Proposed Eskom Arnot-Gumeni 400kV Double Circuit Transmission Line – Mpumalanga Province

EIA Specialist Watercourse Study

Prepared For: Baagi Environmental Consultancy
Email: baagi@ee-sa.com
Tel. nr: +27 12 365 2546 x7
Fax. nr: +27 12 365 3217

Author: LER Grobler
Company: Imperata Consulting

Date: October 2012

IMPERATA CONSULTING

Wetlands • Ecology • Responsibility

CC Reg. No: 2007/043725/23
Sole member: LER Grobler
Pr. Sci. Nat. (400097/09)
Wetland Ecologist

P.O. Box 72914, Lynnwood Ridge
Pretoria, 0040
Email: retief@imperata.co.za
Fax: 012 365 3217

Acknowledgements:

The author would like to thank Baagi Environmental Consultancy for the opportunity to carry out this work.

Suggested Citation:

Grobler, L.E.R. 2012. Proposed Eskom Arnot-Gumeni Double Circuit 400kV Line– Mpumalanga Province. EIA Specialist Watercourse Study. Baagi Environmental Consultancy, Tshwane (Pretoria).

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. Efforts were made to use existing spatial datasets relating to different watercourse types, modeled algorithms in a GIS software package to indicate areas with expected higher surface wetness, and a complete set of aerial photographs to delineate watercourses through on screen digitizing in each alternative corridor. Crane breeding data was also obtained from the Endangered Wildlife Trust (EWT) to help indicate potential crane breeding associated watercourses, which were regarded of a high conservation value.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Baagi Environmental Consultancy has been appointed by Eskom Holding Limited to carry out an environmental assessment and authorisation application for a proposed new 400kV double circuit transmission line from Arnot to Gumeni substations. The study area is located on the Eastern Highveld, in the Mpumalanga Province. Baagi Environmental Consultancy has subcontracted Imperata Consulting to carry out an assessment of watercourses, including wetlands, within the study area and the three route alternative corridors.

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 description of functions performed by wetlands within the study area.
- Provide recommendations with regards to the least sensitive route alignment option from a watercourse consideration.
- Emphasis is placed on the identification and delineation of watercourses within three route alternatives that are buffered to form a total corridor width of ± 2km. These route alternatives are described as:
    - Alternative 1- Located primarily along the southern portion of the study area from west to east. It is aligned along other powerlines for the majority of its length, including Tx lines, DX HV Lines, and a small portion of the Hendrina-Gumeni line.
    - Alternative 3 – Located along the northern portion of the study area and is aligned along the N4 Highway and existing DX HV Lines for the majority of its length.
    - Alternative 5 – Located in the centre of the study area from west to east. It is based on a modeled "Least Cost" or "Least sensitive" alternative that has been derived from technical construction specifications combined with perceived environmental sensitivities derived from existing spatial (GIS) datasets.

- Identify potential issues and impacts associated with the proposed project that could negatively affect watercourses, as well as appropriate impact mitigation measures.

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 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.

1.3.2. General limitations

- Due to the large size of the study area and time constraints, the focus of this report has been on the SALF's present in the potential development footprint alternatives within the study area. This incorporates an approximate 1.8 km wide corridor associated with each route alternative.
- A desktop-based approach was applied to identify potential surface watercourses within the study area and available route alternatives due to the size of the site and distance between the start and end points of the proposed linear development (> 100 km).
- Available spatial databases are not comprehensive in terms of surface watercourse coverage and the results presented are not considered as complete.
- An array of available spatial databases were used and considered as relevant to the identification of surface watercourses. In additional, attempts were made to incorporate more recent spatial database sets to help increase the level of confidence associated with the results.
- Recommendations are presented to help mitigate these constrains prior to the Water Use License application and construction activities should the development application be approved.

1.4. Overview of Watercourses

1.4.1. 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. The types of features included within the definition of a watercourse include:

- "…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…"
- "…any collection of water which the Minister may, by notice in the *Gazette*, declare to be a watercourse…"

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.

1.4.2. 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).

1.4.3. Why protect headwaters and small wetlands?

Small drainage lines and other surface watercourses should be afforded the same protection as well defined wetlands and larger watercourses, as these systems also provide important functions.

Headwater drainage lines

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).

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).

2. METHODS

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

- A two day orientation field survey was undertaken on 22 and 23 November 2011 to help identify watercourse types, impacts and threats 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 along the three different route alternatives. A strong desktop approach was therefore adopted to guide 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 (2529DB, 2529DD, 2530CA, and 2530CC).
- 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 perennial rivers.

- Potential perennial river crossings were identified and assessed through the use of the National Spatial Biodiversity Assessment (NSBA) spatial dataset, which is 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 GIS layer also enables the identification of the Present Ecological Status (PES) of each river crossings, as well as their conservation status (Driver et al., 2004).
- PES scores for a particular reach of river habitat have been classified into one of six categories ranging from unmodified/ pristine (Class A) to critically modified HGM (Class F).
- GIS shape files (layers) of intersecting watercourses, alignment centerlines, and alignment corridors were created to help demarcate potential watercourses in each of the route alternatives.
- A Wetness Index Model was generated through SAGA GIS software and derived from a SRTM-based digital elevation model (DEM). The Wetness Index was used as a backdrop along with aerial photographs and other watercourse datasets to capture watercourse boundaries through on screen digitizing.
- This resulted in a more accurate demarcation of watercourses within each of the three alternative corridors compared to any existing watercourse dataset.
- A conservative approach was applied during the watercourse interpretation and delineation process. It is therefore expected that the created watercourse layer for each corridor is larger than their actual dimensions.
- Quarries and anthropogenic dams that are disconnected from the drainage network such as off channel dams and retention ponds at sewage treatment works and tailing dams were not included as part of the watercourse delineation process.
- Artificial drains, such as contour trenches that were not clearly present within a wetland or other watercourse were also disregarded.
- Small wetlands, specifically small seeps and pans with indistinct wetness features in cultivated fields were often excluded, but larger or more distinct features were recorded. Vegetation textural changes were considered as part of the delineation process in these marginal areas, but these could also have been affected by recent fire events or disturbances.
- A spatial GIS dataset was obtained from the Endangered Wildlife Trust (EWT) that indicated cadastral properties that contained records of breeding crane pairs and crane occurrences. The dataset was used along with the delineated watercourse shapefile to identify potential crane breeding watercourses within the three alternatives. Cadastral

crane breeding data could also be used for the remainder of the study area to indicate other areas with a high conservation value.

- The rational for the combination of crane breeding locations with wetlands is that there is a dependency of some crane species for wetlands as breeding habitat. This is in particular the case for Wattled Cranes that are associated in South Africa with shallow, though permanent wetlands with short and extensive emergent vegetation, especially sedges (Allan 2005). In addition, Wattled Cranes require a wetland of greater than 18 ha as a breeding site, and should also include at least 150 ha of surrounding grassland habitat (Allan 2005).
- Grey Crowned Cranes can breed in natural and artificial wetlands that include marshes, pans and dams with tall emergent vegetation. Blue Cranes are less dependent on watercourses and can breed in wetlands, grassland, Karoo veld and agricultural areas (Allan 2005).
- In addition, Wattled Cranes have a Critically endangered Red Data status in South Africa (Allan 2005). Wetlands that overlap with their breeding localities are therefore expected to support rare wetland-dependant biodiversity and are of a higher conservation value compared to other wetlands.
- The presence of Grey Crowned Grey and Blue Crane breeding sites in wetlands also add to the conservation value of wetlands, as both species have a Vulnerable IUCN Red Data status in South Africa (Allan 2005).
- Crane breeding properties and delineated watercourses were used to help identify the number of potential crane breeding watercourses in each alternative corridor.
- Information obtained from the existing and created spatial datasets were used to compare different route alternatives with one another in order to identify the best suited option for the proposed 400 kV transmission line from a watercourse consideration.

3. PROJECT AND STUDY AREA DESCRIPTION

3.1. Project Description

- The proposed development entails the construction of a new 400kV double circuit transmission line between Arnot Substation located west of Arnot, in close proximity to Arnot Power Station, and Gumeni Substation situated approximately 10 km south of Machadodorp in Mpumalanga.
- Three route alignment corridors were investigated within a larger study area of approximately 1016.87 km^2 (Figure 1). The route alternatives have been buffered by 1 km to create three corridors with the following alignment dimensions:

- Alternative 1 has a surface area of ±116.36 $km^2$and is aligned along the southern boundary of the study area for the majority of its length. The alignment coincides with existing powerlines for the most part, including Tx lines and DX HV Lines. The eastern-most section of Alternative 1 overlaps with Alternative 5, and a small portion of the Hendrina-Gumeni line.
- Alternative 3 has a surface area of ±122.20 $km^2$and is aligned adjacent to the N4 Highway for the majority of its length. The alignment coincides with existing powerlines for the most part, specifically sections of DX HV Lines. Alternative 3 has the least amount of overlap with the other two alternatives and passes south of Belfast along the northern edge of the study area.
- Alternative 5 has a surface area of ±104.78 $km^2$and is aligned along the centre of the study area from west to east. The route is based on a modeled "Least Cost" or "Least sensitive" alternative that has been derived from technical construction specifications combined with perceived environmental sensitivities derived from existing spatial (GIS) datasets. The alignment coincides with existing powerlines, specifically the Hendrina-Gumeni line, and overlap with Alternative 1 along its eastern-most section.

3.2. Surface hydrology

- The western and north-western portions of the study area fall within the Olifants River Water Management Area (WMA), while the remainder is part of the Inkomati WMA.
- The Olifants WMA contains contain Quaternary Catchments B12B, 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).

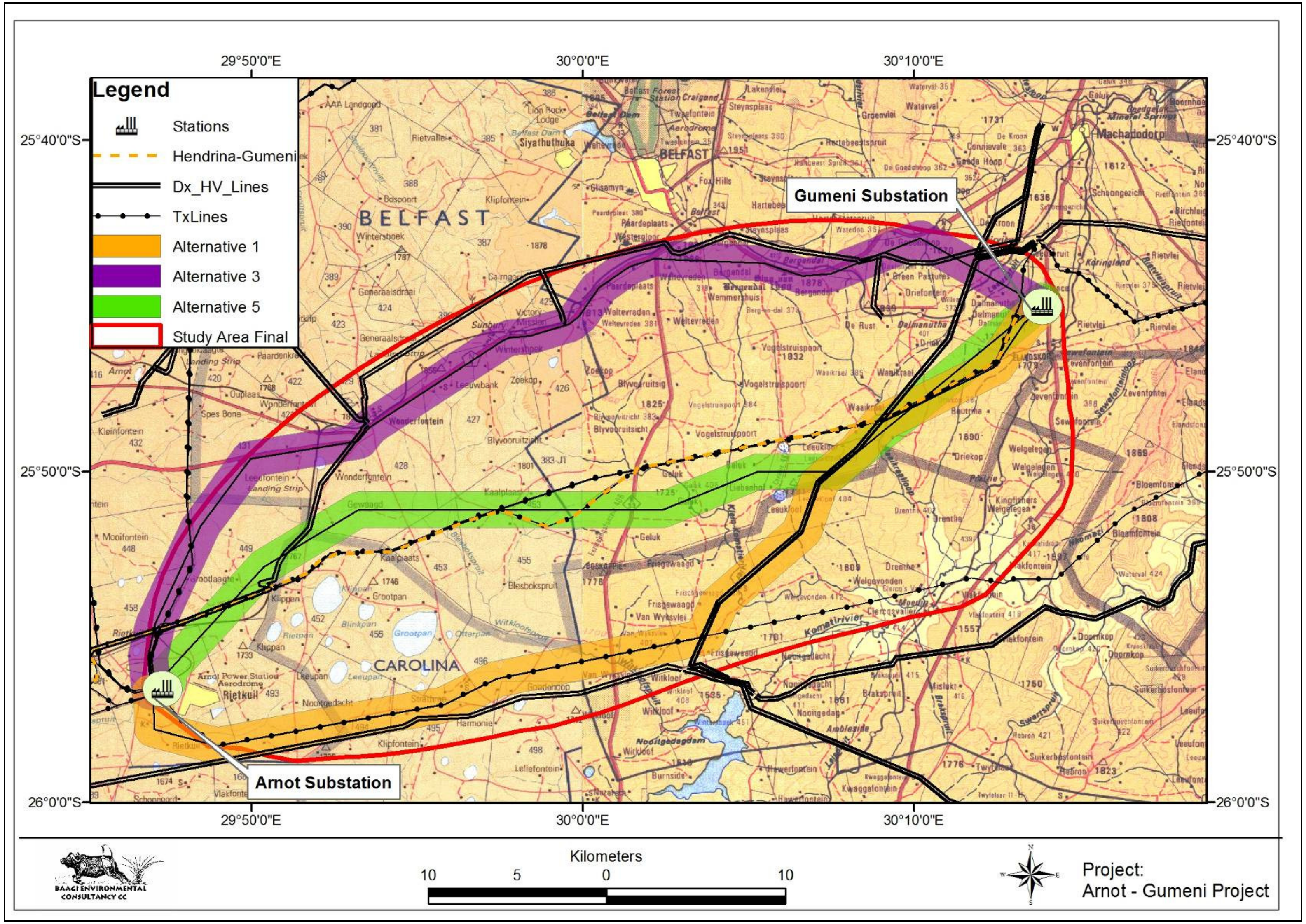


Figure 1: Illustrates the study area, main roads, start point (Arnot Substation) and endpoint (Gumeni Substation), as well as the three route alternative corridors (1, 3 & 5).

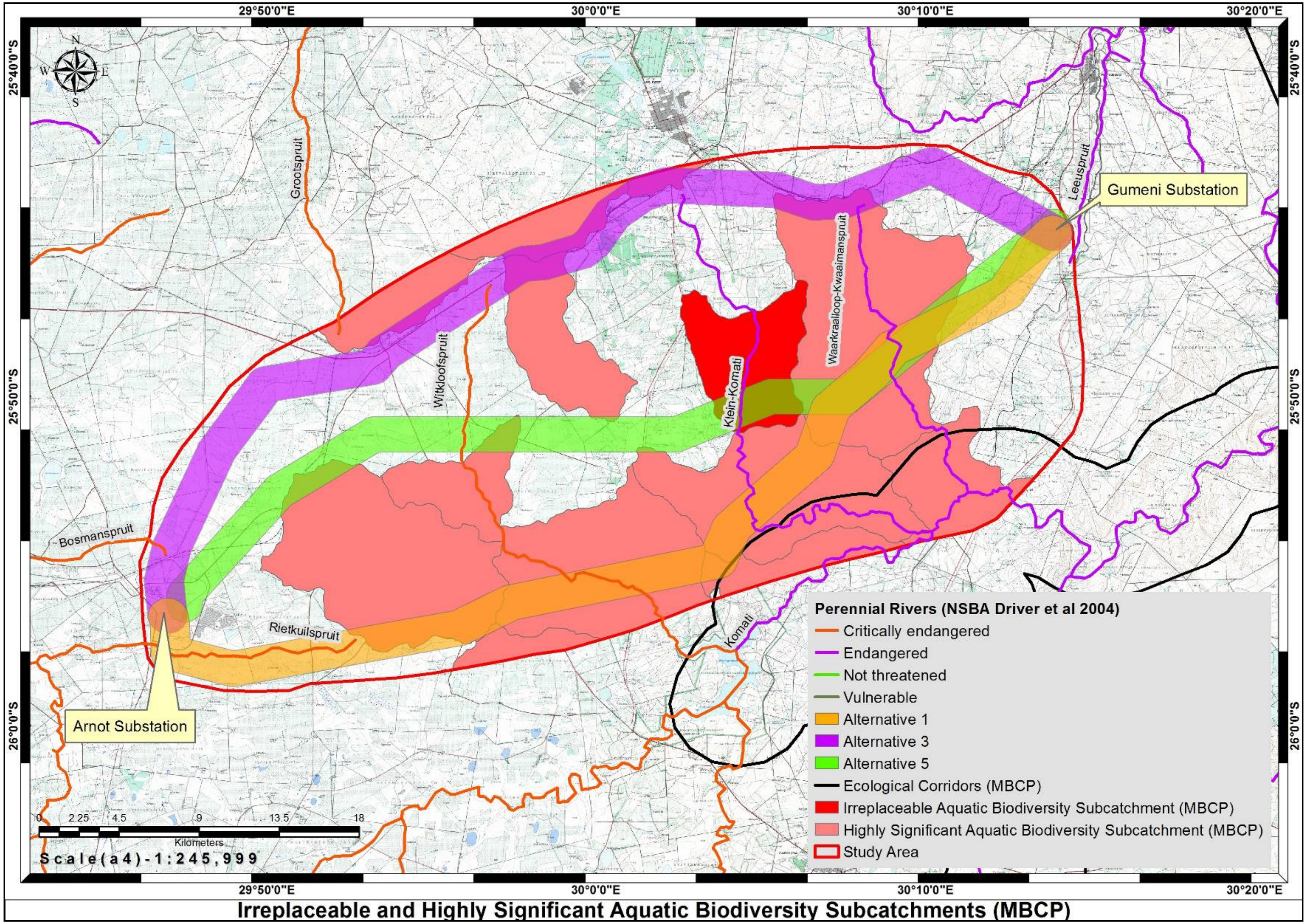


Figure 2 Illustrates perennial rivers along with their conservation state, and Irreplaceable & Highly Significant Aquatic Biodiversity Subcatchments within the study area.

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 Water Management Area and Quaternary Catchment in the study area (Middleton & Bailey, 2008).

Quaternary Catchment	Rainfall (MAP)	Runoff (MAR)	Evapotranspiration (MAE)	EIS class	PES Category
Olifants Water Management Area (WMA)					
B12B	695 mm	21.41 mcm	1552 mm	Moderate	Class D: Largely Modified
B12C	707 mm	19.24 mcm	1552 mm	Moderate	Class C: Moderately Modified
B41A	714 mm	41.97 mcm	1500 mm	Moderate	Class C: Moderately Modified
Inkomati Water Management Area (WMA)					
X11C	715 mm	10.30 mcm	1435 mm	High	Class C: Moderately Modified
X11D	744mm	40.70 mcm	1414 mm	Moderate	Class C: Moderately Modified
X11E	761 mm	21.10 mcm	1390 mm	Moderate	Class C: Moderately Modified
X21F	757 mm	40.86 mcm	1348 mm	Moderate	Class C: Moderately Modified

- Critically endangered perennial rivers within the study area include (Figure 2):
  - Rietkuilspruit overlaps with Alternative 1 parallel to the centre-line
  - Witkloofspruit crosses Alternative 1 and 5 perpendicular to their centre-lines, and partially crosses Alternative 3.
  - Bosmanspruit partially crosses Alternative 3.
  - Grootspruit crosses none of the alternatives.
- Endangered perennial rivers within the study area include (Figure 2):
  - Klein-Komati River crosses Alternative 1 and 5 perpendicular to their centre-lines, and partially crosses Alternative 3.
  - Waarkraalloop (alias Kwaaimanspruit) crosses Alternative 1 and 5 perpendicular to their centre-lines, and partially crosses Alternative 3.
  - Komati River crosses none of the alternatives.
  - Leeuspruit crosses none of the alternatives.
- Aquatic biodiversity subcatchments that are regarded as Highly significant in the Mpumalanga Biodiversity Conservation Plan (MBCP) mainly overlap with Alternatives 1, while only Alternative 5 intersects with an Irreplaceable Aquatic biodiversity subcatchment (Figure 2, Table 2).

- Negligible overlap occurs between the alternatives and ecological corridors identified in the MBCP. No Aquatic Corridor (MBCP) occurs within the study area or its immediate surroundings (Figure 2).

Table 2: Combined surface area for important Aquatic Biodiversity Subcatchments as derived from the Mpumalanga Biodiversity Conservation Plan (MBCP) in each corridor. The highest values are indicated in bold.

Alternative Name	Irreplaceable subcatchment surface area	Highly significant subcatchment surface area
Alternative 1	0 ha	**7106.072 ha**
Alternative 3	0 ha	2091.072 ha
Alternative 5	**823.257 ha**	2528.37 ha

3.3. Climate

Annual rainfall ranges between 695–761 mm and falls mainly during the summer months, often through thundershowers. The mean annual temperature is around 15°C and incidents of frost range between 12 and 32 days. Winters are very dry (Mucina & Rutherford, 2006).

3.4. Regional vegetation

The regional vegetation of the study area has been described as Mesic Highveld Grassland and includes three grassland vegetation units and one freshwater wetland vegetation unit (Mucina & Rutherford, 2006):

- Eastern Temperate Freshwater Wetland vegetation unit has been identified in the form of large pan (depression) wetlands mainly clustered in the western portion of the study area. Pans commonly occur on crests landscape position located on catchment divides. The wetland are characterised by hydrophytic floristic elements and hydromorphic conditions that differ along gradients of wetness. It is important to note that azonal ecosystems, such as wetlands and alluvial watercourses, are underrepresented in regional and even local vegetation maps due to their typically narrow and linear dimensions. The wetland vegetation unit only forms approximately 1 % of the study area based on Mucina & Rutherford (2006), but will be more common in reality. Azonal vegetation units are associated with unique edaphic (soil) conditions and/or hydro-geological conditions (e.g. water-logging) that have a dominant effect on their floristic composition, structure and dynamics compared to macroclimate influences. Eastern Temperate Freshwater Wetlands have a least threatened conservation status, but are poorly protected in statutory reserves.
- Eastern Highveld Grassland is the dominant vegetation unit and covers approximately 66 % of the study area. Wetland and other watercourses are also expected within this vegetation unit. Eastern Highveld Grassland has an endangered conservation status and only a small fraction is protected in nature reserves.

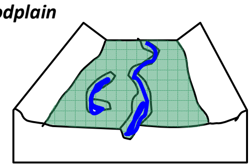
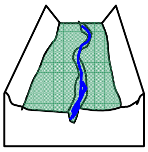
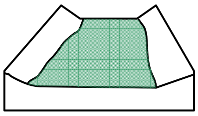
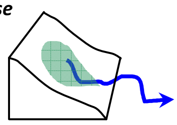
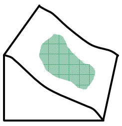
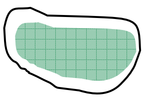
- Lydenburg Montane Grassland is the second most common vegetation unit and cover approximately 20 % of the study area. Wetland and other watercourses are also expected within this vegetation unit. Lydenburg Montane Grassland has a vulnerable status and is hardly protected in formal nature reserves.
- KaNgwane Montane Grassland covers approximately 13 % of the study area. Wetland and other watercourses are also expected within this vegetation unit. KaNgwane Montane Grassland has a vulnerable status and is poorly protected in statutory nature reserves

4. WATERCOURSE DESCRIPTION, DELINEATION & ASSESSMENT

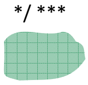
4.1. Watercourse Types

- The National Wetland Classification System (NWCS) categorises wetlands into one of seven hydro-geomorphic (HGM) units, these include (Ewart-Smith et al., 2006; Van Deventer et al., 2010):
  - Channelled valley bottom
  - Depression (Pan)
  - Flat
  - Floodplain
  - Seep
  - Unchannelled valley bottom
  - Valleyhead seep
- The HGM classification system is based on three key parameters pertaining to a wetland and is well suited for wetland functional assessments (Brinson 1993; Kotze et al. 2005):
  - The geomorphic setting of the wetland.
  - The source of water inputs into the wetland
  - The hydrodynamics of the wetland (how does water move through the wetland).
- Kotze et al. (2005) present a similar but less complicated HGM wetland classification system that is useful due to its common use and greater certainty in the selection of the most appropriate HGM unit type. This HGM classification system incorporates six types of wetlands that include (Table 4):
  - Floodplain.
  - Valley bottom with a channel (channelled valley bottom)
  - Valley bottom without a channel (unchannelled valley bottom)
  - Hillslope seepage feeding a watercourse
  - Hillslope seepage not feeding a watercourse
  - Depression (pan)

Table 3: Hydro-geomorphic units present within the study area (modified from Brinson 1993; Kotze 1999, Marneweck & Batchelor 2002; & Kotze et al., 2005).

Hydro-geomorphic types	Description	Source of water maintaining the wetland	
		Surface	**Sub-surface**
Floodplain 	Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel 	Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley bottom without a channel 	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage feeding a watercourse 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from subsurface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.	*	***
Hillslope seepage not feeding a watercourse 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from subsurface flow and outflow either very limited or through diffuse subsurface and/or surface flow but with no direct surface water connection to a watercourse.	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent.	*/ ***	*/ ***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source:	*	Contribution usually small
	***	Contribution usually large
	*/ ***	Contribution may be small or important depending on the local circumstances
		Wetland

- Natural and anthropogenic transformations can modify wetland systems to represent a different type of watercourse compared to their reference condition. Examples include the creation of dams in watercourses and the erosion of unchannelled wetlands (e.g. seeps and unchannelled valley bottoms) into channelled wetland systems.
- Spatial wetland data obtained from the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa shapefile (Van Deventer et al., 2010) indicates the following (Table 4; Figure 3):
    - Six of the seven HGM units are present within the study area, with no floodplain wetland recorded.
    - Six of the seven HGM units are also present within the three alternatives.
    - Alternative 1 has the highest combined surface area of wetland habitat, followed by Alternative 3 and Alternative 5.
    - Based on the Wetland Types for South Africa shapefile, Alternative 5 has significantly less wetland areas within its corridor compared to the other two alternative corridors.

Table 4: Wetlands surface areas as derived from the national wetland layer for each alternative corridor (Van Deventer et al., 2010).

Alternative	Channelled valley bottoms	Unchannelled valley bottoms	Floodplains	Depressions (Pans)	Flats	Seeps	Valley head seeps	Total
Alternative 1	184.99	3.69	0	26.00	157.66	348.03	2.07	**722.44**
Alternative 3	105.82	0.01	0	90.45	161.06	292.49	0	**649.83**
Alternative 5	21.87	0	0	41.30	20.87	88.42	0	**172.47**

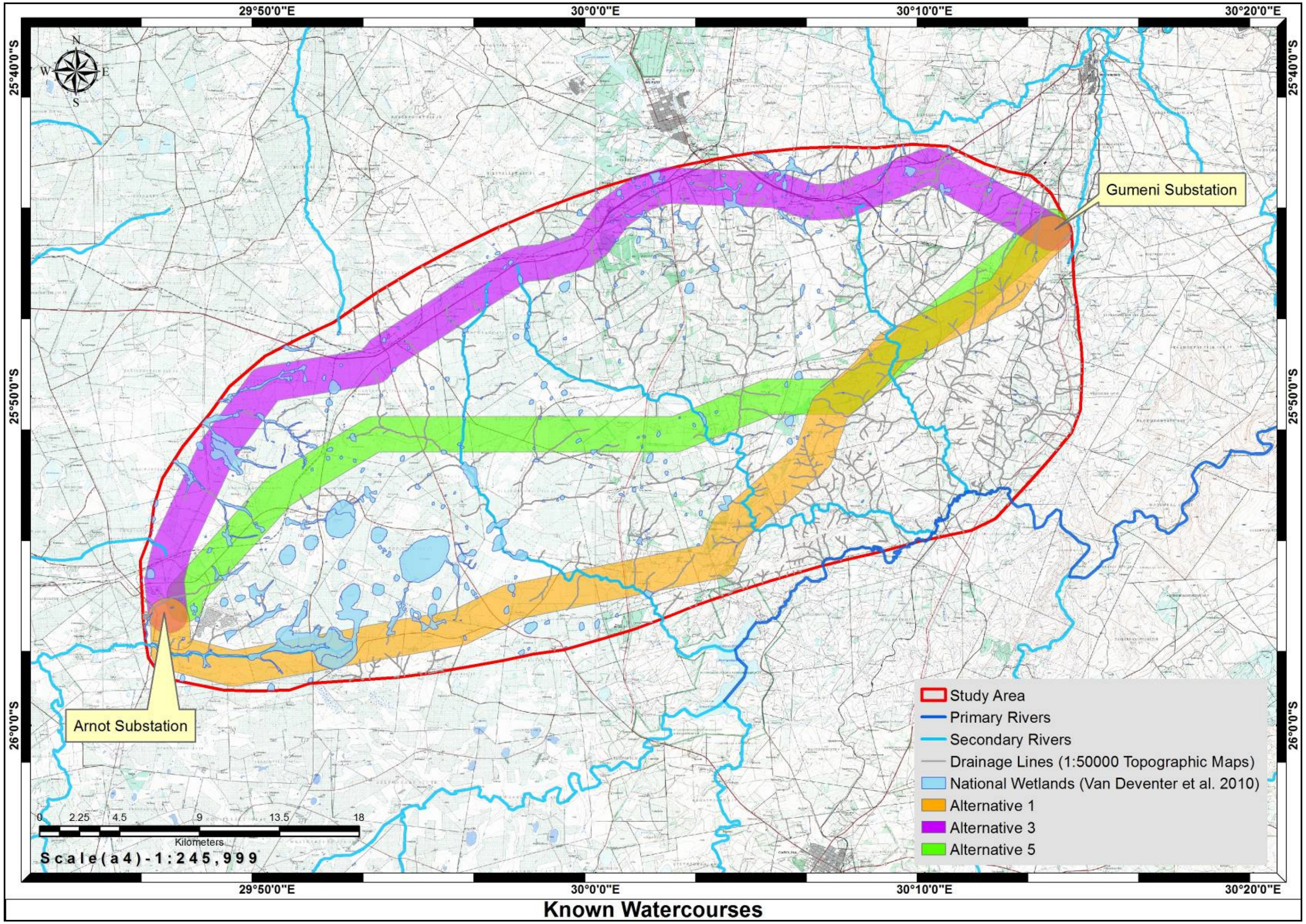


Figure 3: Known wetlands and other watercourses within the Arnot-Gumeni study area and alternatives based on existing spatial datasets; primary and secondary rivers from Middleton & Bailey (2008).

4.2. Watercourse Delineation

- Watercourses were delineated within each alternative corridor through onscreen digitising with aerial photographs, a surface wetness model, and existing drainage line spatial datasets as background features (Table 5; Figure 4).
- Demarcated watercourses were classified into two inclusive groups (Figure 4):
    - *Linear watercourses* include watercourse systems that are distinctly connected to the drainage network. Examples include rivers, headwater drainage lines, and several wetlands (channelled and unchannelled valley bottoms, floodplains, as well as connected seepages and, flats).
    - *Non-linear watercourses* include watercourses systems that are not distinctly connected to the drainage network nor do they commonly have a linear alignment. The most prominent examples include depression (pan) wetlands and seepage wetlands that surround them, other examples include non-connected flat and seepage wetlands.
- The route alternatives avoid the cluster of large depression (pan) wetlands in the western portion of the study area (Figure 5 & 6). These depression pans include Klippan, Grootpan, Leeupan, Blinkpan, and Rietpan among others.
- Alternative 3 has the highest number of Non-linear watercourses (Table 5).
- Surface area calculations based on delineated Linear and Non-linear watercourses is higher compared to that of the Wetland Types for South Africa shapefile (Van Deventer et al., 2010), (Figure 4; Table 5). The results are also completely opposite from that derived from Van Deventer (2010), with Alternative 1 containing the lowest total watercourse surface area and Alternative 5 the highest (Table 4 & 5).

Table 5: Surface area calculations for Linear and Non-linear watercourses, as well as the combined watercourses in each corridor; highest values are indicated in bold.

Alternative Name	Linear watercourses	Non-linear watercourses	Total area
Alternative 1	2237.50 ha	94.84 ha	2332.34 ha
Alternative 3	2255.81 ha	**285.60 ha**	2541.41 ha
Alternative 5	**2697.36 ha**	96.35 ha	**2793.71 ha**

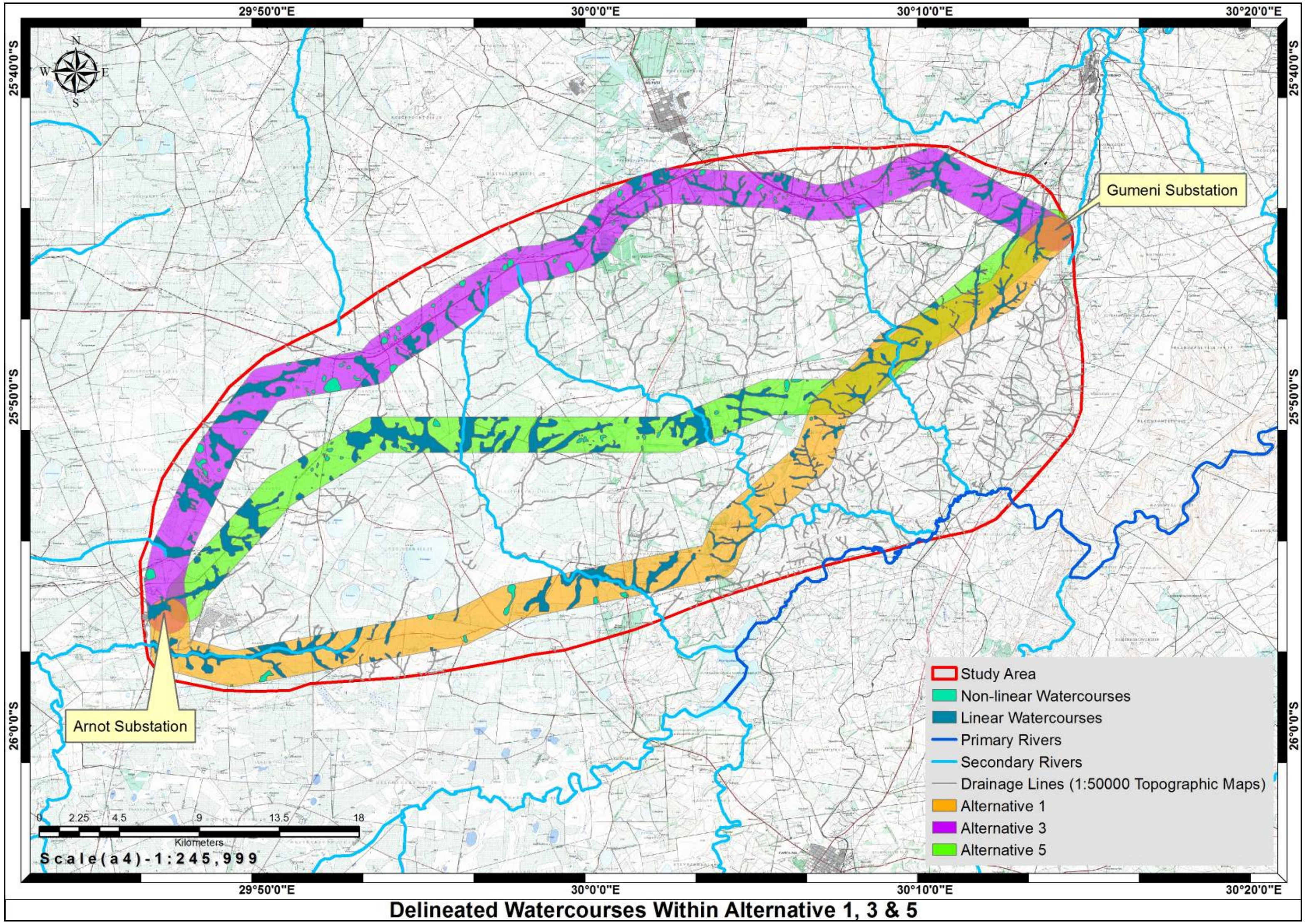


Figure 4: Delineated watercourses based on onscreen digitising within each alternative corridor. Watercourses were demarcated as Linear and Non-linear features and include a range of watercourse types such as wetlands, dams, riparian habitat, natural channels and indistinct headwater drainage lines.

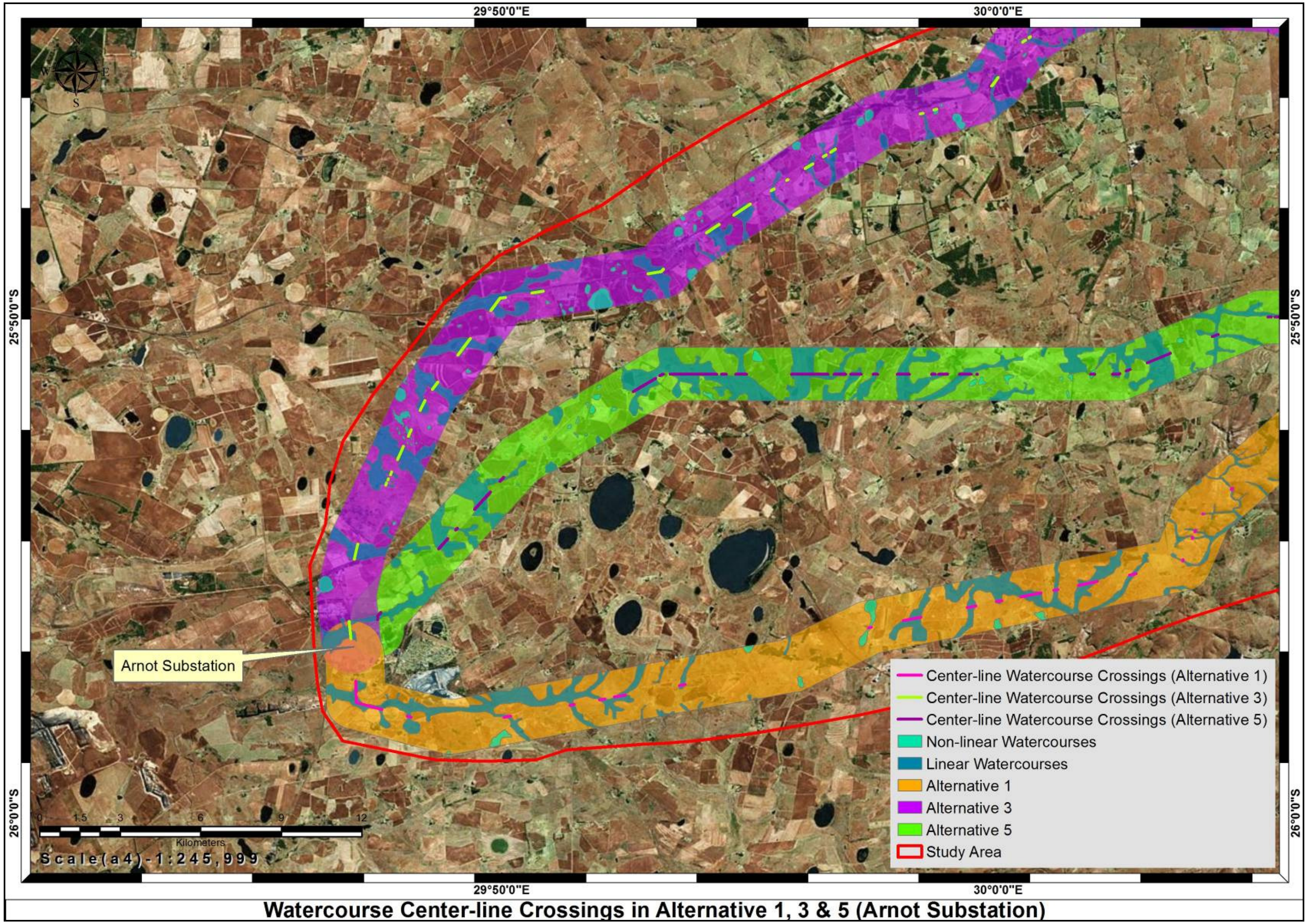


Figure 5: Demarcated watercourses within the three alternative corridors and watercourse crossings along the center-line of each alternative in the western study area section.

- Figure 6 illustrate different watercourses and wetlands identified within the study area. This includes the presence of floodplain wetland habitat, such as the Rietkuilspruit southeast of Arnot Substation.

Figure 6: A selection of different watercourse types identified within the study area: Seepage wetland in a headwater position (top left); transition between non-wetland drainage channels (gullies), seepages and an unchannelled valley bottom wetland (top right); non-wetland headwater drainage lines (center left); floodplain wetland associated with the Rietkuilspruit (center right); narrow channelled valley bottom wetland (bottom left); & a large depression wetland in the western portion of the study area (bottom right).

- Drainage lines in headwater positions are expected to often contain wetland conditions in the form of seepage supported by high annual rainfall and favourable geological strata, including the presence of dolerite intrusions (Palmer et al., 2002).
- Demarcated watercourses indicated in Figure 4 and Table 5 will require further field verification to refine the accuracy of their boundaries and possibly include additional watercourses. Smaller and more indistinct depression and seepage wetlands are more likely to be affected by additions.

4.3. Watercourse Crossings

- Alternative 1 has the lowest number of watercourse crossings and the shortest combined crossings distance of all the alternatives, while Alternative 5 has the highest number and longest total crossing distance (Table 6; Figure 7).
- It is expected that watercourse crossings of up to 400 metre can be spanned fairly simply by 400kV towers. Alternative 3 has the highest number of crossings in excess of 400 m and will therefore in theory require several towers within wetland or watercourse areas.
- However, most of the 400 m plus crossings range between 400-750 metre (10 in total) in Alternative 3, while both Alternative 1 and 5 contain a crossing in excess of 1 km (Table 7). These long crossings are associated with watercourses that are aligned parallel with the proposed 400kV center-line. It is expected that crossings lengths can be reduced by moving individual pylons within the corridor.

Table 6: Combined watercourse crossing length along the centre-line for each alternative; highest values indicated in bold.

Alternative Name	Combined length of watercourse crossings along centre-line	Number of watercourse crossings per centre-line
Alternative 1	7.77 km	37
Alternative 3	12.40 km	41
Alternative 5	**12.68 km**	**44**

Table 7: Number of watercourse crossings greater than 400 m along the centre-line of each alternative. Any number of watercourse crossings that span more than 1000 m and the highest total number of crossings over 400 m are indicated in bold.

Alternative Name	Number of crossings > 400 m	Number of crossings > 500 m	Number of crossings > 750 m	Number of crossings > 1000 m	Number of crossings > 1250 m	Total number of crossings > 400 m
Alternative 1	2	3	-	**1**	-	6
Alternative 3	4	6	3	-	-	**13**
Alternative 5	4	-	3	**1**	**1**	9

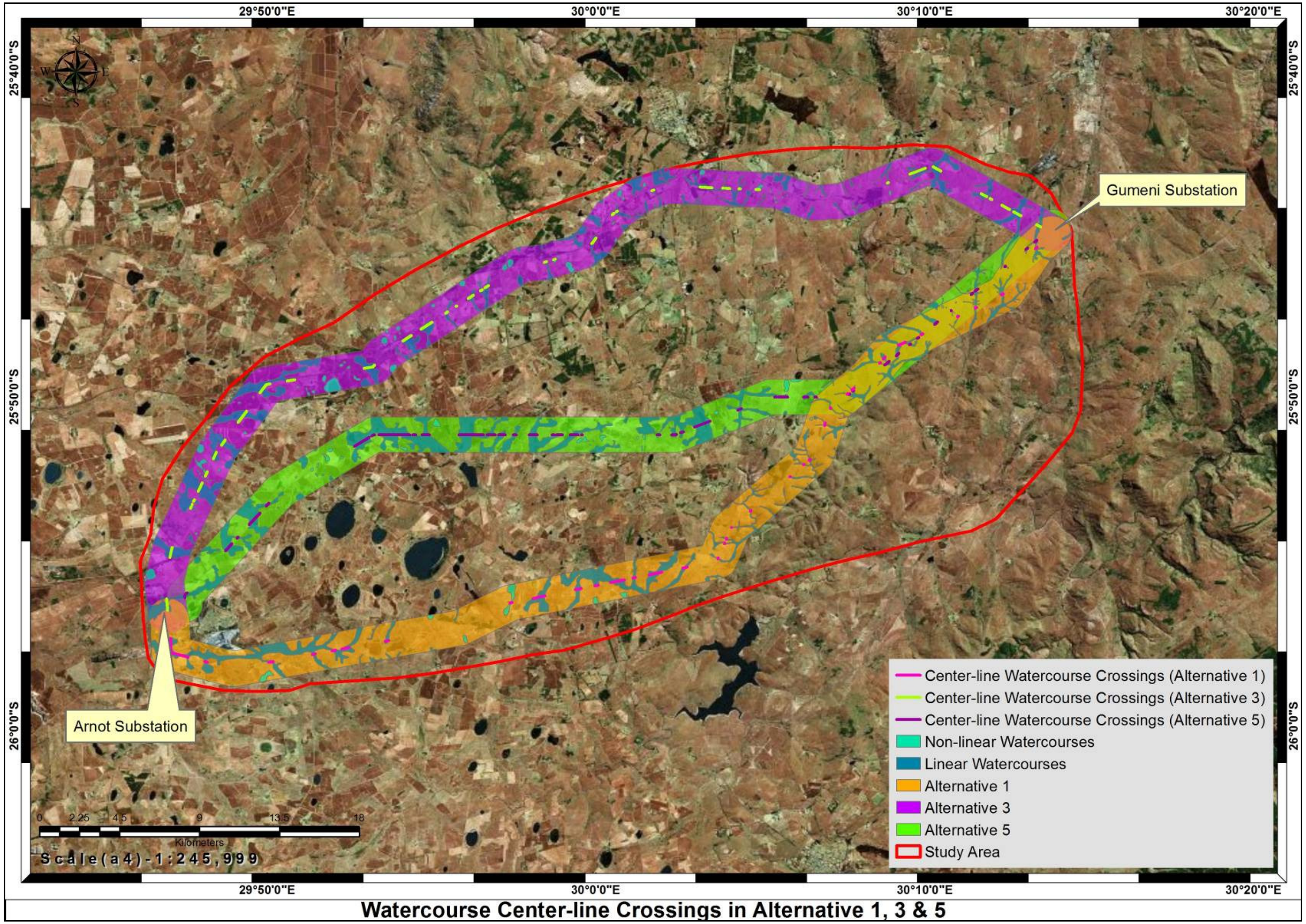


Figure 7: Watercourse crossings along the center-line of each alternative.

4.4. Watercourse Function, Conservation Value and Threats

4.4.1. General functions

Palmer et al. (2002) state that wetland within the Upper Olifants Catchment have a regulatory and augmentary ability to support flow conditions during dry spells by producing baseflow. Sedimentation in depositionary environments, such as floodplains, is important to remove sediment-associate phosphates during high flow events. Sedimentation within floodplain and valley bottom wetlands has been reduced through channalisation and canalisation. During permanently flooded conditions seepage wetlands have the ability for limited removal of ammonia, sulphate and metals, as well as organic transformations (Palmer et al., 2002). Limited specific data is available on the water purification and nutrient removal abilities of wetlands in the area, while observed changes in water quality upstream and downstream of wetlands may in large part also be affected by dilution as a result of groundwater discharge (Palmer et al., 2002).

4.4.2. Conservation value

Plant species of conservation concern associated with wetland environments

Database information pertaining to the plant 'species of conservation concern' (Raimondo et al., 2009) of the region of the Mpumalanga Province within which the study area is situated was obtained from the MTPA PlantDat database, as well as from the National Herbarium PRECIS database (http//:posa.sanbi.org). Species of conservation concern are those that are important for conservation decision-making and include all species that are threatened (Critically Endangered, Endangered, Vulnerable), Extinct in the Wild (EW), Data Deficient (DDD), Near Threatened, Critically Rare, Rare and Declining (Raimindo et al., 2009).

All 'species of conservation concern' historically recorded from the quarter degree grid squares within which the study area is situated (2529DB, 2529DD, 2530CA and 2530CC), were extracted from these lists. A total of 28 plant species that are regarded as 'species of conservation concern' at a national level (Raimondo et al., 2009 and http//:redlist.sanbi.org, downloaded October 2012) or at a provincial level (MTPA PlantDat database), have historically been recorded from these grid squares. Of these 28 species, ten are typically wetland species that are entirely or largely restricted to wetland habitats (obligate wetland species and facultative wetland species that occur largely in wetland habitats). These ten species are listed, together with their latest conservation status categorisation and grids where historically recorded, in Table 8.

The widespread occurrence of wetlands and other watercourses provide ample habitat for identified plant species of conservation concern throughout the study area. However, Alternative 1 is expected to be the most favourble for the maintenance of these species, as it contains the largest total surface area of watercourses for all three corridors (Table 5).

Table 8: List of the ten plant 'species of conservation concern' that have historically been recorded within the grid squares 2529 DB, 2529 DD, 2530 CA and 2530 CC, and which are entirely or largely restricted to wetland habitats (obligate wetland species and facultative wetland species that occur largely in wetland habitats).

FAMILY and *Species*	**Latest Conservation Status Category for South Africa***	**Latest MTPA Conservation Status Category**	**Grids where species historically recorded**
AMARYLLIDACEAE			
Crinum bulbispermum	Declining	Declining	2529 DB 2530 CA
Nerine gracilis	Near Threatened	Near Threatened	2529 DB 2530 CC
ASPODELACEAE			
Kniphofia rigidifolia	Least Concern	Rare	2530 CA
Kniphofia typhoides	Near Threatened	Near Threatened	2529 DD
GUNNERACEAE			
Gunnera perpensa	Declining	Declining	2530 CA
HYACINTHACEAE			
Eucomis autumnalis	Declining	Declining	2529 DB 2529 DD 2530 CA 2530 CC
Eucomis pallidiflora	Near Threatened	Near Threatened	2529 DB
ORCHIDACEAE			
Centrostigma occultans	Least Conern	Rare	2530 CA
Habenaria humilior	Least Conern	Rare	2530 CC
POACEAE			
Helictotrichon naatalense	Vulnerable	Vulnerable	2530 CA

* Status follows the latest Red Data Plant Book of South African Plants (Raimondo *et al*., 2009), and the continuously updated online Red List of SANBI (http:redlist.sanbi.org, downloaded October 2012). Conservation Status Category assessment according to IUCN Ver. 3.1 (IUCN, 2001).

Potential crane breeding watercourses

- The use of crane breeding location information can be used as an indicator of wetlands and other watercourses that are of a high conservation value as they contribute to the maintenance of protected avifauna species.
- Wattled Cranes have a high conservation value due to the Critically endangered Red Data status of this crane species (Allan 2005).
- This crane species commonly select wetlands that are in an untransformed/pristine condition as breeding sites. Suitable wetland breeding habitat should include a large grassland buffer that surrounds the wetland (Allan 2005). The breeding pair is sensitive

to various disturbances such as livestock movement, which further favours the selection of untransformed wetland systems.

- Grey Crowned Cranes breeding sites are associated with natural and artificial wetlands that include marshes, pans and dams with tall emergent vegetation. This provides an indication of the conservation value of a wetland or other watercourse due to the Vulnerable IUCN Red Data status of Grey Crowned Cranes (Allan 2005).
- Wattled Cranes and Grey Crowned Cranes are therefore regarded as wetland-dependant species with a high conservation value. Wattled Cranes are regarded to have a higher conservation value due to its higher Red Data status and breeding selection of specific pristine wetland systems.
- Crane breeding property data received from the Endangered Wildlife Trust was used to identify potential crane breeding watercourses by overlaying the cadastral data with delineated watercourses. The delineated watercourses include a range of different watercourse types.
- Table 9 and Figure 8 provide values and an illustration of Potential crane breeding watercourses in the three alternative corridors. Alternative 3 contains the lowest number and the smallest total surface area of Potential crane breeding watercourses, while Alternative 5 is deemed the most sensitive and therefore the least desirable.
- Alternative 3 is clearly less sensitive compared to Alternative 1 and 5 in terms of the total surface area and number of Potential crane breeding watercourses (Table 9).

Table 9: Potential crane breeding watercourses based on recorded properties with breeding crane pairs (EWT 2012), and overlapping watercourses delineated in each corridor.

Alternative name	Combined watercourse surface area	Number of potential crane breeding watercourses
Alternative 1	652.07 ha	30
Alternative 3	130.67 ha	17
Alternative 5	**703.77 ha**	**31**

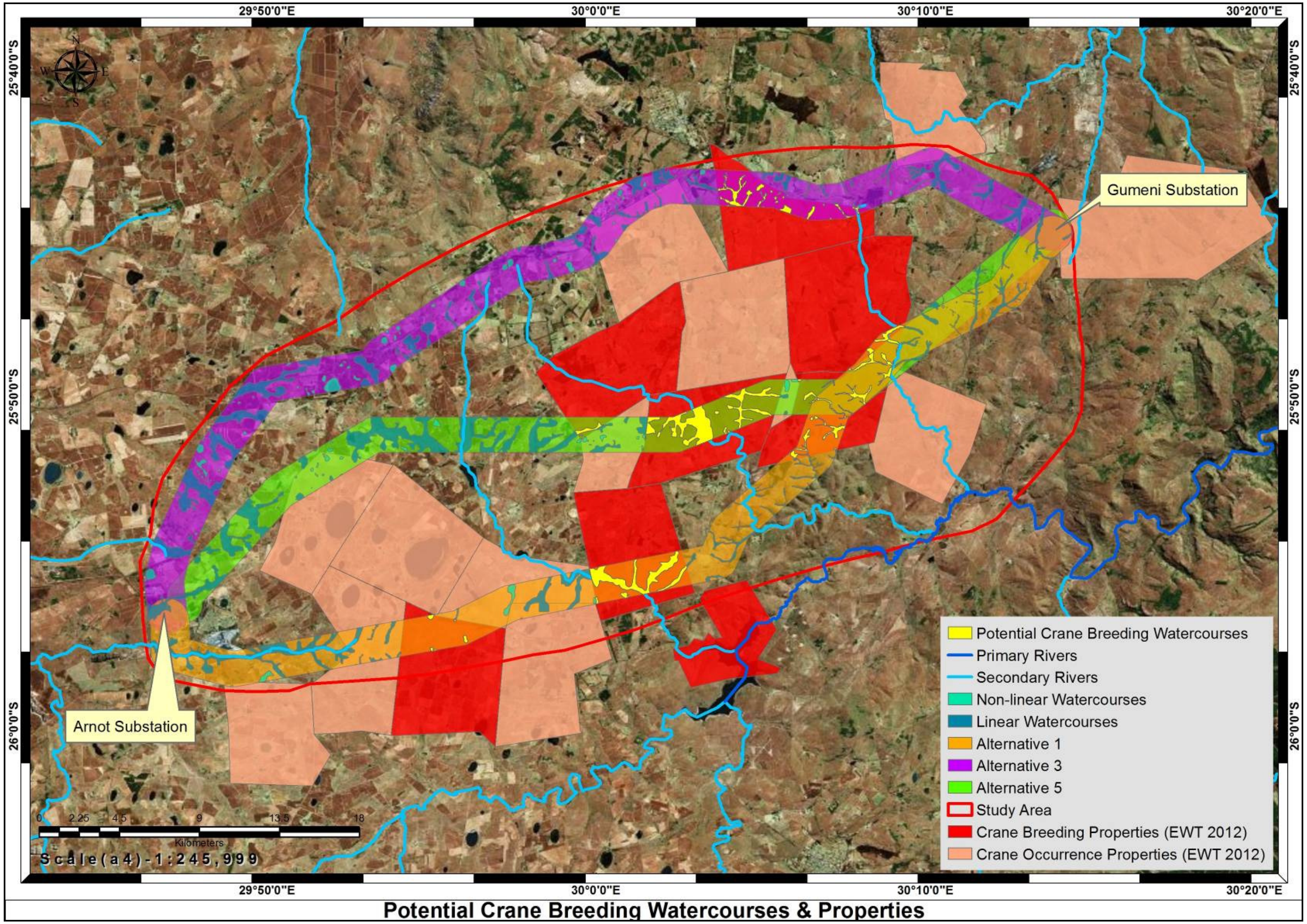


Figure 8: Potential Crane breeding Watercourses based on delineated watercourses in each alternative corridor and crane breeding locality data from the Endangered Wildlife Trust (EWT).

4.4.3. Watercourse threats in the study area.

Mining

- Coal extraction has resulted in permanent wetland and watercourse loss in the study area and its surroundings. Excavation in watercourses destroys or permanently modifies wetlands and rivers.
- Mobilised sediment decreases water quality in receiving watercourses and can smother vegetation and lead to decreased water quality.
- Watercourse water quality has also been affected by different mining impacts, including the discharge of groundwater with a low pH from mining voids into watercourses.
- Future mining impacts on watercourses are expected to increase in extent and magnitude within the study area as new mining applications await approval.

Erosion

- Erosion can be part of a natural process and play a role in the development of the drainage network in a landscape. Erosion can also be initiated and/or accelerated by anthropogenic actions that modify the pattern, velocity and volume of water movement, and reduce vegetation cover. The risk of erosion is greatest on erosion prone soils that can weather to form incised gullies with vertical and unstable banks that have little to no vegetation cover.
- In South African these types of gullies are commonly referred to as dongas, which can be considered as natural channel watercourses where natural erosion resulted in their development.
- Types of erosion that threaten watercourses include headcut initiation and advancement, channel initiation and incision, and channel widening.
- Watercourses are under increasing erosion threat as the number of road crossings increase and hardened surface expand in the catchment. Agricultural impacts in the form of high grazing pressures and cultivation in watercourses can also result in increased erosion rates.

Cultivation

- Cultivation often encroaches into wetlands and other watercourses in the study area, which results in the direct input of sediment and agriculture-related pollutants, such as fertilizers, pesticides, and herbicides.
- Temporary wetland, including smaller pans and flats are often cleared, drained, and ploughed for cultivation of certain crops, such as maize.
- Dams are created in watercourses for livestock and irrigation, which submerge upstream wetland vegetation and can result in downstream channelisation impacts.

Forestry and alien plants:

- Non-indigenous tree species, especially Eucalyptus spp., have a higher rate of water consumption compared to indigenous trees. The presence of these trees in a catchment reduces the amount of water available for a watercourse compared to its reference condition.
- More soil water is available for consumption closer to wetland and riparian areas. The presence of plantations and invasive alien trees species within or in close proximity to watercourses results therefore in a greater desiccation effect in the watercourse.
- Natural wetland and river vegetation is lost as a result of the encroachment of invasive alien plant species.

Urban development:

- An increase in hard surface areas results in larger flood peak volumes and velocities that reach watercourses in a shorter period of time.
- Dams, road and other infrastructure in wetlands functions as hydrological barriers and result in modified flow patters with desiccation and erosion impacts that follow.
- Low water quality inputs occur as a result of urban runoff and released flows from sewage treatment works into watercourses.
- Habitat is lost due to development within watercourses.
- Existing distribution and transmission lines that are common within the study area have pylon (tower) footprints within watercourses.

5. DISCUSSION & RECOMMENDATIONS

5.1. Discussion

- Results from the Wetland Types for South Africa spatial dataset (Van Deventer et al., 2010) and the watercourse delineation created as part of this investigation contradicted one another with regards to watercourse surface areas in each alternative corridor.
- Created delineated watercourses (Linear and Non-linear watercourses) are regarded as more accurate compared to results from the national wetland datasets created by Van Deventer et al. (2010). This is based on the absence of aerial photograph interpretation and the regional scale of the Wetland Types for South Africa dataset (Van Deventer et al., 2010).
- Different watercourse properties investigated 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 10 for comparison.

Table 10: Comparison of different watercourse properties in each alternative corridor and center-line. 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.

Alternative 1	
Properties in favour:	Properties against:
The corridor has the lowest combined watercourse surface area. However, the value does not differ by a large margin from the second highest and highest corridors	The corridor has the highest overlap with Highly Sensitive Aquatic Subcatchments areas (obtained from the Mpumalanga Biodiversity Conservation Plan)
The center-line has the lowest combined length and number of watercourse crossings. The combined length value is distinctly lower than the second highest and highest corridors	The corridor contains the second highest surface area and number of Potential crane breeding watercourses. This value is close to the most sensitive corridor and distinctly higher than the lowest.
The center-line has the lowest number of watercourse crossing lengths greater than 400 m.	
Alternative 3	
Properties in favour:	Properties against:
The corridor has the lowest overlap with Highly Sensitive Aquatic Subcatchments areas (obtained from the Mpumalanga Biodiversity Conservation	The corridor has the highest surface area of non-linear watercourses (e.g. pan wetlands).

Plan)	
The corridor contains the lowest surface area and number of Potential crane breeding watercourses. This value is distinctly lower than the second highest corridor.	The center-line has the highest number of crossing lengths greater than 400 m.
The center-line has no watercourse crossing lengths greater than 1 kilometer.	
Alternative 5	
Properties in favour:	Properties against:
	The corridor has the highest combined watercourse surface area
	The center-line has the longest combined length and number of watercourse crossings
	The center-line has the highest number of crossings greater than 1 kilometer.
	The corridor contains the highest surface area and number of Potential crane breeding watercourses.

- The following deductions can be made based on the comparison presented in Table 10:
  - The most favourable route selection is a close match between Alternative 1 and Alternative 3
  - Several of the unfavourable watercourse properties can be mitigated by careful pylon positioning. This will reduce long watercourse crossing distances and pylon placement within watercourses, specifically smaller and narrower watercourses.
  - However, impact mitigation on potential watercourse crane breeding habitat is expected to be more difficult to achieve. This is due to the sensitivity of crane species to new watercourse impacts for breeding habitat selection, specifically Wattled Cranes. The avifauna report should also be reviewed in this regard.
- Based on the above, **Alternative 3** is regarded as the **most favourable route selection** from a watercourse consideration, while **Alternative 1** is regarded as **a close second choice**.
- **Alternative 5 should not be considered** based on results from this investigation.

5.2. Recommendations

- All drainage lines, depressions (pans), other wetlands and riparian areas are regarded as sensitive landscape 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.
- It is especially important that wetlands associated with breeding sites receive additional attention. Recommendations made in the avifauna report should be adhered to in order to help mitigate construction, operation and decommission phase impacts.
- GIS watercourse delineation shapefiles produced in this study should be used by the Eskom engineers and planner to help find a best fit route alignment in the selected alternative corridor. 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.
- 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.
- Information obtained from such as walk down component can then be included as part of an EMP.
- 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.
- Additional recommendations associated with watercourse impact mitigation measures should also be adhered to (Section 6).

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 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 10.

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 recommended mitigation measures.

Impact	Probability	Duration	Scale	Magnitude/Severity	Significance (without mitigation)	Significance (with mitigation)
CONSTRUCTION PHASE						
1. Compaction of watercourse soils	Definite	Short term	Local	Medium	**Moderate**	**Negligible**
	Recommendation(s): 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.					
2. Changes to the hydrological regime caused by infrastructure construction in watercourses	Definite	Long term	Site	High	**High**	**Low**
	Recommendation(s): • Restrict the construction of infrastructure in watercourses as far as possible.					

Impact	Probability	Duration	Scale	Magnitude/Severity	Significance (without mitigation)	Significance (with mitigation)
	• Pylon construction in wetland, riparian and wash buffer zones should only be allowed in exceptional circumstances where these areas cannot be 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.).					
4. Decrease in water quality	Highly probable	Medium term	Site	High	**High**	**Negligible**
	Recommendation(s): No refueling of construction vehicles should occur within 50 m of demarcated watercourses. Hydrocarbons should not be stored within 50 m of buffered watercourses.					
5. Loss of wetland, riparian, and drainage line vegetation and habitat as a result of pylon construction, new quarries and created construction camps.	Definite	Long term	Local	High	**High**	**Negligible**
	Recommendation(s): • 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. • Excavated watercourses should be re-sloped to a stable gradient (e.g. at least a slope of 1:3), revegetated with naturally occurring					

Impact	Probability	Duration	Scale	Magnitude/Severity	Significance (without mitigation)	Significance (with mitigation)
	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. • 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.					
OPERATIONAL PHASE						
6. Increased sedimentation and erosion	Highly probable	Long term	Site	Moderate	**Moderate**	**Negligible**
	Recommendation(s): • 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					

Impact	**Probability**	**Duration**	**Scale**	**Magnitude/Severity**	**Significance (without mitigation)**	**Significance (with mitigation)**
	and 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): o Where possible locate crossings on straight channel segments (avoid meanders). o To the extent possible align crossings perpendicular to the stream channel. o Minimize the extent and duration of the hydrological disruption. o Use appropriate energy dissipaters and erosion control at the outlet drop. o Minimize impact to riparian vegetation during construction o Prevent excavated material from running into water bodies and other sensitive areas. o Use appropriate sediment barriers (silt fence and hay bales). o Dewater prior to excavation. o Check construction surveys to ensure slopes and elevations meet design specifications. o Use appropriately graded material (according to design specifications) that has been properly mixed before placement inside the structure. o Compact bed material. o Tie constructed banks into upstream and downstream banks. o Evaluate structure stability.					
7. Encroachment of invasive alien vegetation into watercourses	Probable	Long term	Site	Moderate	**Moderate**	**Low**
	Recommendation(s): • 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.					

7. REFERENCES AND FURTHER READING

Anon. 2006. Massachusetts River and Stream Crossing Standards. River and Stream Continuity Partnership. University of Massachusetts Amherst, MA Riverways Program, The Nature Conservancy

Bates, R.L. & Jackson, J.A. (Eds). 1984. Dictionary of geological terms. Third edition. Anchor Press/Doubleday, Garden City, New York

Belk, D. 1998. Global status and trends in ephemeral pool invertebrate conservation: implications for Californian fairy shrimp. In Witham, C.W., Bauder, E.T., Belk, D., Ferren, W.R. Jr. and Ornduff, R. (Eds), Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA, p. 147-150.

Berner J.T., Thiesing M.A., Simpson R. & Jantz C. (2008). Alternative Futures for Headwater Stream and Wetland Landscapes in the Upper Delaware Basin, New York, USA. Unpublished document.

Brinson M.M. 1993. A hydro-geomorphic classification for wetlands. Wetland Research Programme Technical Report WRP-DE-4. US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Bullock, A. and Acreman, M. 2003. The role of wetlands in the hydrological cycle. Hydrology and Earth System Sciences, 7, 3, 358-389.

Calhoun, A.J.K., Miller, N.A. and Klemens, M.W. 2005. Conserving pool-breeding amphibians in human-dominated landscapes through local implementation of Best Management Practices. Wetlands Ecology and Management, 13, 291-304.

Castelle, A.J., Conolly, C., Emers, M., Metz, E.D., Meyer, S., Witter, M., Mauermann, S., Erickson, T. and Cooke, S.S.. 1992. Wetland Buffers: use and effectiveness. Adolfson Associates, Inc., Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia, Publication No. 92-10.

Department of Water Affairs and Forestry (DWAF). 1996. Aquatic ecosystems. Volume 7. South African Water quality guidelines. Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry (DWAF). 1999. Resource Directed Measures for Protection of Water Resources. Wetland Ecosystems. Version 1.0, September 1999.

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry (DWAF). 2007. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L.

Dodds W.K. & Oaks R.M. 2008. Headwater influences on downstream water quality. Environmental Management 41:367–377.

Driver, A., Maze, K., Lombard, A.T., Nel, J., Rouget, M., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. & Strauss, T. 2004. South African National Spatial Biodiversity Assessment 2004: Summary Report. Pretoria: South African National Biodiversity Institute.

Ewart-Smith, J.L., Ollis, D.J., Day, J.A. and Malan, H.L. 2006. National wetland inventory: development of a wetland classification system for South Africa. WRC Report No. KV 174/06.

Grobler, L.E.R. 2008. Wetland assessment for Wetland A21A-02 for the South African National Biodiversity Institute Working for Wetland Programme. Land Resources International (LRI).

Gomi, T., Sidl, R.C., Richardson, J.S. 2002. Understanding processes and downstream linkages of headwater systems. BioScience, 52, 10, 905-916.

Hargreaves, J.A. 1999. Control of clay turbidity in ponds. SRAC Publication No. 460, Southern Regional Aquaculture Center.

Josselyn, M.N., Martindale, M. and Duffield, J.. 1989. Public Access and Wetlands: impacts of recreational use. California Coastal Conservancy, 56 pp..

Kemp A. 2004. Sediment Control on Unsealed Roads: A Handbook of Practical Guidelines for Improving Stormwater Quality. EPA Victoria and Cardinia Shire Council. Victoria, Australia

Kotze D.C. 1997a. Wetlands and people: what values do wetlands have for us and how are these values affected by our land-use activities? WETLAND-USE Booklet 1. SHARE-NET, Wildlife and Environment Society of South Africa, Howick.

Kotze D.C. 1997b. How wet is a wetland? An introduction to understanding wetland hydrology, soils and landforms, WWELAND-USE Booklet 2. SHARE-NET, Wildlife and Environment Society of South Africa, Howick.

Kotze D.C. 1999. A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Kotze, D.C. 2004. Guidelines for managing wetlands in forestry areas. Report prepared for the Mondi Wetlands Project.

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. and Collins, N.B.. 2005. Wet-Ecoservices. A technique for rapidly assessing ecosystem services supplied by wetlands. Unpublished report.

Lynch, J.A., Corbett, E.S. and Mussallem, K. 1985. Best management practices for controlling nonpoint-source pollution on forested watersheds. J. Soil and Water Conservation, 40,164-167.

Marneweck G.C. and batchelor A.L. 2002. Wetland classification, mapping and inventory. In: Palmer R.W., Turpie J., Marneweck G.C. & Batchelor A.L. Ecological and economic evaluation of wetlands in the upper Olifants River Catchment, South Africa. WRC Report No. 1162/1/02. Water Research Commission, Pretoria.

Mayhew S. 2009. A dictionary of Geography. Forth edition. Oxford University Press. Oxford, UK.

Martens, K. and de Moor, F. 1995. The fate of the Rhino Ridge pool at Thomas Baines Nature Reserve: a cautionary tale for nature conservationists. South African Journal of Science, 91, 385-387.

Macfarlane D.M, Kotze D, Walters D, Ellery W, Koopman V, Goodman P, and Goge C. 2009. WET-Health: A Technique for Rapidly Assessing Wetland Health. WRC Report No. TT340/09. Water Research Commission, Pretoria.

Meyer K.G. 2001. Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments. USDA Forest Service Technology and Development Program Missoula, MT. 2E22A68—NPS OHV Management.

Meyer J.L., Kaplan L.A., Newbold D., Strayer D.L., Woltemade C.J., Zedler J.B., Beilfuss R., Carpenter Q., Semlitsch R., Watzin M.C. and Zedler P.H. undated. Where rivers are born: the scientific imperative for defending small streams and wetlands. Factsheet. Sierra Club and American Rivers.

Minter, L.R., Burger, M., Harison, J.A., Braack, H.H., Bishop, P.J. and Kloepfer, D. (Eds). 2004. Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, D.C..

Mucina, L. and Rutherford, M.C. (Eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19, South African National Biodiversity Institute, Pretoria.

Nanson, G.C. and Croke, J.C. 1992. A genetic classification of floodplains. Geomorphology, 4, 459-486.

NC Division of Water Quality. 2005. Identification Methods for the Origins of Intermittent and Perennial streams, Version 3.1. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

Nel, J., Maree, G., Roux, D., Moolman, J., Kleynhans, N., Silberbauer, M. and Driver, A. 2005. South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 2: River Component. CSIR Report Number ENV-S-I-2004-063. Council for Scientific and Industrial Research, Stellenbosch.

Newbold, J.D., Erman, D.C., Roby, K.B.. 1980. Effects of logging on macroinvertebrates in streams with and without buffer strips. Can. J. Fish Aquat. Sci., 37,1076-1085.

Palmer, R.W., Turpie, J., Marnewick, G.C., & Batchelor, A.L. (eds). 2002. Ecological and Economic Evaluation of Wetlands in the Upper Olifnts River Catchment, South Africa. Water Research Commission Report No. K5/1162.

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kumundi, D.A. & Manyama, P.A. (eds). 2009. Red List of South African Plants. Sterlitzia 25. South African Biodiversity Institute, Pretoria.

Ramsar Convention Secretariat. 2007a. Wise use of wetlands: A conceptual framework for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands. 3rd Edition. Volume 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/).

Ramsar Convention Secretariat. 2007b. Designating Ramsar sites: The strategic framework and guidelines for the future development of the List of Wetlands of International Importance.

Ramsar handbooks for the wise use of wetlands. 3rd Edition. Volume 14. Ramsar Convention Secretariat, Gland, Switzerland.

Rittenhouse, T.A.G. and Semlitsch, R.D. 2007. Distribution of amphibians in terrestrial habitat surrounding wetlands. Wetlands, 27, 1, 153-161.

Semlitsch, R.D. 2000. Size does matter: the value of small isolated wetlands. National Wetlands Newsletter, January-February, 5-13.

Shisler, J.K., Jordan, R.A. and Wargo, R.N.. 1987. Coastal wetland buffer delineation. New Jersey Dept. of Environmental Protection, Division of Coastal Resources, Trenton, New Jersey, 102 pp..

Stockdale, E.C. 1991. Freshwater Wetlands, Urban Stormwater, and Non-point Pollution Control: A literature review and annotated bibliography. Second Edition. Washington State Department of Ecology, Olympia, WA..

Strahler, A.N. 1952. Hypsometric (area altitude) analysis of erosional topography. Geological Society of America Bulletin, 63: 1117–1142.

Van Deventer et al. 2010. Using landscape data to classify wetlands for country-wide conservation planning.

Von der Heyden, C.J. and New, M.G. 2003. The role of a dambo in the hydrology of a catchment and the river network downstream. Hydrology and Earth System Sciences, 7, 3, 339-357.

Walsh, G. and Jonker M. 2010. Draft Rand Water River Crossing Report Nelmapius, Pretoria. Aquatic Biodiversity Assessment Report Pienaars River. Florida, Johannesburg.

Young, R.A., Huntrods, T. and Anderson, W.. 1980. Effectiveness of vegetated buffer strips in controlling pollution from feedlot runoff. J Environ. Qual., 9, 483-497.