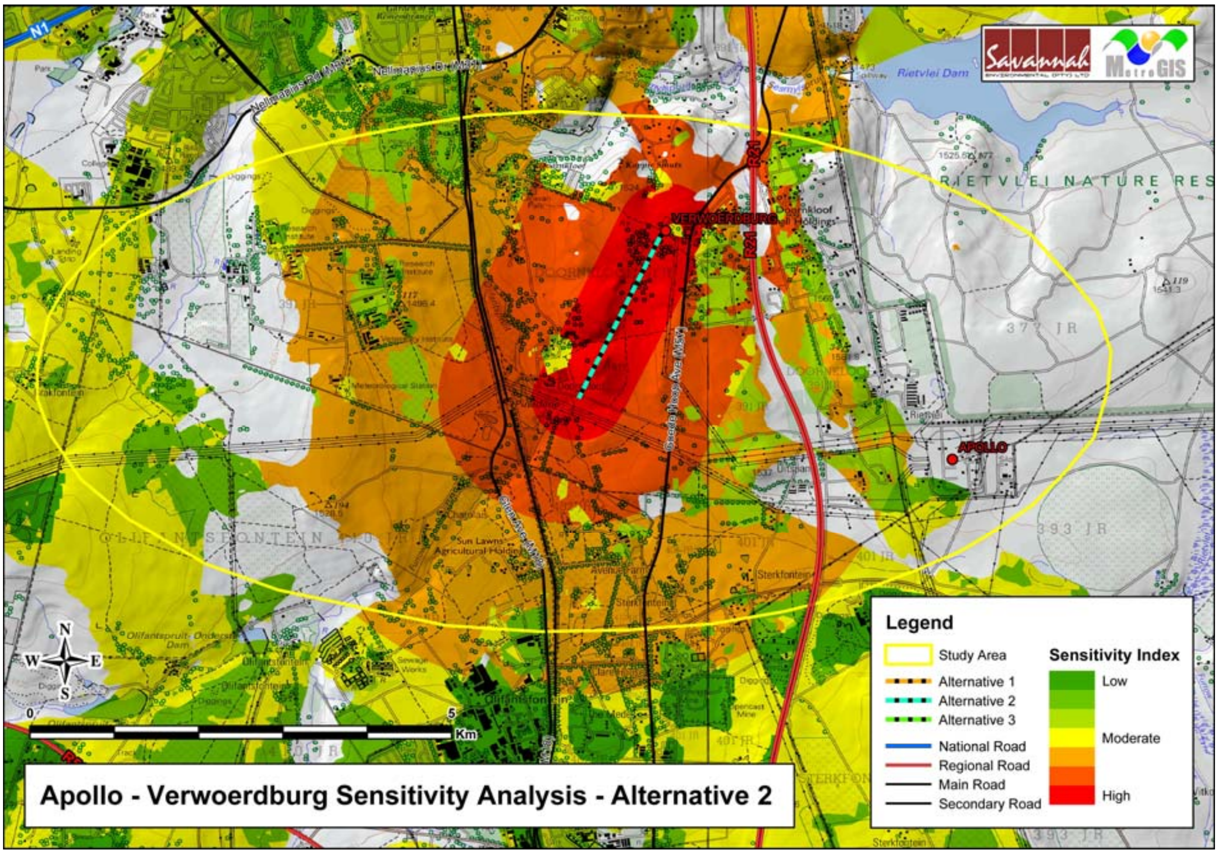

Figure 3. Sensitivity Index of Alternative 2

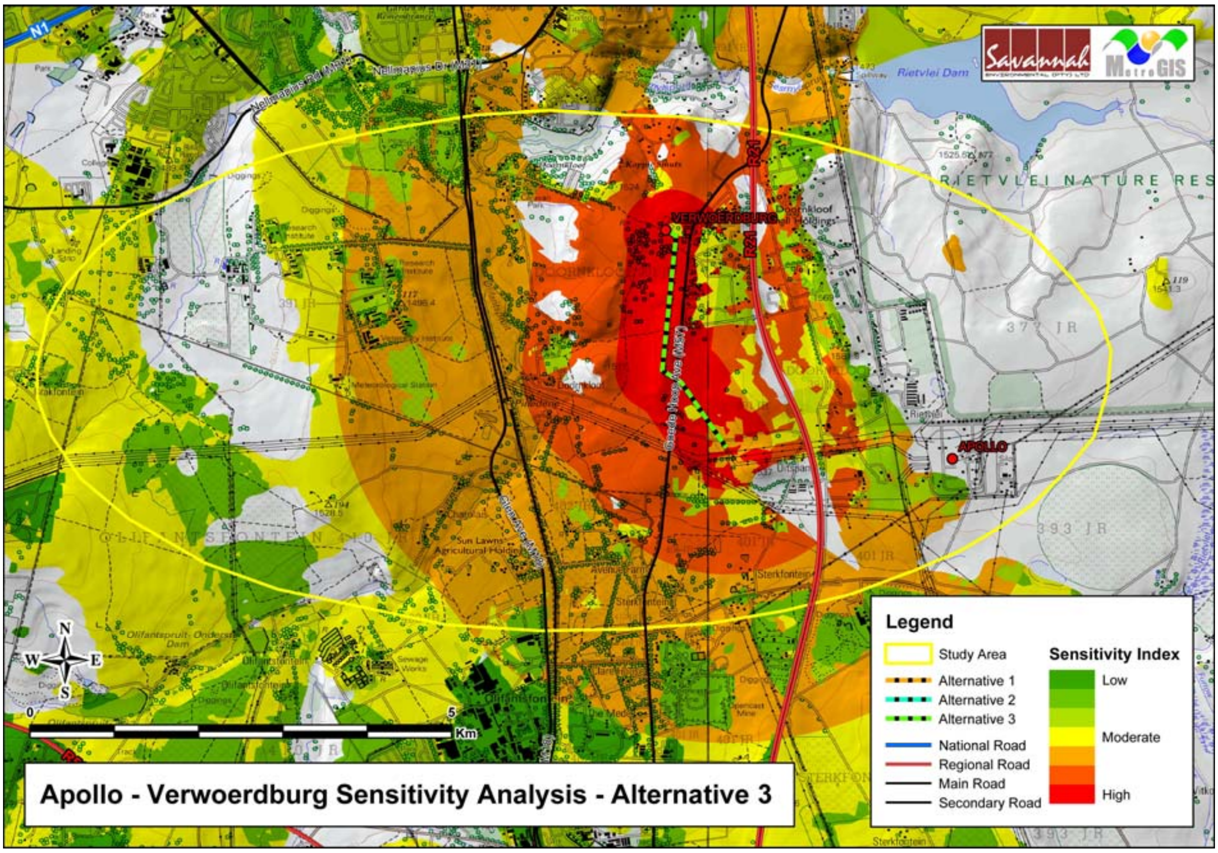

Figure 4. Sensitivity Index of Alternative 3

From the above sensitivity analyses, it a clear difference in visual impact of the three alternatives is not obviously apparent. The area calculation (in hectares) below gives a numerical value, and thus a quantifiable value, to compare sensitivities.

Sens Index	Alternative 1	Alternative 2	Alternative 3
Low	1766.34	1818.91	1609.73
	1662.89	1945.98	2580.56
	4039.19	4032.64	3987.25
Moderate	7068.87	7001.21	7659.15
	2011.92	2124.23	2283.96
	844.78	796.31	729.07
High	325.68	286.88	297.77

Table 1. Comparative Sensitivity Category Area Calculations

From the above table, it is clear that there is only a marginal difference in area covered by each sensitivity category. If the highest and second highest categories are merged to represent where the alignment would have the greatest impact, i.e. in relatively close proximity in areas considered visually sensitive, **alternative 3** (1026.84 ha) **is preferred** on the basis of least overall area of high impact, followed by alternative 2 (1083.19 ha) and alternative 1 (1170.46 ha). Alternative 3 would also be preferable because it follows a path adjacent to an existing power line, thus reducing the cumulative impact caused by adding to an exiting impact. It should be noted, however, that there are no fatal flaws from a visual impact standpoint.

There is no comparative study for the substation upgrades since no information on alternatives was available. It is expected that the upgrades are largely governed by site-specific technical constraints of the substation layout.

5. Significance

The methodology for the assessment of potential visual impacts states the **nature** of the potential visual impact (e.g. the visual impact on users of major roads in the vicinity of the proposed alignments) and includes a table quantifying the potential visual impact according to the following criteria:

- **Extent** - site only (very high = 5), local (high = 4), regional (medium = 3), national (low = 2) or international (very low = 1)
- **Duration** - very short (0-1 yrs = 1), short (2-5 yrs = 2), medium (5-15 yrs = 3), long (>15 yrs = 4), and permanent (= 5)
- **Magnitude** - None (= 0), minor (= 1), low (= 2), medium/moderate (= 3), high (= 4) and very high (= 5)
- **Probability** - none (= 0), improbable (= 1), low probability (= 2), medium probability (= 3), high probability (= 4) and definite (= 5)
- **Status** (positive, negative or neutral)
- **Reversibility** - reversible (= 1), recoverable (= 3) and irreversible (= 5)
- **Significance** - low, medium or high.

The **significance** of the potential visual impact is equal to the **consequence** multiplied by the **probability** of the impact occurring, where the consequence is determined by the sum of the individual scores for magnitude, reversibility, duration and extent (i.e. **significance = consequence (magnitude + reversibility + duration + extent) x probability**).

The significance weighting for each potential visual impact (as calculated above) is as follows:

- <30 points: Low (where the impact would not have a direct influence on the decision to develop in the area)

- 31-60 points: Medium/moderate (where the impact could influence the decision to develop in the area)
- >60: High (where the impact must have an influence on the decision to develop in the area)

Please note that due to the declining visual impact over distance, the ***extent*** *(or spatial scale) rating is reversed (i.e. a localized visual impact has a higher value rating than a national or regional value rating). This implies that the visual impact is highly unlikely to have a national or international extent, but that the local or site-specific impact could be of high significance.*

Table 2. Impact table summarising the significance of visual impacts to the **main roads**

Nature of Impact: Potential visual impact on users of these roads			
	Alignment 1	Alignment 2	Alignment 3
Extent	Local **(4)**	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**	Long term **(4)**
Magnitude	Minor **(1)**	Minor **(1)**	Minor **(1)**
Probability	High **(4)**	High **(4)**	High **(4)**
Significance	Moderate **(48)**	Moderate **(48)**	Moderate **(48)**
Status (positive or negative)	Negative	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No	No
Can impacts be mitigated during operational phase?	No	No	No
Mitigation: Mitigation is not possible.			
Cumulative impacts: The construction of numerous towers will increase the cumulative visual impact of existing power lines that traverse the study area.			
Residual impacts: N.A.			

Table 3. Impact table summarising the significance of visual impacts to **residential areas**

Nature of Impact: Potential visual impact on receptors within residential areas			
	Alignment 1	Alignment 2	Alignment 3
Extent	Local **(4)**	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**	Long term **(4)**
Magnitude	Low **(2)**	Low **(2)**	Low **(2)**
Probability	High **(4)**	High **(4)**	High **(4)**
Significance	Moderate **(52)**	Moderate **(52)**	Moderate **(52)**
Status (positive or negative)	Negative	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No	No
Can impacts be mitigated during operational phase?	No	No	No
Mitigation: Mitigation is not possible.			
Cumulative impacts: The construction of numerous towers will increase the cumulative visual impact of existing power lines that traverse the study area.			
Residual impacts: N.A.			

Table 4. Impact table summarising the significance of visual impacts to the **substation upgrade.**

Nature of Impact: Potential visual impact from the Verwoerdberg substation upgrade			
	Alignment 1	Alignment 2	Alignment 3
Extent	Local **(4)**	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**	Long term **(4)**
Magnitude	Minor **(1)**	Minor **(1)**	Minor **(1)**
Probability	High **(4)**	High **(4)**	High **(4)**
Significance	Moderate **(48)**	Moderate **(48)**	Moderate **(48)**
Status (positive or negative)	Negative	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No	No
Can impacts be mitigated during operational phase?	No	No	No
Mitigation: The possible increase of the substation footprint might present new visual impacts. Since the infrastructure is not expected to be taller than a single storey, tree line planting can be effectively used to screen the substation upgrades.			
Cumulative impacts: The possible widening of the substation footprint will increase the cumulative visual impact of existing substation.			
Residual impacts: N.A.			

6. Mitigation

Power line towers are the most visually intrusive features of a transmission line that are numerous and traverse long distances. Visual obstruction from intervening topography or vegetation is incidental and varies hugely depending on the landscape. This means that the visual intrusion of power lines cannot be effectively mitigated.

Should the substation upgrade constitute an increase in the footprint and thus a potential new visual impact, the common practise of planting a tree line of the species naturally found in the area should prove an effective screen and contribute greatly to visual absorption. These measures would probably be best implemented on a case-by-case basis for individual visual receptors if the substation upgrade presents a new visual impact over and above the existing impact of the Verwoerdburg substation.

7. Conclusions and Recommendations

The construction of power line and substation infrastructure in areas with potentially conflicting land uses will always be problematic from a visual impact point of view.

The visual impact of a 400kV transmission line is definite, long-term, and not given to effective mitigation, but is otherwise entirely limited to the local context. The results of the sensitivity analyses indicate that the **preferred alignment is Alternative 3** based on total area of high visual impact and cumulative impact of existing power lines, although there are no fatal flaws eliminating any alternatives.

The upgrade to the Verwoerdburg substation is not likely to cause a major change in the landscape, if at all. However, should there be an increase in the footprint area to an extent that presents a significantly new visual impact, mitigation in the form of visual absorption from planted tree lines is usually an effective and relatively cheap method of offsetting this negative visual impact.

8. Management Plan

The management plan table aims to summarise the key findings of the visual impact report and to suggest possible management actions in order to mitigate the potential visual impacts.

Table 5: Management plan - 400kV transmission power lines

OBJECTIVE: The mitigation of potential visual impacts caused by the unnecessary removal (clearing) of vegetation cover for the power line servitude or the creation of new access roads during the construction phase.

Project component/s	Transmission line servitudes.
Potential Impact	The potential scarring of the landscape due to the creation of cleared cut-lines and new roads/tracks, especially where the servitudes traverse elevated topographical features with natural vegetation.
Activity/risk source	The viewing of the abovementioned cutlines/roads by observers.
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity of the proposed transmission lines.

Mitigation: Action/control	Responsibility	Timeframe
Avoid the unnecessary removal of vegetation for the power line servitudes and limit access to the servitude (during both construction and operational phases) along existing access roads.	Contractor/Eskom	Construction/operation.
Utilise existing power line servitudes where possible.	Contractor/Eskom	Construction/operation.

Performance Indicator	Vegetation cover that remains intact with no visible cutlines, access roads or erosion scarring in and around the power line servitudes.
Monitoring	The monitoring of vegetation clearing during the construction and operational phases of the project.

Table 6: Management plan – Substation upgrades

OBJECTIVE: The mitigation of potential visual impacts caused by an expanded footprint area and associated removal (clearing) of vegetation cover.

Project component/s	Substation upgrades
Potential Impact	The potential removal of existing vegetation to accommodate an enlarged substation footprint area and resultant loss of visual

	absorption capacity.
Activity/risk source	The viewing of the Verwoerdburg substation by observers.
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity of the substation.

Mitigation: Action/control	Responsibility	Timeframe
Avoid the unnecessary removal of vegetation and/or plant new screening vegetation where possible.	Contractor/Eskom	Construction/operation.

Performance Indicator	Vegetation cover that remains intact around the substation perimeter and effectiveness of new vegetation (where necessary) used for screening.
Monitoring	The monitoring of vegetation clearing during the construction and operational phases of the project.