Terra Logix
CONSULTING

EIA REPORT

TITLE: Visual Impact Assessment: Oryx - Tetra4 33kV Power Line

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1 Introduction

The potential visual impact of the proposed Oryx – Tetra4 33 kV power line in the Freestate province is the subject of this EIA report which forms part of the Environmental Authorisation Process.

2 Study area

The study area is approximately 15km to the south of Welkom (see Figure 1), with the centre located at approximately at 28° 09' S and 26° 44' E.

3 Terms of Reference

General terms of reference for environmental impact assessment apply.

4 Assumptions and Limitations

The following assumption and limitations are relevant:

- The analyses are based on available data at a scale of 1:50 000 and smaller
- The analyses do not take any vegetation cover into account and can thus be regarded as worst-case scenarios.
- The provided planned pylon height ranges between 18m and 24m – for the analyses the worst-case scenario of 24m was used.
- For the analyses, the provided positions of the pylons were used.

5 Analysis

5.1 Viewshed and viewing distance

Viewshed analyses (proportional viewshed) for the different options were done to determine the modelled visibility, limited to a distance of 2000m. At a distance of more than 2000m a power line becomes such a small component of the visual scene that it is regarded as insignificant. The reduction of visibility with distance (exponential decay) was combined with the viewshed and the results are shown in Figures 2 and 3.

5.2 Visual Exposure Analysis

Visual exposure analysis uses the digital terrain model (DTM) and derivatives thereof to determine to what extent the topography of the study area exposes or hides human structures. The DTM with 10m pixels was generated using available 5m contours. Visual exposure scores range from -3 to 3; negative values indicate a reduction in visual exposure, positive values an increase in visual exposure.

Slope

The slopes were derived from the DTM and the produced raster dataset (in degrees) was classified into the following visual exposure (VE) scores:

Table 1 VE scores for slope

Slope	Visual Exposure Score
< 5°	-1
5-10°	1
10-15°	2
15-20°	3
> 25°	3

The scores above assume that structures on steep slopes and ridges would be more exposed that those situated on flat slopes (for example a flat valley bottom).

Aspect

The aspect, derived from the DTM was classified into the following VE scores:

Table 2 VE scores for aspect

Aspect	Visual Exposure Score
Flat	3
North	2
East	1
South	-1
West	1

The scores are based on the following assumptions:

- structures on flat areas are illuminated by the sun during the whole day and visible from all direction
- Structures on north facing slopes are predominantly illuminated by the sun during the day but not visible from the south
- Structures on west- and east-facing slopes are illuminated by the sun during one part of the day and in the shade during the other part of the day.
- Structures on south-facing slopes are mostly in the shade.

Landforms

Certain landforms will expose structures more than others. Structures located on top of a ridge will be more visible than structures located in a deep canyon. The DTM and the Topographic Position Index (TPI) as defined by Weiss [1] were used to determine a landform raster dataset. For the analysis, focal statistics with annulus neighbourhoods (ESRI, Arcgis 10) with radii of 150m & 300m and 1860m & 2010m were used. The landform types are classified in terms of visual exposure as follows:

Table 3 VE scores for landforms

Landform Type	Visual Exposure Score
Canyons, deeply incised streams	-3
Midslope drainages, shallow valleys	-1
Upland drainages, headwaters	-1
U-shape valleys	-2
Plains	1
Open slopes	2
Upper slopes, mesas	3
Local ridges, hills in valleys	3
Midslope ridges, small hills in plains	3
Mountain tops, high ridges	3

Slope Position

The visibility of structures positioned on slopes is dependent on where the structures are positioned. Structures on upper slopes and ridges are prone to be more visible than structures in on lower slopes or in valleys. Using the DTM and the TPI analysis with a focal statistics annulus neighbourhood (ESRI, Arcgis 10) with radii of 900m and 1050m, the slope position raster dataset was determined. The slope position is classified in terms of VE as follows:

Table 4 VE scores for slope position

Slope Position	Visual Exposure Score
Ridge, hilltop, canyon edge	3
Upper slope	3
Mid slope	2
Flat slope	1
Lower slope	-1
Valleys, cliff base	-2

Relative elevation

The visibility of a structure at any given position is *inter alia* determined by that position's elevation relative to the elevation of the surrounding topography. If at any given position, most of the immediate surrounding topography has a higher elevation, any structure would be less visible than if most of the immediate surrounding topography has a lower elevation.

For this analysis, the mean elevation of a focal statistic circular neighbourhood (ESRI, Arcgis 10) with a radius of 1000m was determined and subtracted from the DTM. In the resulting raster dataset, negative values indicate surrounding topography with a higher elevation and positive values indicate surrounding topography with a lower elevation. Using a tower height of 24m the dataset was classified as follows:

Table 5 VE scores for relative elevations

Relative elevation	Visual Exposure Score
< -24	-3
-24 – -12	-2
-12 – 0	-1
0 – 12	1
12 – 24	2
> 24	3

Ruggedness

Ruggedness refers to the topographic diversity of an area. It is assumed that if at any given position the surrounding topography is very homogenous, any structure will be easier visible than if the surrounding topography is diverse. Ruggedness was determined by calculating the standard variation of the DTM using a focal statistics circular neighbourhood (ESRI, Arcgis 10) with a radius of 1000m. The resulting raster dataset was classified into 6 classes using the “Natural Breaks (Jenks)” method (Arcgis 10) as follows:

Table 6 VE scores for ruggedness

Ruggedness	Visual Exposure Score
Low STD values	3
	2
	1
	-1
	-2
High STD values	-3

Final Visual Exposure Raster

The above mentioned six raster datasets were summed and the result is shown in Figure 4.

5.3 Visual Absorption Capacity

Visual absorption capacity (VAC) is a measure of the ability of topographical features to hide introduced structures. It is thus the inverse of the visual exposure analysis (See Figure 5).

For analytical purposes it is preferred to use the Visual Exposure scores.

5.4 Viewer sensitivity

A viewer sensitivity raster dataset was created using the following datasets:

- Topographic data (NGI)
- Conservation (ENPAT)
- Natural Features (ENPAT)
- Formal protected Areas (SANBI)
- Informal protected areas (SANBI)
- Landcover 2013/2014

The sensitivity of viewers (visual receptors) is closely related to the activities taking place (land use) as well as natural features. Values between -3 and 3 were assigned to the topographic data, such that -3 represents existing topographic data that reduce the visual sensitivity (e.g. high urban density, infrastructure) and 3 represents data that increase the visual sensitivity (e.g. nature reserve, parks, heritage site). The individual ratings are given in Tables 7 and 8.

Table 7 Ratings of topographical data

Description	Score
ARTERIAL ROUTE	-3
BRIDGE	1
CARAVAN PARK	2
CONVEYOR BELT	-2
CULTIVATED LAND	-1
DAM	1
DIGGING	-3
DRY PAN	1
ERODED AREA	1
EXCAVATION	-3
FLOOD BANK	1
FOUNTAIN	2
GRAVE	1
HIGH URBAN DENSITY	-2
HOUSE	-1
LARGE BUILDING	-2
LARGE RESERVOIR	1
MARSH VLEI	2
MINE	-3
MINE DUMP	-3

Description	Score
NON-PERENNIAL CENTER LINE	1
NON-PERENNIAL PAN	1
ORCHARD VINEYARD	-1
OTHER ACCESS	-1
PERENNIAL CENTER LINE	2
PERENNIAL EXTENT	2
RECREATION AREA	2
RESERVOIR	0
RUIN	1
SANDY AREA	1
SCHOOL	-1
SECONDARY ROAD	-2
SEWERAGE WORKS	-3
SILO	-3
SLIMES DAM	-3
TELECOM TOWER	-3
TRACK FOOTPATH	-1
TREE LINE	1
WINDPUMP	0
WOODLAND	3

Table 8 Ratings of land cover data

Description	Score
Bare none vegetated	1
Cultivated comm fields (high)	-1
Cultivated comm fields (low)	-1
Cultivated comm fields (med)	-1
Cultivated comm pivots (high)	-1
Cultivated comm pivots (low)	-1
Cultivated comm pivots (med)	-1
Cultivated orchards (high)	-2
Cultivated orchards (med)	-2
Erosion (donga)	2
Grassland	0
Low shrubland	-1
Mine buildings	-2
Mines 1 bare	-3
Mines 2 semi-bare	-3
Mines water permanent	-1

Description	Score
Urban commercial	-3
Urban industrial	-3
Urban informal (dense trees / bush)	-1
Urban informal (low veg / grass)	-2
Urban informal (open trees / bush)	-2
Urban residential (bare)	-1
Urban residential (dense trees / bush)	-2
Urban residential (low veg / grass)	-2
Urban residential (open trees / bush)	-2
Urban smallholding (bare)	-1
Urban smallholding (dense trees / bush)	-1
Urban smallholding (low veg / grass)	-1
Urban smallholding (open trees / bush)	-1
Urban township (dense trees / bush)	-2
Urban township (low veg / grass)	-2
Urban township (open trees / bush)	-2

Description	Score
Mines water seasonal	-1
Plantation / Woodlots young	-3
Plantations / Woodlots mature	-3
Thicket /Dense bush	0

Description	Score
Water permanent	1
Water seasonal	1
Wetlands	2
Woodland/Open bush	1

The viewer sensitivity raster dataset (see Figure 6) was combined with the final visual exposure dataset to obtain the modelled visual sensitivity raster dataset which is shown in Figure 7.

Locations of the photographs taken during the site visit (July 2020) are shown in Figure 8. Photos were taken manually at selected locations recording the geo-location as well as the direction of the photograph. Selected sites (see Figure 9) of various modelled visual sensitivities were subjected to a visual contrast rating to ground truth the computer modelling. The contrast rating is based on the methods given by the Landscape Institute & IEMA [2], the BLM [3], Smardon [4], and Blair [5]. The method involves describing the existing landscape and the planned development in terms of land, water, vegetation and structures, followed by rating the contrast between the existing elements and the planned elements. In each case, the visual contrast is plotted against the modelled visual sensitivity show the comparison between computer (GIS) modelling and field observations. Photographs that were taken during the site visit form part of the site description. The site assessments are given in Figures 10 to 15.

Generally, the modelled visual sensitivity shows similar scores than the visual contrast rating. Vegetation cover over the study area is generally clustered and scattered.

The visual contrast rating tends to me more site specific (local) while the modelled visual sensitivity tends to be more regional.

5.5 Visual Impact

The potential visual impact is determined by combining the visual sensitivity with the viewshed and the reduced visibility over distance (see Figures 16 and 17). The visual impact values for all both options are displayed using the same 5 classes, for visual comparison.

A comparison of the provided options is given as follows:

Table 9 Comparison of options

Option	Visual impact Score (ha)				
	Very Low	Low	Moderate	High	Very High
Option A	3788.23	486.14	2.43	0	0
Option B	3777.93	537.74	2.25	0	0

The values in the table above are calculated by summing the visual impact values of the visual impact raster cells that cover the 2000m visual limit buffer around the respective options.

6 Impact Assessment

The significance of the visual impact was assessed using the following criteria:

Table 10 Significance rating

Aspect	Description	Weight
Probability (P)	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration (D)	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale (S)	Local	1
	Site	2
	Regional	3
Magnitude/Severity (M)	Low	2
	Medium	6
	High	8

Aspect	Description	Weight
Significance	Sum (Duration, Scale, Magnitude) x Probability	
	Negligible	≤20
	Low	>20 ≤40
	Moderate	>40 ≤60
	High	>60

The following associated activities were assessed:

- Construction camps
- Burrow pits
- Power line
- Access Roads

Table 11 Impact assessment

Nature of Impact	Probability	Duration	Scale	Magnitude/ Severity	Significance	Comment
CONSTUTION PHASE: CAMPS						
Visual scars in the landscape due clearing of vegetation, off-road driving and poor erosion control	4	3	1	4	32	Low, can be reduced by rehabilitation
CONSTRUCTION PHASE: BURROW PITS						
Excavations and associated erosion leave visual scars in the landscape	4	4	2	4	40	Low, can be reduced by rehabilitation
OPERATIONAL PHASE: POWER LINE						
Visual intrusion by pylons	5	5	2	2	45	Moderate, but can be reduced by mitigation measures (see Section 8)
Visual intrusion by power lines	5	5	1	2	40	Low
Visual scars due to poor erosion control at pylon foundations	4	4	1	4	36	Low, can be reduced by proper management
OPERATIONAL PHASE: ACCESS ROADS						
Visual scars in the landscape due to poor erosion control	4	4	2	4	40	Low, can be reduced by proper management

7 Conclusion

The modelled visual impact is predominately very low and ranges from very low to moderate.

The analysis shows that in terms of visual impact, both options are similar and thus there is no preferred option. As far as can be determined there are not any *no-go* options.

8 General mitigation measures

The most important mitigation measure is planning and design in such that the transmission line is placed in a manner that the visual intrusion is either avoided or limited as far as possible.
Secondarily, it is important that during the construction phase the short term visual disturbance is kept to a minimum and that any such disturbance is adequately rehabilitated such that no long term disturbance remains.
General mitigation measures include the following:

- Colour/Coating: Using a coating on the steel that is darker than galvanized steel will reduce the visual impact.
- Existing linear features: Placing new linear structures alongside existing linear features will reduce the overall impact.
- Erosion: special attention to erosion control is important as erosion tends to develop long term scars in the landscape.
- Clearing of vegetation: Any clearing of vegetation should be limited to cutting only – no earth moving equipment. Clearing of any vegetation that would provide a screening effect should be avoided. Generally, the overall area has clustered and scattered trees and bushes which have only a limited use as visual shields.
- Access Roads: Use existing roads and tracks as far as possible
- Rehabilitation: Any temporary disturbance should be rehabilitated as soon as possible to reduce the effects of erosion.

9 References

1. WEISS, A. 2001. Topographic Position and Landforms Analysis. Poster presentation, ESRI User Conference, San Diego, CA.
2. THE LANDSCAPE INSTITUTE with THE INSTITUTE OF ENVRIONMENTAL MANAGEMENT AND ASSESSMENT. 2002. Guidelines for Landscape and Visual Impact Assessment. Second Edition, Spon Press, New York.
3. U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT. Manual 8431 – Visual Resource Contrast Rating. Available online at http://www.blm.gov/nstc/VRM/8431.html (viewed June 2006)
4. SMARDON R.C. 1979. Prototype Visual Impact Assessment Manual. School of Landscape Architecture, State University of New York, College of Environmental Science and Forestry.
5. BLAIR W.G.E. (1986). Chapter 13: Visual Impact Assessments in urban Environments. *In: Foundations for Visual Project Analysis,* edited by Smardon R. C., Palmer J, & Felleman J. State University of New York, College of Environmental Science and Forestry.

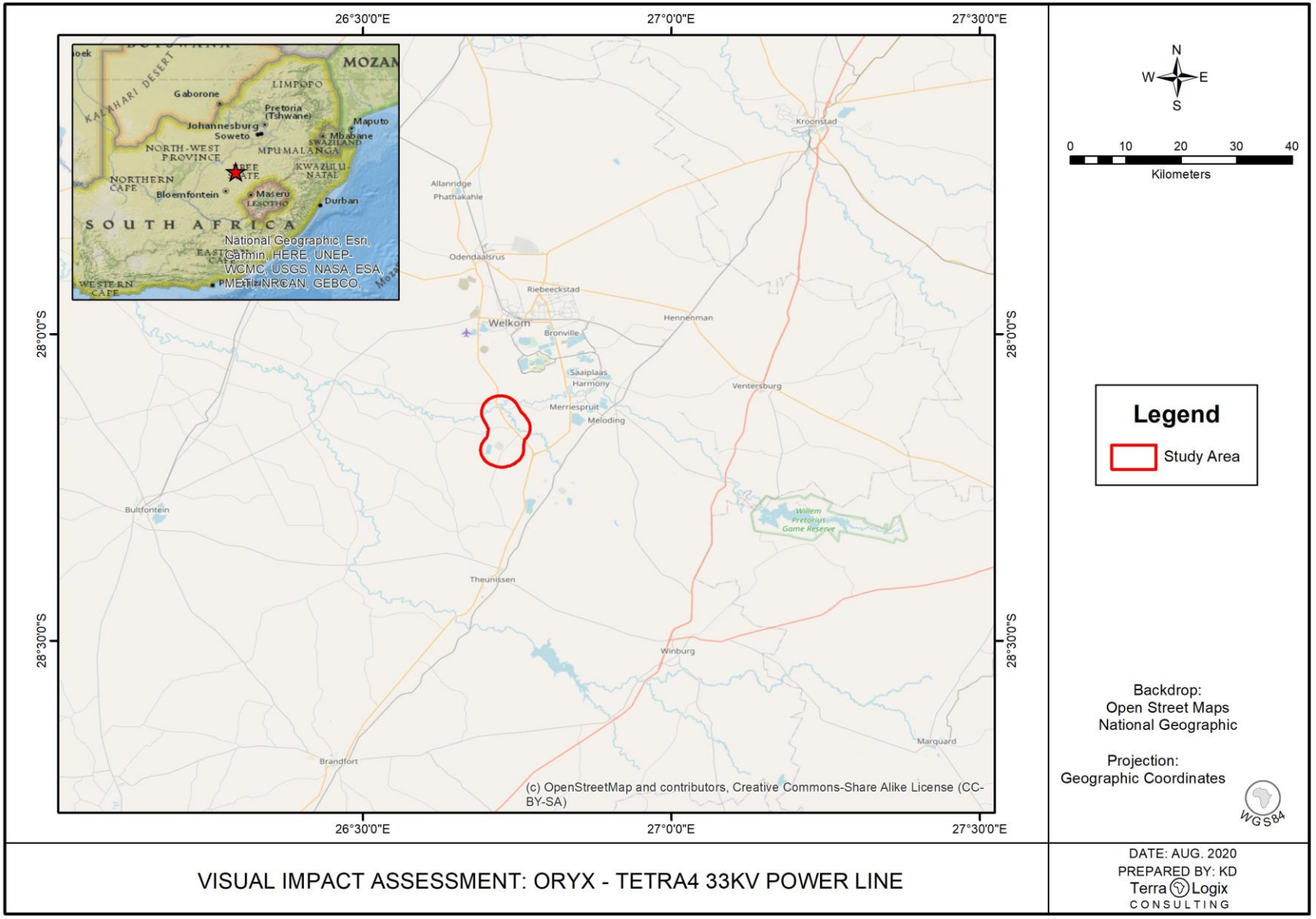

Figure 1 Location Map

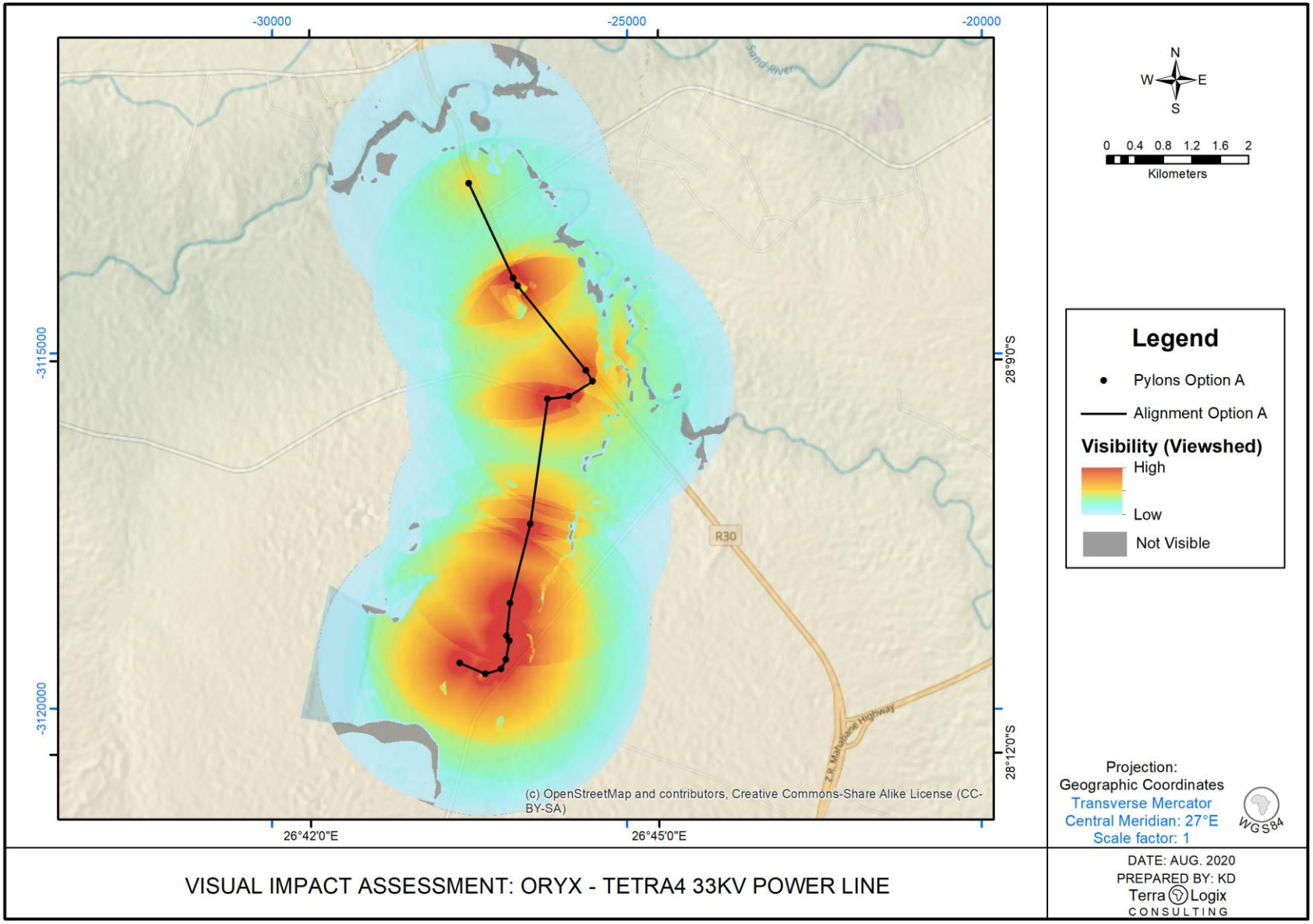

Figure 2 Viewshed combined with viewing distance for Option A

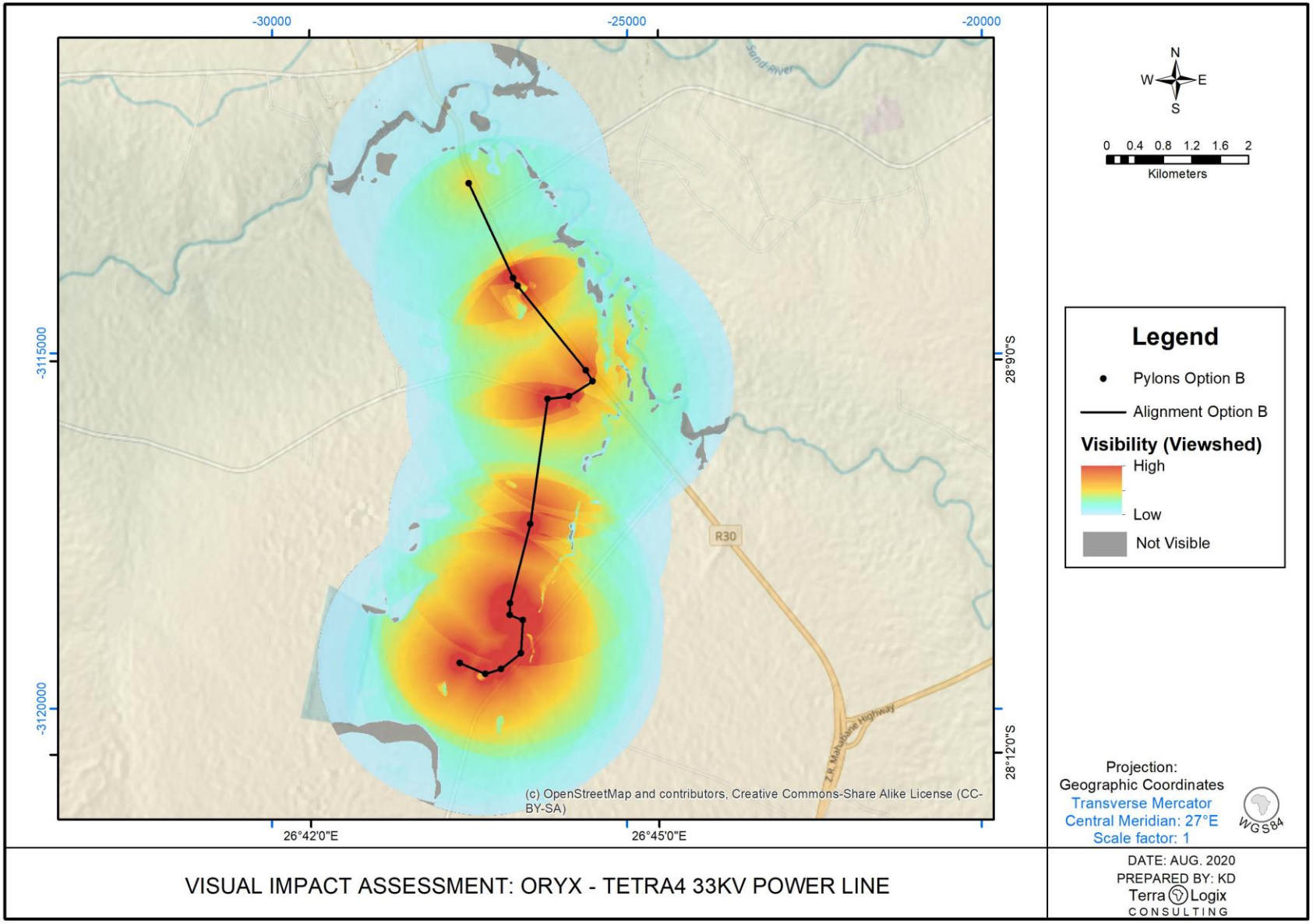

Figure 3 Viewshed combined with viewing distance for Option B

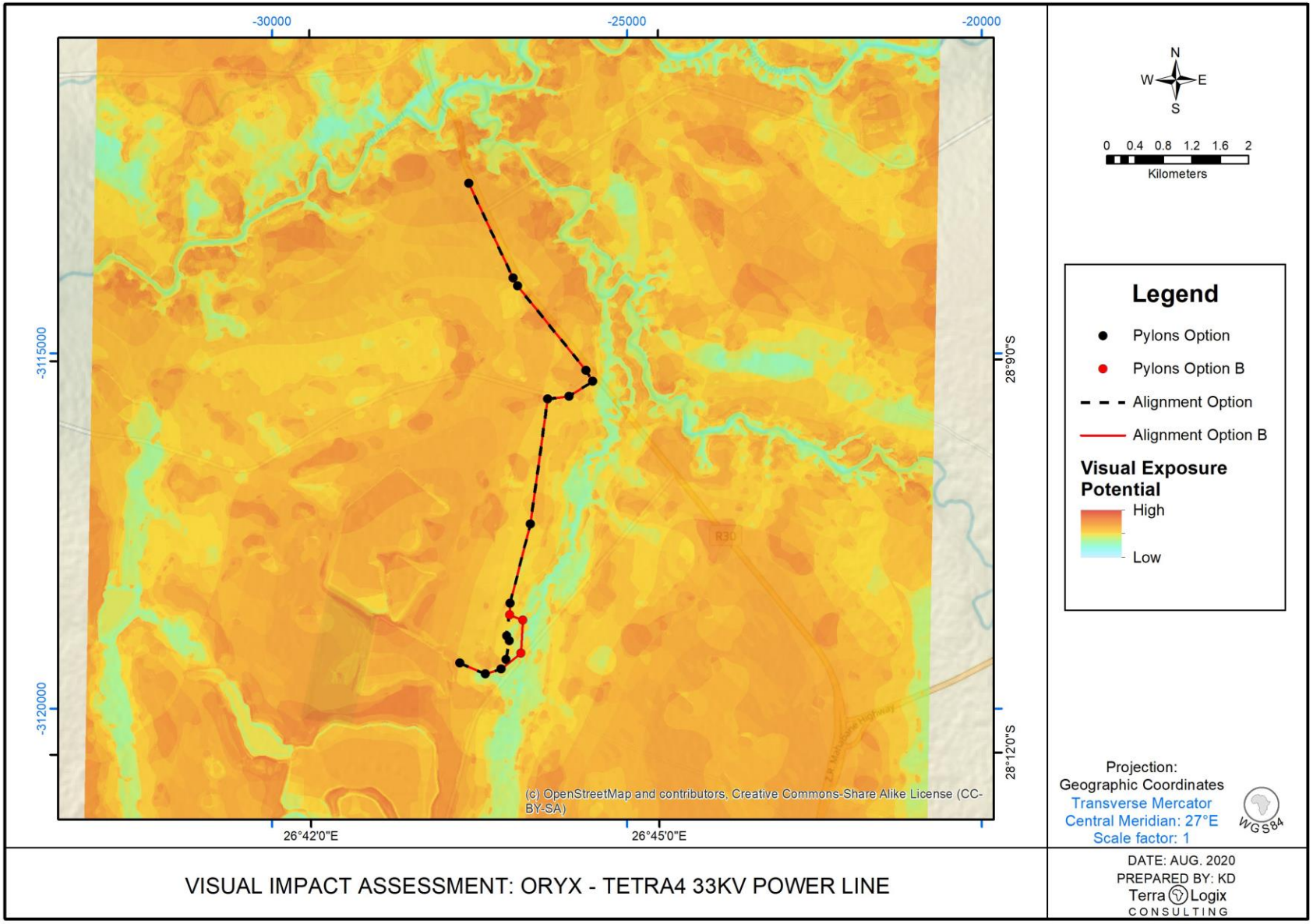

Figure 4 Visual exposure potential (VEP)

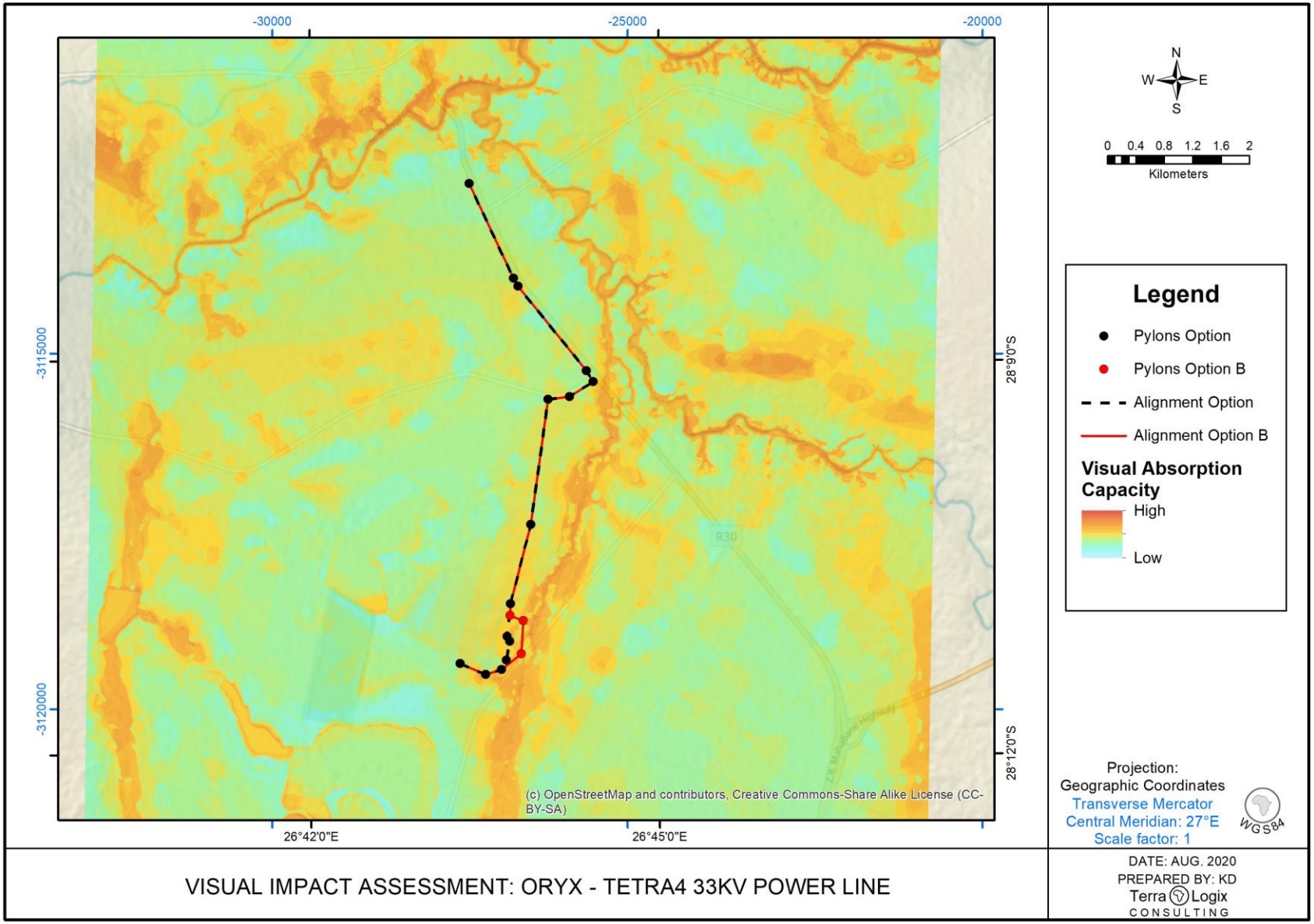

Figure 5 Visual absorption capacity (VAC)

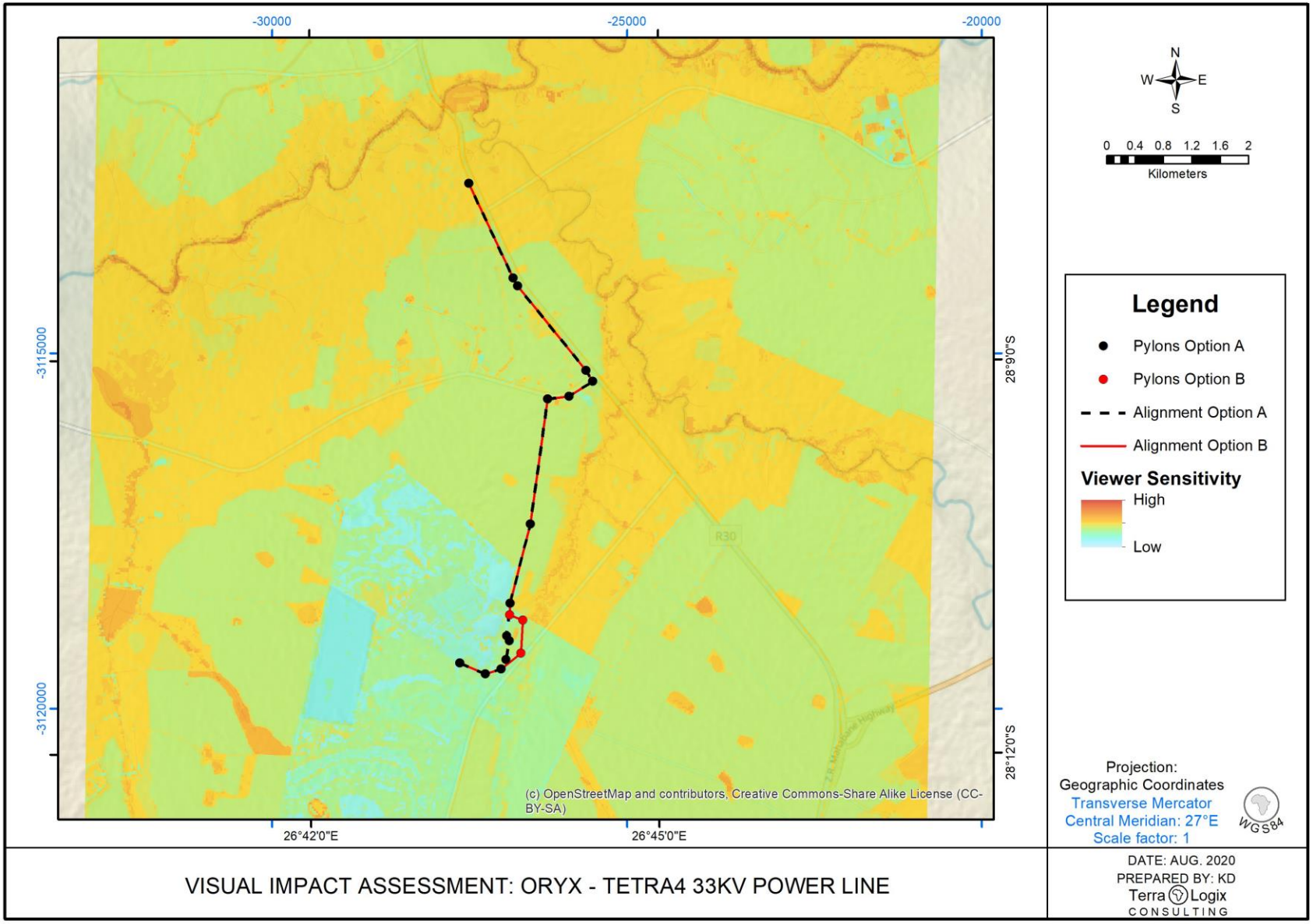

Figure 6 Viewer sensitivity

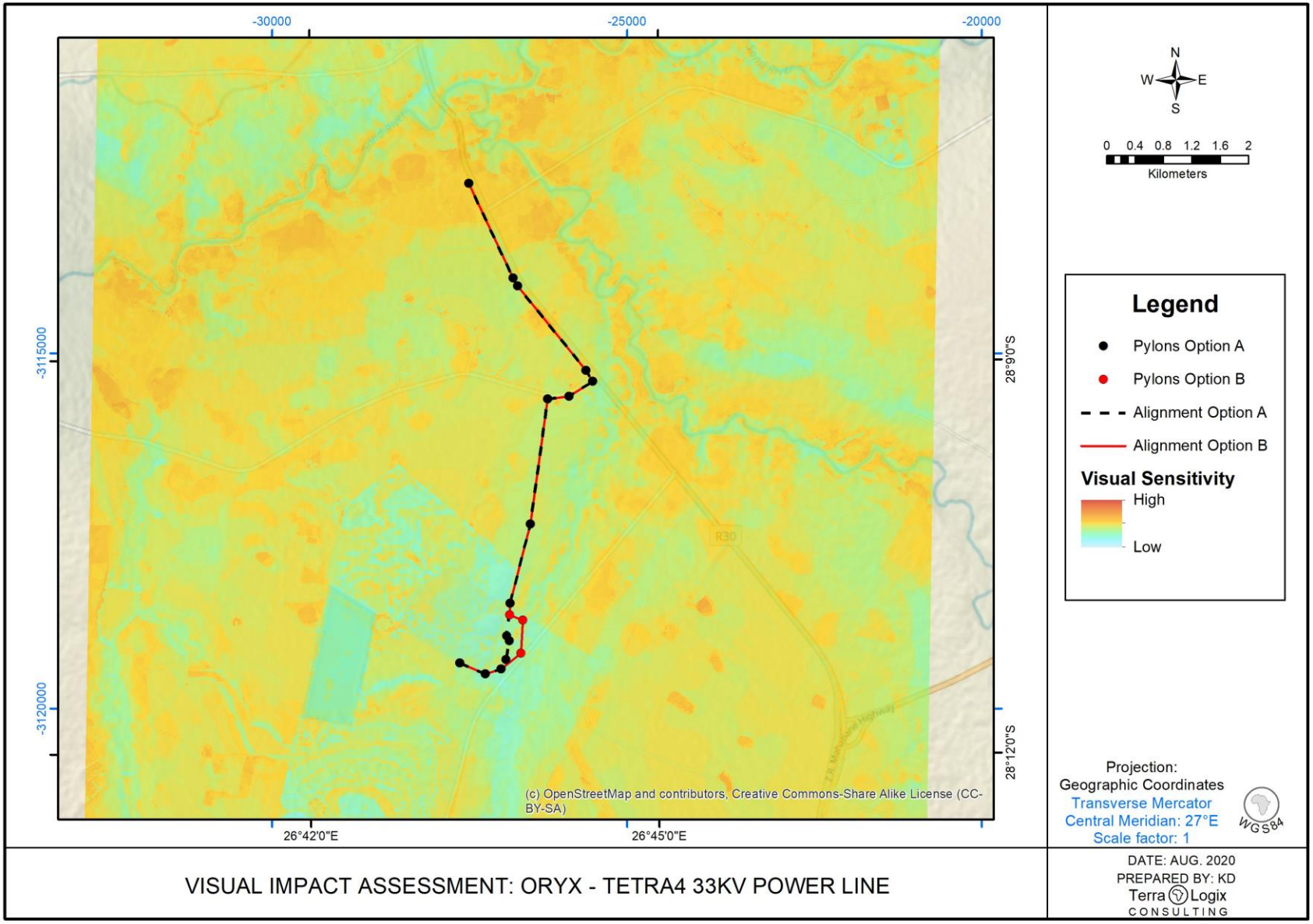

Figure 7 Visual sensitivity

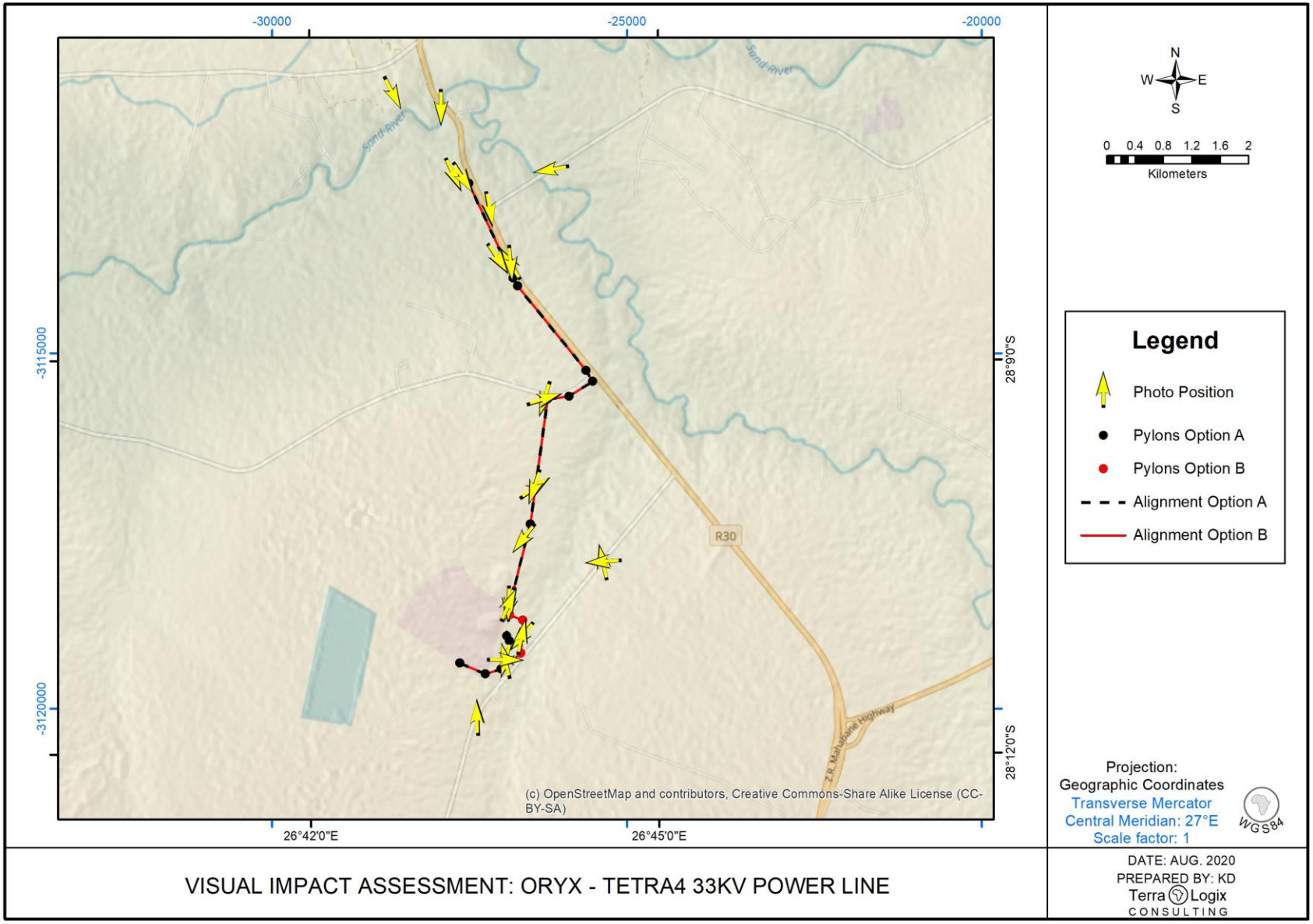

Figure 8 Site visit photo positions

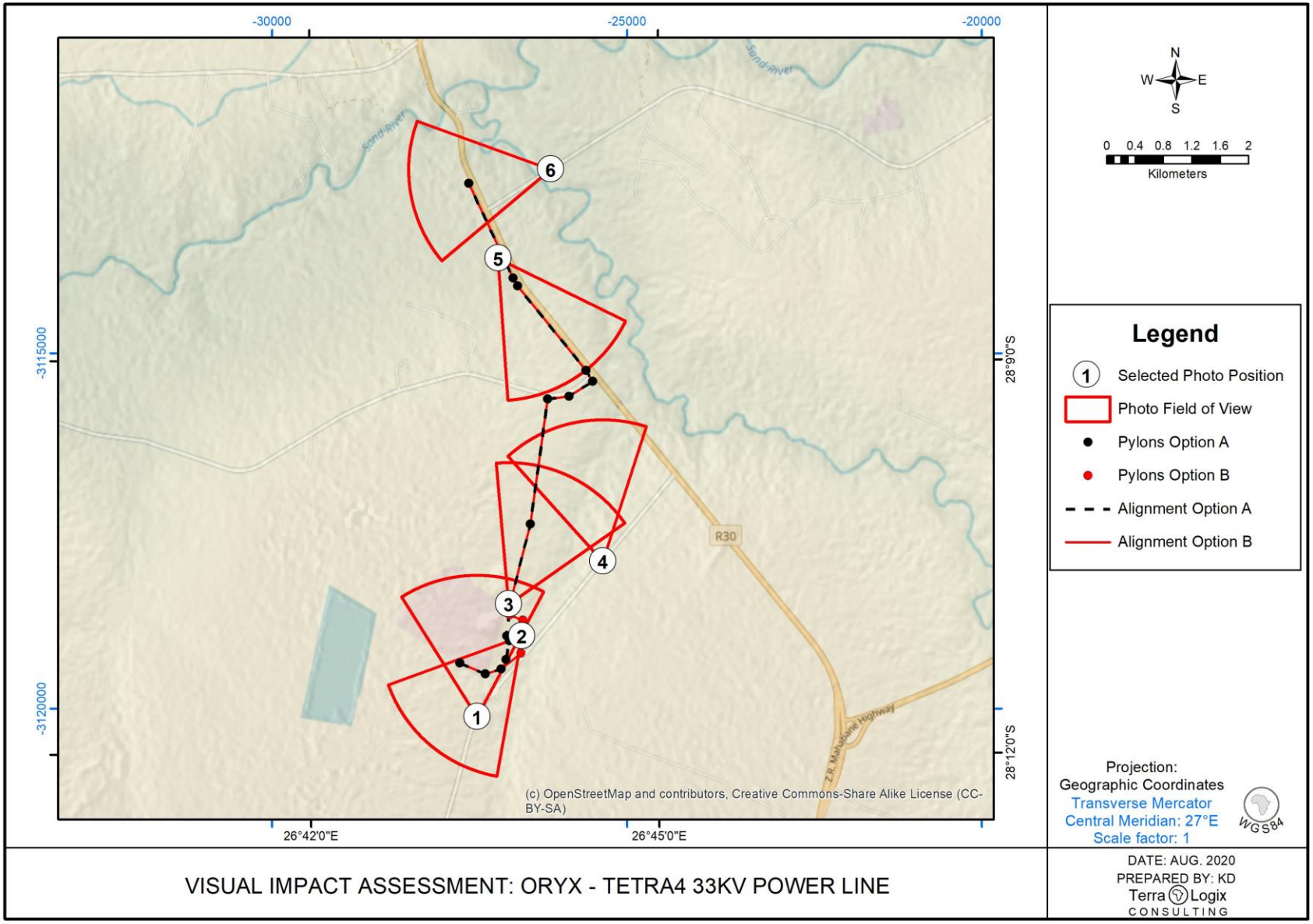

Figure 9 Selected sites for visual contrast rating

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Flat plain	Pasture / trees	Mine structures / roads
	Line	diffuse edge	weak, irregular	Strong vertical and horizontal
	Colour	blue-grey in distant background	light brown / brown to green	dominantly grey / dark grey
	Texture	fine	fine / medium, scattered	fine to medium / fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	green to brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form			X				X					X
	Line		X				X						X
	Colour		X					X					X
	Texture			X				X					X

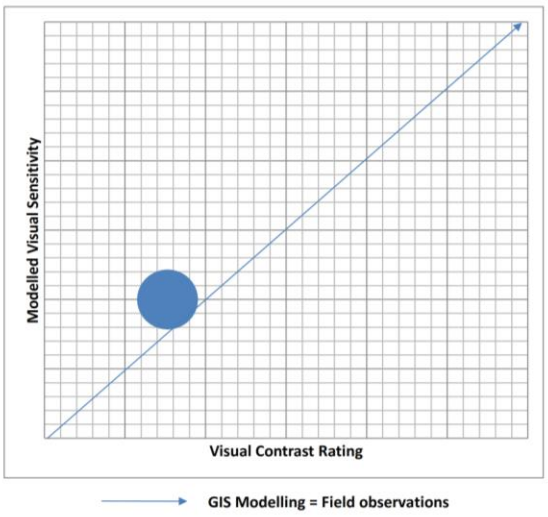

Figure 10 Site 1

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Rolling small hill	Trees	Tracks
	Line	diffuse edge	weak, irregular	weak, horizontal
	Colour	blue-grey in distant background	light brown to green	light brown
	Texture	fine	medium, dense	fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	green to brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form		X			X						X	
	Line		X				X					X	
	Colour		X					X			X		
	Texture			X				X				x	

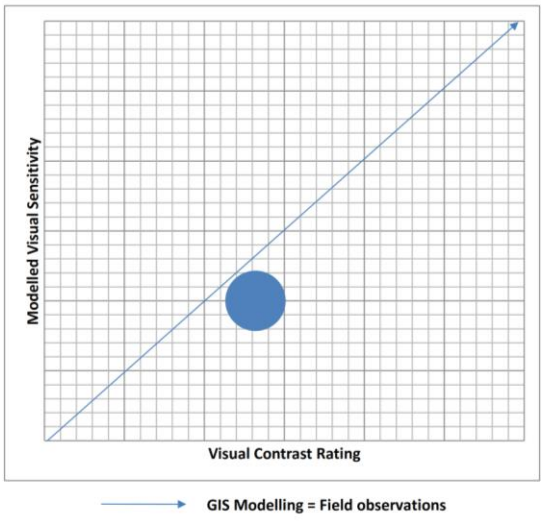

Figure 11 Site 2

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Flat plain	Trees / pasture	Road
	Line	diffuse edge	weak, irregular, dominant tree line	bold, horizontal
	Colour	blue-grey in distant background	brown to green / light brown	light brown
	Texture	fine	medium, clustered / fine	fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	green to brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form		X			X						X	
	Line		X					X					X
	Colour		X					X			X		
	Texture			X				X				x	

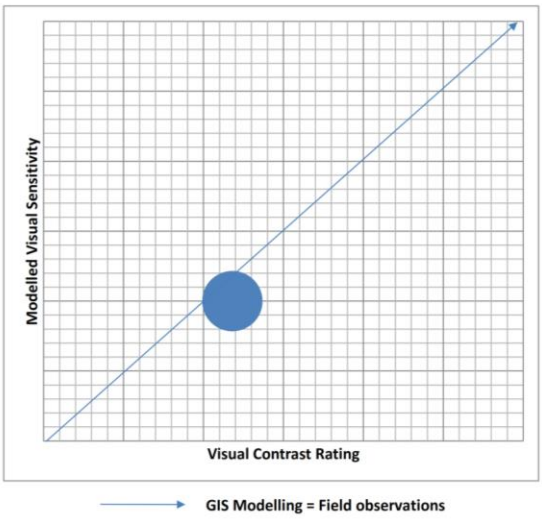

Figure 12 Site 3

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Flat plain	Pasture / trees	Roads, tracks
	Line	diffuse edge	weak, irregular, sub-ordinate tree line	bold, horizontal
	Colour	blue-grey in distant background	light brown / brown to green	dark grey ,light brown
	Texture	fine	fine / medium, scattered	fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	green to brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form		X			X						X	
	Line		X					X					X
	Colour		X					X			X		
	Texture			X				X				x	

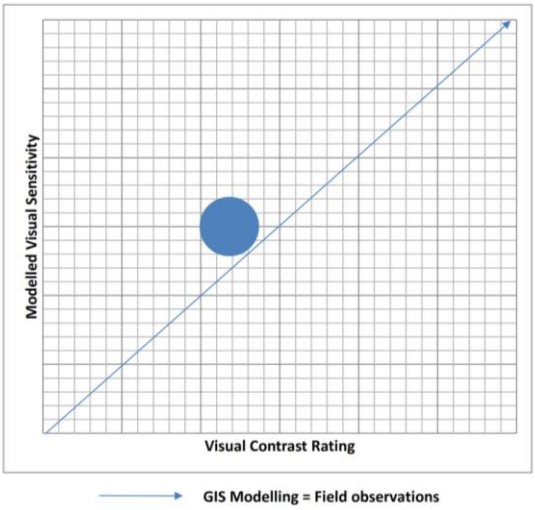

Figure 13 Site 4

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Flat plain	Pasture	Tracks / distant buildings
	Line	diffuse edge	weak, irregular	weak horizontal
	Colour	blue-grey in distant background	light brown	light brown / white, light red
	Texture	fine	fine	fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	green to brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form		X			X						X	
	Line		X			X					x		
	Colour		X					X			X		
	Texture			X				X				x	

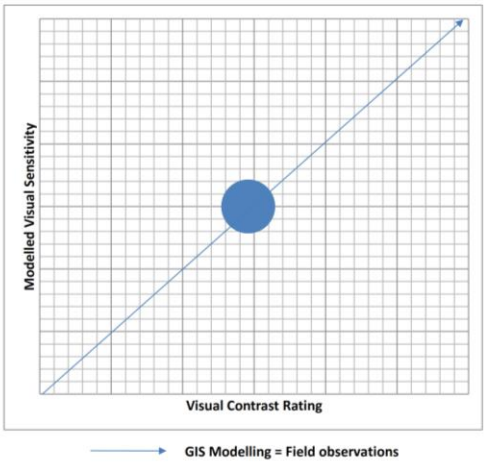

Figure 14 Site 5

Characteristic Landscape Description

		Land/Water	Vegetation	Structures
Elements	Form	Flat plain	Bush / pasture	Road
	Line	diffuse edge	weak, irregular	bold, horizontal
	Colour	blue-grey in distant background	brown to green / light brown	dark grey
	Texture	fine	medium, scattered / fine	fine

Proposed Activity Description

		Land/Water	Vegetation	Structures
Elements	Form	linear forms: servitude / access roads (gravel)	linear forms created by clearings (servitude / access roads)	lattice towers, power lines
	Line	bold band	regular lines: edge effect of servitude / access roads	bold horizontal, vertical
	Colour	brown	light brown	steel grey
	Texture	fine	fine	fine to medium, regular

Contrast Rating

		Land/Water				Vegetation				Structures			
Degree of Contrast		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Elements	Form		X			X						X	
	Line		X				X						X
	Colour		X					X				X	
	Texture			X				X				x	

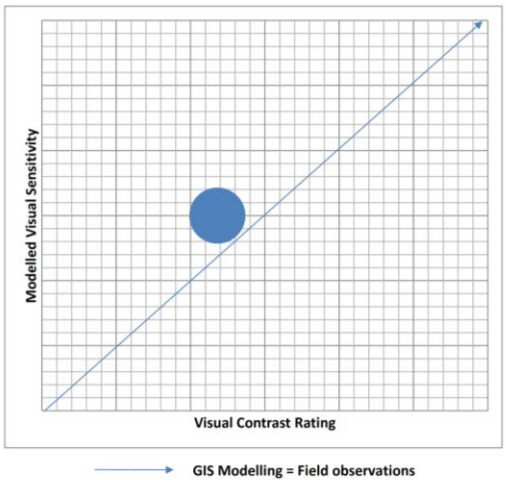

Figure 15 Site 6

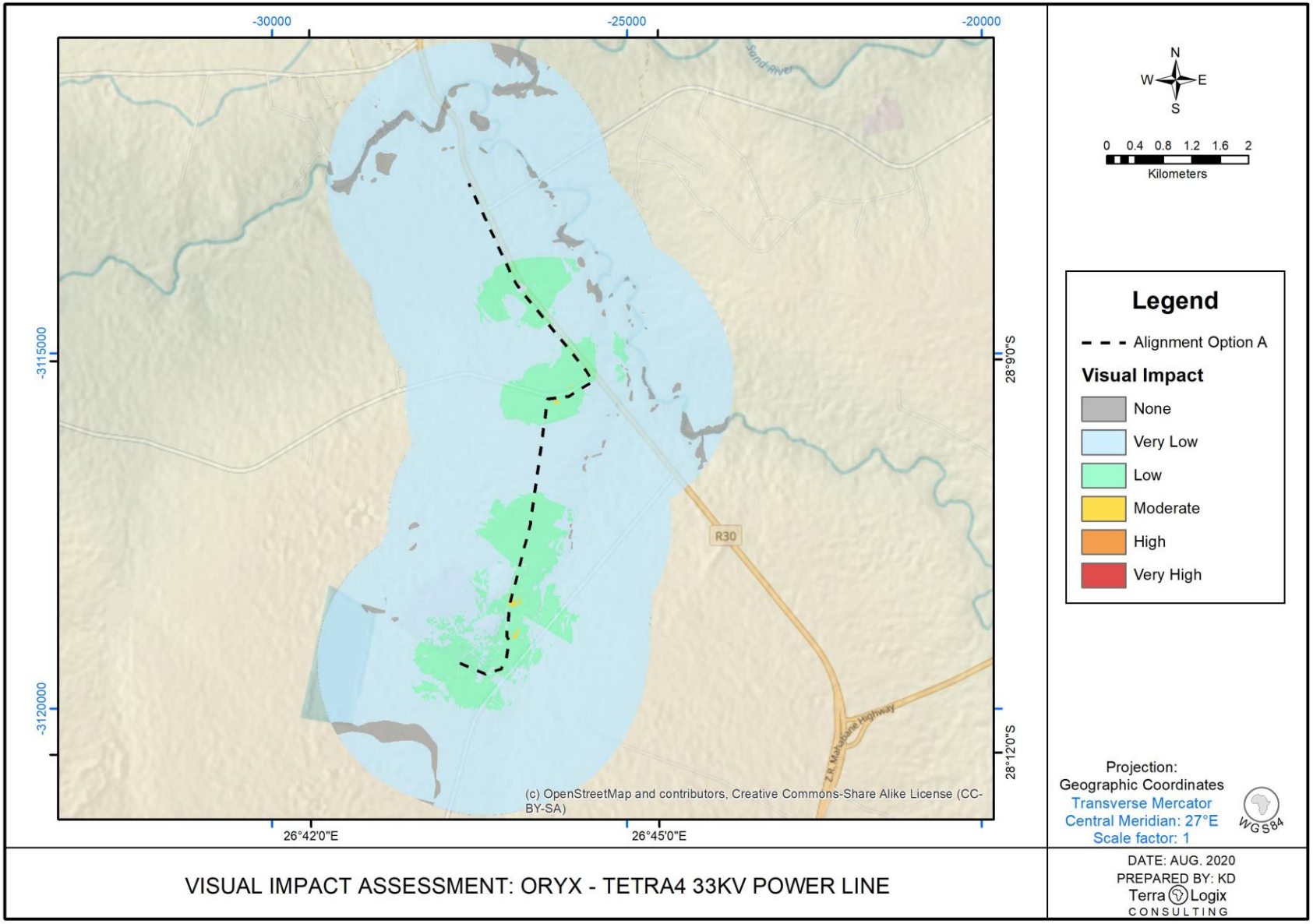

Figure 16 Visual Impact Option A

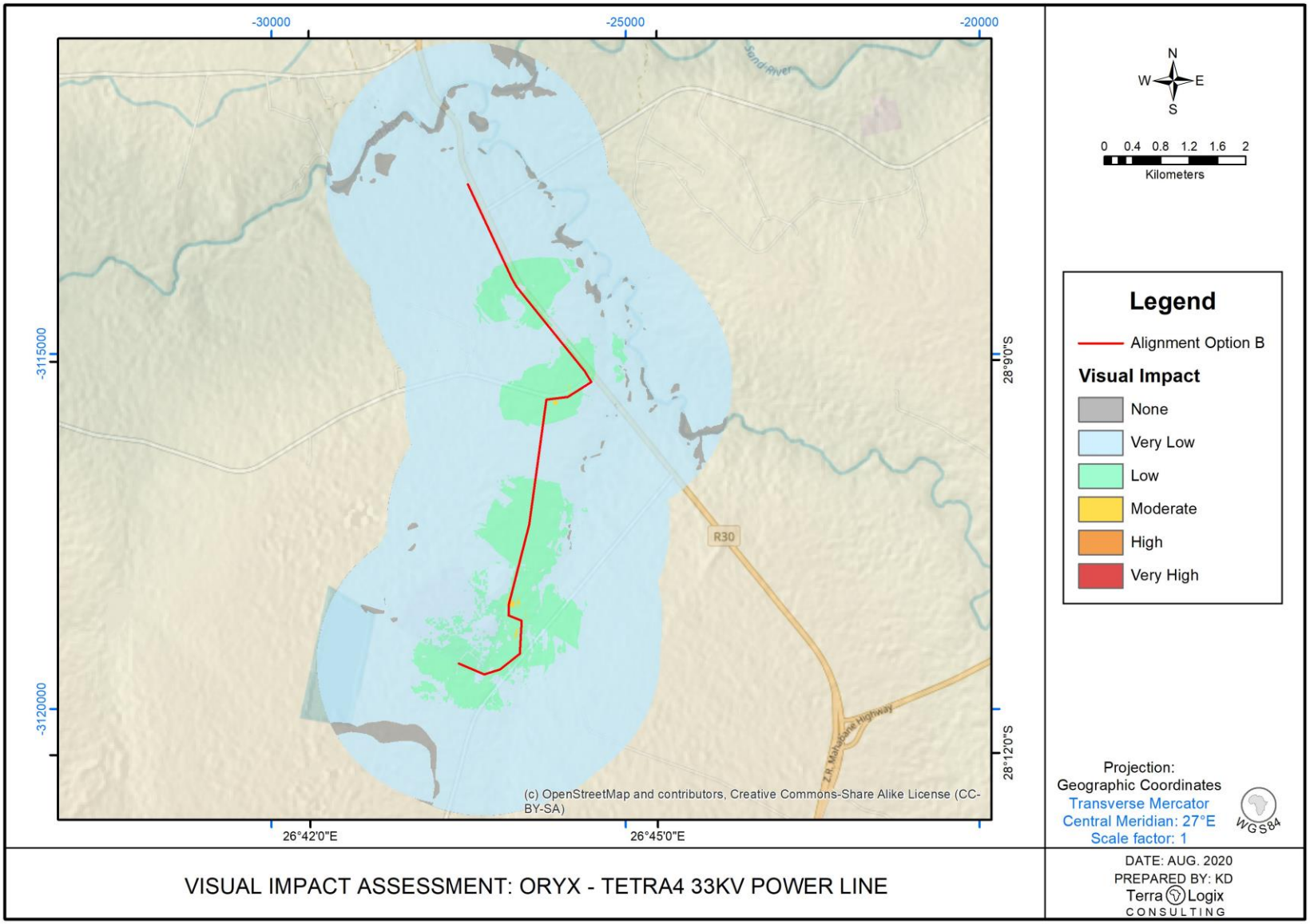

Figure 17 Visual Impact Option B