Proposed Tshwane Strengthening Project – Phase 1

400kV Transmission Power Lines between the Kwagga and Phoebus Substations

Visual Impact Assessment

Draft EIR (EIA reference number 12/12/20/1471)

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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 (with specialization in 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 connect the Kwagga substation in the Atteridgeville area with the proposed Phoebus substation in the Shoshanguve area with a 400kV power line. This report aims to address issues related to the visual impact of the infrastructure required for this power line.

The study area for the Kwagga-Phoebus line stretches from Kwaggasrand in the south to some parts of Shoshanguve in the north and Ga-Rankuwa in the west. There are many arterial routes running the length and breadth of this study area as indicated on the locality map in Figure 1. Due to the size of the study area and proximity to the City of Pretoria, the land uses include many varied types including protected natural environments, heavy industrial zones, agricultural holdings, and high-density residential zones. Prominent hydrological features include the Skinnerspruit in the south and the Sand River with many tributaries in the west and northwest. Prominent geological features include the Daspoortrand ridge and the Magaliesberg to the south. The topography of the area is described as gentle plains in the north with distinct ridges in the south.

The natural landcover has been extensively altered by urbanisation and agriculture over most of the study area. However, significant Nature Reserves and other protected areas are found either within or in very 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 Kwagga-Phoebus 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

Three alternatives have been carried over from the scoping phase. The locality map below details these proposed alignments.

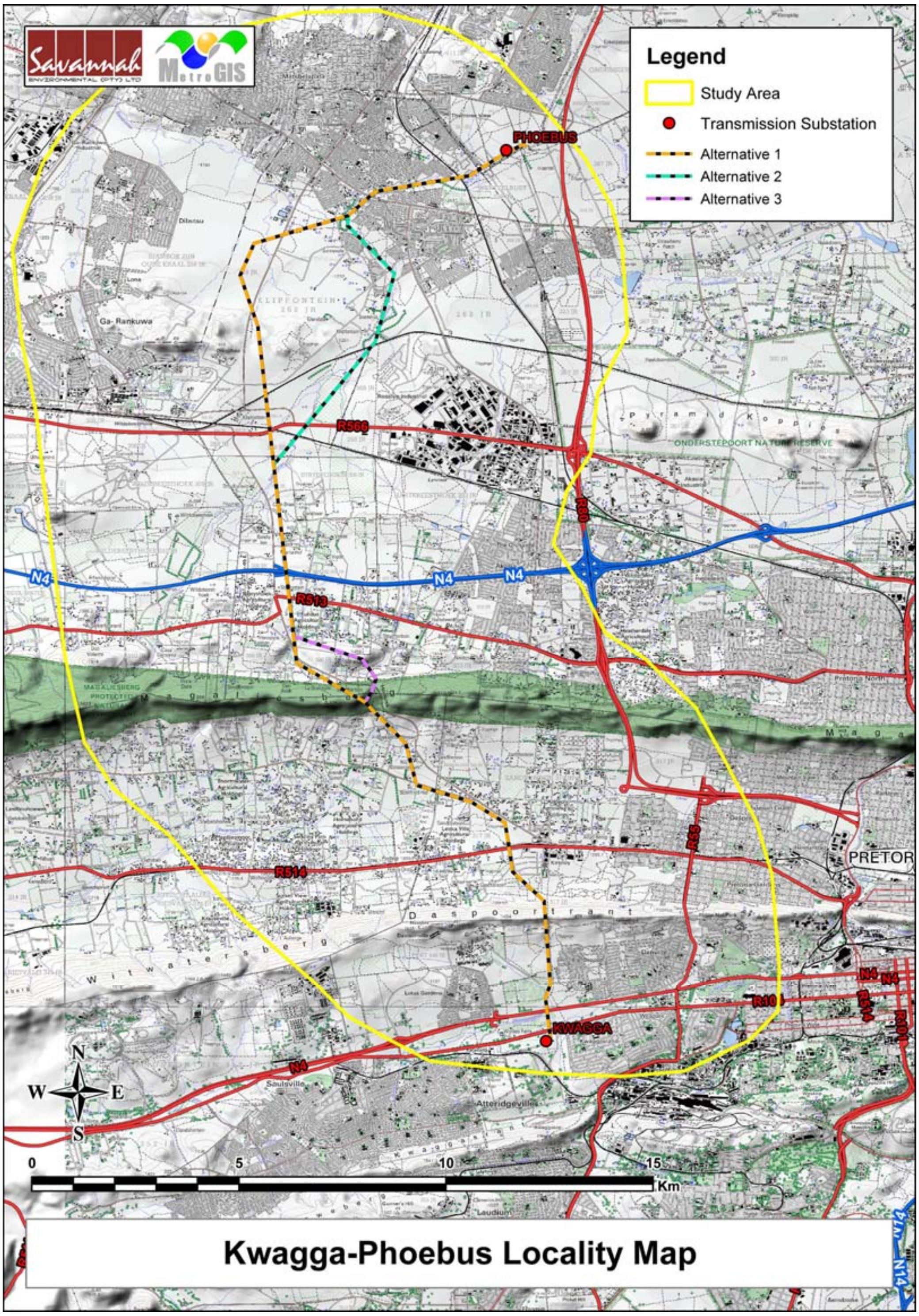

Figure 1. Kwagga-Phoebus Locality Map

3.1 Description of Affected Environment

Most of the land within the study area for the Kwagga-Phoebus alignment has been permanently altered by extensive urbanisation in the region. Although most of the area is covered by residential areas or agricultural holdings, one heavy industrial zone, Rosslyn, falls entirely within the study area. Of potentially crucial environmental importance is the area where all alignments cross the Magaliesberg Protected Natural Environment (MPNE). Some form of visual impact in this area is inevitable, but existing power lines in the area already mar the essential visual quality of the MPNE.

Figure 2. View approximately 8km north of MPNE, looking south.

Figure 3. View from Hornsnek road (M17) within MPNE, looking south.

3.2 Description of Issues Identified in the Scoping Phase

The preliminary viewshed analyses done for the Scoping Phase established that there was minimal difference in visual exposure between the three proposed alternatives largely due to much of the length of the paths being common to all three. Visual receptors were most likely distributed across the entire study area but the only potentially highly sensitive receptors would occur on the prominent ridges in the area, namely, the Magaliesberg and Daspoortrand ridges, although only the Magaliesberg ridge has been declared a protected natural environment (the **MPNE**). It was recommended that a higher resolution viewshed and sensitivity analysis be done to ensure a more thorough study of visual impact.

An increased frequency of visual receptors would occur where the proposed alignments cross or are in close proximity to **main arterial roads**. Within the study area, these were identified as the N4, the R513, the R514, and the R566.

All three alignment options traverse significantly large areas of **residential** zones and/or agricultural holdings. The wider area and less frequent visual incidence necessitates a different assessment of these receptors although the impact is expected to be roughly similar throughout the study area depending on proximity to the actual power line towers.

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 were undertaken at an offset of 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

Below are the results of the sensitivity analysis done for each alignment alternatives.

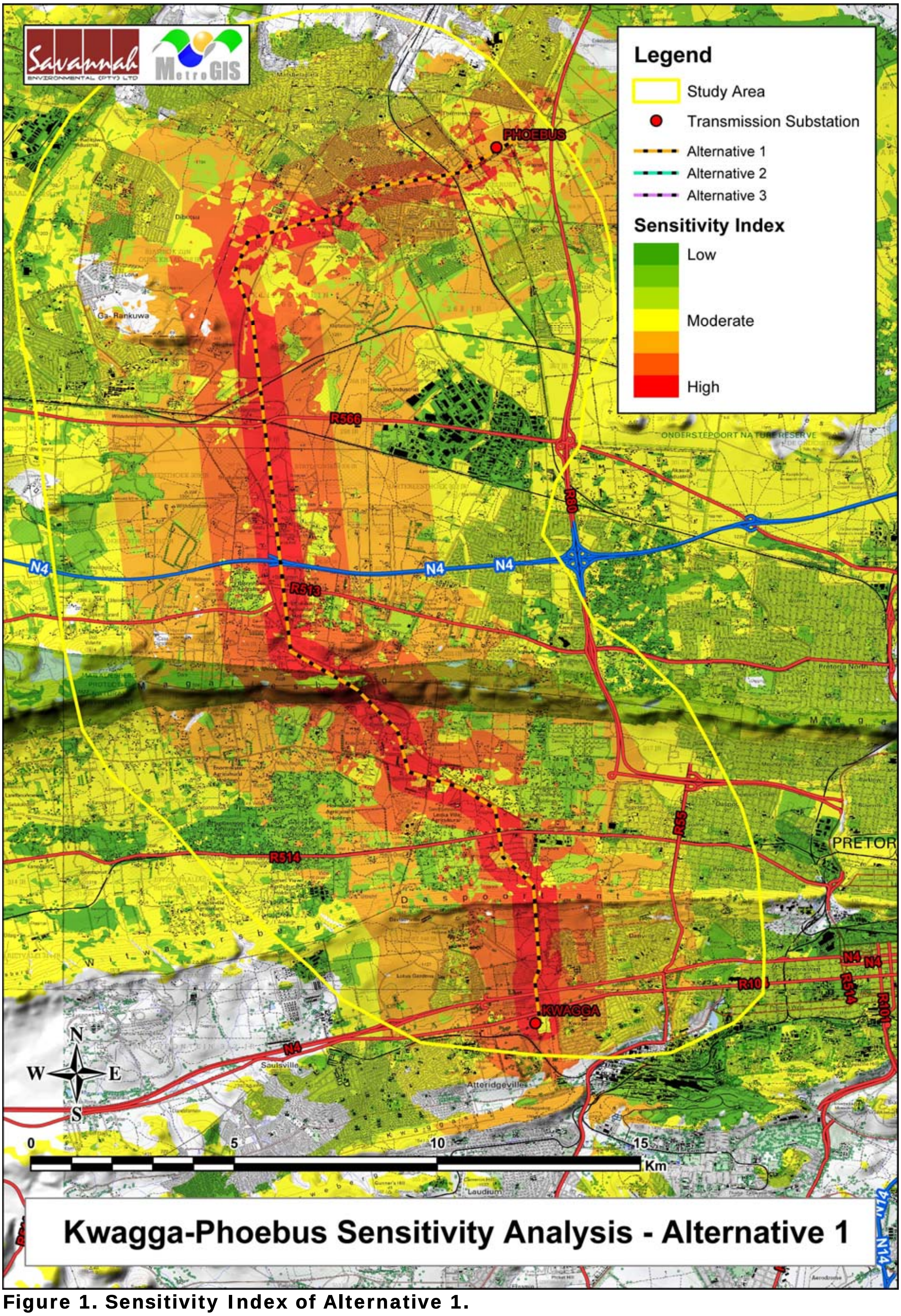

Figure 1. Sensitivity Index of Alternative 1.

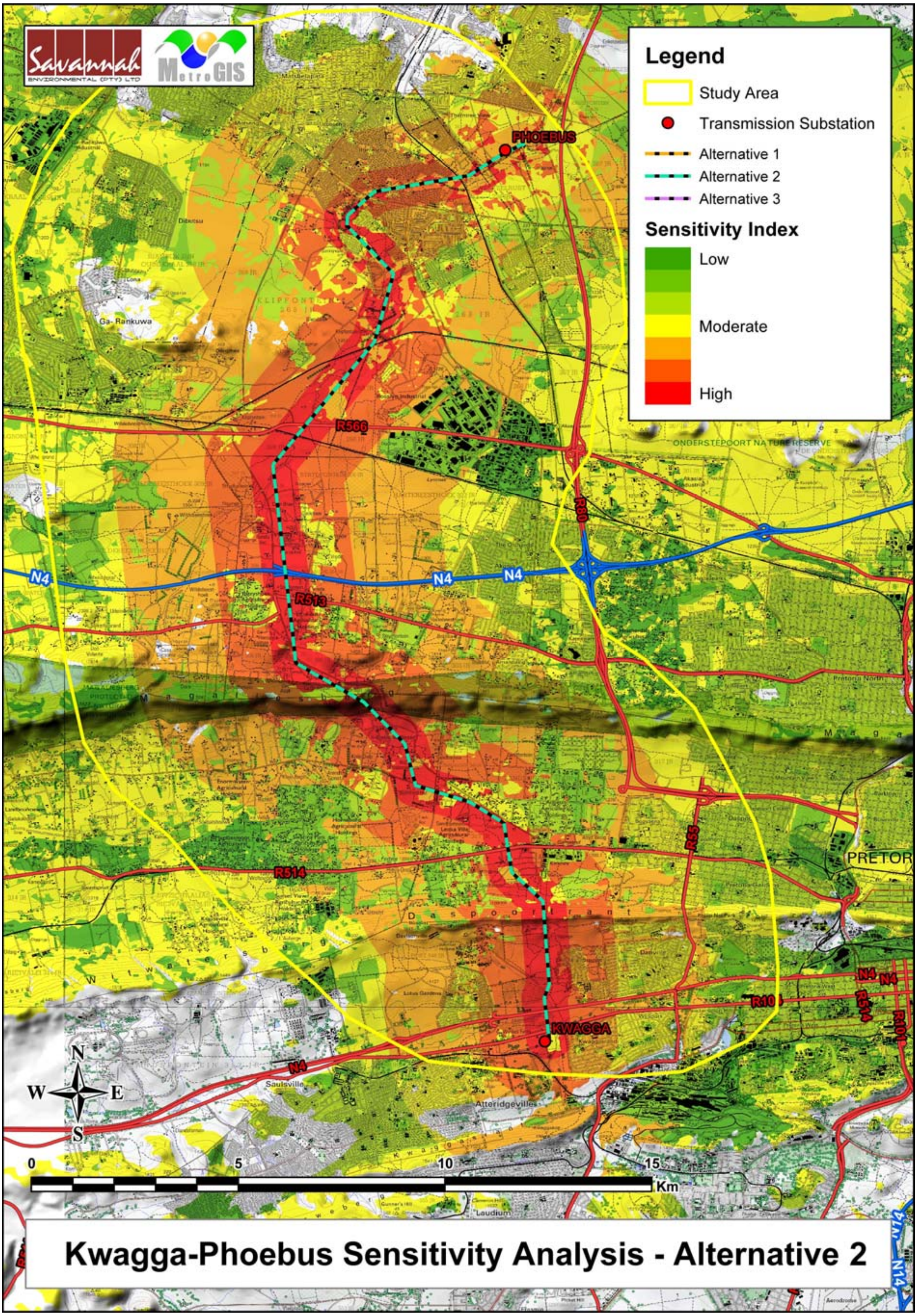

Figure 2. Sensitivity Index of Aligment 2.

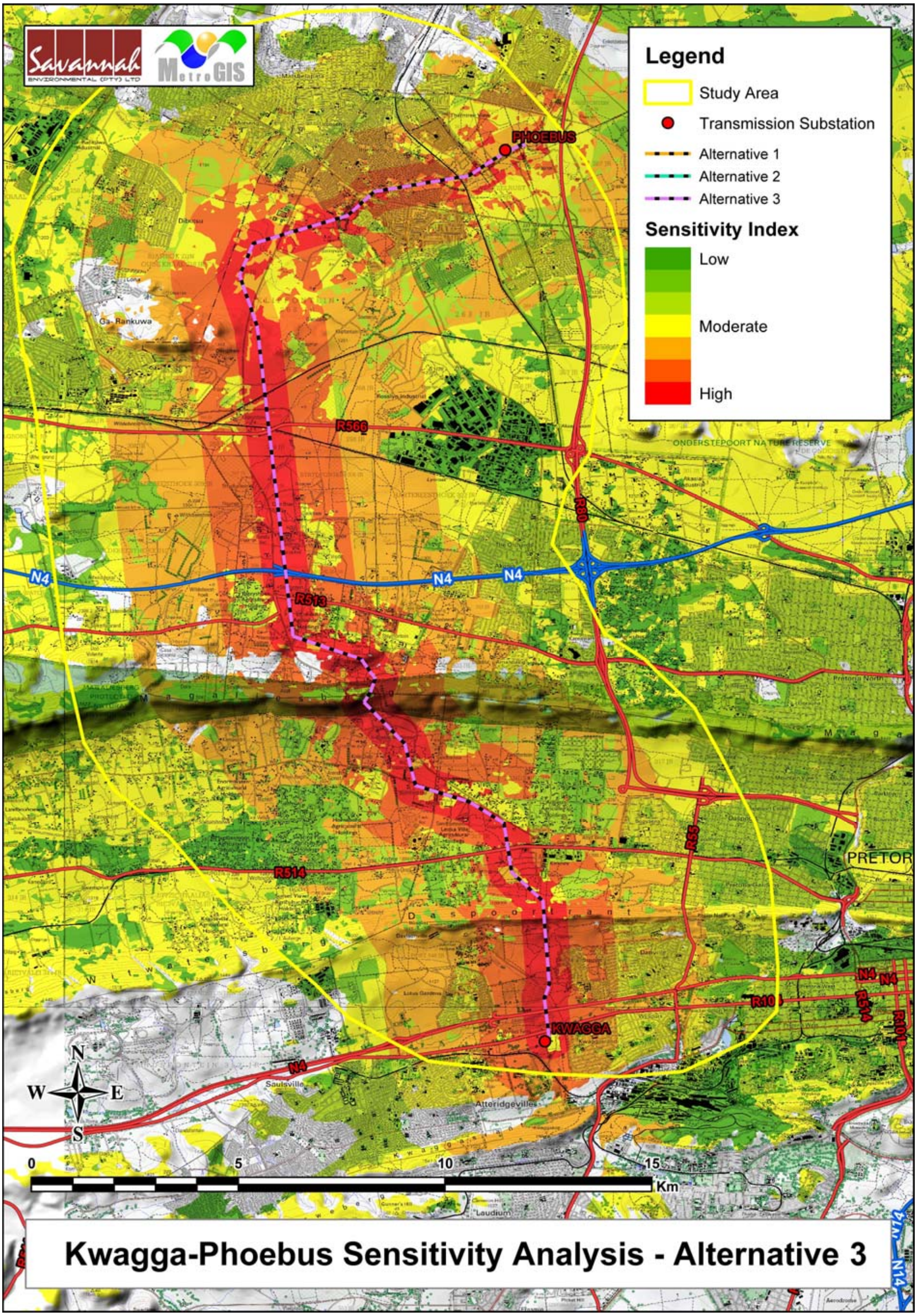

Figure 3. Sensitivity Index of Alignment 3

From the above sensitivity analyses, it is clear that the difference in visual impact of the three alternatives is marginal due to the relative flatness of the topography and commonality of paths. The alternatives may thus be considered equally in terms of visual exposure and significance. The fact that all proposed alignments impact unavoidably on a declared protected natural environment necessitates that the **"Do Nothing"** option is preferred, although there are no fatal flaws from a visual impact standpoint. The area calculation (in hectares) below gives a numerical value, and thus a quantifiable value, to compare sensitivities.

Table 1. Comparative Impact Category Area Calculations

Sens Index	Alternative 1	Alternative 2	Alternative 3
Low	12 547.38	11 601.08	11 798.38
	11 839.97	11 217.53	10 744.70
	19 368.23	19 066.59	17 488.65
Moderate	45 673.92	43 983.47	41 712.57
	8 055.21	8 042.62	7 845.81
	3 788.20	3 771.03	3 698.30
High	2 148.52	2 042.61	2 164.11

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 2 (5813.64 ha) would have been preferred on the basis of least overall area of high impact, followed by alternative 3 (5862.61 ha) and alternative 1 (5936.72 ha). However, **alternative 3 is preferred** on the basis that it is the deviation that follows an existing power line that already crosses the MPNE, thus confining the cumulative impact with existing power lines to one area.

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 **MPNE**

Nature of Impact: Potential visual impact on receptors within the MPNE			
	Alignment 1	Alignment 2	Alignment 3
Extent	Local **(4)**	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**	Long term **(4)**
Magnitude	Moderate **(3)**	Moderate **(3)**	Moderate **(3)**
Probability	High **(4)**	High **(4)**	High **(4)**
Significance	Moderate **(56)**	Moderate **(56)**	Moderate **(56)**
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 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 4. Impact table summarising the significance of visual impacts to the **residential zones**

Nature of Impact: Potential visual impact on receptors within these 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.			

Note: The Magaliesberg Protected Natural Environment
Although it is preferable for a new proposal to be placed adjacent to a structure of similar impact to minimize cumulative impacts by concentrating additional impacts to one place, the fact that the proposed Kwagga-Phoebus alignments traverse an area declared as protected should be given special attention. From a visual standpoint, the MPNE cannot be considered a fatal flaw to the project as a new transmission line would not prevent the continued functioning of the area as a protected environment. However, the nature of the project does run directly contrary to the purpose of the MPNE. Any infrastructure development within its boundaries would conflict with and contribute to undermining its continued status as a protected natural environment.

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 effectively be mitigated.

7. Conclusions and Recommendations

The construction of power line and substation infrastructure in natural areas with potential 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 fact that all proposed alignments of the Kwagga-Phoebus section of the Tshwane Strengthening Project Phase 1 impact unavoidably on a declared protected natural environment necessitates that the **"Do Nothing"** option be preferred, although there are no fatal flaws as the development would not cause a cessation of existing processes or functions. The marginal difference in total area calculated of high impact for each alternative indicates that alternative 2 has the lowest total, but since the deviation in **alternative 3** follows an existing power line that already crosses the MPNE, the cumulative impact is confined to one area within the most visually sensitive area, it is thus preferred above alternative 1 or 2.

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 potential visual impacts.

Table 15: 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.

Proposed Tshwane Strengthening Project – Phase 1

Kwagga Substation Expansion and Phoebus Substation Establishment

Visual Impact Assessment

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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 Kwagga substation in the Atteridgeville area and construct a new substation adjacent to the Hangklip substation in the Ga-Rankuwa area as a concurrent development to the construction of a 400kV transmission power line connecting the two substations. This report aims to address issues of visual impact relating only to the two substations.

The study areas encompass the immediate area within approximately 5km of each substation. For the Kwagga substation this extends from the Daspoortrant in the north to the Kwaggasrant in the south, and Atteridgeville in the west to Proclamation Hill in the east. For the proposed Pheobus substation this extends from Soshanguve in the north to Rendstephine in the south, and from Itumeleng in the west to parts of the Ondertepoort Agricultural Holdings in the east. The natural landcover has been extensively altered by urbanisation and agriculture over most of both study areas.

In the Kwagga study area, notable main roads include the N4 and the R104. Notable hydrological features include the Skinnerspruit (perennial) in close proximity to the north.

In the Phoebus study area, the only notable main road is the R80. Notable hydrological features include the Kaalplaasspruit (perennial) in the south and the Metsi Metsuane (non-perenial) in the east.

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 substation upgrades and construction 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. Alternatives

It is assumed that both the Kwagga substation upgrade and the new Phoebus substation have sufficient space at their respective sites to encompass the proposed developments and not conflict with existing landuse. Separate alternatives have thus not been suggested and it is also assumed that the substation layout is largely governed by technical constraints.

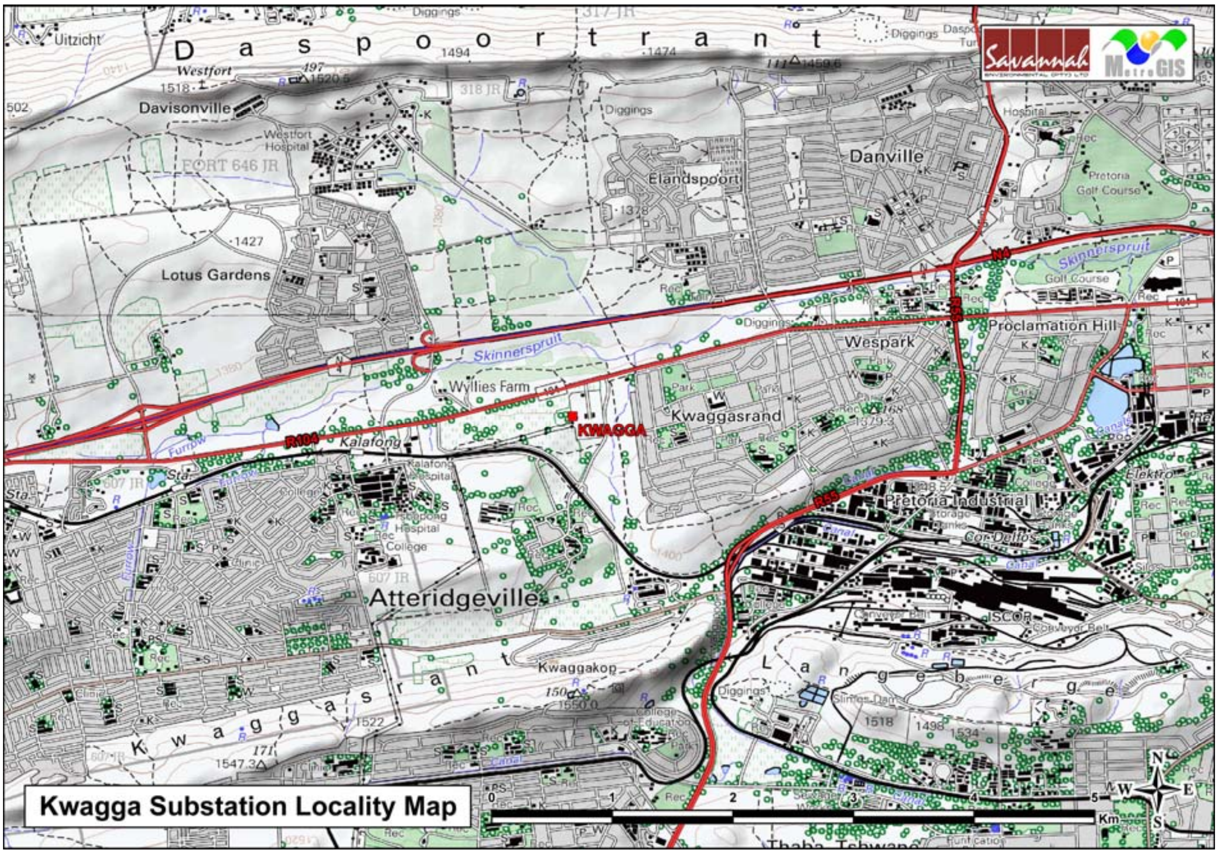

Figure 1. Kwagga Substation Locality Map

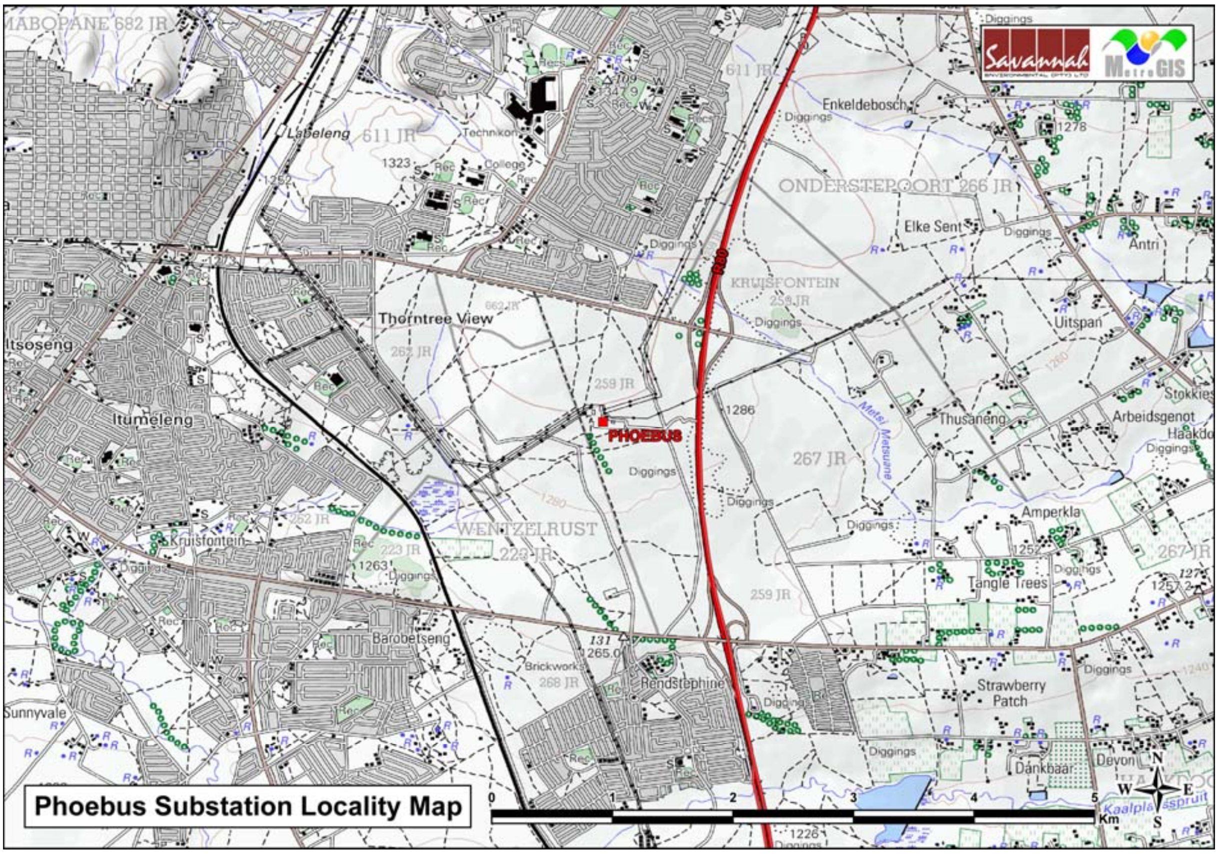

Figure 2. Phoebus Substation Locality Map

3.1 Description of Affected Environment

Most of the land in both study areas has been permanently altered by extensive urbanisation and/or agriculture. Although most of the area is covered by residential areas or agricultural holdings one heavy industrial zone, Pretoria Industrial, falls entirely within the Kwagga substation study area. Several unoccupied open spaces also occur in the vicinity of both the Phoebus and Kwagga substations.

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 almost no difference in visual exposure between the existing Phoebus substation and the new extension. A more detailed analysis using a DTM generated from a 5m contours interval dataset would not likely yield different results, but would suffice to determine this beyond doubt. The issues thus raised in the scoping phase were as follows:

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

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 (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 were undertaken at an offset of 25m above ground level (the typical height of communications mast) in order to simulate a worst-case scenario of the tallest structure of a power substation. 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.

3.4 Assumptions

It is understood that the footprint of the Kwagga substation upgrade will not be sufficient to warrant a dramatically increased impact on the existing impact that the substation already presents upon the landscape. Furthermore, it is expected that the impact of the upgraded infrastructure would be entirely overshadowed by the cumulative impact of existing substation together with the turn-in sections of the new transmission lines (addressed in a separate report of the Tshwane Strengthening Project Phase 1) as the 400kV towers are significantly taller than any of the substation infrastructure and would present a much wider ranging visual exposure that cannot be effectively mitigated.

At the time of writing, no layout plans were available for the proposed Phoebus substation but a general footprint was available and deemed sufficient to generate a “worst-case” viewshed analysis while maintaining plausible accuracy.

4. Findings and Implications

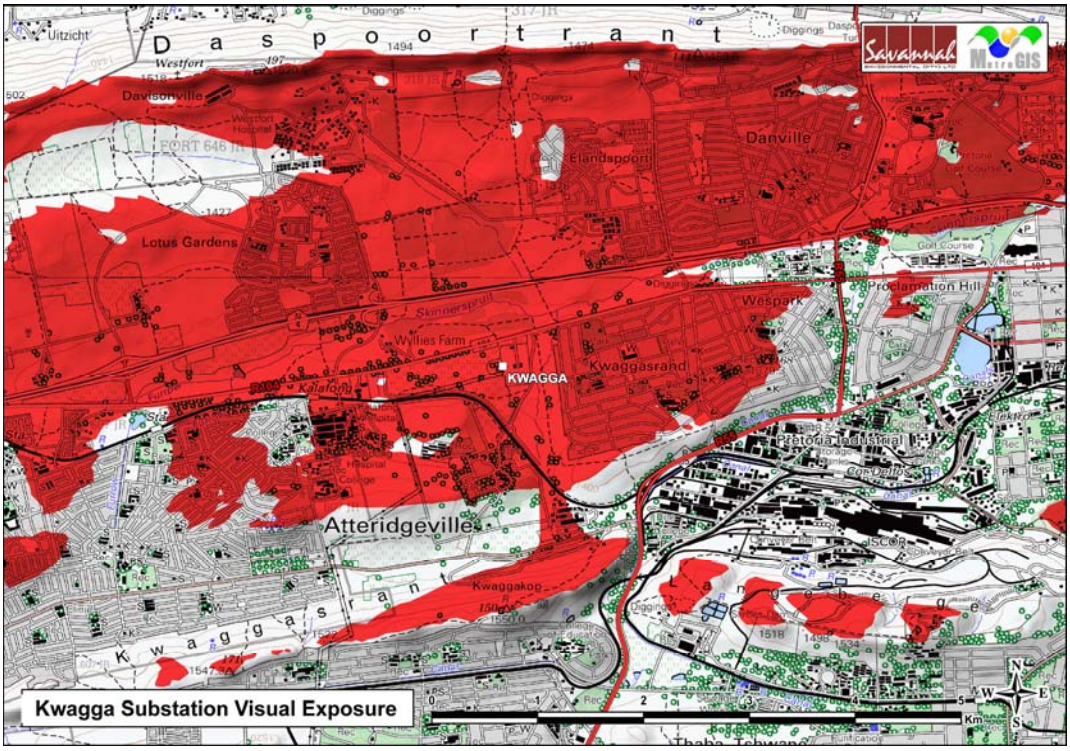

Figure 3. Viewshed of existing Kwagga Substation

Figure 3 above shows the existing potential visual exposure of the Kwagga substation. The proposed upgrade is only expected to increase this extent marginally, if at all.

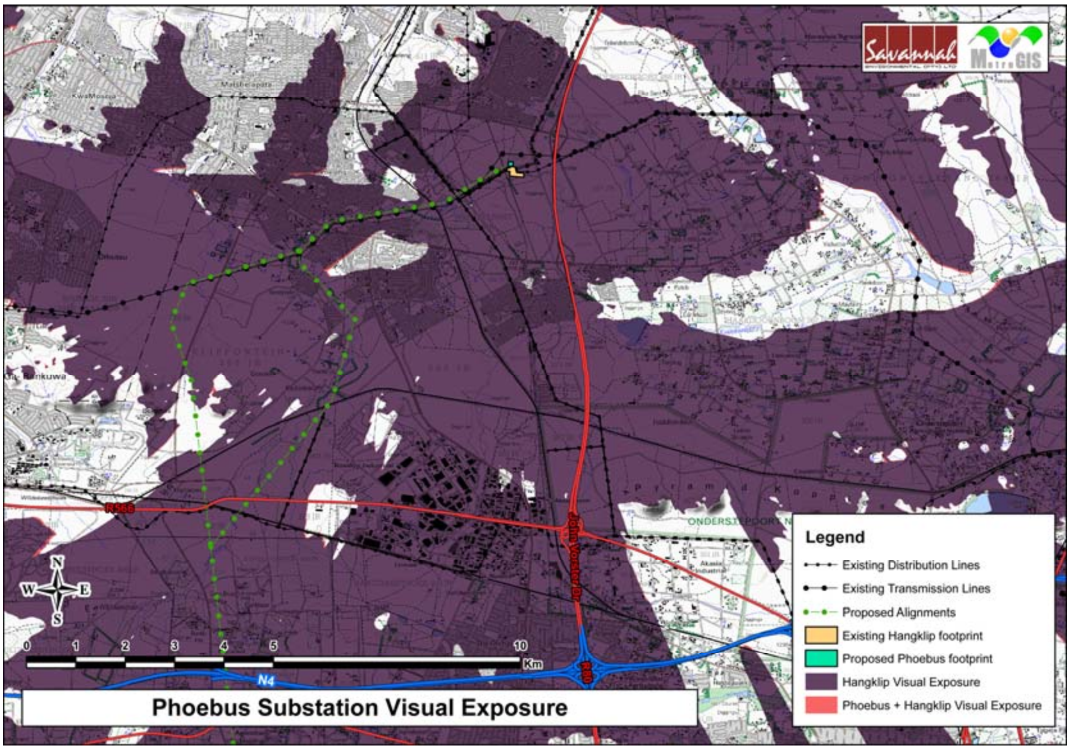

Figure 4. Viewshed overlay of Hangklip and Phoebus substations.

From the viewshed comparison in figure 4, it is clear that the proposed Phoebus substation will present a minimal increase in visual exposure to that already imposed by the Hangklip substation. However, the additional infrastructure will compound the visual intrusion of the existing impact that the substation already has on the surroundings.

Lighting can become a serious problem for a substation if it is either close to visual receptors or has not been adequately managed to minimize light trespass and/or glare. The proposed Phoebus substation will likely necessitate new lighting fixtures be installed, but the site itself is aproximately 1km from the nearest residential zone and the R80 so is not expected to have a significantly increased lighting impact than that already imposed by the Hangklip susbstation. The Kwagga substation, on the other hand, is very close to the Kwaggasrant suburb and less than 2km from the Kalafong Hospital, but is not expected to need any additional lighting for the proposed upgrades.

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

Nature of Impact: Potential visual impact on users of main roads.		
	Kwagga Substation	**Phoebus Substation**
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Minor **(1)**	Minor **(1)**
Probability	High probability **(4)**	High probability **(4)**
Significance	Moderate **(48)**	Moderate **(48)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated during operational phase?	No	No
Mitigation: Decommissioning: removal of the cables and towers after operational life.		
Cumulative impacts: The construction of associated infrastructure including bus bars and towers will increase the cumulative visual impact of the proposed substation upgrade and establishment.		
Residual impacts: N.A.		

Table 2. Impact table summarising the significance of visual impacts to the **residential areas**

Nature of Impact: Potential visual impact on receptors in affected residential areas.		
	Kwagga Substation	**Phoebus Substation**
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Minor **(1)**	Minor **(1)**
Probability	High probability **(4)**	High probability **(4)**
Significance	Moderate **(48)**	Moderate **(48)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated during operational phase?	No	No
Mitigation: Decommissioning: removal of the cables and towers after operational life.		
Cumulative impacts: The construction of associated infrastructure including bus bars and towers will increase the cumulative visual impact of the proposed substation upgrade and establishment.		
Residual impacts: N.A.		

6. Mitigation

Most of the infrastructure of a substation is dependent on technical functionality and thus effective mitigation is limited to potential screening from vegetation. Visual impact absorption through the use of planted vegetation can be an effective and relatively cheap means of reducing the visual impact of a development over time, especially if the duration is intended to be permanent or long-term. Such mitigation measures would be superseded by the need for servitudes for the turn-in lines, and thus the planning and implementation of such measures would require technical considerations as well as aesthetic and functional factors. It is normally good practice to use species typically found in the region for screen planting.

7. Conclusions and Recommendations

The construction of substation infrastructure in natural areas with potential conflicting land uses will always be problematic from a visual impact point of view. The structures of a substation cannot be effectively mitigated due to technical constraints but the extent of the visual impact is usually localised to a relatively small area. Screening by planned planting and maintenance thus presents the most effective means of mitigation.

New lighting fixtures for either the proposed Phoebus substation or the Kwagga substation upgrades will necessitate that a lighting engineer be appointed to ensure that light trespass and/or glare is minimized for receptors in the surrounding residential zones and motorists on the main roads.

Overall, the increase in visual impact of the Kwagga substation upgrades and the proposed Phoebus substations are considered negligible and the changes to the landscape are unlikely to be noticed by the casual viewer. Additionally, these impacts are considerably less than those presented by the power lines for which these developments are intended as the 400kV towers are taller than all other components of a substation and cannot be effectively mitigated, thus having a more prominent and wider ranging impact than the substation.

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 3: Management plan - substations

OBJECTIVE: The mitigation and possible negation of the additional visual impacts associated with the upgrade and/or extension of existing substations.	
Project component/s	Substation construction site and access roads.
Potential Impact	The potential scarring of the landscape due to the creation of new access roads/tracks or the unnecessary removal of vegetation causing the increased visual exposure of the substation to sensitive visual receptors.
Activity/risk source	The viewing of the substation and abovementioned visual scarring by observers (residents and road users) in the vicinity of the substation.
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity to the proposed substation site.

Mitigation: Action/control	Responsibility	Timeframe
Adopt responsible construction practices aimed at containing the construction activities to specifically demarcated areas thereby limiting the removal of natural and/or planted vegetation to the minimum.	Eskom/contractors.	During construction.
Limit access to the substation site	Eskom/contractors.	Construction/operational

(during both construction and operational phases) along existing access roads.		phases
Maintain the general appearance of the facility in an aesthetically pleasing way.	Eskom.	Operational phase

Performance Indicator	Vegetation cover that remains intact with no new access roads or erosion scarring in close proximity of the substation.
Monitoring	Monitoring of vegetation clearing during the construction phase.

Table 4: Management plan – substation lighting

OBJECTIVE: The mitigation and possible negation of the additional visual impacts caused by lighting of associated upgrade and/or extension of existing substations.	
Project component/s	Substation construction site and access roads.
Potential Impact	The potential visual impact from light trespass and glare from flood-lighting of the substation.
Activity/risk source	The viewing of the substation and abovementioned lights by observers (residents and road users) in the vicinity of the substation.
Mitigation: Target/Objective	Minimise light trespass and glare in the vicinity of the substation.

Mitigation: Action/control	Responsibility	Timeframe
Appoint a lighting engineer to place lights strategically and directional shields to eliminate glare and minimize light trespass.	Eskom/contractors.	During construction.
Maintain the lighting fixtures and shields that direct light onto the substation premises.	Eskom.	Operational phase

Performance Indicator	Correctly directed lighting fixtures and shields. No complaints from the public concerning lighting from the substation.
Monitoring	Monitoring of lighting fixtures during construction and operation of the substation.