PROPOSED 2X500kV TRANSMISSION LINES FROM NZHELELE SUBSTATION TO CONNECT WITH POWER LINES FROM TRIANGLE SUBSTATION (ZIMBABWE) IN MUSINA (SOUTH AFRICA), WITHIN THE VHEMBE DISTRICT MUNICIPALITY, LIMPOPO PROVINCE

EIA Specialist Watercourse Study

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Disclaimer and Approach:

This report provides a description and assessment of identified watercourse, including wetlands, rivers and headwater drainage lines present within the investigated route alternatives and the larger study area. It also provides a concise description of the proposed development and identifies potential project-related impacts and mitigation measures.

This study does not provide detailed descriptions of the geology, soils, climate of the area, hydrology of the aquatic environments, assessments of surface and ground water quality, detailed descriptions of aquatic and terrestrial flora and fauna, or provide a detailed review of the legal constraints associated with potential project related impacts on the environment. It has been assumed for the purposes of this report that these aspects will be the subject of separate specialist studies during the EIA phase.

Watercourse assessments were not undertaken through the use of detailed field surveys along each of the route alternatives, but selected areas in each of the alternative were visited to obtain a better understanding of watercourses within the study area. Efforts were made to use existing spatial datasets and available aerial imagery, in order to delineate watercourses through on screen digitizing in each alternative corridor.

Specialist reports and reports on specialist processes - Checklist		
	NEMA Regs (2014) - Appendix 6	**Reference to section of specialist report or justification for not meeting requirement**
1	A specialist report or a report on a specialised process prepared in terms of these Regulations must contain -	
(a) i	the person who prepared the report; and	Title page
(a) ii	the expertise of that person to carry out the specialist study or specialised process;	Appendix B
(b)	a declaration that the person is independent in a form as may be specified by the competent authority;	Page 5
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Page 10 – 11
(d)	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Page 13 - 14
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Page 12 – 14
(f)	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Page 18 – 34 See also comment below in row (h)
(g)	an identification of any areas to be avoided, including buffers;	Page 18 – 40
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Not applicable – No proposed development infrastructure footprints are currently available, only different corridors were assessed.
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Page 2 and 14
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;	Page 35 – 40

(k)	any mitigation measures for inclusion in the EMPr	Page 38 - 56
(l)	any conditions for inclusion in the environmental authorisation	Page 38 - 56
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation	Page 38 - 56
(n)	a reasoned opinion -	
.i	as to whether the proposed activity or portions thereof should be authorised and	Page 38
.ii	if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Page 38 - 56
(o)	a description of any consultation process that was undertaken during the course of carrying out the study;	No formal consultation was undertaken
(p)	a summary and copies if any comments that were received during any consultation process, and -	No formal consultation was undertaken
(q)	any other information requested by the competent authority.	None

DECLARATION

I, Lourens Erasmus Retief Grobler, declare that I –

- act as an independent specialist consultant in the fields of botanical and ecological science;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report; and
- will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

LOURENS ERASMUS RETIEF GROBLER

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1. INTRODUCTION

1.1. Background and project Description

Baagi Environmental Consultancy has been appointed by Eskom Holding Limited to carry out an environmental assessment and authorisation application for a proposed new 2 x 500kV transmission line from Nzhelele Substation to the Limpopo River on the South Africa - Zimbabwe border. The proposed Nzhelele transmission line will cross an international border at the Limpopo River and extend further north into Zimbabwe to connect with Triangle Substation. The official project description received states:

Proposed Construction of 2x500kv transmission lines from Nzhelele Substation to connect with power lines from Triangle Substation (Zimbabwe) in Musina, within the Vhembe District Municipality, Limpopo Province.

Baagi Environmental Consultancy has subcontracted Imperata Consulting to carry out an assessment of watercourses, including wetlands, within the study area. The study area on the South African side of the proposed development is located in Limpopo Province and consists of five corridor alternatives. Each corridor has a width of 4km. The five corridors, can be grouped into three corridors for practical purposes. This specialist watercourse assessment study only assesses watercourses within the South African portion of the project.

1.2. Terms of Reference

The following terms of references are associated with the surface watercourse scoping study:

- The description of watercourses, particularly wetlands and rivers within the study area. Watercourses assessed during this study are based on the definitions stated in the National Water Act (NWA), Act No. 36 of 1998:
    - A river or spring.
    - A natural channel in which water flows regularly or intermittently.
    - A wetland, lake or dam into which, or from which, water flows.
- Identify important watercourse properties and components, which may be influenced by the proposed transmission line, and may influence the proposed transmission line during construction and operation.
- General overview of watercourses within each of the corridor alternatives (henceforth referred to collectively as the study area).
- Emphasis is placed on the identification and delineation of watercourses within the five route alternatives (corridors). The corridors were received from the client (Baagi Environmental Consultancy) and include the following alternatives:

  - Alternative 1 (Alt 1)
  - Alternative 1/2 (Alt 1/2)
  - Alternative 2 (Alt 2)
  - Alternative 2A (Alt 2A)
- Identify potential issues and impacts associated with the proposed project that could negatively affect watercourses. Appropriate impact mitigation measures are also discussed.

1.3. General Assumptions and Limitations

1.3.1. General assumptions

- This study assumes that the project proponents will always strive to avoid, mitigate or offset potentially negative project-related impacts on the environment. It further assumes that the project proponents will seek to enhance potential positive impacts on the environment.
- The received spatial data (corridor shapefiles) are accurate and have not changed as indicated in this report.
- The project proponents will commission an additional study to assess the impact(s) should any changes be made to the route layouts that can potentially have a highly significant and unavoidable impact on watercourses.

1.4. Overview of Watercourses

An overview of wetlands and other watercourses that pertain to the study area and assessment are provided in Appendix A.

2. METHODS

2.1. General

The following methods and approaches were applied as part of the watercourse investigation:

- A three day orientation field survey was undertaken on 14-16 July 2014 to help identify watercourse types and features within the study area.
- The size of the study area, with related access constrains in areas made it impractical to visit each possible wetland and river crossing within the different corridor alternatives. A strong desktop approach was therefore adopted to inform the watercourse delineation study.
- The recently completed National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa shapefile (RSA Wetland Types) was used to identify potential wetland areas within the study area and route alternatives (Van Deventer et al., 2010). The data was obtained from the BGIS website supported by the South African National Biodiversity Institute (SANBI).
- This Wetland Types for South Africa GIS layer has been formed by combing information from the National Land Cover 2000 data set (NLC 2000), 1:50 000 topographic maps and sub national data (Van Deventer et al., 2010). This wetland layer is regarded to be one of the most up to date spatial representatives of wetland areas on a regional scale.
- The 1:50000 drainage line network spatial dataset of the study area was obtained from the relevant topographic maps (2229BB, 2229BD, 2229DB, 2230AC, 2230CA & 2230AD).
- Drainage line information from the topographic maps represent the entire drainage network within the study area and include first and second order headwater streams, as defined by Strahler (1952), which may or may not be associated with wetland conditions. Drainage lines with higher Strahler stream orders are more likely to be associated with riparian habitat and/or wetland conditions.
- Potential perennial river crossings were identified and assessed through the use of the National Spatial Biodiversity Assessment (NSBA) spatial dataset and NFEPA River dataset, which are and based on the DWAF 1:500 000 rivers GIS layer (Driver et al., 2004). The GIS layer was obtained via the BGIS website hosted by the South African National Biodiversity Institute.
- The recently finalised PESEIS (Present Ecological State and Ecological Importance and Ecological Sensitivity) data for South African Rivers on a Sub-Quaternary level was also used. This dataset provides the most recent and most detailed available information on a desktop level for all rivers within the country (DWS 2014). The following components are specifically relevant to this assessment:
    - The Present Ecological State (PES) of rivers present within the study area.
    - The Ecological Importance (EI) of rivers present within the study area.

  - The Ecological Sensitivity (ES) of rivers present within the study area.
  - The Ecological Condition (EC) of rivers present within the study area, based on a combination of the PES, EI and ES values.
- Available GIS shape files (layers) of drainage lines and wetlands were used, while potential watercourse lines and watercourse polygons were delineated within each corridor alternative through an on-screen digitizing process making use of Google Earth Pro and GIS software.
- A conservative approach was applied during the watercourse interpretation and delineation process. Delineated watercourses were grouped into two classes:
  - Watercourse Lines, which mainly represent headwater drainage lines.
  - Watercourse polygons, which includes wetlands, rivers with riparian habitat, washes, larger ephemeral channels, dams, etc (Appendix A).
- Quarries and dams that are no connected to the drainage network, such as off channel dams, retention ponds at sewage treatment works, and tailing dams were not included as part of the watercourse delineation process.
- Vegetation textural changes were considered as part of the delineation process in these marginal areas, but these could also have been affected by disturbances.
- Existing roads and tracks were obtained from the 1:50000 topographical maps and were as shapefiles to illustrate existing access in each corridor. The rational being the more roads and tracks that are present will potentially allow the creation of fewer new tracks through wetlands and other watercourses.
- In order to assess the extent of road and track networks more accurately, a centre line was created for each corridor, as well as a 500m buffer around each centre line. It is expected that the centre line and the surrounding central zone (500 m buffer) will be the most likely area for the position of individual towers during the route design phase of the selected corridor.
- The presence of drainage lines from the 50000 topographical map, rivers, NFEPA wetlands, road and tracks, as well as newly delineated watercourse lines and polygons will therefore be assessed at different spatial scales. These can include within corridor alternatives, along centre lines of corridor alternatives and within a 500 m buffer in the centre of corridor alternatives.
- Information obtained from the existing and created spatial datasets were used to compare different corridor alternatives to one another, in order to identify the best suited option for the proposed 500 kV transmission line from a watercourse consideration.
- A survey was undertaken during 14-18 July 2014 whereby the physical environment of the proposed corridors were inspected by road and from the air. Wetland and related watercourses investigations are not constrained by seasonality, specifically for the purpose of this assessment which did not involve detailed surveyed along proposed

infrastructure positions. This will be completed as part of the EMP Walk Down survey, for which a summer survey is recommended.

2.2. Limitations

- Due to the large size of the study area and time constraints, the focus of this report has been on the potential watercourses present in the corridor alternatives. These corridor alternatives form the study area.
- No detailed surveying within each of the corridor alternatives were undertaken to identify and delineate wetlands and other watercourses within the study area.
- A desktop-based approach was applied to identify potential watercourses within the study area and available route alternatives due to the size of the combined corridors, as well as the large distances between the start and end points of the different corridor alternatives.
- Verification of the presence and extend of delineated watercourses is therefore needed. Such a survey will form part of the EMP 'Walk Down' watercourse assessment study once the final route has been selected (to be undertaken after the EIA process).
- Spatial databases available in the public domain are not comprehensive in terms of watercourse, and especially wetland coverage. Results from these datasets, as well as the newly created watercourse spatial layer specific to the study area, are therefore not considered as complete. Indistinct drainage lines and small wetlands, specifically small seeps and pans, are expected to be under represented in the created watercourse layers.

3. PROJECT AND STUDY AREA DESCRIPTION

3.1. Project Description

- The proposed development entails the construction of 2 x new 500kV transmission lines from Nzhelele Substation in the south (Limpopo Province) to Triangle Substation in the north (Zimbabwe). This study solely focuses on the five corridor alternatives within the South African portion of the project; from Nzhelele Substation in the south to the Limpopo River in the north (Figure 1).
- The three 4km wide corridor alternatives consists of the following (Figure 1):
  - Alternative 1 (Alt 1)
  - Alternative 1/2 (Alt 1/2)
  - Alternative 2 (Alt 2)
  - Alternative 2A (Alt 2A)
  - Alternative 2B (Alt 2B)

- These five corridors can be reduced to three functional corridors (Figure 1):
    - Alternative 1 (Alt 1) & Alternative 1/2
    - Alternative 1/2 (Alt 1/2), Alternative 2 (Alt 2) and Alternative 2A (Alt2A)
    - Alternative 1/2 (Alt 1/2), Alternative 2 (Alt 2) and Alternative 2A (Alt2B)

3.2. Study Area

- The study area is entirely located within the Limpopo Water Management Area (WMA).
- Four Quaternary Catchments overlap with the five corridor alternatives. These include A71K, A71L, A80F, and A80G. Of these four Quaternary Catchment A71K and A80G are overlap with the largest portion of the study area and incorporates the majority of the corridor alternatives. Quaternary Catchment A71L overlaps with a small portion of Corridor Alt 1 at its northern-most section, while A80F has a negligible overlap with the southern-most section of the study area (Table 1).
- barely overlaps with the study area and should for alB12B, B12C, and B41A, while X11C, X11D, X11E, and X21F are located within the Inkomati WMA (Table 1).
- All of the perennial rivers in the study area and its immediate surroundings have a Critically endangered or Endangered conservation status based on data from the National Spatial Biodiversity Assessment (Driver et al. 2004), (Figure 2).
- The climate of the study area can be described as arid to semi-arid with an average rainfall of close to 300 mm per annum (Table 1).
- The Present Ecological Condition (PES) of the quaternary catchments vary between Largely Natural to Largely Modified, while the Ecological Importance and Sensitivity (EIS) range between Low to High (Table 1).
- The study area forms part of the Mopane Bioregion of the Savanna Biome (Mucina & Rutherford, 2006).
- No Threatened Ecosystem listed according to the 2011 Schedule (Government Gazette of December 2011) of the Biodiversity Act (Act 10 of 2004) overlaps with the study area.
- Formal protected areas present include the Baobab Tree Reserve (Corridor Alt 1 & Alt 2A), the Blouberg Langjan NPAE focus area (Corridor Alt 1 & Alt 2A), as well as the Maremani Nature Reserve (Corridor Alt 2A & Alt 2B) and Limpopo View Conservancy (Corridor Alt 2B).
- Watercourses present within the study area forms part of the Limpopo Flats geomorphological province and Limpopo Plains Ecoregion (Level 1), (Middleton & Bailey, 2008).

Table 1: Indicates the mean annual precipitation (MAP), mean annual runoff (MAR) in million cubic meters (mcm), mean annual evapotranspiration (MAE), Ecological Importance and Sensitivity (EIS) class, and Present Ecological State (PES) per Quaternary Catchment for the Limpopo Water Management Area that overlaps with the study area (Middleton & Bailey, 2008).

Quaternary Catchment	**Rainfall (MAP)**	**Runoff (MAR)**	**Evapotranspiration (MAE)**	**PES Category**	**EIS class**
A71K	305 mm	7.5 mcm	2000 mm	Class B: Largely natural	Moderate
A71L	288mm	5.59 mcm	2050 mm	Class B: Largely natural	Low/Marginal
A80F	388 mm	3.37 mcm	1750 mm	Class D:Largely modified	High
A80G	333 mm	5.72 mcm	1950 mm	Class D:Largely modified	Moderate

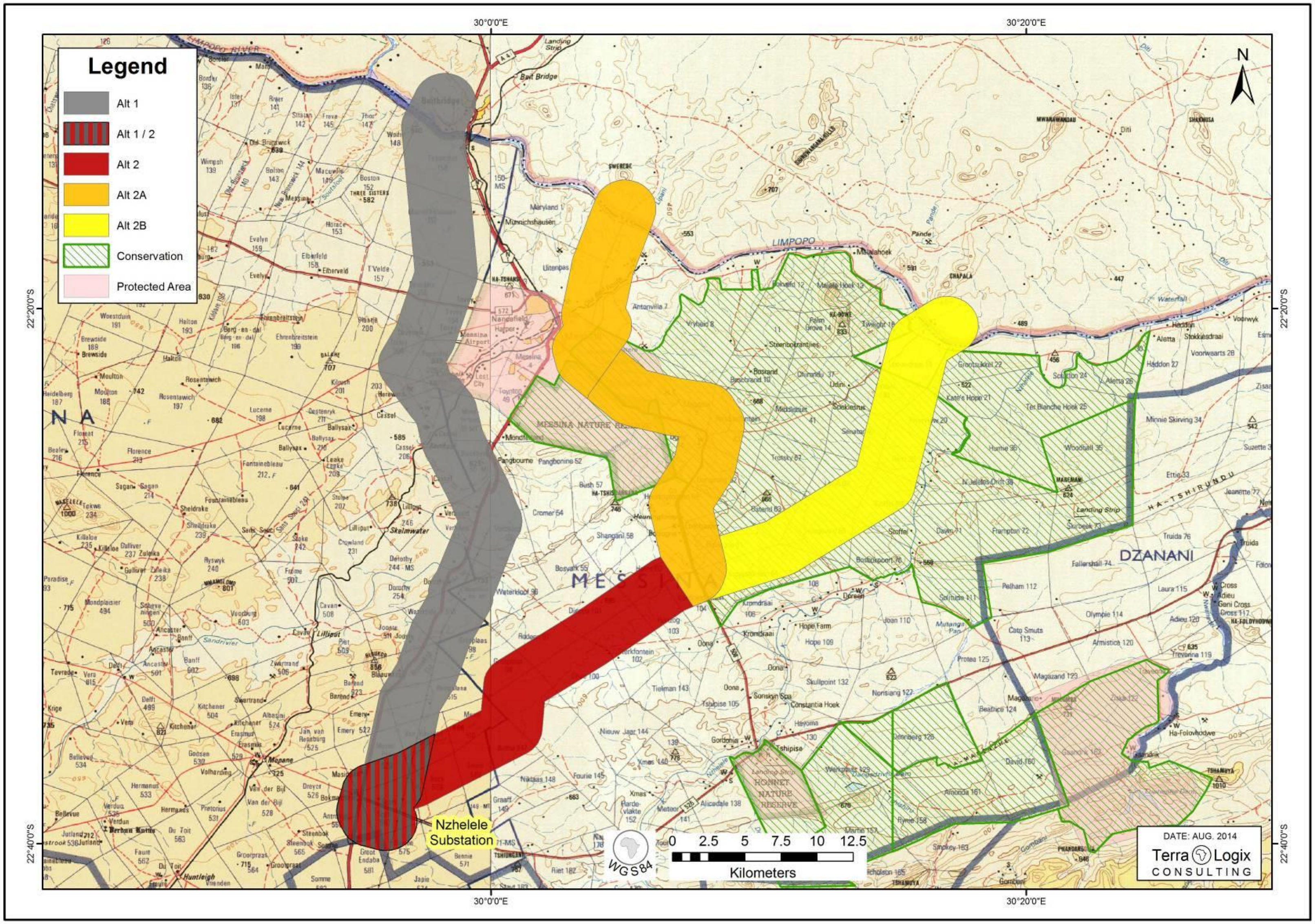

Figure 1: Illustrates the study area along with the different corridor alternatives. Of the five alternatives there are only three practical alternatives: Alt 1 and Alt1/2; Alt1/2, Alt 2 and Alt 2A; & Alt1/2, Alt 2 and Alt 2B.

4. WATERCOURSE DELINEATION & ASSESSMENT

4.1. Watercourse Delineation

- Watercourse information from available spatial data sets, such as the 1:50000 topographical maps, and the NFEPA River and Wetland data sets are illustrated in Figure 2 & 3 for the 500m corridors around the centre lines of corridor alternatives.
- Information from a desktop assessment per Sub Quaternary Reaches for river sections that overlap with the study area indicate that Corridor Alternative 1 contains the highest number of river reaches (six), with an Ecological Condition (EC) that range from B-C. Corridor Alternative 2 and 2A have three river crossings with an EC that range from B-C, while Corridor Alternative 2 and 2B have two river crossings, both with a B Ecological Condition (Table 2).
- Based on experience existing spatial datasets under represent the number and extent of watercourses that may be present within a site. Even in arid to semi-arid environments, such as this particular study area. This is due in part to the azonal features of wetlands and related watercourses (Mucina & Rutherford, 2006), and the fact that existing watercourse inventories and datasets data sets are typically created at a national scale, which reduce the level of resolution and detail.
- In order to increase the accuracy regarding the number of watercourses present within the corridor alternatives, centre lines and centre line buffers a on-screen watercourse delineation process was applied to create new data sets that are expected to be of a better quality and more representative compared to existing watercourse datasets.
- Demarcated watercourses were classified into two groups (Figure 4-12):
    - *Watercourse lines*, which include headwater drainage lines, narrow streams and channels, and narrow riparian systems and channelled valley bottom wetlands. The level of confidence associated with this watercourse category is low to moderate, as some non-watercourse linear features, such as vehicle, game and livestock tracks could also mistakenly have been included as part of the delineation process. Further field verification is therefore necessary during an EMP Walk Down assessment.
    - *Watercourse polygons*, which include dams, larger riparian systems, channels, and channelled valley bottom wetlands. Seep, flat and pan wetlands are also included as part of this watercourse category. The level of confidence associated with this watercourse category is moderate and will benefit from field verification during an EMP walk down assessment.

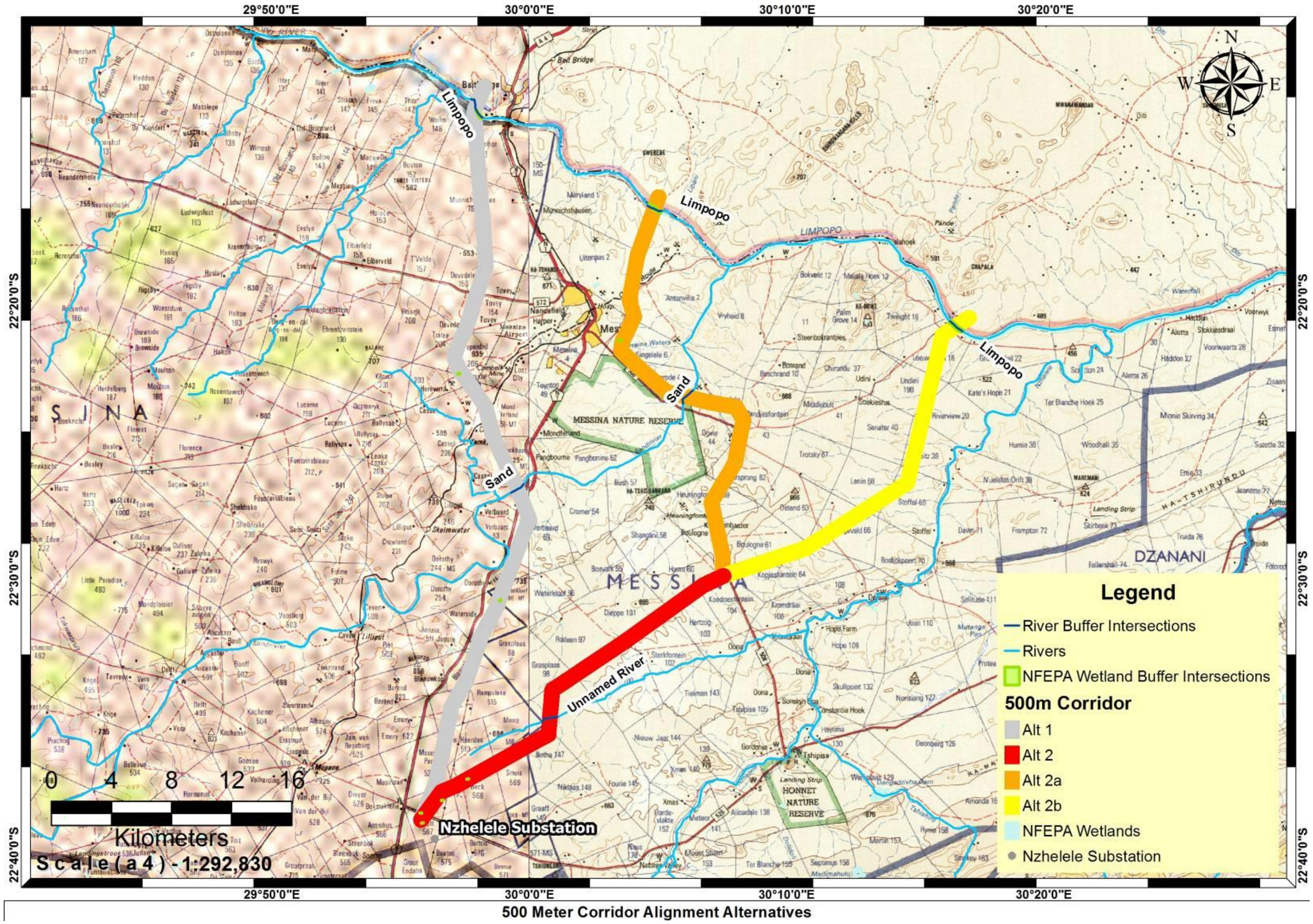

Figure 2: Illustrates rivers and expected wetlands within the study area and surroundings from the NFEPA data sets. River crossings are illustrated within a 500m buffer around the centre line of the corridor alternatives. This map illustrates the combined 500m buffer sections in Alt 1 and Alt 1/2 simply as Alt 1, and the combined 500m buffer in Alt 1/2 and Alt 2 simply as Alt 2.

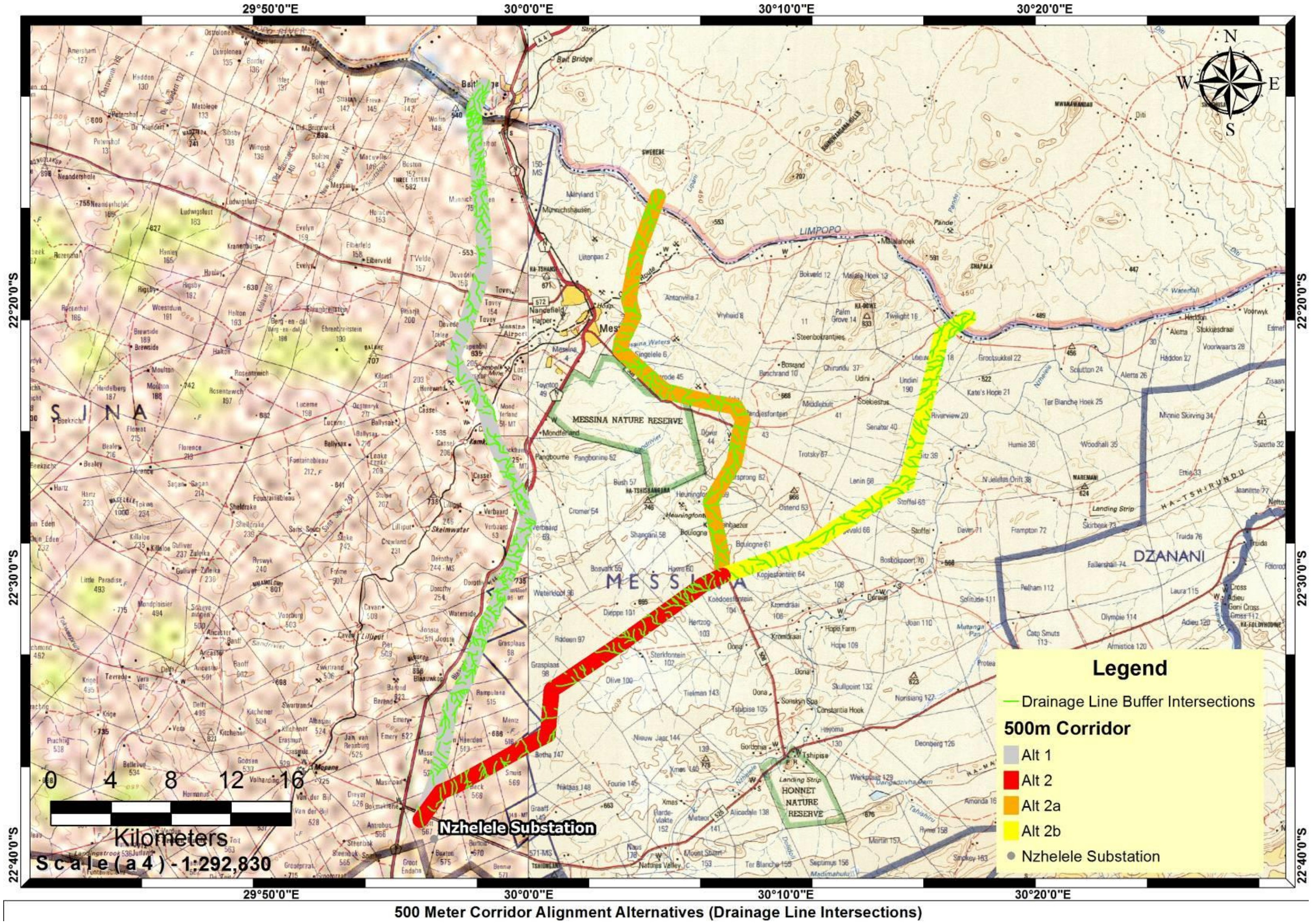

Figure 3: Illustrates drainage lines from the 1:50000 topographical maps clipped to the 500m buffers around corridor alternative centre lines. This map illustrates the combined 500m buffer sections in Alt 1 and Alt 1/2 simply as Alt 1, and the combined 500m buffer in Alt 1/2 and Alt 2 simply as Alt 2.

Table 2: Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and the combined Ecological Condition (EC) per Sub Quaternary Reaches for river sections that overlap with 4 km wide corridor alternatives (study area), centre lines and 500m centre line buffers (DWS 2014).

Corridor name	Number of SQ river reaches in corridor	River name	SQ river reach code	PES category (Median)	Mean EI class	Mean ES class	Stream order	EC (Based on median PES and highest of EI or ES means)	Overlap with
Alt 1	1	Sand	A71K-00019Sand	B	High	Moderate	3	B	Corridor, centre line and 500m centre line buffer
	2	Limpopo	A71K-00019Limpopo	C	High	High	5	B	Corridor, centre line and 500m centre line buffer
	3	Unnamed Sand River tributary	A71K-00029	B	Moderate	Very low	1	C	Only with Corridor 1
	4	Sand	A71K-00031	C	High	Moderate	3	B	Only with Corridor 1
	5	Soutsloot	A71L-00015	A	Moderate	Very low	2	C	Only with Corridor 1
	6	Limpopo	A71L-00006Limpopo	C	High	High	5	B	Only with Corridor 1
Alt 1/2	0	-	-	-	-	-	-	-	No overlap
Alt 2	1	Unnamed Nzhelele River tributary	A80G-00043	B	Moderate	Very low	1	C	Corridor, centre line and 500m centre line buffer
Alt 2A	1	Sand	A71K-00019Sand	B	High	Moderate	3	B	Corridor, centre line and 500m centre line buffer
	2	Limpopo	A71K-00019Limpopo	C	High	High	5	B	Corridor, centre line and 500m centre line buffer
Alt 2B	1	Limpopo	A80G-00026	C	High	High	5	B	Corridor, centre line and 500m centre line buffer

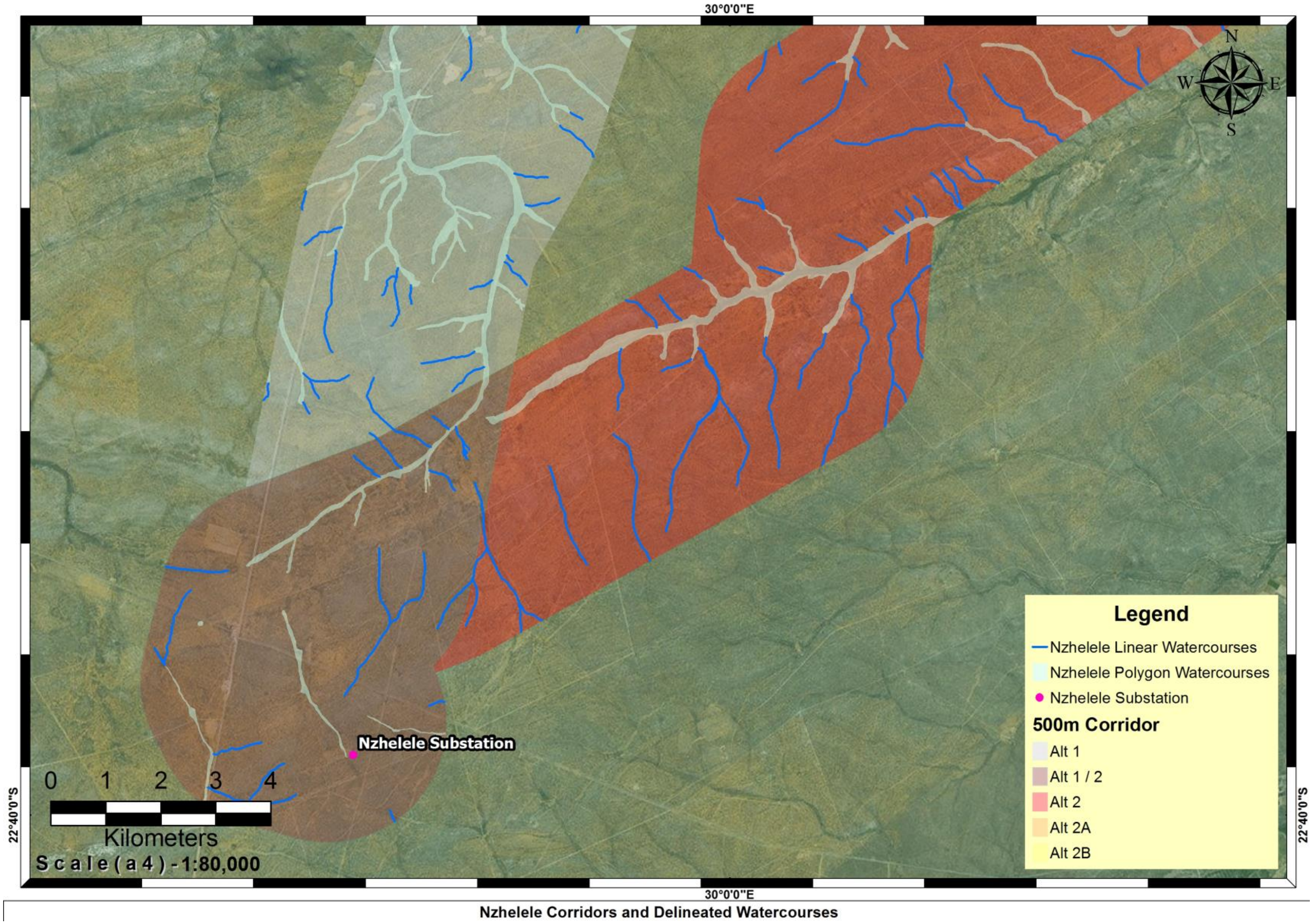

Figure 4: Illustrates delineated Watercourse Lines and Polygons around the southernmost section of the study area around Nzhelele Substation, with Corridor Alternative 1 and 1/2 visible.

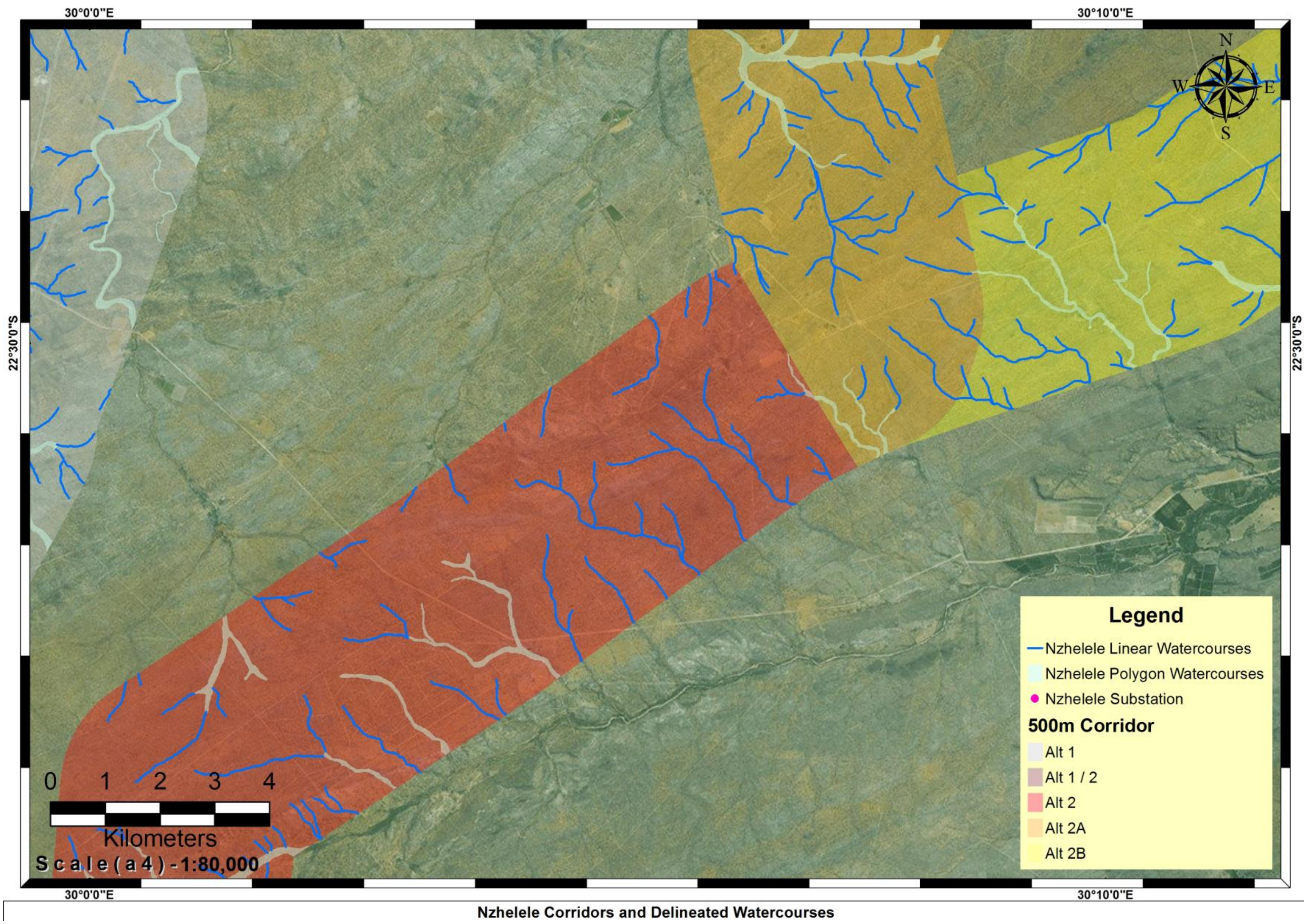

Figure 5: Illustrates delineated Watercourse Lines and Polygons around the split from Corridor Alternative 2 into Alternatives 2A and 2B.

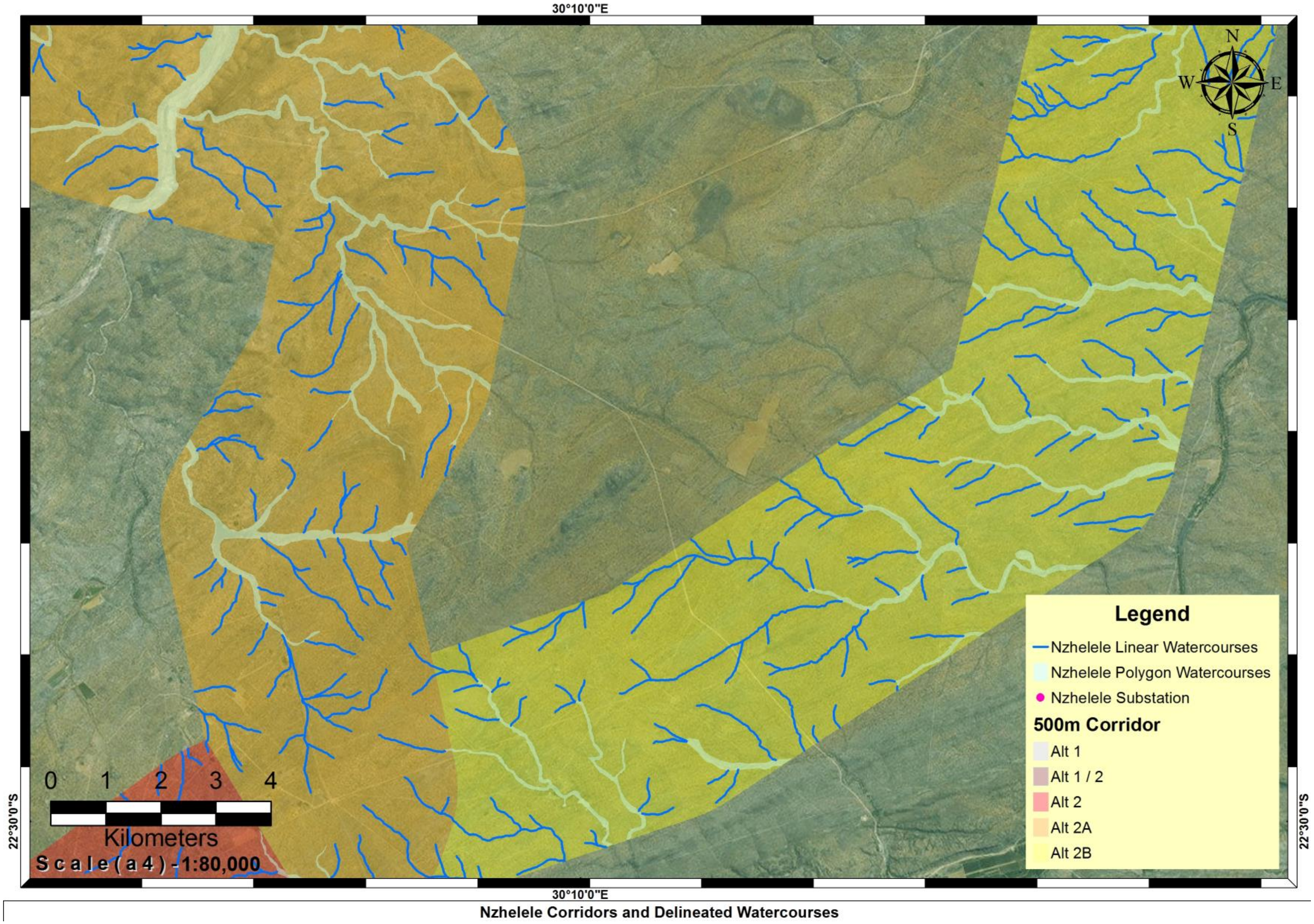

Figure 6: Illustrates delineated Watercourse Lines and Polygons north of the split from Corridor Alternative 2 into Alternatives 2A and 2B.

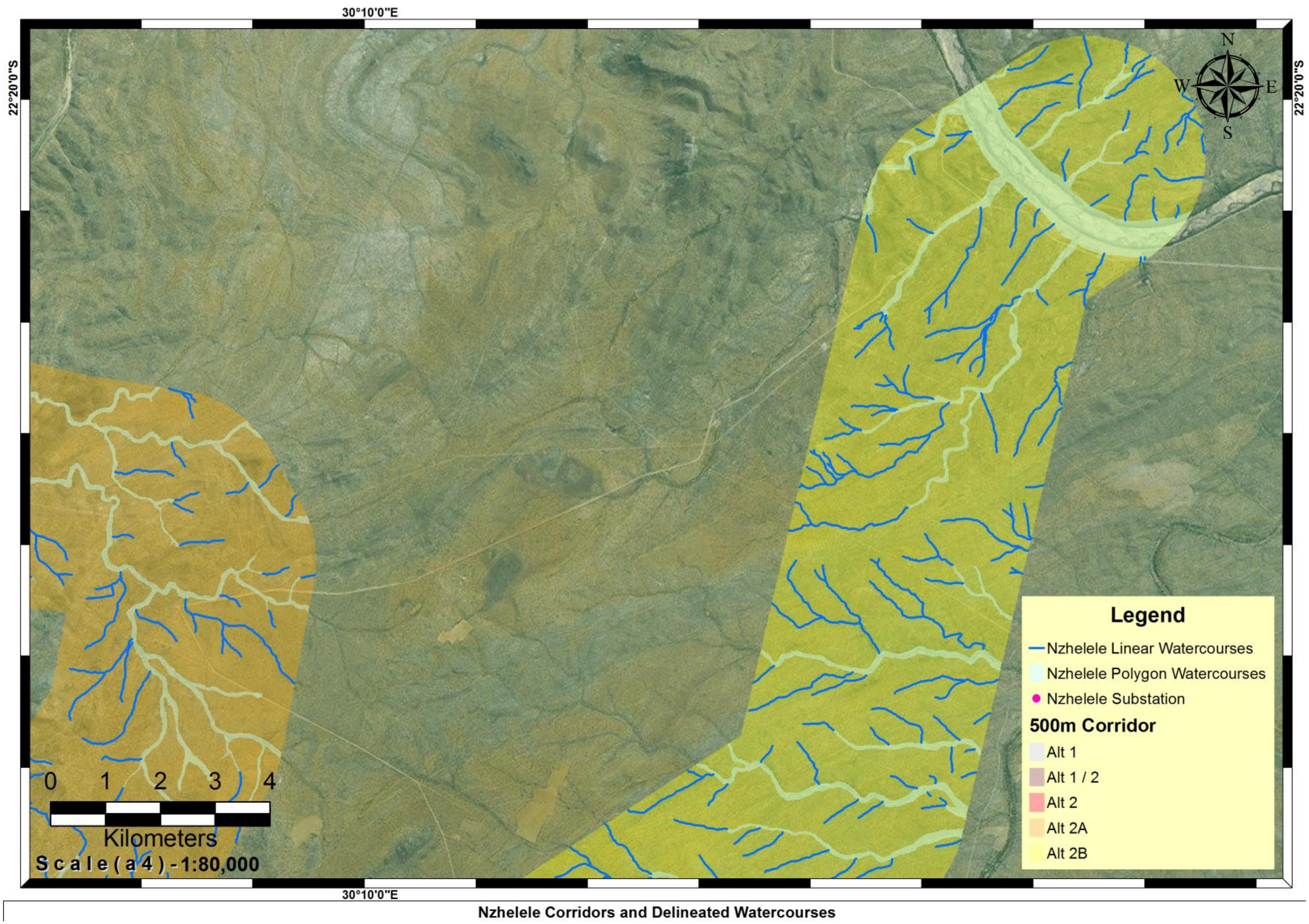

Figure 7: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 2B, with the Limpopo River crossing visible in the north.

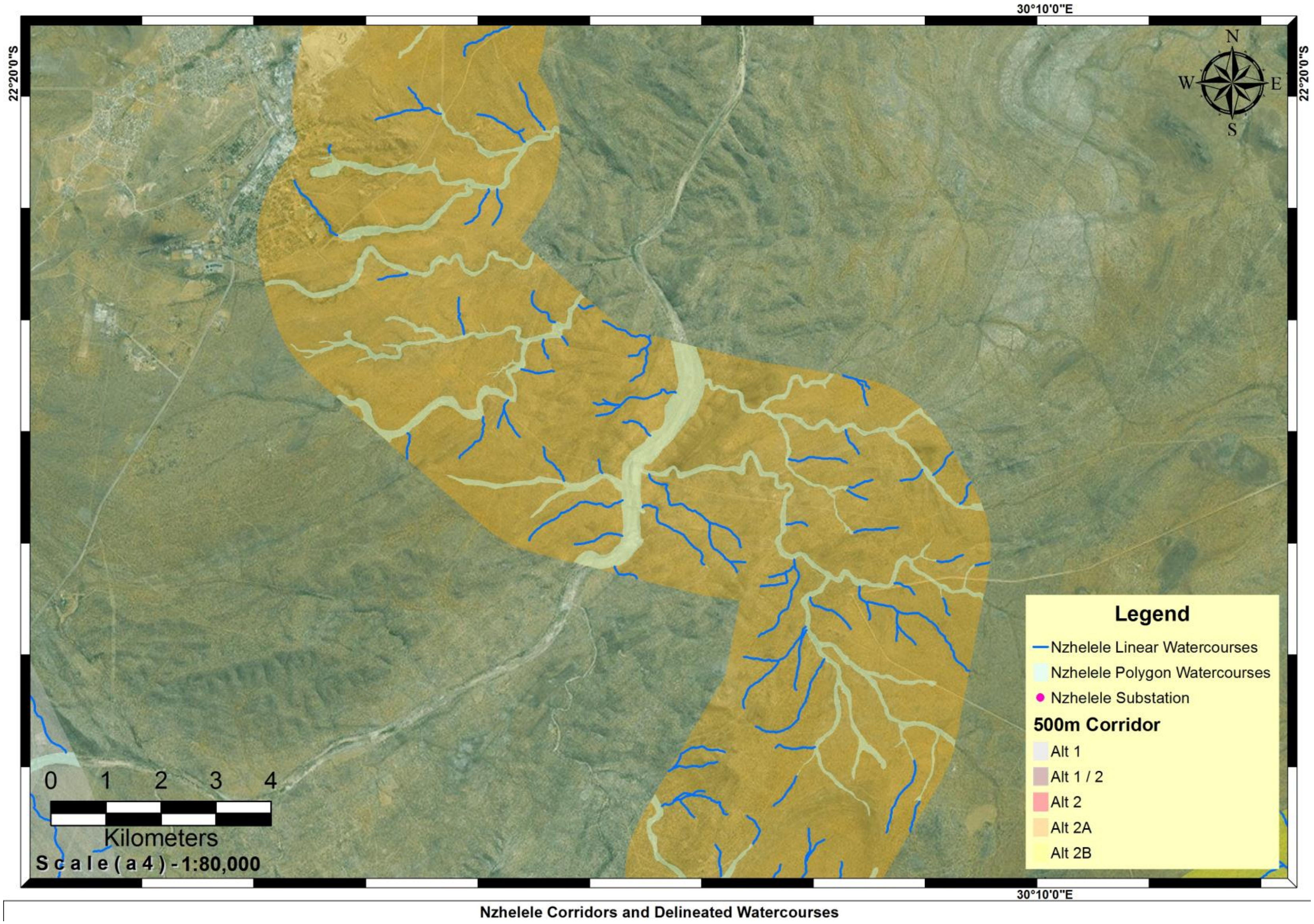

Figure 8: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 2A, with the Sand River crossing visible in the centre and a portion of the town of Musina visible in the northwest.

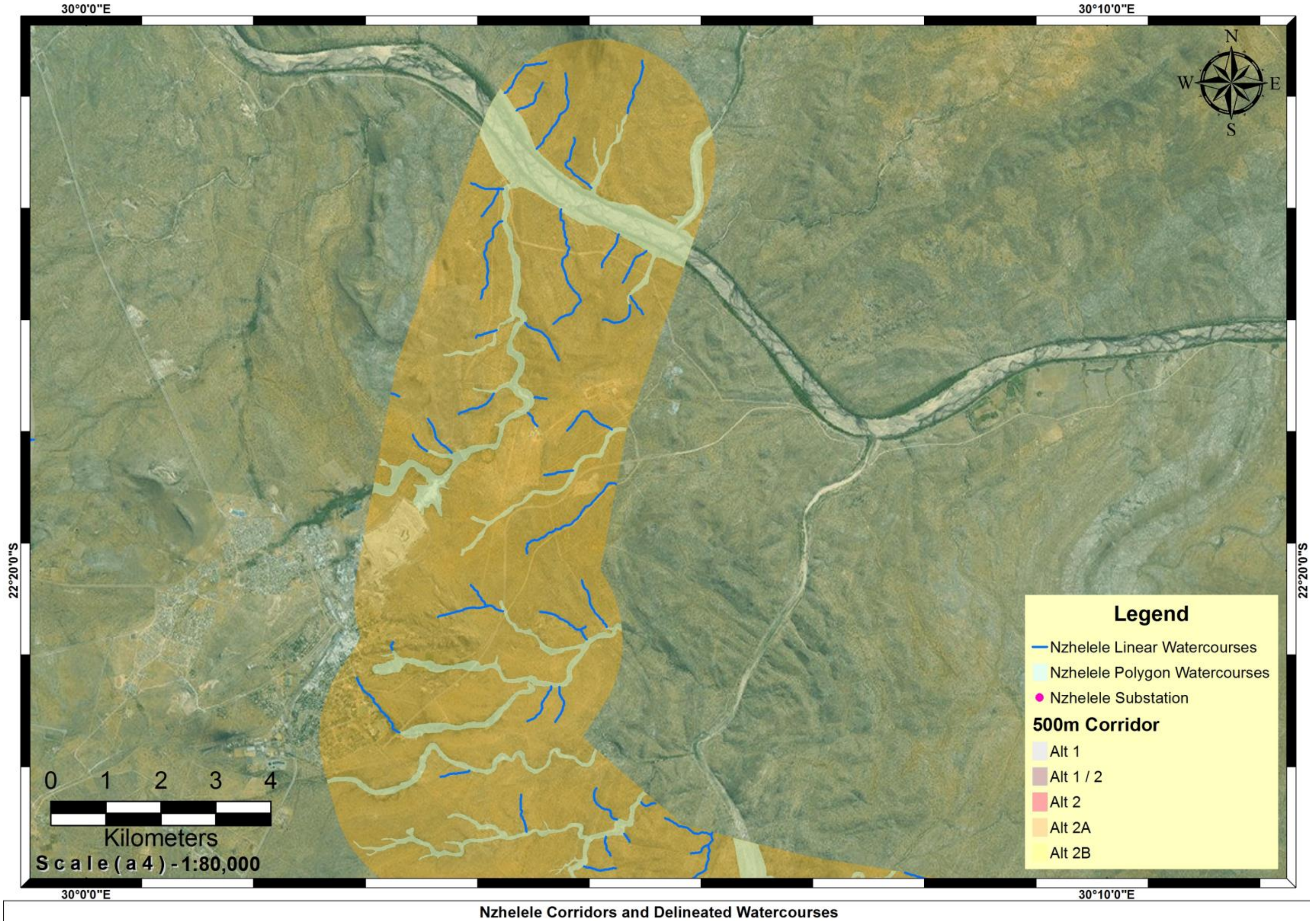

Figure 9: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 2A, with the Limpopo River crossing visible in the north and the town of Musina visible in the southwest.

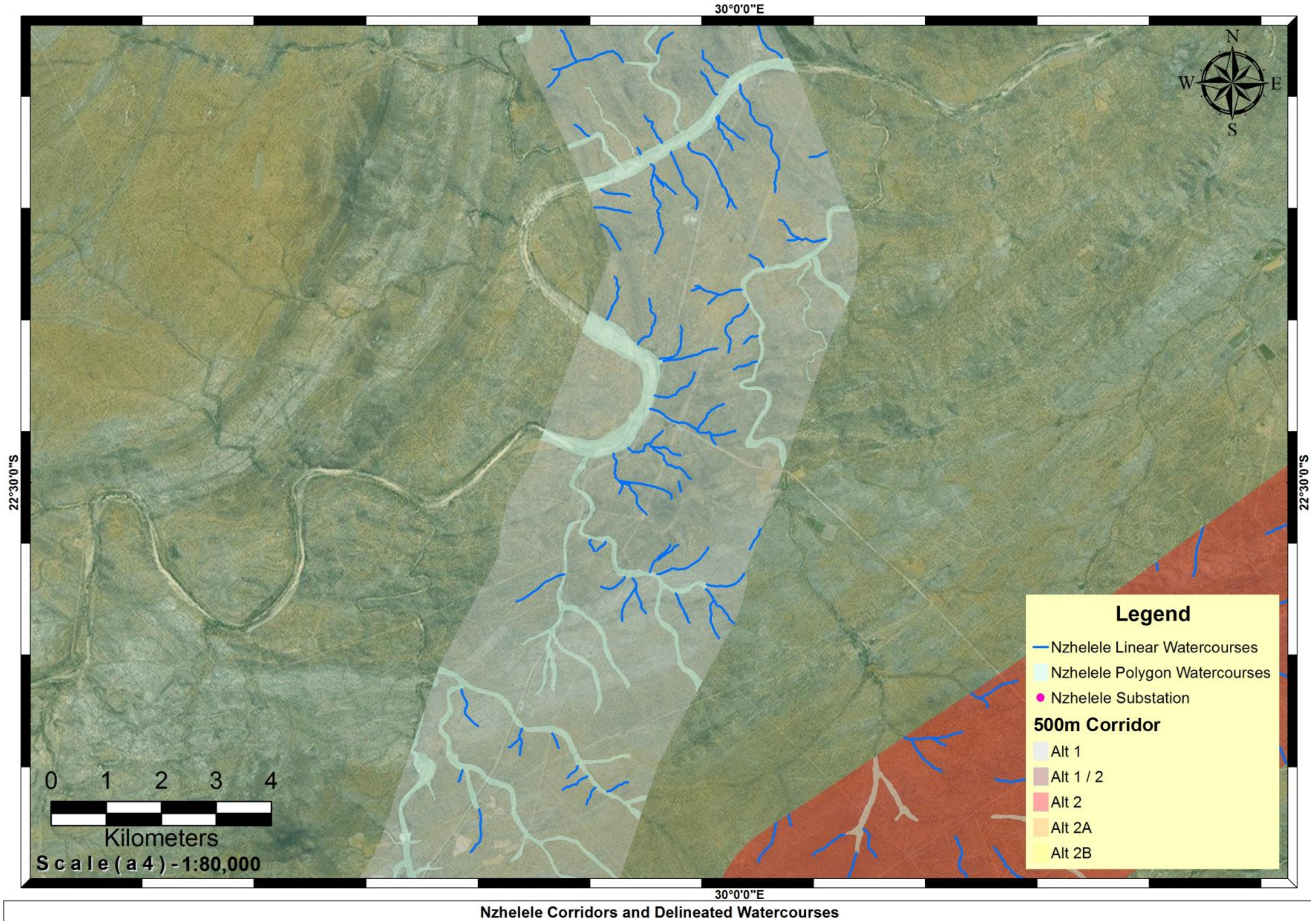

Figure 10: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 1, with the two Sand River crossings visible in the centre and north.

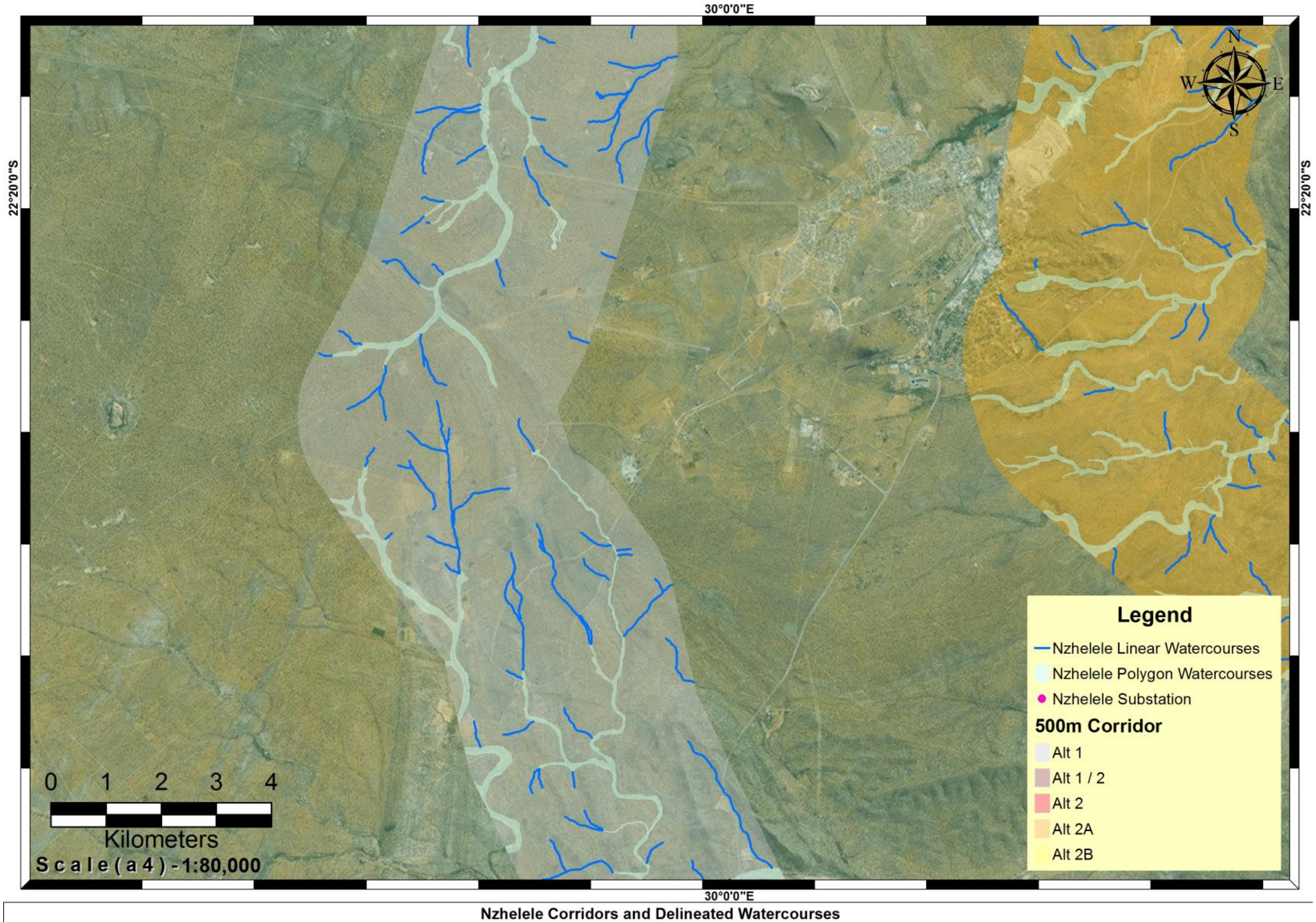

Figure 11: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 1, with a portion of Corridor Alternative 2A the town of Musina visible in the east.

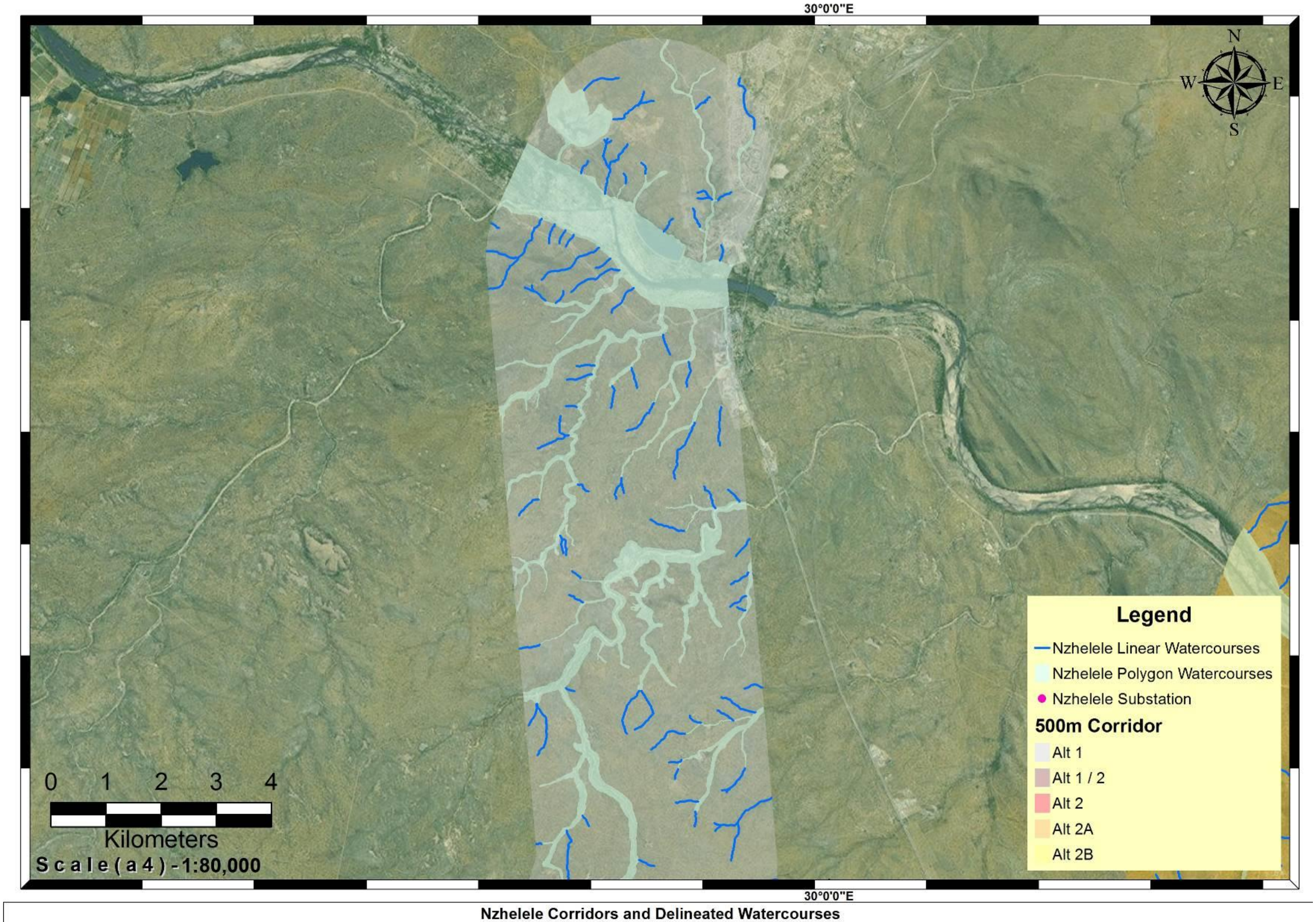

Figure 12: Illustrates delineated Watercourse Lines and Polygons in Corridor Alternative 1, with the Limpopo River crossing visible in the north.

4.2. Watercourse Assessments

- Data obtained from existing watercourse-related and road spatial datasets are indicated in Table 3-5 for the centre lines of corridor alternatives and 500m buffers around centre lines. The following can be inferred for each of the three **functional corridor alternatives** as defined in Section 3.1 (Table 3-5):
    - The combined centre line through and 500m centre line buffer around Alternative 1 and 1/2, overlap with the highest number of drainage lines and contains the longest combined length of drainage lines, as obtained from the 1:50000 topographical data sets.
    - The combined centre line through and 500m centre line buffer around Alternative 1/2, . Alt 2 and Alt 2B, overlap with the lowest number of drainage lines and contains the shortest combined length of drainage lines, as obtained from the 1:50000 topographical data sets.
    - The combined 500m centre line buffer around Alternative 1/2, . Alt 2 and Alt 2B, contain the highest combined surface area for NFEPA Wetlands. NFEPA Wetlands are however not regarded as representative of wetland within the study area and their presence is therefore associated with a low level of confidence.
- Data obtained from newly delineated (created) Watercourse Line and Polygon datasets are indicated in Table 6-8 for the centre lines of corridor alternatives and 500m buffers around centre lines. The following can be inferred for each of the three **functional corridor alternatives** as defined in Section 3.1 (Table 6-8):
    - The combined 4km wide corridor and 500m centre line buffer around Alternative 1 and 1/2, overlap with the highest number of delineated Watercourse polygons, contain the largest combined size of Watercourse polygons, and its centre line intersects with the largest combined length of Watercourse polygons.
    - The combined 4km wide corridor and 500m centre line buffer around Alternative 1/2, Alt 2 and Alt 2B, overlap with the highest number of delineated Watercourse lines and contain the largest combined length. The combined centre line also transects the largest number of Watercourse lines. It is however important to note that the same functional corridor contain a low number (nearly the lowest) of Watercourse polygons in its 4km wide corridor, and the lowest number of Watercourse polygons in its 500m centre line buffer. In addition, it contains the smallest combined surface area size of Watercourse polygons in its 4 km buffer and 500 m centre line buffer. Lastly and importantly, the centre line of this functional corridor alternative intersects the smallest combined length of Watercourse polygon crossings.

Table 3: Indicates data from available spatial datasets for 500m buffers round the centre line of corridor alternatives (Figure 2). This includes the number of drainage line, their combined length, the number of NFEPA Rivers, and the combined river length in assessed 500m centre line buffer. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of drainage lines (1:50000 topomaps)	Combined length of drainage lines (1:50000 topomaps)	No. of rivers (NFEPA River dataset)	Combined length of rivers (NFEPA River dataset)
Alt 1 & Alt 1/2	268	154 330 m	2	2 602 m
Alt 1/2 & Alt 2	99	57 349 m	1	1 095 m
Alt 2A	110	88 064 m	2	2 216 m
Alt 2B	105	65947 m	1	1 056 m
Alt 1/2, Alt 2 & Alt 2A	209	145 413 m	3	3 311 m
Alt 1/2, Alt 2 & Alt 2B	204	123 296 m	2	2 151 m

Table 4: Indicates data from available spatial datasets for 500m buffers round the centre line of corridor alternatives (Figure 3). This includes the number of NFEPA Wetlands, their combined surface area, the number of road and track sections from the 1:50000 topographical maps, their combined distance in assessed 500m centre line buffer. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of NFEPA wetlands	Combined surface area of NFEPA wetlands	No. of road sections	Combined length of road sections
Alt 1 & Alt 1/2	5	9.26 ha	124	104 076 m
Alt 1/2 & Alt 2 &	4	1.96 ha	37	22 944 m
Alt 2A	3	11.71 ha	47	50 976 m
Alt 2B	2	21.12 ha	59	39 192 m
Alt 1/2, Alt 2 & Alt 2A	7	13.67 ha	84	73 920 m
Alt 1/2, Alt 2 & Alt 2B	6	23.08 ha	96	62 136 m

Table 5: Indicates data from available spatial datasets for the centre lines of corridor alternatives. This includes the number of drainage line crossings, the number of NFEPA River crossings, the number of NFEPA Wetland crossings, and the number of road and track crossings. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of drainage line crossings (1:50000 topomaps)	No. of river crossings (NFEPA)	No. of wetland crossings (NFEPA)	No. of road crossings (1:50000 topomaps)
Alt 1 & Alt 1/2	88	2	0	66
Alt 1/2 & Alt 2 &	46	1	1	19
Alt 2A	40	2	1	25
Alt 2B	36	1	1	22
Alt 1/2, Alt 2 & Alt 2A	86	3	2	44
Alt 1/2, Alt 2 & Alt 2B	82	2	2	41

Table 6: Indicates data from delineated (created) Watercourse Polygon and Watercourse Line data sets for assessed 4 km wide corridor alternatives (Figure 2). This includes the number of Watercourse lines, their combined length, the number of Watercourse polygons and the combined length. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of Watercourse lines (delineated)	Combined length of Watercourse lines (delineated)	No. of Watercourse polygons (delineated)	Combined Watercourse polygon area (delineated)
Alt 1	238	138 264 m	47	2071.67 ha
Alt 1/2	22	16 392 m	6	81.29 ha
Alt 1 & Alt 1/2	260	154 657 m	53	2152.96 ha
Alt 1/2 & Alt 2	80	82 192 m	7	279.97 ha
Alt 2A	147	110 292 m	23	1284.6 ha
Alt 2B	213	157 861 m	25	794.71 ha
Alt 1/2, Alt 2 & Alt 2A	227	192 484 m	30	1564.57 ha
Alt 1/2, Alt 2 & Alt 2B	293	240 053 m	32	1074.68 ha

Table 7: Indicates data from delineated (created) Watercourse Polygon and Watercourse Line data sets for 500m buffers round the centre line of corridor alternatives (Figure 2). This includes the number of Watercourse lines, their combined length, the number of Watercourse polygons and the combined length. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of Watercourse lines (delineated)	Combined length of Watercourse lines (delineated)	No. of Watercourse polygons (delineated)	Combined Watercourse polygon area (delineated)
Alt 1 & Alt 1/2	85	42 726 m	24	518 ha
Alt 1/2 & Alt 2	34	21 976 m	7	65.93 ha
Alt 2A	46	25 528 m	15	351.88 ha
Alt 2B	58	31 967 m	11	184.69 ha
Alt 1/2, Alt 2 & Alt 2A	80	47 504 m	22	417.81 ha
Alt 1/2, Alt 2 & Alt 2B	92	53 943 m	18	250.62 ha

Table 8: Indicates data from delineated (created) Watercourse Polygon and Watercourse Line data sets along the centre line of corridor alternatives (Figure 2). This includes the number of Watercourse lines, the number of Watercourse polygons, and their combined intersection length as transected by centre lines. Maximum values are highlighted in red, minimum values are highlighted in green for each functional corridor alternative (total of three).

Corridor name	No. of Watercourse lines (delineated)	Combined length of Watercourse lines (delineated)	No. of Watercourse polygons (delineated)	Combined Watercourse Polygon intersection length (delineated)(
Alt 1 & Alt 1/2	23	N/A	13	5444 ha
Alt 1/2 & Alt 2	17	N/A	5	597 ha
Alt 2A	12	N/A	12	3965 ha
Alt 2B	14	N/A	9	1700 ha
Alt 1/2, Alt 2 & Alt 2A	29	N/A	17	4561 ha
Alt 1/2, Alt 2 & Alt 2B	31	N/A	14	2297 ha

5. SUMMARY & CONCLUSION

5.1. Discussion

- Created delineated watercourses (Lines and Polygons) are regarded as more accurate compared to results from existing watercourse-related spatial datasets, such as the NFEPA Wetlands and drainage lines from the 1:50000 topographical maps.
- Watercourse Polygons are in return regarded as more accurate compared to Watercourse Lines, with the latter likely to include some non-watercourse linear features, such as vehicle, game and livestock tracks due to the method through which these features have been captured.
- Different watercourse spatial features favoured different alternatives, which complicated the selection of a preferably alternative route selection from a watercourse consideration.
- Results of different watercourse properties in each alternative corridor and alternative center-line are summarised in Table 9 for comparison.

Table 9: Comparison of different watercourse properties in each of the **three functional corridor alternatives** (Section 3.2). Properties in favour refer to features that are associated with a lower watercourse sensitivity and properties against are associated with features that have a higher perceived sensitivity.

Properties in favour:	Properties against:
Option 1: Functional Corridor Alternative 1 & Alt 1/2	
Contains the highest number of existing road and track sections in its 500 m centre line buffer and crossings through it centre line.	The centre line 500m centre line buffer of this alternative overlap with the highest number of drainage lines and contains the longest combined length of drainage lines, as obtained from the 1:50000 topographical data sets.
Contains the longest length of existing road and track sections in its 500 m centre line buffer.	The 4km wide corridor and 500m centre line buffer overlap with the highest number of delineated Watercourse polygons, contain the largest combined size of Watercourse polygons, and its centre line intersects with the largest combined length of Watercourse polygons.
The combined 500m centre line buffer contains the lowest number of NFEPA Wetlands.	Contains the highest number of NFEPA River sections in its 4 km wide corridor
The combined 500m centre line buffer contains the lowest combined surface area for NFEPA Wetlands.	
Option 2: Functional Corridor Alternative 1/2, Alt 2 & Alt 2A	
Contains the lowest number of delineated Watercourse lines in its 4 km corridor	Contains the highest number of NFEPA River sections in its 500 m centre line buffer

Properties in favour:	**Properties against:**
Contains the lowest number of delineated Watercourse polygons in its 4 km corridor	Contains the longest distance of combined river reach length in its 500 m centre line buffer.
Contains the lowest number of delineated Watercourse lines in its 500 m centre line buffer.	Contains the highest number of NFPEA Wetlands in its 500 m centre line buffer and crossings through its centre line.
	Contains the highest number of Watercourse polygon crossings through its centre line
Option 3: Functional Corridor Alternative 1/2, Alt 2 & Alt 2B	
The 4 km wide corridor contains a low number (nearly the lowest) of Watercourse polygons.	The 4km wide corridor and 500m centre line buffer overlap with the highest number of delineated Watercourse lines and contain the largest combined length of Watercourse line.
The 500m centre line buffer contains the lowest number of Watercourse polygons.	The centre line transects the largest number of Watercourse lines.
The 4km wide corridor and 500 m centre line buffer contains the smallest combined surface area size of Watercourse polygons.	Nearly the entire Corridor Alt 2B is located within a nature reserve (Maremani Nature Reserve). This is the largest portion of any of the assessed corridor alternatives that overlap with a protected area.
The centre line intersects the smallest combined length of Watercourse polygon crossings.	The combined 500m centre line buffer contains the highest combined surface area for NFEPA Wetlands

- The following deductions can be made based on the comparison presented in Table 9:
  - Several of the unfavourable watercourse properties can be mitigated by careful pylon positioning. This will reduce the length of transmission lines and number of pylons in watercourse crossings. Many watercourse crossings can be spanned through design planning that regards the mapped watercourse polygons and lines as sensitive habitats that should be avoided as far as possible
  - Impacts associated with the construction of permanent access tracks for maintenance of pylons and the servitude are, however, more difficult to mitigate. The number of Watercourse polygon crossings and the combined centre line intersect length through delineated Watercourse polygons are specifically relevant in this instance.
  - This is one of the main reasons why Option 1 is regarded as the most sensitive and the least favourable alignment alternative (Alt 1 and Alt 1/2), (Table 9). Option 1 should therefore not be considered.
  - The most favourable route selection is a close match between Option 2 and Option 3.

- Option 2 (Alt 1/2, Alt 2 and Alt 2A) is considered more favourable compared to Option 3 (Alt 1/2, Alt 2 and Alt 2B).

Wetlands and other watercourses are protected water resources in the National Water Act (Act 36 of 1998) (NWA). Development within watercourses is regarded as a water use, which can only be allowed through an approved Water Use License, irrespective of the condition of the affected watercourse.
Section 21 of the NWA defines different types of water use in a watercourse. Water uses activities associated with wetland and riparian stream typically include the following:

(c) impeding or diverting the flow of water in a watercourse

(i) altering the bed, banks, course or characteristics of a watercourse.

The implication is that authorization will have to be obtained from the Department of Water and Sanitation (DWS) before water use activities can be initiated in demarcated wetlands, and riparian areas. This will have to be done through a Water Use License Application (WULA). Various Listed Activities, as provided in the National Environmental Management Act (Act 107 of 1998) (NEMA) and amended in December 2014, also pertain to wetlands and other watercourses for which permission will have to be obtained from the Department of Environmental Affairs (DEA).

In order to obtain environmental authorisation the proposed transmission line infrastructure will have to be assessed in terms of their expected impacts on sensitive environmental features, such as watercourses, along with recommended impact mitigation measures. This study is only concerned with the selection of a suitable corridor from the available alternatives, but also provides an impact assessment with mitigation measures (Section 6). Pylon specific mitigation and access road mitigation will only be possible once a final corridor alternative has been approved and after a walk down EMP survey has been undertaken for the final alignment with proposed pylon positions.

All of the delineated watercourses along with their buffers are regarded as sensitive features that should be protected from project-related impacts. These watercourses should therefore receive thorough attention and consideration during the environmental planning phase, and changes should be made to infrastructure components that currently overlap with them as far as possible.

Six project-related watercourse impacts have been identified (refer to Section 6 for more information):

- Compaction of watercourse soils (Construction and Operational Phases)
- Changes to the hydrological regime caused by infrastructure construction in watercourses (Construction Phase)

- Decrease in water quality (Construction Phase)
- Loss of watercourse habitat (e.g. wetland, riparian, and drainage lines), as a result of pylon construction, new access roads, quarries and created construction camps. It also applies to the removal of project-related infrastructure from watercourses during the Decommissioning Phase (Construction and Decommission Phases)
- Increased sedimentation and erosion (Construction and Operational Phases)
- Encroachment of invasive alien plant species into watercourses (Operational Phase)

None of the six identified impacts have a High significance rate after mitigation for any of the three phases of the proposed development (Table 10).

The proposed project is not considered to contain any fatal flaws in terms of wetlands and other watercourses that were assessed in this report, provided that recommendations and impact mitigation measures provided in this report are implemented (also refer to Section 6 in this regard). There is therefore no objection to the project from a watercourse perspective given the above conditions.

5.2. Recommendations

The following recommendations have been made with regards to expected project-related watercourse impacts (also refer to Figures 4 to 12):

- All watercourse lines and polygons, which include headwater drainage lines, dams, depressions (pans), other wetlands, and riparian areas are regarded as sensitive features.
- These areas should therefore be avoided by all practical means and no construction may be undertaken in these areas without the necessary environmental authorization and adherence to mitigation measures.
- It follows, that construction impacts should be avoided or reduced as far as possible in watercourses and headwater drainage lines due to their vulnerability to erosion and potential to support rare and protected biodiversity.
- Watercourse lines and polygons that were delineated as part of this study and submitted with this report as GIS shapefiles should be used by the Eskom engineers and technical personnel to help find a best fit route alignment in the selected corridor alternative.
- Such as best fit would require planning input to reduce the number of watercourse crossings and the number of crossing lengths that cannot be spanned. The extent and positioning of watercourse boundaries can then be refined through a field verification process along the final alignment (EMP Walk Down assessment).

Table 10: Provides a summary of results from the assessment for each of the 6 identified project related watercourse impacts for each of the project phases (also refer to Section 6 for more information).

Project phase	Nature of Impact	Management Measures	Duration	Scale	Magnitude / Severity	Probability	Significance rate
Construction Phase	Compaction of watercourse soils	Without management	1	1	6	5	Moderate
		With management	1	1	2	5	Negligible
	Changes to the hydrological regime caused by infrastructure construction in watercourses	Without management	4	1	8	5	High
		With management	4	1	2	4	Low
	Decrease in water quality	Without management	3	1	8	5	High
		With management	3	1	2	3	Negligible
	Loss of watercourse habitat (e.g. wetland, riparian, and drainage lines), as a result of pylon construction, new access roads, quarries and created construction camps.	Without management	5	1	8	5	High
		With management	5	1	6	5	Moderate
	Increased sedimentation and erosion	Without management	4	1	6	4	Moderate
		With management	3	1	2	4	Negligible
	Nature of Impact	**Management Measures**	**Duration**	**Scale**	**Severity**	**Probability**	**Significance**
Operational Phase	Compaction of watercourse soils	Without management	1	1	6	5	Moderate
		With management	1	1	2	2	Negligible
	Increased sedimentation and erosion	Without management	4	1	6	4	Moderate
		With management	3	1	2	4	Negligible
	Encroachment of invasive alien plant species into watercourses	Without management	4	1	6	4	Moderate
		With management	3	1	2	4	Low
	Nature of Impact	**Management Measures**	**Duration**	**Scale**	**Severity**	**Probability**	**Significance**
Decommission Phase	Loss of watercourse habitat (e.g. wetland, riparian, and drainage lines), as a result of pylon and access road infrastructure removals.	Without management	5	1	8	5	High
		With management	5	1	6	5	Moderate

- It is strongly recommended that individual watercourses should be demarcated along the selected alternative centerline during a Walk Down phase. This will enable a more accurate identification and demarcation of wetlands, rivers and other watercourses as defined by the National Water Act (NWA), Act 36 of 1998. It will also enable the provision of pylon specific recommendations regarding watercourse impacts.

- Watercourse boundaries should be marked for the construction team to ensure easy identification and trigger appropriate mitigation measures/actions.
- Any water use in a watercourse that is unavoidable during the construction phase of the proposed project will require a Water Use License from the Department of Water Affairs. Water Use, as defined by the NWA, include the following.
  (c) impeding or diverting the flow of water in a watercourse
  (i) altering the bed, banks, course or characteristics of a watercourse
- It is important to determine whether new project-related infrastructure structures in watercourses will be permanent or temporary. Water Use License requirements for permanent structures, such as road crossings, are expected to require more thorough mitigation compared to temporary watercourse road crossing structures.
- The creation of new permanent watercourse road crossing structures should be kept to the absolute minimum.
- Monitoring is recommended along sediment control structures and road crossings in and through watercourse crossings during the construction phase. Permanent vehicle tracks / roads that have been created for access and maintenance in watercourses should be monitored for erosion and blockages during the operational phase of the project.
- More detailed watercourse impact mitigation measures are provided for the proposed development in Section 6 and should also be adhered to.

6. IMPACT EVALUATION & MITIGATION

6.1. Introduction

This section of the report evaluates the potential impact of the proposed development on the environment, specifically regarding watercourses present within the selected alternative. The impact of the development should ideally be assessed in terms of the following development phases:

- Construction Phase
- Operational Phase
- Decommissioning Phase

Limited emphasis will be provided on the decommissioning phase, with most of the attention focused on the construction followed by the operational phase of the project.

6.2. Approach

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The significance of the aspects/impacts of the process will be rated by using a matrix derived from Plomp (2004) and adapted to some extent to fit this process. These matrixes use the consequence and the likelihood of the different aspects and associated impacts to determine the significance of the impacts. The significance of the impacts will be determined through a synthesis of the criteria below:

Probability: Described the likelihood of the impact actually occurring.

Improbable - The possibility of the impact occurring is very low, due to the circumstances, design or experience.

Probable - There is a probability that the impact will occur to the extent that provision must be made therefore.

Highly Probable - It is most likely that the impact will occur at some stage of the development.

Definite - The impact will take place regardless of any prevention plans and there can only be relied on mitigatory measures or contingency plans to contain the effect.

Duration: The lifetime of the project

Short Term: The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.

Medium Term: The impact will last up to the end of the phases, where after it will be negated.

Long Term: The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.

Permanent: The impact is non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Spatial Scale. The physical and spatial size of the impact

Local: The impacted area extends only as far as the activity, e.g. footprint

Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.

Regional: The impact could affect the area including the neighbouring residential areas.

Magnitude/ Severity: Does the impact destroy the environment, or alter its function

Low: The impact alters the affected environment in such a way that natural processes are not affected.

Medium: The affected environment is altered, but functions and processes continue in a modified way.

High: Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance: This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

Negligible: The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.

Low: The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.

Moderate: The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.

High: The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

Each of the abovementioned ratings are associated with specific weights illustrated in Table 11.

Table 11: The following weights are assigned to each attribute as part of the impact evaluation process.

Aspect	**Description**	**Weight**
Probability	Improbable	1
	Probable	2
	Highly probable	4
	Definite	5
Duration	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/Severity	Low	2
	Medium	6
	High	8
Significance	Sum (Duration, Scale, Magnitude) x Probability	
	Negligible	≤20
	Low	>20 ≤40
	Moderate	>40 ≤60
	High	>60

6.3. Impact assessment table

Project-related impacts on wetlands, riparian areas, and other watercourses, as well as recommended mitigation measures are discussed below for different project phases based on the above. The significance of each impact is rated without mitigation measures and with impact mitigation measures.

<table>
<tr><th>Impact</th><th>Probability</th><th>Duration</th><th>Scale</th><th>Magnitude/Severity</th><th>Significance (without mitigation)</th><th>Significance (with mitigation)</th></tr>
<tr><td colspan="7">CONSTRUCTION PHASE</td></tr>
<tr><td>Compaction of watercourse soils</td><td>Definite</td><td>Short term</td><td>Local</td><td>Medium</td><td>Moderate</td><td>Negligible</td></tr>
<tr><td colspan="7">Mitigation:
Avoid driving on watercourses during construction of the transmission line to prevent vehicle track incision and the potential for channel initiation. Where this is unavoidable crossing structures should be in place across affected wetlands and other watercourses along with a relevant Water Use License (WULA). These crossing structures can include the following:
• A wearing course (wear surface) should be added as a surface layer on top of geotextile fabrics, which forms base for surface capping.
• A wearing course (surface cap) of good quality clastic or gravel material also has the potential to reduce surface scour by creating a mix that will easily bind together and minimise detachment of particles.
• Geotextiles provide four important functions in temporary road and trail surface construction that includes separation, drainage, reinforcement, and stabilisation.
• Geotextiles work as separation fabrics when they are placed between gravel caps and underlying soils to prevent the materials from mixing.
• Additional benefits of such as crossing structure include:
o It defines a single route alignment for vehicle travel.
o Provides a ‘wear and carry’ surface over unsuitable and easily compactable wetland soils.
o This results in a stable, durable crossing surface for vehicle access, including heavy motor vehicle traffic.
o Halts the widening and the development of braided crossing sections, while formerly used track alignments are allowed to naturally stabilise and revegetate.</td></tr>
<tr><td>Changes to the hydrological regime caused by infrastructure construction in watercourses</td><td>Definite</td><td>Long term</td><td>Site</td><td>High</td><td>High</td><td>Low</td></tr>
<tr><td colspan="7">Mitigation:
• Restrict the construction of infrastructure in watercourses as far as possible.
• Pylon construction in wetland, riparian and wash buffer zones should only be allowed in exceptional circumstances where these areas cannot be</td></tr>
</table>

Impact	Probability	Duration	Scale	Magnitude/Severity	Significance (without mitigation)	Significance (with mitigation)
spanned. • All unavoidable overlap between individual pylons and along road crossings in demarcated watercourses will require a Water Use License (WUL) in order to be allowable. Efforts should therefore be undertaken during the planning phase and proposed walk down phase to avoid infrastructure overlap as far as possible. • Construction and maintenance tracks and roads should also be located outside of watercourses (see impact 1.).						
Decrease in water quality	Highly probable	Medium term	Site	High	**High**	**Negligible**
Mitigation: No refueling of construction vehicles should occur within 50 m of demarcated watercourses. Hydrocarbons should not be stored within 50 m of buffered watercourses.						
Loss of watercourse habitat (e.g. wetland, riparian, and drainage lines), as a result of pylon construction, new access roads, new quarries and created construction camps.	Definite	Long term	Local	High	**High**	**Moderate**
Mitigation: • No pylons, construction camps or quarries should not be constructed within watercourses (i.e. wetlands, riparian habitat, and headwater drainage lines). • The smallest possible footprint should be utilized and positioned as close to the boundary of the affected watercourse in cases where pylon construction in a watercourse is unavoidable. • Pylon construction activities in these areas should be completed in the shortest possible time and preferably during the dry season.						

Impact	Probability	Duration	Scale	Magnitude/Severity	Significance (without mitigation)	Significance (with mitigation)
• Excavated watercourses should be re-sloped to a stable gradient (e.g. at least a slope of 1:3), revegetated with naturally occurring indigenous species or annual grass species such as *Eragrotis tef*, and covered with biojute to help facilitate revegetation soon after construction. • Pylons in wetlands or other watercourses should not be located on steep slopes, channels or other surfaces with visible erosion features. • New roads and access tracks should not be constructed in watercourses as far as possible. Existing access tracks and roads should rather be used where available. • Please note that these pylon construction recommendations are the last mitigation option and all other attempts should first be attempted to prevent pylons in watercourses. Infrastructure construction in watercourses would also require a WULA.						
Increased sedimentation and erosion	Highly probable	Long term	Site	Moderate	**Moderate**	**Negligible**
Mitigation: • Road crossings should make provision for dispersed flow and energy dissipation. Refer to the abovementioned recommendation regarding pylon (tower) construction in watercourses. • Management of roadside drainage is the most effective way of controlling sediment runoff from unsealed roads. • To minimise sediment load, an unsealed road network should have an emphasis on slowing drainage flows and dispersing them more frequently. • Stormwater should be diverted away from the road early and often, so as to reduce the catchment area of the road. • The use of drains, such as table drains and cut-off drains, should not be used in any of the watercourse crossings. These types of drains typically have concentrated high-velocity flows and can frequently form channels within the watercourse. These channels provide an easy pathway for sediment to reach streams and adversely impact on water quality. • Alternative options for stormwater control should therefore be considered. These include the use of: o Grass swales. o Entrenched rock (rip rap) aprons. o Sediment traps, such as hay bales or silt traps. These structures do, however, require maintenance. o Vegetated buffer/ filter strips. The use of vegetation in the watercourse, especially downstream of unsealed road surfaces, will help to provide soil stability and reduce sediment input. It is important to use local and indigenous plant species. • Permanent crossing structures across channelled watercourses can include unvented fords that are constructed of riprap, gabions, or concrete to provide a stream crossing without the use of pipes. Water will periodically flow over the crossing. • If the construction of a crossing is unavoidable make sure that substrate continuity in the watercourse is maintained within upstream and downstream portions of the channel bed.						

<table>
<tr><th>Impact</th><th>Probability</th><th>Duration</th><th>Scale</th><th>Magnitude/Severity</th><th>Significance (without mitigation)</th><th>Significance (with mitigation)</th></tr>
<tr><td colspan="7">Unvented fords are best suited for ephemeral or intermittent streams (streams that are dry most of the year). Unvented fords may also be used across some shallow, low velocity perennial streams.
Other important best management practices associated with ford design, construction, operation and maintenance that should be adhered to as far as possible, include (Anon 2006):
Where possible locate crossings on straight channel segments (avoid meanders).
To the extent possible align crossings perpendicular to the stream channel.
Minimize the extent and duration of the hydrological disruption.
Use appropriate energy dissipaters and erosion control at the outlet drop.
Minimize impact to riparian vegetation during construction
Prevent excavated material from running into water bodies and other sensitive areas.
Use appropriate sediment barriers (silt fence and hay bales).
Dewater prior to excavation.
Check construction surveys to ensure slopes and elevations meet design specifications.
Use appropriately graded material (according to design specifications) that has been properly mixed before placement inside the structure.
Compact bed material.
Tie constructed banks into upstream and downstream banks.
Evaluate structure stability.</td></tr>
<tr><td colspan="7">OPERATIONAL PHASE</td></tr>
<tr><td>Compaction of watercourse soils</td><td>Definite</td><td>Short term</td><td>Local</td><td>Medium</td><td>Moderate</td><td>Negligible</td></tr>
<tr><td colspan="7">Mitigation:
Avoid driving through watercourses during the operation phase of the project to prevent vehicle track incision and the potential for channel initiation, as well as other forms of erosion. Where this is unavoidable crossing structures should be in place across affected wetlands and other watercourses along with a relevant Water Use License (WULA). These crossing structures can include the following:
A wearing course (wear surface) should be added as a surface layer on top of geotextile fabrics, which forms base for surface capping.
A wearing course (surface cap) of good quality clastic or gravel material also has the potential to reduce surface scour by creating a mix that will easily bind together and minimise detachment of particles.
Geotextiles provide four important functions in temporary road and trail surface construction that includes separation, drainage, reinforcement, and stabilisation.</td></tr>
</table>

<table>
<tr><th>Impact</th><th>Probability</th><th>Duration</th><th>Scale</th><th>Magnitude/Severity</th><th>Significance (without mitigation)</th><th>Significance (with mitigation)</th></tr>
<tr><td colspan="7">

Geotextiles work as separation fabrics when they are placed between gravel caps and underlying soils to prevent the materials from mixing.
Additional benefits of such as crossing structure include:

It defines a single route alignment for vehicle travel.
Provides a ‘wear and carry’ surface over unsuitable and easily compactable wetland soils.
This results in a stable, durable crossing surface for vehicle access, including heavy motor vehicle traffic.
Halts the widening and the development of braided crossing sections, while formerly used track alignments are allowed to naturally stabilise and revegetate.

</td></tr>
<tr><td>Increased sedimentation and erosion</td><td>Highly probable</td><td>Long term</td><td>Site</td><td>Moderate</td><td>Moderate</td><td>Negligible</td></tr>
<tr><td colspan="7">Mitigation:

Road crossings should make provision for dispersed flow and energy dissipation. Refer to the abovementioned recommendation regarding pylon (tower) construction in watercourses.
Management of roadside drainage is the most effective way of controlling sediment runoff from unsealed roads.
To minimise sediment load, an unsealed road network should have an emphasis on slowing drainage flows and dispersing them more frequently.
Stormwater should be diverted away from the road early and often, so as to reduce the catchment area of the road.
The use of drains, such as table drains and cut-off drains, should not be used in any of the watercourse crossings. These types of drains typically have concentrated high-velocity flows and can frequently form channels within the watercourse. These channels provide an easy pathway for sediment to reach streams and adversely impact on water quality.
Alternative options for stormwater control should therefore be considered. These include the use of:

Grass swales.
Entrenched rock (rip rap) aprons.
Sediment traps, such as hay bales or silt traps. These structures do, however, require maintenance.
Vegetated buffer/ filter strips. The use of vegetation in the watercourse, especially downstream of unsealed road surfaces, will help to provide soil stability and reduce sediment input. It is important to use local and indigenous plant species.

Permanent crossing structures across channelled watercourses can include unvented fords that are constructed of riprap, gabions, or concrete to provide a stream crossing without the use of pipes. Water will periodically flow over the crossing.
If the construction of a crossing is unavoidable make sure that substrate continuity in the watercourse is maintained within upstream and

</td></tr>
</table>

<table>
<tr><th>Impact</th><th>Probability</th><th>Duration</th><th>Scale</th><th>Magnitude/Severity</th><th>Significance (without mitigation)</th><th>Significance (with mitigation)</th></tr>
<tr><td colspan="7">downstream portions of the channel bed.
• Unvented fords are best suited for ephemeral or intermittent streams (streams that are dry most of the year). Unvented fords may also be used across some shallow, low velocity perennial streams.
• Other important best management practices associated with ford design, construction, operation and maintenance that should be adhered to as far as possible, include (Anon 2006):
○ Where possible locate crossings on straight channel segments (avoid meanders).
○ To the extent possible align crossings perpendicular to the stream channel.
○ Minimize the extent and duration of the hydrological disruption.
○ Use appropriate energy dissipaters and erosion control at the outlet drop.
○ Minimize impact to riparian vegetation during construction
○ Prevent excavated material from running into water bodies and other sensitive areas.
○ Use appropriate sediment barriers (silt fence and hay bales).
○ Dewater prior to excavation.
○ Check construction surveys to ensure slopes and elevations meet design specifications.
○ Use appropriately graded material (according to design specifications) that has been properly mixed before placement inside the structure.
○ Compact bed material.
○ Tie constructed banks into upstream and downstream banks.
○ Evaluate structure stability.</td></tr>
<tr><td>Encroachment of invasive alien plant species into watercourses</td><td>Highly probable</td><td>Long term</td><td>Site</td><td>Moderate</td><td>Moderate</td><td>Low</td></tr>
<tr><td colspan="7">Mitigation:
• Transmission line infrastructure (e.g. pylons) should be located outside of demarcated watercourses with a buffer of 50 m to avoid edge effects and opportunity for the encroachment of invasive alien plant species.
• Restrict the clearing of watercourse vegetation as far as possible. Areas that have been cleared should be revegetated with indigenous species after construction.
• Compile and implement an alien plant control program during the operational phase of the project.</td></tr>
<tr><td colspan="7">DECOMISSIONING PHASE</td></tr>
</table>

Impact	**Probability**	**Duration**	**Scale**	**Magnitude/Severity**	**Significance (without mitigation)**	**Significance (with mitigation)**
Loss of watercourse habitat (e.g. wetland, riparian, and drainage lines), as a result of infrastructure removal, such as pylons and access roads.	Definite	Long term	Local	High	**High**	**Moderate**
Mitigation: • Rehabilitate old pylon footprints and access road footprints that will no longer be used. It is recommended that a site specific rehabilitation plan be developed to address affected infrastructure footprints located in watercourses and other sensitive areas prior to the decommissioning phase.						

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APPENDIX A: OVERVIEW OF WATERCOURSES

What are wetlands?

In terms of the Ramsar Convention on Wetlands (Iran, 1971), to which South Africa is a contracting party, "… wetlands include a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as saltmarshes, mangroves, and seagrass beds, but also coral reefs and other marine areas no deeper than six metres at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs (Ramsar Convention Secretariat 2007).

In South Africa, wetlands are defined as "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil" (National Water Act, Act No. 36 of 1998) (NWA). Wetlands are also included in the definition of a watercourse within the NWA, which implies that whatever legislation refers to the aforementioned will also be applicable to wetlands.

In addition, the NWA stipulates that "…reference to a watercourse includes, where relevant, its bed and banks…". This has important implications for the management of watercourses and encroachment on their boundaries, as discussed further on in this document.

The Act defines riparian areas as "…the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized 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…". Note that this does not imply that the plant species within a riparian zone must be aquatic, only that the species composition of plant assemblages must be different within the riparian area and adjacent uplands.

In terms of the latest wetland delineation document available from the Department of Water Affairs and Forestry (DWAF), now known as the Department of Water Affairs (DWA), "wetlands must have one of the following attributes" (DWAF 2005):

- **Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation.
- The presence, at least occasionally, of **water loving plants (hydrophytes)**.

- A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil." (DWAF 2005, p.4)

It follows that the level of confidence associated with a specific area being considered as a wetland is proportionate to the number of confirmed indicators that positively correlate with wetland habitat. Not all indicators are always present within a specific biophysical and land use setting, while not all indicators are always reliable and/or useful under all conditions. The use of additional wetness indicators from different disciplines that are internationally applied therefore adds value and confidence in the identification and delineation of wetland habitats, especially in challenging environments.

Why are wetlands important?

Wetlands are reputed to inter alia:

- Attenuate floods.
- Retain contaminants, nutrients and sediments.
- To facilitate the recharge of groundwater resources.
- Provide an important habitat for aquatic fauna and flora.
- Provide food, building and other materials for a variety of uses.

However, it is important to note that not all wetlands perform all of these functions, and that the potential to perform specific functions depends on the available opportunity, the type of wetland and the condition (state) of the wetland system (Kotze et al. 2005; Macfarlane et al. 2008).

Why protect headwaters, arid drainage lines and small wetlands?

Small drainage lines and other surface watercourses should also afforded protection, similar to larger and better defined watercourses, as these systems also provide important functions.

Headwater drainage lines

Headwater drainage lines that only carry storm flow are ephemeral streams or A section channels that form part of first-order and even second-order streams of rivers, located at the source of drainage line networks. These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions (DWAF 2005).

Headwater drainage lines that only carry storm flow are located at the source of drainage line networks. They differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation, and their need for different protection measures from land use activities (Gomi et al. 2002). These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions. Headwater systems form part of a continuum between hillslopes and stream channels, which can be classified into four topographic units (Gomi et al. 2002):

- Hillslopes have divergent or straight contour lines with no channelised flow.
- Zero-order basins have convergent contour lines and form unchannelised hollows.
- Transitional channels (temporary or ephemeral channels) can have defined channel banks, as well as discontinuous channel segments along their length, and emerge out of zero-order basin. They form the headmost definable portion of the drainage line network (first-order channels) and can have either ephemeral or intermittent flow.
- Well defined first and second-order streams that are continuous with either intermittent or perennial flow.

Most detailed topographic maps do not include the majority of headwater channels that might be recorded during field inventories (Meyer & Wallace 2001), while their demarcation is also dependant on the scale of maps used (Gomi et al. 2002). Indistinct and discontinuous headwater drainage lines (i.e. transitional channels) should not be overlooked as they provide important functions that include:

- The value of headwater functions is normally underestimated due to their inconspicuous nature and numerous occurrences (high density) in the drainage network (Gomi et al. 2002; Berner et al. 2008).
- Headwater drainage lines are important systems for nutrient dynamics as a link between hillslopes and downstream watercourses (Gomi et al. 2002).
- They are directly linked to downstream aquatic systems and have a direct bearing on the health and functioning of larger aquatic systems, especially regarding water quality of downstream aquatic systems (Gomi et al. 2002; Dodds & Oaks 2008).
- The large spatial extent of headwater channels in the total catchment area make these systems important sources of sediment, water, nutrients and organic matter for downstream systems (Gomi et al., 2002).
- The role and functions of headwater streams within catchments and their linkages with downstream aquatic systems are not thoroughly understood (Gomi et al. 2002). Recent research, however, ascribes increasing importance to these systems regarding catchment and water resource management (Berner et al. 2008).

Drainage lines that lack distinct and/or continuous channel features or wetland indicators could be interpreted as non-watercourses, based on the watercourse definitions described in the National Water Act. These definitions require the presence of a channel for non-wetland and non-river (riparian) drainage lines (not including dams) to qualify as a watercourse. However, it can be argued that these discontinuously channeled headwater drainage lines should still be regarded as sensitive drainage systems based on international literature:

- “Smaller drainage basins have a greater sensitivity to large floods, especially in arid climates, where stream widths remain largely unchanged for drainage areas exceeding 50 km^2 due to transmission losses” (Lichvar & Wakeley, 2004).
- “…scientists know that headwater streams make up at least 80 percent of the nation’s stream network” (Meyer et al. undated, with reference to the United States of America).
- “Seasonal streams and wetlands are usually linked to the larger network through groundwater even when they have no visible overland connections.” (Meyer et al., undated).
- The role and functions of headwater streams within catchments and their linkages with downstream aquatic systems are not thoroughly understood (Gomi et al., 2002). Recent research, however, ascribes increasing importance to these systems regarding catchment and water resource management (Berner et al., 2008).
- Headwater drainage lines are crucial systems for nutrient dynamics as a link between hillslopes and downstream watercourses (Gomi et al., 2002).
- They are directly linked to downstream aquatic systems and have a direct bearing on the health and functioning of larger aquatic systems, especially regarding water quality of downstream aquatic systems (Gomi et al., 2002; Dodds & Oaks 2008).
- The large spatial extent of headwater channels in the total catchment area make these systems important sources of sediment, water, nutrients and organic matter for downstream systems (Gomi et al., 2002).

Arid drainage lines

Arid ephemeral streams are also referred to as **Washes** or ***Wadis*** in Arabia, ***Arroyos*** in Spanish, and ***Laagtes*** in Afrikaans. Laagtes are typically discontinuous channels on a flat topography in dry environments. Washes that lack distinct channel features do often display braided channel configuration referred to as *bar and swale* topography. Discontinuous streams can also display a stream pattern characterized by alternating erosional and depositional reaches. Some definitions of an arroyo specifically refer to an entrenched arid ephemeral stream with vertical walls (Lichvar & Wakeley, 2004). This definition of an arroyo is consistent with definitions of a gully or *donga* in South Africa. Ephemeral streams imply that the watercourse only flows briefly in direct response to rainfall in its immediate vicinity and that the channel is at all times isolated from groundwater inputs (Levick et al., 2008).

Extracts in italics were taken from a review article by Lichvar & Wakeley (2004) with related references (own comments are provided in brackets). Information presented here is intended to provide an overview of arid rivers and streams (drainage lines) based on international understanding:

Arid drainage lines can typically include discontinuous, ephemeral, compound, alluvial fan, anastomosing, and single-threaded channels, which vary due to a range of gradients (slopes), sediment sizes, and volumes and rates of discharge. Discontinuous ephemeral stream systems and alluvial fans are most prevalent in, but not restricted to, piedmont settings, while compound channels, anastomosing rivers, and single-thread channels with adjacent floodplains generally occupy the valley bottoms. Ephemeral and intermittent streams are the dominant stream types (drainage lines) in the arid south-western United States (they are expected to also dominate the drainage network in other arid environments). For example, in Arizona most of the stream networks—96% by length—are classified as ephemeral or intermittent (Beven &Kirby 1993).

The "master variable" responsible for shaping a drainage line is associated with the flow regime of the system, which includes variations and patterns in surface flow magnitude, frequency, duration, and timing (Poff et al., 1997). It follows that the size and shape of a drainage line channel is controlled in large part by the dominant discharge in a particular region (Lichvar & Wakeley, 2004). Fluvial morphology is frequently associated with extreme discharge events; streams and floodplains trap sediments and nutrients in addition to attenuating flood waters (Graf 1988; Leopold 1994).

Arid-land fluvial systems are critically important environments that provide valuable ecological benefits. Arid drainage lines provide inter alia the following ecosystem services (Brinson et al., 1981; Davis et al. 1996; Meyer et al. 2003).:

- Convey floodwaters.
- Help ameliorate flood damage.
- Maintain water quality and quantity.
- Provide habitat for plants, aquatic organisms, and wildlife; and determine the physical characteristics and biological productivity of downstream environments.

Limited research had been undertaken on ephemeral and intermittent arid drainage lines in South Africa, particularly systems that are characterized by indistinct or discontinuous channels. No guideline document or other local documentation exist that specifically addresses the identification and delineation of these seni-arid and often unchannelled drainage lines as riparian habitat. International literature do described these arid or semi-arid drainage lines as sensitive landscape features (Lichvar & Wakeley, 2004):

- *"Arid-region drainage line channels, especially those with sandy banks, are often very responsive to large flows and recover slowly from them because of the limited vegetation growth and the large inter-annual variability in peak discharges (Cooke et al. 1993, Tooth 2000)."*

- "*Nonexistent or poor armoring of ephemeral stream beds (Reid & Laronne 1995) increases the sensitivity of the river channel to a range of flow events and hinders the ability of the river to "hold" any one pattern. Consequently, desert rivers are often in a perpetual state of change—working to recover from a large flood but unable to "heal" completely before the next extreme event widens the channel and renews the process (Cooke et al. 1993, Tooth and Nanson 2000a).*"
- "*Smaller drainage basins have a greater sensitivity to large floods, especially in arid climates, where stream widths remain largely unchanged for drainage areas exceeding 50 km^2 due to transmission losses (Wolman and Gerson 1978).*"
- "*Arid drainage lines display a high sensitivity to change and rarely reach a state of equilibrium (Graf 1988a, Tooth and Nanson 2000a)."*

Small and isolated wetlands including, pans (depressions), seeps, and flats:

- "Ecologists describe the value of small isolated wetlands by their aggregate role in protecting wetland-dependent species through "source-sink dynamics". More variable than larger wetlands, each small wetland in an area may fluctuate in the number of individuals of a species it contains; at times a wetland may act as a "sink" when the population of a species dies out locally from that wetland, or it may be a "source" that produces surplus individuals, which can colonize a nearby sink wetland. Populations of a species that are spread over a number of locations are referred to as "metapopulations", and this source-sink dynamic is crucial to the regional survival of species. A metapopulation of a wetland-dependent species depends on the abundance and proximity of wetlands, rather than a critical size threshold. The disappearance of small wetlands from an area that relies on source-sink dynamics could result in the loss of ecological connectedness and potentially collapse the metapopulations of wetland-dependent species, causing many local extinctions." (Semlitsch 2000).
- "To protect ecological connectedness and source-sink dynamics of species populations, wetland regulations should focus not just on size but also on local and regional wetland distribution. At the very least, wetland regulations should protect wetlands as small as 0.2 hectares – the lower limit of detection by most remote sensing – until additional data are available to directly compare diversity across a range of wetland sizes." (Semlitsch 2000).

APPENDIX B: CURRICULUM VITAE OF L.E.R. GROBLER

Name:	RETIEF GROBLER
Name of Firm:	IMPERATA CONSULTING CC
Position:	Wetland Ecologist
Nationality:	South African
Languages:	Afrikaans (mother tongue), English

EDUCATIONAL QUALIFICATIONS

- BSc (Botany), University of Pretoria (1999–2001)
- BSc Hons (Botany) (cum laude), University of Pretoria (2004)
  Title of Thesis: "*The Impact of subsistence banana (Musa x paradisiaca) farming on the vegetation of peat swamp forest surrounding the Kosi Bay Lake System.*"
- MSc Botany (cum laude), University of Pretoria (2009)
  Title of Thesis: "*Phytosociology of Peat Swamp Forests of the Kosi Bay Lake System.*"

KEY QUALIFICATIONS

- **<u>Watercourse Investigations, Including Wetland and Riparian Habitat Delineation (Mapping), Assessments, Management & Rehabilitation</u>**:

Involved in wetland inventories, classification and description of watercourses, mapping of drainage lines (e.g. wetlands, rivers and ephemeral headwaters), ecological assessments, and wetland rehabilitation studies. A selection of projects demonstrating relevant experience, include:

Wetland rehabilitation

- Wetland rehabilitation assessment plans for the South African National Biodiversity Institute (SANBI) for several wetlands in the Eastern Free State. 2005.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2007-2009.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National

Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2010-2011

- Wetland health and rehabilitation assessments for two wetland rehabilitation projects, upstream of Boksburg Lake, Ekurhuleni Metropolitan Municipality, Gauteng. Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2011
- Wetland rehabilitation and assessment report for the Hogsback area (Eastern Cape Province), as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2011
- Wetland & river reinstatement and monitoring guideline report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2010
- Alien plant control in watercourse crossings (wetlands & rivers) report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2012

Wetland studies for a variety of strategic planning, residential, commercial and industrial projects

- Ecological functional assessment of wetland areas surrounding the Orlando Power Station for the proposed Ekhaya development, Soweto, Gauteng. Strategic Environmental Focus (SEF), (Pty) Ltd 2005.
- Wetland Audit for the City of Johannesburg. Reviewer and sub-consultant for Strategic Environmental Focus (SEF), (Pty) Ltd. 2008
- Elsburgspruit wetland and habitat assessment, Ekurhuleni Metropolitan Municipality, Gauteng Province. Sub-consultant for Van Riet & Louw Landscape Architects (Pty) Ltd. 2008
- Wetland and watercourse delineation and assessment for the proposed Sun City Vacation Club and Golf Course Phase 3 Development, North West Province. EkoInfo CC. 2008
- Wetland delineation & assessment study for the proposed construction and operation of an aluminum fluoride production facility and associated infrastructure on the farm Jobarne 489 JR, Ekandustria, Gauteng Province. African Geo-Environmental Services (AGES). 2010
- Development of a prioritisation framework for wetland rehabilitation in Ekurhuleni Metropolitan Municipality. Land Resources International (Pty) Ltd. 2011
- Surface watercourse and wetland desktop investigation for the Ivory Park Urban Development Framework, City of Johannesburg, Gauteng Province. Aurecon Group. 2011

- Wetland Study (Delineation & Assessment) for the proposed Witfontein Commercial & Residential Development, Ekurhuleni Metropolitan Municipality, Gauteng Province. Aurecon Group. 2011

Wetland & watercourse assessments in linear developments (power lines, roads, railway and pipeline projects) and other projects in the energy sector (e.g. solar electricity installations):

- Wetland investigation for The Hills road alternatives, Pretoria-East, Gauteng. African-EPA. 2007
- Wetland and river bio-monitoring assessments for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2009-2013
- Wetland and surface watercourse study for the proposed Ariadne-Venus 475 kV transmission line, Kwa-Zulu Natal. Baagi Environmental Consultancy. 2010
- Surface watercourse assessment study for the proposed R5 Rand Water pipeline between Rietvlei N.R. and Mamelodi, Gauteng. Aurecon Group. 2010
- Wetland and surface watercourse study for the proposed Paulputs-Aggeneys 220kV transmission line, Northern Cape. SSI Engineers and Environmental Consultants. 2011
- Surface watercourse investigation for a proposed 20MW solar electricity installation at Kalgold Mine, North West Province. Mark Wood Consultants. 2011
- Wetland and surface watercourse study for the proposed Arnot-Ginaledi 475 kV transmission line, Mpumalanga Province. Baagi Environmental Consultancy. 2012
- Watercourse investigation for the proposed upgrade of a section of the N4 Platinum Highway, Rustenburg, North West Province. Environamic. 2012.
- Wetland delineation review for the proposed 80 MW photovoltaic solar electricity installation, Grootvlei, Mpumalanga Province. Mark Wood Consultants. 2012
- Wetland and watercourse assessment study for a proposed 75MW Photovoltiac (PV) plant and associated infrastructure on a portion of the remaining extent of Erf 1, Prieska Northern Cape Province. Enviro Insight. 2012
- Water Use License application & watercourse assessment for permanent access roads on Section PL1-PL4 (Durban to Kendal) of Transnet's New Multi Product Pipeline (NMPP) Project. Transnet Capital Projects. 2012-2014
- Watercourse assessments for the Ngqura 16 MTPA manganese ore rail expansion: Area 1 & 3 (Coega – De Aar; Eastern & Northern Cape). Hatch South Africa. 2013
- Watercourse assessment for the Douglas-Hopetown road upgrade project, Northern Cape. EIMS. 2013.
- Specialist Wetland & Drainage Line Investigation for the Proposed Hermes 132 kV Distribution Line and Substation, Klerksdorp, North West Province. Envirolution Consulting. 2013

- Specialist Medupi-Borutho 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Lines. North West Province. Baagi Environmental Consultancy. 2013.
- Specialist Gromis-Orangemund 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Systems, Northern Cape Province. Baagi Environmental Consultancy. 2013
- Watercourse delineation, PES & EIS assessment specialist study for a Water Use License Application for 8 proposed distribution lines around Ngwedi MTS, SA Chrome, Boschkoppie, Impofu Substation, Styldrift, Bakubung, Ledig, Sun City, Mokwase Industries, and Manyane Substations, North West Province. Baagi Environmental Consultancy. 2014
- Environmental Impact Assessment for the Sasol PSA and LPG Project: Botanical Biodiversity and Terrestrial and Wetland Habitat. Specialist Report, Inhassoro, Mozambique. In collaboration with De Castro & Brits C.C. for Mark Wood Consultants on behalf of SASOL. 2014.
- Specialist Watercourse and Wetland Study For the Proposed 500kV Nzhelele to Triangle Eskom Powerline Project (RSA Section Only) EIA Project, Limpopo Province. Baagi Environmental Consultancy. 2014

Green Star eco-conditional office development assessments:

- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 2 development, Gauteng. Aurecon Group. 2011
- Green Star eco-conditional office assessment for the GCIS Hatfield head office development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the USAID expansion development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the Atrium on 5th development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 3 development, Gauteng. Aurecon Group. 2013
- Green Star eco-conditional office assessment for the Athol Towers development, Gauteng. Aurecon Group. 2013

Wetlands and surface watercourse assessments for mining-related developments:

- Wetland and drainage line watercourse study for a proposed Fluorspar Mine in Dinokeng, Gauteng Province. African Geo-Environmental Services (AGES), (Pty) Ltd. 2009.
- Wetland assessment study for the proposed Northern Coal Colliery near Breyton, Mpumalanga Province. Terra Soil Science. 2010.

- Desktop wetland & watercourse assessment for Harmony Gold's Kusasalethu Mine as part of their ISO 14000 environmental management certification, North West Province. DD Science. 2012.
- Watercourse assessment for a water re-use and reclamation project at Mponeng Mine, North West Province, De Castro & Brits Ecological Consultants. 2013

Additional Wetland Related Training:

- Attended a two-day DWAF (DWA) facilitated wetland training course on the Wetland Index of Habitat Integrity assessment technique (Wetland IHI methodology) presented by Mark Rountree, June 2009.

Training - Course Lecturer :

- Co-lecturer and founding member of an Introductory Wetland Training Course, presented by the Department of Botany (University of Pretoria) through the University's Continued Education at UP (CE@UP) program, and the Gauteng Department of Agriculture, Conservation and Environment (GDACE). Aspects focused on include the legislation, delineation, drivers and ecology, assessments, management and rehabilitation of wetlands. This course was started in November 2004 and presented since then on September 2005, November 2005, May 2006, July 2007, May 2008, May 2010, and May 2012.

Publications:

- Grobler, R., Bredenkamp, G. & Grundling, P-L. 2004. Subsistence farming and conservation constrains in coastal peat swamp forests of the Kosi Bay Lake System, Maputaland, South Africa. Géocarrefour 79: 4.
- Grundling, P-L. & Grobler, R. 2005. Peatlands and mires of South Africa. In: Steiner, G.M. (ed.) Mires from Siberia to Tierra Del Fuego. Stapfia 85, Landesmuseen Neue Serie 35, pp. 379-396.
- Sliva J., Grundling P-L., Kotze D., Ellery F., Moning C., Grobler R., Taylor P.B. (2005). *MAPUTALAND – Wise Use Management in Coastal Peatland Swamp Forests in Maputaland, Mozambique / South Africa.* Wetlands International, Project No: WGP2 – 36 GPI 56.

MEMBERSHIPS IN PROFESSIONAL AND GENERAL SOCIETY

Professional Society

- Pr. Sci. Nat (Professional Natural Scientist) in the fields of Botanical and Ecological Science (Registration No. 400097/09).

- Please refer to the SACNASP website to undertake a search of their registered scientists in order to authenticate that Mr. LER Grobler is registered SACNASP member and is registered for the two fields indicated. Searches can be done according to employer (Imperata Consulting) or other criteria provided in this document. http://www.sacnaspregister.co.za/search/

- **General Society**
  - International Mire Conservation Group (IMCG), since 2003.
  - Gauteng Wetland Forum (GWF), since 2006.
  - South African Wetland Society (SAWS), since 2014.

EMPLOYMENT EXPERIENCE

- **Wetland Ecologist and Project Manager: Imperata Consulting** (March 2007 – Present) Tasks include:
  - Wetland and riparian habitat delineation according to the DWAF (2005) prescribed delineation guideline, as well as the demarcation of other drainage line types (e.g. headwater streams or A Section Channels)
  - Wetland Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessments.
  - Ecosystem assessments based on phytosociological investigations (vegetation unit identification, description, and assessment), as well as associated mapping and sensitivity rating of vegetation assemblages.
  - Inventory, classification and mapping of wetland ecosystems.
  - Wetland rehabilitation and monitoring.
  - Wetland management and recommendation of impact mitigation measures.
  - Environmental risk assessments related to the presence of wetland and riparian ecosystems.
  - Project management related to specialist wetland, riparian and headwater ecosystem investigations.

- **Wetland Ecologist: SEF** (January 2006 – February 2007) Tasks included:
  - Wetland and riparian habitat delineation and wetland ecosystem functional assessments.
  - Strategic wetland assessments and mapping.

  - Vegetation analysis and description, including mapping of sensitive vegetation assemblages.

- **Nature Conservator: Tshwane Nature Conservation** (July 2005 – December 2005) Tasks included:
  - General management of the ecological integrity of greenbelt areas in the eastern section of the City of Tshwane Metropolitan Municipality, including the Colbyn Valley Peatland, Faerie Glen Nature Reserve, Moreletakloof Nature Reserve, Meyerspark Bird Sanctuary, and Murrayfield Koppie.

REFERRALS

- **Mr. Tim Liversage:** NMPP Environmental Manager at Transnet Capital Projects
  Email: Timothy.Liversage@transnet.net

  Mr. Umesh Bahadur: Director: Working for Wetlands at the Department of Environmental Affairs (DEA)
  Email: Ubahadur@environment.gov.za
  Office: 012 399 8980

- **Mr. Piet-Louis Grundling:** Independent Wetland Consultant and Researcher, as well as Chair of the South African Wetland Society (SAWS) and the International Mire Conservation Group (IMCG).
  Email: peatland@mweb.co.za