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Ngwenya Lodge Extention: Wetland and Riparian Zone Identification and Description

Submitted to:

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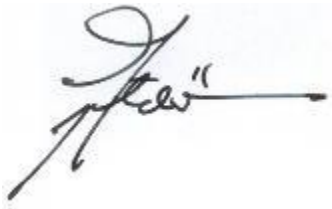
DECLARATION OF INDEPENDENCE

The specialist/s appointed in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010:

I/We, Anton Linström declare that:

General declaration

- I/We act as the independent specialist/s in this application;
- I/We do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010;
- I/We will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I/We declare that there are no circumstances that may compromise my/our objectivity in performing such work;
- I/We have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I/We will comply with the Act, regulations and all other applicable legislation;
- I/We have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I/We undertake to disclose to the applicant and the competent authority all material information in my/our possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself/ourselves for submission to the competent authority;
- All the particulars furnished by me/us in this form are true and correct; and
- I/We realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of Ecologist

Executive Summary

Wet-Earth Eco-Specs was appointed by NuLeaf Planning & Environmental to conduct a wetland / riparian survey for a Basic Assessment Report (BAR) on the Ngwenya Lodge property north-west of the small hamlet of Komatipoort. The landowner intends to extend its resort with recreational facilities on the said property.

The following activities were conducted:

- Identification of wetlands and riparian areas;
- Delineation of wetlands and riparian areas;
- Classification of the wetlands;
- Characterisation of wetlands and riparian areas,
- PES and EIS description of wetlands,
- PES evaluation of riparian areas,
- Buffer zone recommendations.
- Impact Assessment, and
- Mitigation measures.

The study area lies on the southern border of the Kruger National Park, about 6km east of Marloth Park and about 10km north-west of the town of Komatipoort. The N4 lies approximately 5km to the south. The study area falls within the Nkomazi Local Municipality, Ehlanzeni District Municipality, , Mpumalanga Province. It falls within the Delagoa Lowveld vegetation unit and covers land types Dc34 and Ea76. According to the MBSP terrestrial assessment, the study area is classified primarily as 'Heavily Modified' and 'Other Natural Areas', with some patches of 'Moderately Modified – Old Lands' and a small section of 'Protected Area: National Parks and Nature Reserves', which equates to the Kruger National Park.

The study area falls within quaternary catchment X24H, part of the Crocodile Sub-water Management Area, Inkomati Water Management Area. The study area is associated with one perennial river (Crocodile) and several non-perennial rivers, including the Kumoyana River. The Crocodile River has a condition of 'D'. According to the MBSP freshwater assessment, the study area includes four ESA wetland areas. Three of these are associated with dams and one is associated with the Crocodile River. They are all classified as channelled valley-bottom wetlands. The three wetlands associated with dams have a condition of Z1, while the one associated with the Crocodile River has a condition of DEF. The sub-catchment within which the study area falls has been classified by the MBSP as an 'ESA Important Sub-catchment', but does include large sections of 'Heavily Modified' areas as well as four dams. The sub-catchment is important as it is a Fish Support Area supporting the Tiger Fish (*Hydrocynus vittatus*).

The field survey revealed 4 watercourses one of which one is artificial. The delineated riparian areas are demarcated and indicated as N01 to N04.

Site N01 Riparian Index of Habitat Integrity (RIHI) is a D/E (41.8%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation (*Tecoma stans* being the dominant species) and a housing development.

Site N02 Riparian Index of Habitat Integrity (RIHI) is a D/E (37.6%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation infestations (*Lantana camara* and *Tecoma stans* being the dominant species) and greywater being released into the system.

Site N03 is an artificial dam site, which is briefly discussed, but not assessed.

Site N04 the Crocodile River Riparian Index of Habitat Integrity (RIHI) is a D (56.8%), with the main impacts being dumping of building rubble, flood events, grazing and trampling, water abstraction and the presence of exotic species.

The riparian edge of the water resources has been delineated. However, according to the Preliminary Guidelines for the Determination of Buffer Zones for Rivers the buffer starting point for the delineation of the aquatic impact buffer zones are on the outer edge of the active channel. Buffer widths for the denominated riparian zones are:

- N01 – 17m
- N02 – 17m
- N03 - NA
- N04 - 42m

The final buffer zone will then cover the riparian zone and the aquatic impact buffer zone.

The proposed development could result in the increase of hardened surfaces and subsequent storm water runoff, increased flows, decrease in water quality, etc.

The following is recommended:

- All activities should stay out of the 1:100-year flood line area;
- All activities should stay out of the riparian areas and its recommended buffer zones;
- Greywater should be treated to remove contaminants, be it through physical, chemical and/or biological processes and to produce environmentally safer, treated greywater, before it is released into the environment.
- Nutrient levels should be controlled.
- Chemical levels of Sodium, Nitrite, Phosphate and Chlorine should be monitored and managed.
- All storm water should be diverted to a point from where the water must be released in a controlled manner that will not initiate or enhance any erosion. The way storm water enters a natural waterway is important because high-energy flows can cause serious damage (especially to riparian zones);
- Energy dissipaters and smaller permeable gabion-structures, covered with reeds can be constructed at the effluent points of all storm water.
- To cater for the present and the proposed developments in the above-mentioned riparian areas, on-site and off-site mitigation is recommended to mitigate the negative effects thereof.

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GLOSSARY

Term	Explanation
Anaerobic	Without air.
Biota	All the plants and animals inhabiting an area.
Biodiversity	The variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems which they form part of.
Catchment	A drainage basin or land area with convergent contour lines where water flow starts and accumulates to form a drainage network. Also referred to as a watershed (specifically in the US), but a watershed can also refer to a catchment divide.
Catchment divide	Divisions between catchments, located in areas with divergent contour lines.
Connectivity	In this context, referring to either the upstream-downstream or lateral (between the channel and the adjacent floodplain) connectivity of a drainage line. Upstream-downstream connectivity is an important consideration for the movement of sediment as well as migratory aquatic biota. Lateral connectivity is important for the floodplain species dependent on the wetting and nutrients associated with overbank flooding.
Diversity	A combination of the number of taxa and the relative abundance of those taxa. A variety of diversity indexes have been developed to calculate diversity.
Ecosystem	Any unit that includes all the organisms that function together in a given area interacting with the physical environment so that a flow of energy leads to clearly defined biotic structure and cycling of materials between living and non-living parts (Odum 1983).
Ecoregion	A region defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.
Exotic	From another part of the world; foreign and/or alien.
Geology	The study of the composition, structure, physical properties, dynamics, and history of earth materials, and the processes by which they are formed, moved, and changed.
Gleyed soil	A material that has been or is subject to intense reduction as a result of prolonged saturation with water. Grey colours are due to an absence of iron compounds.
Habitat	The sum of the physical, chemical, and biological environment occupied by individuals of a particular species, population, or community.
Head-cut	An erosion feature that can develop within a channel, at the proximal end of a channel, or on an unchanneled slope. They are the precursors to channel development as head-cut migration creates or extends channels.
Hydro-geomorphic	Refers to the water source and geology forms.
Invasive	Any alien species of insect, animal, plant or pathogen, including its seeds, eggs, spores, or other biological material capable of propagating that species.
Palustrine	Relating to a system of inland, non-tidal wetlands characterised by the presence of trees, shrubs and emergent vegetation.
Pedology	The branch of soil science that treats soils and all their properties as natural phenomena.
Rivers and streams	This type of water resource is described as a channel (river, including the banks) in the National Wetland Classification System (SANBI, 2009). This is defined as ***"an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-***

Term	Explanation
	contained horizontal flow characterises the hydrodynamic nature of these units." According to the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding. This definition is consistent with the NWA (Act No. 36 of 1998) which makes reference to (i) a river or spring and (ii) a natural channel in which water flows regularly or intermittently within the definition of a water resource. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks which can be identified and delineated.
Riparian Zone	Area of land directly adjacent to the active channel of a river, which is influenced by river-induced or river-related processes.
Seep	A wetland area located on gently to steeply sloping land and dominated by the colluvial unidirectional movement of water and material down-slope. Water inputs are primarily via subsurface flows from an up-slope direction.
Soils	Dynamic natural body composed of mineral and organic materials (as well as living organisms) in which plants grow. It can also be described as the collection of natural bodies occupying parts of the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.
Topographical maps	Detailed depiction of land features shown on a map.
Topography	Detailed description of land features.
Unchanneled valley bottom	Linear fluvial, net depositional valley bottom surfaces that do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas.
Watercourse	Watercourse definitions as provided in the NWA: • 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 and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse. • A reference to a watercourse includes, where relevant, its bed and banks.
Wetland	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 live in saturated soil (NWA).

List of Acronyms

Acronym	Explanation
C-Plan	Conservation Plan (typically in the form of a spatial dataset at a provincial level)
DEA	Department of Environmental Affairs
DWA(F)	Department of Water Affairs (and Forestry, i.e. prior to 2009)
EC	Ecological Category
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
EMC	Ecological Management Class
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographic Information System
HGM	Hydro-geomorphic
IHI	Index of Habitat Integrity
MBSP	Mpumalanga Biodiversity Sector Plan
MPRDA	Mineral and Petroleum Resources Development Act
NFEPA	National Freshwater Ecosystem Priority Areas
NEMA	National Environmental Management Act
NWA	National Water Act (Act No. 36 of 1998)
PES	Present Ecological State
SAM	Significance after mitigation
SANBI	South African National Biodiversity Institute
SBM	Significance before mitigation
TDS	Total Dissolved Solids
VEGRAI	Vegetation Response Assessment Index

1 INTRODUCTION

Wet-Earth Eco-Specs was appointed by NuLeaf Planning & Environmental to conduct a wetland/riparian survey for a Basic Assessment Report (BAR) on the Ngwenya Lodge property, north-west of the small hamlet of Komatipoort. The study entails the identification and delineation of possible wetland/riparian areas and the assessment of their integrity.

The landowner intends to extend its resort with recreational facilities on the said property.

2 SCOPE OF WORK

The following activities were conducted:

- Identification of wetlands and riparian areas;
- Delineation of wetlands and riparian areas;
- Classification of the wetlands;
- Characterisation of wetlands and riparian areas;
- PES and EIS description of wetlands;
- PES evaluation of riparian areas;
- Buffer zone recommendations;
- Impact Assessment, and
- Mitigation measures.

3 LIMITATIONS OF THIS INVESTIGATION

The following limitations were placed on the wetland ecosystem and biodiversity study of this project:

- This survey only focus in the area as indicated by the client;
- A single baseline assessment was conducted, thus limiting the amount of biota identified at the site;
- Accuracy of the maps, aquatic ecosystems, routes and desktop assessments was limited to the current 1:50 000 topographical map series of South Africa;
- Accuracy of Global Positioning System (GPS) coordinates was limited to 15m accuracy in the field;
- Delineations and related spatial data generated will be supplied in GIS (shape file) format only and will be for the purpose of conceptual planning only and not detailed design. If the client requires that data be accurate to detailed design level, this can be negotiated and budgeted for separately;
- The assessment of the impact of past activities on the wetlands was based on professional judgement, since no data (to our knowledge) exists prior to the developments that have already taken place on the site, to which the current state can be compared;
- Time and costs related to surveys have been calculated based on the proposed area (route) as indicated by the client;
- Whilst every care is taken to ensure that the data presented is qualitatively adequate, inevitably conditions are never such that that is entirely possible. Under the

circumstances, it must be pointed out that the nature of the vegetation, the time of year, human intervention and the like, limit the veracity of the material presented.

4 METHODOLOGY

4.1 Characterisation of the flora

The area was traversed on foot and all indications of plant species observed were recorded. Background literature surveys were also conducted to assess which species have been recorded in the general area.

4.2 Riparian Vegetation Response Assessment Index (VEGRAI)

The assessment of the riparian vegetation was done according to the Level 3: Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans et al. 2007). According to this index, the following components were assessed:

Site extent determination

Flow, geomorphology, substrata, elevation, vegetation structure and species diversity, as well as the importance of these, were recorded, as they play an important role in determining riparian vegetation distribution. General characteristics were described.

Site delineation

In order to cover a representative area of the riparian zone in the study area, several transect surveys were necessary. Areas in between these transects were also traversed on foot, and spot surveys contributed to a more complete survey.

Zone determination

The following zones within the riparian vegetation were identified for a Level 3 assessment and were assessed at each site:

- Marginal zone: starts at the water's edge and extends a few metres up the bank, along a lateral gradient.
- Non-Marginal zone: Starts at the end of the marginal zone and extends away from the river to a point where there is a significant decrease in lateral slope or where vegetation species composition changes from riparian to non-riparian vegetation species.

Species list

Key/dominant/easily identifiable vegetation species were listed and indicated as woody or non-*woody* species and the zones where they occur were recorded.

Land use and impact evaluation

The surrounding and upstream land uses that could have an impact on the site were identified. Vegetation removal, changes to water quality and changes to water quantity were the three impacts that were considered for intensity and extent. The impacts were assessed on a scale from 0–5 (where 0 = no impact and 5 = extreme impact).

Exotic vegetation and invasion

Exotic vegetation has an impact on indigenous riparian vegetation. The impact is measured using the cover percentage of exotic species. A list of exotic species and the zones in which they are found was recorded at each of the sites.

Reference condition reconstruction

Reference conditions can be reconstructed in one of two ways:

- By using an unaffected river in the same eco-region to reconstruct the reference state, or
- By eliminating impacts to reconstruct the reference conditions.

Response metrics rating

For Level 3 VEGRAI assessments, only abundance and cover were rated. Using the guideline illustrations provided by the index, the abundance and cover for woody and non-woody species were rated separately for each of the zones. The abundance and cover rating was based on indigenous species density and percentage aerial cover.

Ecological Category

Field data was transferred to the VEGRAI Excel spreadsheet. The Ecological Category was calculated from the results obtained.

Metric groups and the calculation of the Ecological Category

The following procedure was followed to integrate the conditions of metric groups, and to provide an estimated Ecological Category for the riparian vegetation:

- The degree to which a metric group has changed from the natural state is subtracted from 100 to provide the degree to which the metric group is still intact.
- Each metric group (vegetation zone) is ranked and weighted according to its relative importance to the functioning of the river under natural conditions (cf. above). The focus is on the in-stream aspect of the river.
- These weights are summed and the weight for each metric group is expressed as a proportion of this total.
- This proportional weight is multiplied by the percentage of the metric group in a natural condition and summed for all metric groups. This provides an integrated value that relates to the Ecological Category for the riparian vegetation that ranges from A to F (Table 1).

Table 1. Generic ecological categories for EcoStatus components (modified from Kleynhans 1996 & Kleynhans 1999)

Ecological Category	Description	Score (% of total)
A	Unmodified, natural	90 - 100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place, but the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 - 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 - 39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

4.3 Buffer Zone

The literature review revealed that international approaches used to determine required buffer zone widths varied considerably from simple one-size-fits-all approaches to others that rely on extensive site-specific information to inform buffer width requirements (Macfarlane, 2014). Three generic approaches were identified in the literature, and are briefly outlined below:

- Fixed-width: The fixed width approach typically applies a standard buffer width to a particular water resource type. In some instances, a generic width is applied regardless of any characteristics of the water resource. However, this approach is more typically applied to a class of wetland or river type, or a specific land use type / activity.
- Modified fixed-width: In this approach, a matrix of factors is typically used to categorise wetlands and / land-uses with category-specific standard buffer widths being applied to the resource. These widths may, however be modified based on relevant on-site factors where more detailed information is available.
- Variable-width: This approach usually requires the development of a detailed formula and methodology for considering site-specific factors such as wetland type, adjacent land use, vegetation, soils, wildlife habitats, slope, desired function and other special site-specific characteristics to calculate buffer widths.

While each approach has a number of advantages and disadvantages, the modified fixed-width approach is regarded as most appropriate for the South African context. This is principally due to the need to develop a tool that could be applied across different levels (i.e. desktop and site-based), while maintaining a level of predictability and consistency between approaches. The method outlined in this document therefore proposes highly conservative buffer widths based on generic relationships for broad-scale assessments, but allows these to be modified based on more detailed site-level information. Resultant buffers therefore

range from highly conservative, fixed-widths for different land-uses at a desktop level, to buffers that are modified based on a more thorough understanding of the water resource and specific site characteristics (Macfarlane, 2014).

4.3.1 Impact Assessment and Mitigation

In order to assess the impacts of the proposed project on the aquatic ecosystems, the following components were included:

- The identification of the main areas of impact associated with the proposed project;
- The assessment of the impacts of the proposed project on the aquatic ecosystems;
- The recommendation of mitigation and management measures to deal with significant impacts;
- The identification of aspects which may require further study.

The impacts of the proposed project were assessed in terms of impact significance and recommended mitigation measures. The determination of significant impacts relates to the degree of change in the environmental resource measured against some standard or threshold (DEAT, 2002). This requires a definition of the magnitude, prevalence, duration, frequency and likelihood of potential change (DEAT, 2002). The following criteria have been proposed by the Department of Environmental Affairs for the description of the magnitude and significance of impact (DEAT, 2002):

This section of the report describes and evaluates the potential impact of the development on the receiving riperian environment. The significance of the impact was determined using the criteria given in Table 2 in accordance with the ratings contained therein.

Table 2: Criteria for Assessment of Impacts

Severity (Magnitude)	
The severity of the impact is considered by examining whether the impact is destructive or benign, whether it destroys the affected environment, alters its functioning, or slightly alters the environment itself. The intensity is rated as:	
(I)nsignificant	The impact alters the affected environment in such a way that the natural processes or functions are not affected.
(M)oderate	The affected environment is altered, but functions and processes continue, albeit in a modified way.
(V)ery High	The function or process of the affected environment is disturbed to the extent that it temporarily or permanently ceases.
Duration	
The lifetime of the impact that is measured in relation to the lifetime of the proposed development.	
(T)emporary	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than that of the construction phase.
(S)hort term	The impact will be relevant through to the end of a construction phase (1.5 – 2 years).
(M)edium term	The impact will last up to the end of the development phases, after which it will be entirely negated.
(L)ong term	The impact will continue for the entire operational lifespan i.e. exceed 30 years of the development, but will be mitigated by direct human action or by natural processes thereafter.
(P)ermanent	This is the only class of impact that will be non-transitory. Mitigation either by man-made or natural processes will not occur in such a way or in such a time span that the impact is considered transient.
Spatial scale	
Classification of the physical and spatial scale of the impact.	
(F)ootprint	The impacted area extends only as far as the activity, such as the footprint occurring within the total site area.
(S)ite	The impact could affect the whole, or a significant portion of the site.
(R)egional	The impact could affect the area, including the neighbouring farms, the transport routes and the adjoining towns.
(N)ational	The impact could have an effect on the whole country (South Africa).
(I)nternational	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
Probability	
This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:	
(I)improbable	The possibility of the impact occurring is nil, due either to the circumstances, design or experience. The chance of this impact occurring is defined as 0%.
(P)ossible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chance of this impact occurring is defined as 25%.
(L)ikely	There is a possibility that the impact will occur to the extent that provisions for mitigation must therefore be made. The chance of this impact occurring is defined as 50%.
(H)ighly Likely	It is most likely that the impact will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chance of this impact occurring is defined as 75%.
(D)efinite	The impact will take place regardless of any preventative plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined as 100%.

In order to assess each of these factors for each impact, the following ranking scales will be used (Table 3).

Table 3: Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	Score	Description / Meaning	Score
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Moderate	6
Possible	2	Low	4
Improbable	1	Insignificant	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	Score	Description / Meaning	Score
Permanent	5	International	5
Long term	4	National	4
Medium term	3	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1/0

Details of the significance of the various impacts identified are presented in Table 4 and Table 5.

Determination of Significance – With Mitigation

Determination of significance refers to the foreseeable significance of the impact after the successful implementation of the necessary mitigation measures. The Significance Rating (SR) is determined as follows:

Equation 1:

Significance Rating (SR) = (Extent + Intensity + Duration) x Probability

Identifying the Potential Impact without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures). Significance without mitigation is rated on the following scale:

Table 4: Significance Rating Scales without mitigation

SR < 30	Low (L)	Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.
30 < SR < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit that is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact that could influence the decision about whether or not to proceed with the project.

Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale as contemplated in Table 5.

Table 5: Significance Rating Scales with mitigation

SR < 30	Low (L)	The impact is mitigated to the point where it is of limited importance.
30 < SR < 60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR > 60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as of high importance and, taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance after mitigation could render the entire development option or entire project proposal unacceptable.

5 RESULTS AND DISCUSSION

5.1 Study Area

5.1.1 Location

The study area lies on the southern border of the Kruger National Park, about 6km east of Marloth Park and about 10km north-west of the town of Komatipoort (Figure 1). The N4 lies approximately 5km to the south (Figure 1). The study area falls within the Nkomazi Local Municipality in the Ehlanzeni District Municipality, Mpumalanga Province and is situated on the farm Tenbosch 162 JU.

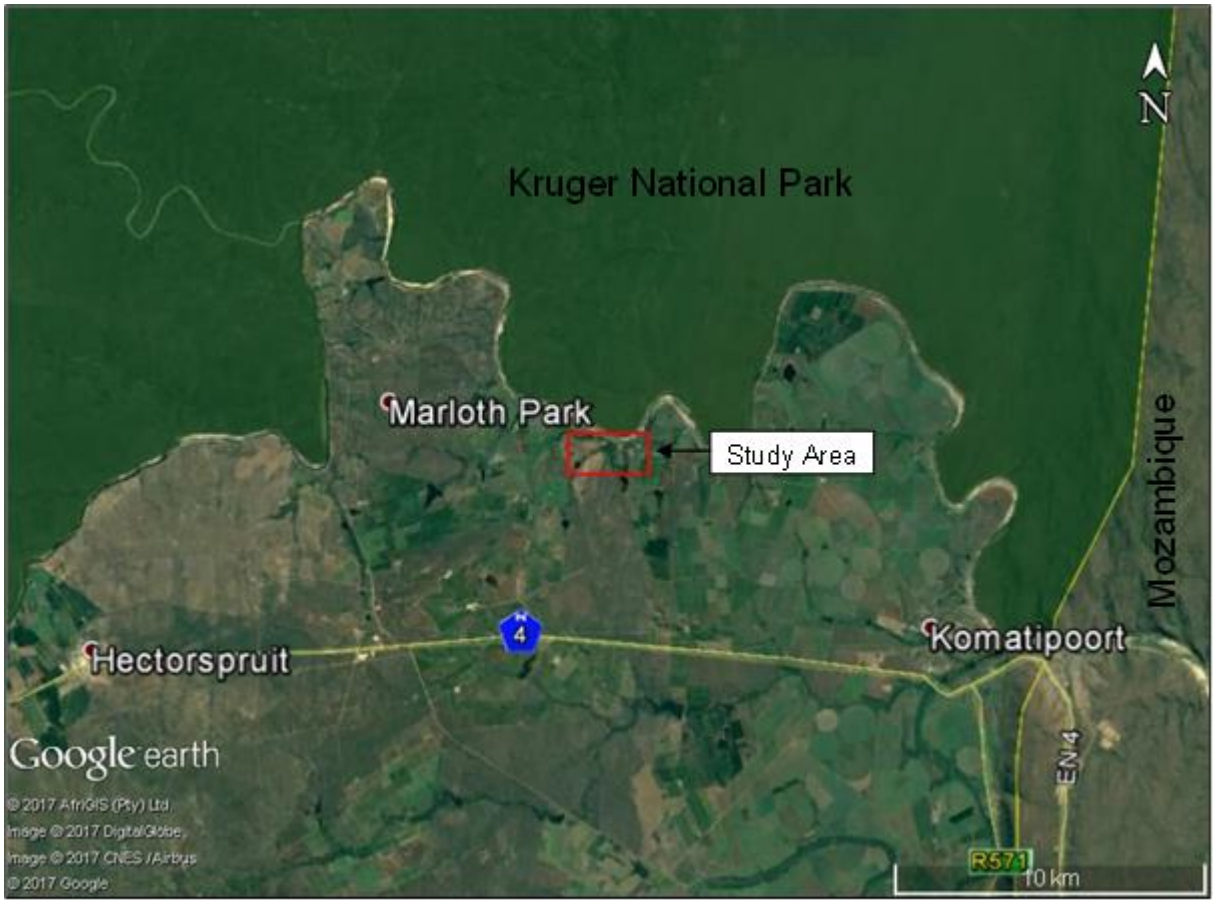


Figure 1: Google Earth image showing the study area in relation to the surrounding places and roads

5.1.2 Land-use

According to the 2013/2014 land-cover data, the predominant Land-use within the study area is cultivation, in addition to smaller areas of urban development and plantations (Figure 2). Natural areas, water and bare patches are also present (Figure 2). The area surrounding the study site is very similar (Figure 2).

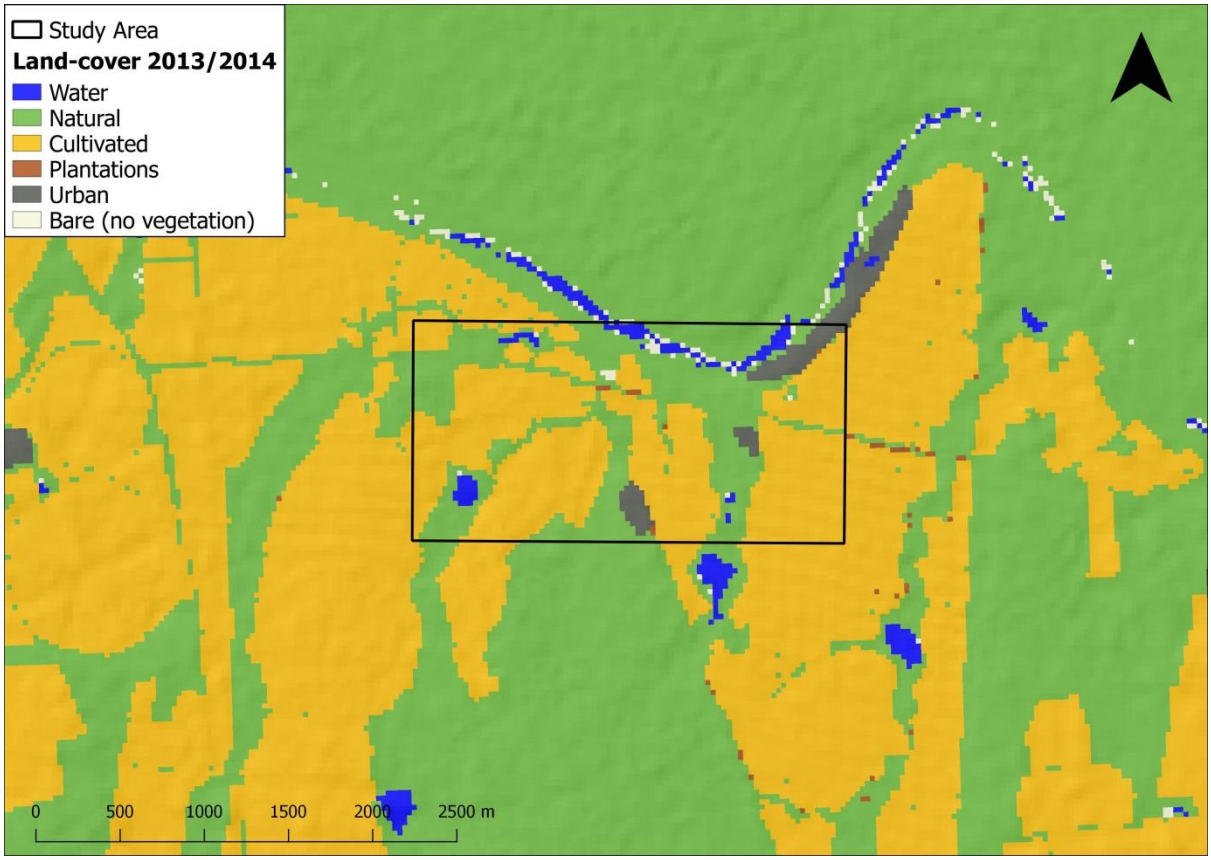


Figure 2: 2013/2014 land-cover data showing the different land-uses within and surrounding the study area

5.1.3 Vegetation Units

According to Mucina & Rutherford (2006), the study area falls within the Delagoa Lowveld (SVl4) vegetation unit (Figure 3). The following description applies to the unit as a whole and is taken from Mucina & Rutherford (2006).

Delagoa Lowveld has an altitude range of 150 to 450 m. The vegetation comprises a dense tree or tall shrub layer dominated by Acacia welwitschii, often forming thickets. The herb layer has, in addition to grass species, a wide variety of forbs. Areas are often heavily grazed, which sometimes drastically reduces the grass cover. It is a summer rainfall region with dry winters and is generally frost-free. Delagoa Lowveld has a conservation target of 19%. About 18% is statutorily conserved in the Kruger National Park. Some 33% is transformed, almost all by cultivation.

Mean monthly minimum and maximum temperatures at the study site itself are 8.9˚C and 32.2˚C in July and December respectively, while the annual average is 22.6˚C; the mean annual precipitation is 639 mm (WorldClim database, Hijmans et al., 2005).

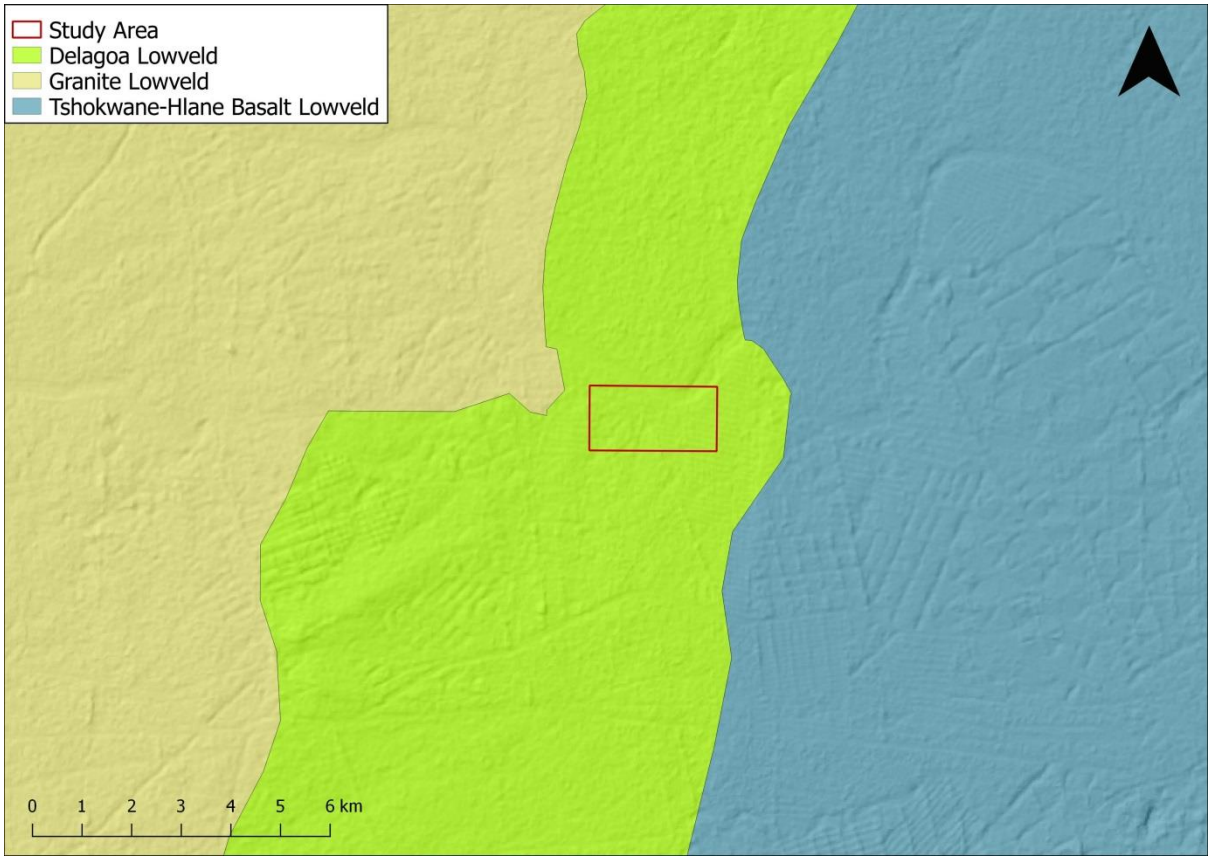


Figure 3: The position of the study area in relation to the surrounding vegetation units

5.1.4 Land Types

The study area covers two land types, as per Table 6 (Figure 4).

Table 6: A description of the soils and geology of the two land types associated with the study area (Land Type Survey Staff, 1972–2006)

Land type	Soil Description	Geology
Dc34	Prismacutanic and/or pedocutanic diagnostic horizons dominant. In addition, one or more of: vertic, melanic, red structured diagnostic horizons.	Shale, sandstone, mudstone, coal, siltstone and basalt of the Karoo Sequence.
Ea76	One or more of: vertic, melanic, red structured diagnostic horizons, undifferentiated.	Shale and sandstone of the Karoo Sequence; dolerite.

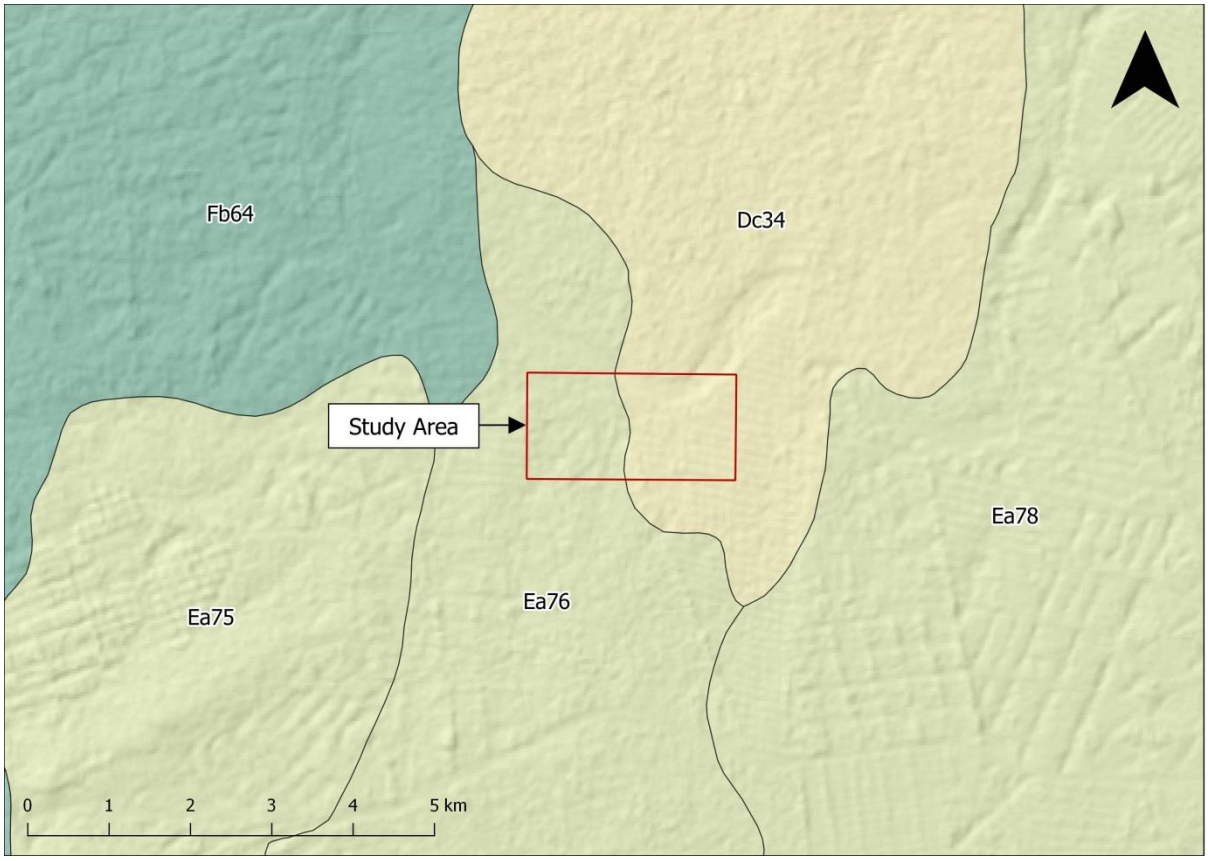


Figure 4: Study area in relation to the land types in the vicinity

5.1.5 Mpumalanga Biodiversity Sector Plan (Terrestrial Assessment)

The Mpumalanga Biodiversity Sector Plan (MBSP) identifies terrestrial and freshwater areas that are important for conserving biodiversity pattern and ecological processes (MTPA, 2014). According to the MBSP terrestrial assessment, the study area is classified primarily as 'Heavily Modified' and 'Other Natural Areas', with some patches of 'Moderately Modified – Old Lands' and a small section of 'Protected Area: National Parks & Nature Reserves', which equates to the Kruger National Park (Table 7 and Figure 5).

Table 7: Summary of relevant map categories for MBSP terrestrial assessment, taken from MTPA (2014)

Map Category	Description	Sub-category	Description
Protected Areas	Areas that are formally protected by law and recognised in terms of the Protected Areas Act, including contract protected areas declared through the biodiversity stewardship programme.	National Parks & Nature Reserves	Includes formally proclaimed National Parks, Nature Reserves, Special Nature Reserves, and Forest Nature Reserves.
Other Natural Areas	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions.		
Moderately or Heavily Modified Areas	Areas in which significant or complete loss of natural habitat and ecological function has taken place due to activities such as ploughing, hardening of surfaces, open-cast mining, cultivation and so on.	Heavily Modified	All areas currently modified to such an extent that any valuable biodiversity and ecological functions have been lost.
		Moderately Modified: Old lands	Old cultivated lands that have been allowed to recover, and support some natural vegetation. Although biodiversity pattern and ecological functioning may have been compromised, the areas may still play a role in supporting biodiversity and providing ecosystem services.

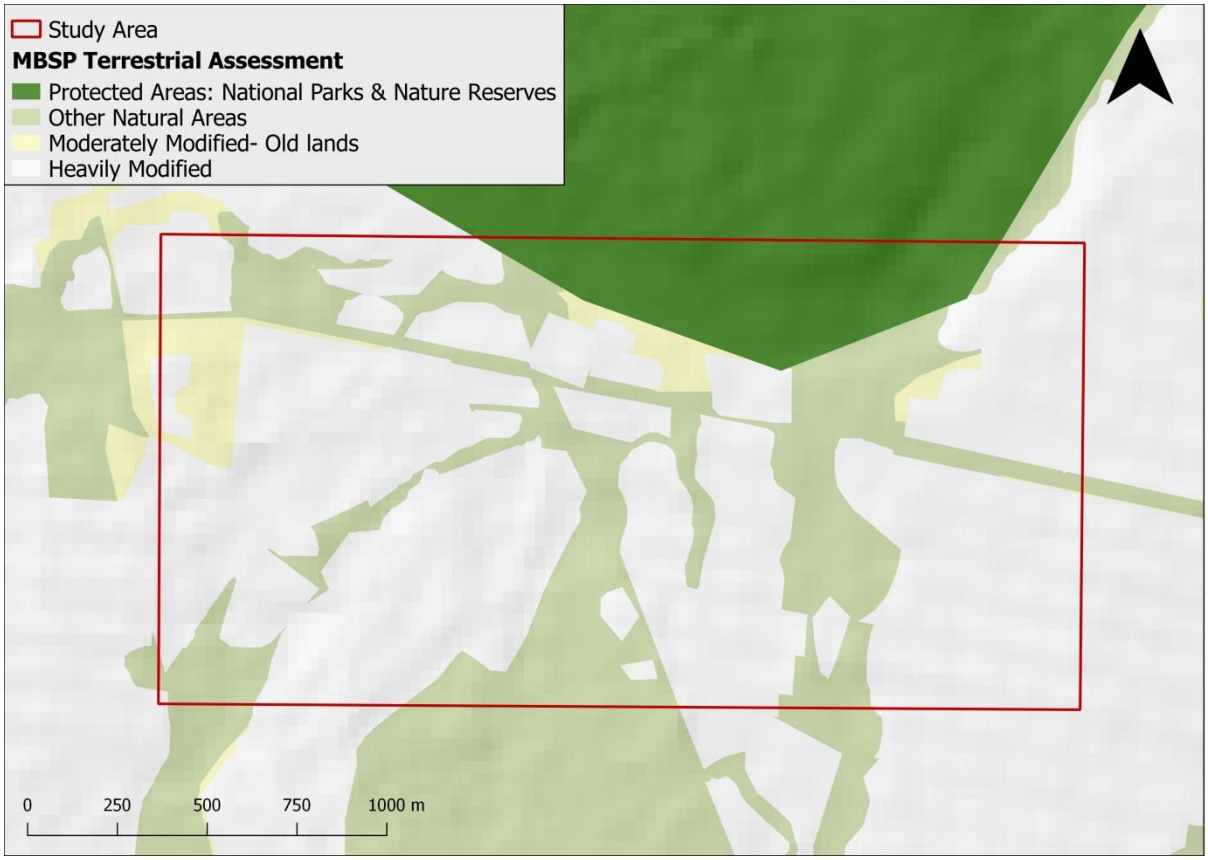


Figure 5: Study area in relation to the MBSP terrestrial assessment

5.1.6 Quaternary Catchments, Wetlands and Rivers (desktop assessment)

This desktop assessment is based on a combination of the MBSP freshwater assessment and the NFEPA project (National Freshwater Ecosystem Priority Areas). The MBSP freshwater assessment relied heavily on the NFEPA project but was improved for Mpumalanga (Lötter, 2015). The NFEPA project identifies FEPAs (Freshwater Ecosystem Priority Areas), which are rivers, wetlands and estuaries that need to remain in a good condition to conserve freshwater ecosystems and protect water resources for human use (Nel et al., 2011).

The study area falls within quaternary catchment X24H (Figure 6), which forms part of the Crocodile Sub-water Management Area, Inkomati Water Management Area.

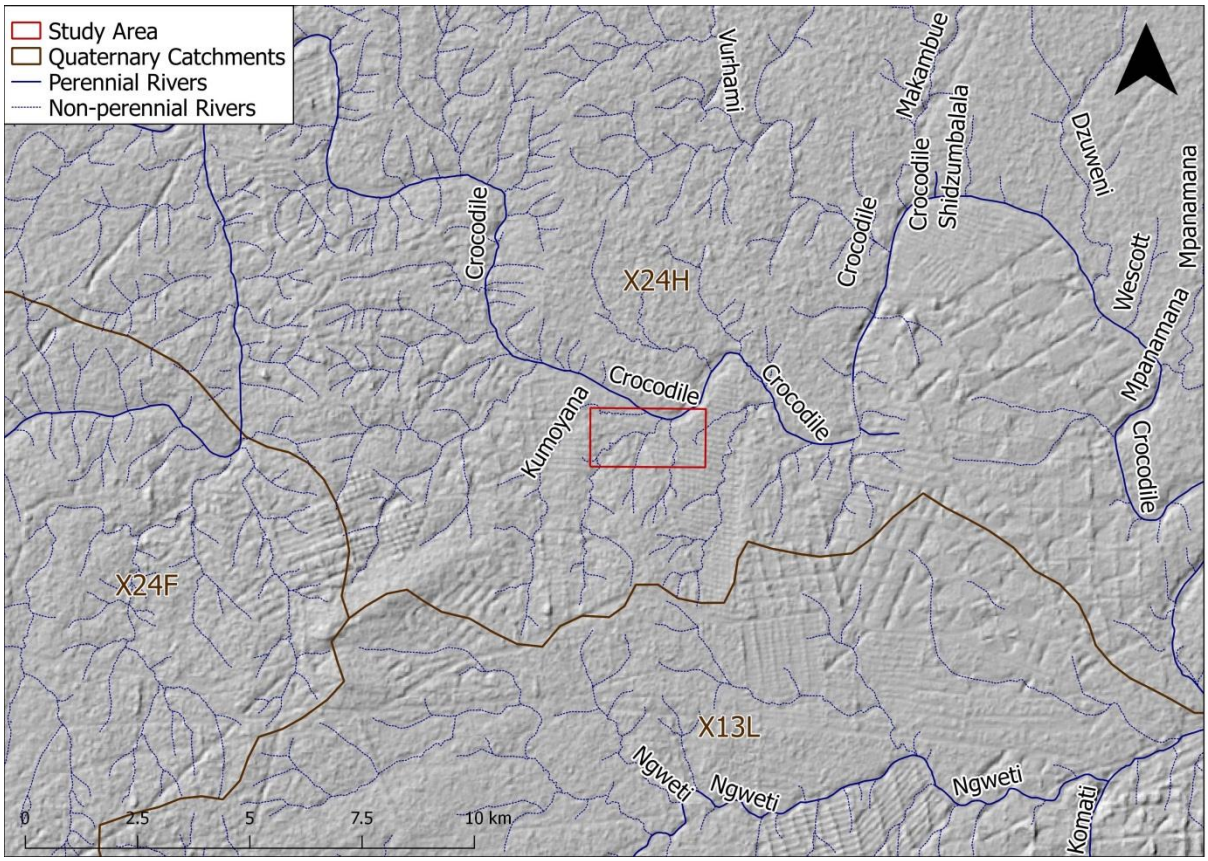


Figure 6: The study area in relation to quaternary catchments and rivers

The study area is associated with one perennial river (Crocodile) and several non-perennial rivers, including the Kumoyana River (Figure 6). The extent to which a river has been modified by human activity is referred to as the river condition (Nel *et al.*, 2011). According to NFEPA, the Crocodile River has a condition of 'D', which means that it is largely modified such that a large loss of natural habitat, biota and basic ecosystem functions has occurred (Nel *et al.*, 2011).

According to the MBSP freshwater assessment, the study area includes four ESA wetland areas (Table 8). Three of these are associated with dams and one is associated with the Crocodile River (Figure 7). They are all classified by NFEPA as channelled valley-bottom wetlands. According to NFEPA, the three wetlands associated with dams have a condition of Z1 (i.e. 'critically modified' – wetland overlaps with a 1:50 000 artificial inland water body),

while the one associated with the Crocodile River has a condition of DEF (i.e. 'heavily modified' – riverine wetland associated with a D, E, F or Z ecological category river).

The sub-catchment within which the study area falls has been classified by the MBSP as an 'ESA Important Sub-catchment', but does include large sections of 'Heavily Modified' areas as well as four dams (Table 8). The sub-catchment is important as it is a Fish Support Area (FSA), as per NFEPA. FSAs are fish sanctuaries that are in a lower than A or B ecological condition. Fish sanctuaries, which include both river FEPAs and FSAs, are rivers and their associated sub-quaternary catchments that are essential for protecting threatened and near threatened fish; consequently, there should be no further deterioration in the condition of the associated rivers (Nel *et al.*, 2011). This particular FSA supports the Tiger Fish (*Hydrocynus vittatus*), a fish species of conservation concern.

Table 8: Descriptions of the relevant map categories for the MBSP freshwater assessment, taken from MTPA (2014).

Map Category	Description	Sub-category	Description
Ecological Support Areas (ESA)	Areas that are not essential for meeting targets, but that play an important role in supporting the functioning of CBAs (Critical Biodiversity Areas) and that deliver important ecosystem services.	ESA: Wetlands	All non-FEPA wetlands. Although not classed as FEPAs, these wetlands support the hydrological functioning of rivers, water tables and freshwater biodiversity, as well as providing a host of ecosystem services through the ecological infrastructure that they provide.
		ESA: Important Sub-catchments	Sub-catchments that either contain river FEPAs and/or Fish Support Areas.
Heavily Modified Areas	Areas in which significant or complete loss of natural habitat and ecological function has taken place due to activities such as ploughing, building of dams, hardening of surfaces, open-cast mining, cultivation, and so on.	Heavily Modified	All areas currently modified to such an extent that any valuable biodiversity and ecological functions have been lost.
		Heavily Modified: Dams	Artificial water bodies that have impacted wetland or river ecosystems. These areas may still have a recharge effect on wetlands, groundwater and river systems and may support river- or water-dependent fauna and flora, such as water birds and wetland vegetation.

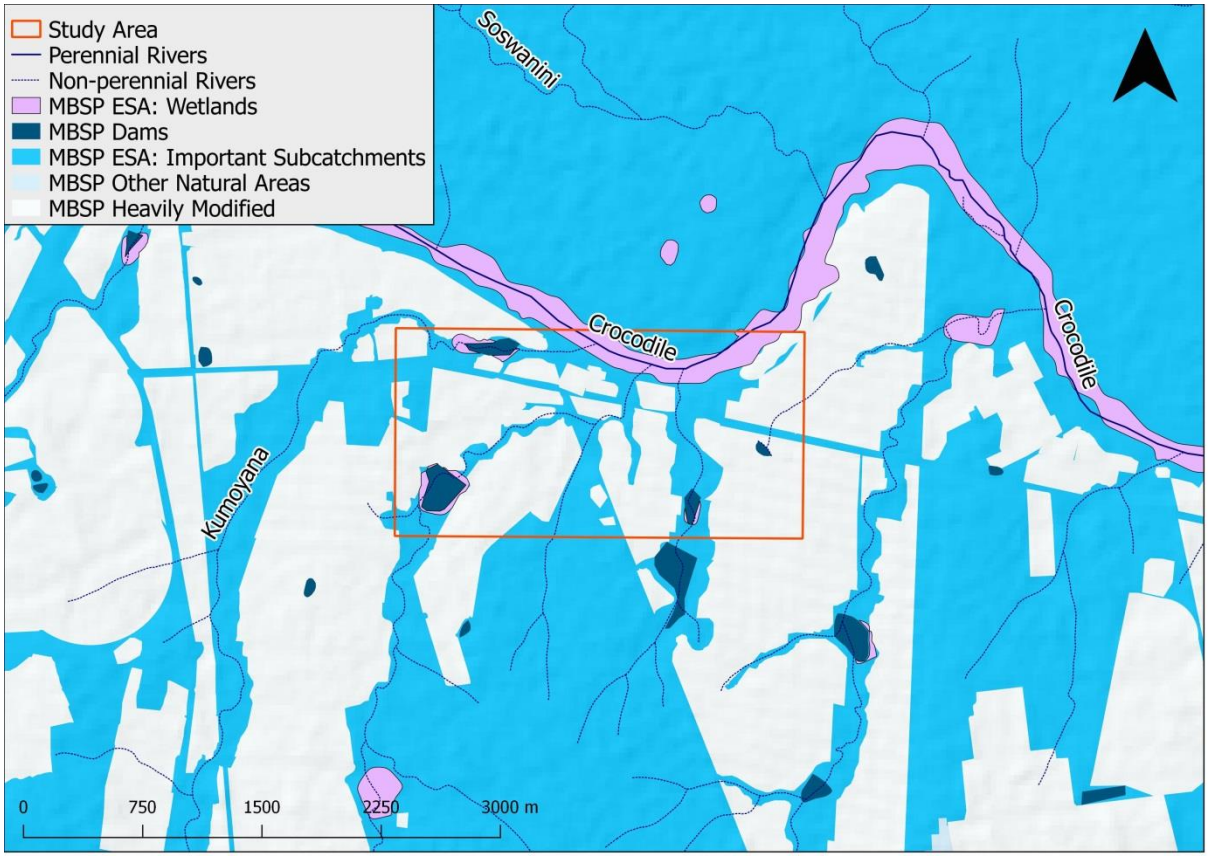


Figure 7: The study area in relation to rivers and the MBSP freshwater assessment; ESA = Ecological Support Area

5.2 Riparian Area Identification and Delineation

In order to cover a representative area of the water courses in the study area, several surveys were necessary. Four water courses were identified and surveyed in the study area. No wetland systems were found.

The riparian areas identified in the study area were delineated in accordance with the guidelines for delineating the boundaries of a wetland, set out by the Department of Water Affairs and Forestry (DWAF) (DWAF, 2005). These delineated riparian areas are demarcated and indicated as per the map shown in Figure 8.

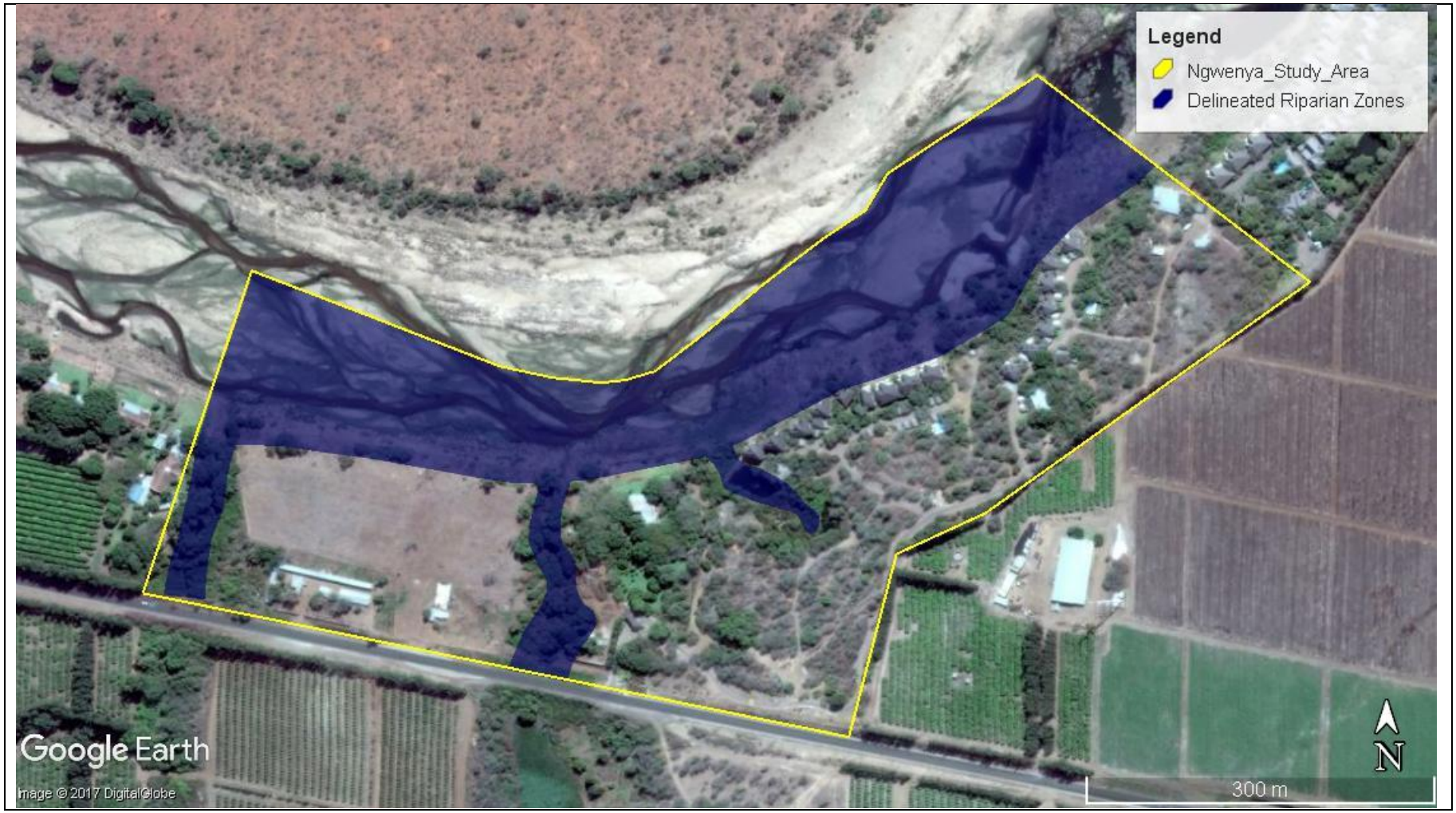


Figure 8: Delineated riparian areas within the Ngwenya study area

5.3 Wetland and Riparian Characterization and Integrity Study

In order to cover a representative section of the riparian zone within the study area, several transect surveys were necessary. The riparian areas in the study area were delineated in accordance with the guidelines for delineating the boundaries set out by the then Department of Water Affairs and Forestry (DWAF, 2005).

Four watercourses were identified in the study area and can be described as riverine areas. The delineated riparian areas are demarcated and indicated as N01, N02, N03 and N04 for the purpose of this study. These areas are denominated and indicated as per the map in Figure 9. Please take note that site N03 is an artificial dam and receives its water from the Crocodile River (Herholdt, pers. comm.)

No wetland areas were identified in the study area.

Figure 9: Identified watercourses denominated for the purpose of this study

5.3.1 Site N01

This site is located at 25°22'49.74 S, 31°50'55.93 E. The riparian zone extends upstream from the edge of the Crocodile River to the tar road between the R571 and the Tenbosch road. Features of this riparian area can be viewed in Figure 10 and Figure 11.

Figure 10: Google image of the delineated N01 Riparian Area

This visual was taken from the road downstream

Downstream portion where this drainage channel meets the Crocodile River

Figure 11: Images indicating the nature of ephemeral Site N01

Marginal zone (Figure 12)**:**
In this area, trees are the dominant vegetation component with shrubs, which occur in vast numbers. Due to the road crossing and lateral bank erosion, little cover occurs in places. The substrate consists mainly of high organic soil. The following woody species occur: *Phyllanthus reticulatus, Ficus sycomorus, Syzygium cordatum, Celtis africana, Ficus sycomorus, Syzygium cordatum,* etc. The cover and species composition appear to be good. Understory plants such as *Hypoestes forskaolii, Syngonium podophyllum, Jasminum fluminense, Setaria megaphylla, Panicum coloratum* and *Panicum maximum* occur. Some exotic vegetation such as *Achyranthes aspera* var. *aspera, Solanum mauritianum, Lantana camara, Tecoma stans,* etc. was also found. Exotic vegetation dominates the area just downstream of the road crossing and then occurs sporadically throughout the non-marginal zone.

Non-marginal zone (Figure 12)**:**
In this area, trees are the dominant vegetation component with shrubs which occur in vast numbers. Due to the road crossing and lateral bank erosion, little cover occurs in places. The substrate consists mainly of high organic soil with a heavy leaf layer. The following woody species occur: *Phyllanthus reticulatus, Ficus sycomorus, Syzygium cordatum, Celtis africana, Ficus sycomorus, Syzygium cordatum,* etc. The cover and species composition appear to be good. Understory plants such as *Hypoestes forskaolii, Syngonium podophyllum, Jasminum fluminense, Setaria megaphylla, Panicum coloratum* and *Panicum maximum* occur. Some exotic vegetation such as *Achyranthes aspera* var. *aspera, Solanum mauritianum, Lantana camara, Tecoma stans,* etc. was also found. Exotic vegetation dominates the area just downstream of the road crossing and then occurs sporadically throughout the non-marginal zone.


View of the marginal zone

View of the non-marginal zone

Figure 12: Photos of selected VEGRAI at site N01

Reference Condition for Site N01

The reference condition for the components are summarised in Table 9.

Table 9: Reference conditions

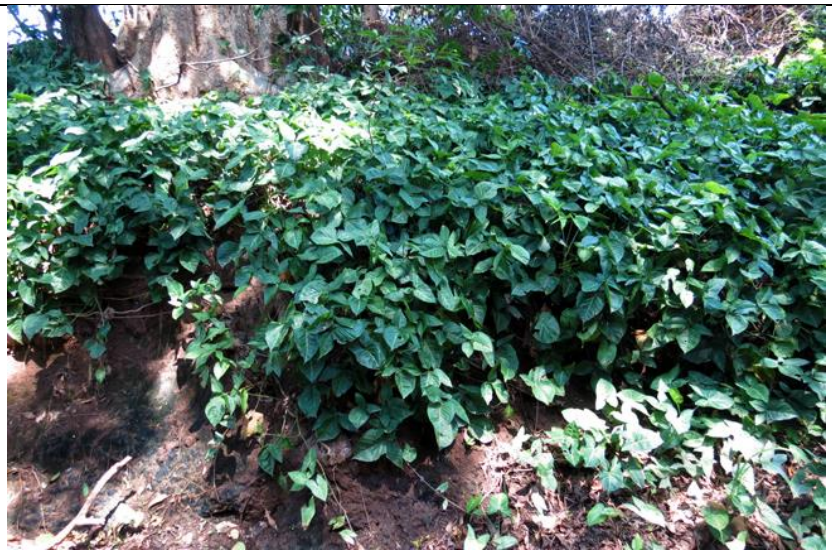
Component	Reference conditions	Confidence
Riparian vegetation	**Marginal zone:** A grass and herb-dominated state, with pockets of sedge. Under ideal circumstances it is expected that reeds would also occur in pockets. It is expected that isolated woody species such as *Ficus sycomorus, Trichilia emetica, Bridelia micrantha*, etc. would also occur. Sedges and grasses such as *Leersia hexandra, Panicum coloratum, Cyperus sexangularis, Schoenoplectus brachyceras*, and *S. muricinux*, etc. could also occur. Without the influence of a road crossing and occurrence of exotic vegetation, more indigenous vegetation cover is expected. A better species composition, cover and abundance is expected. **Non-marginal zone:** A more tree, shrub and grass-dominated state is expected. More graminoides are anticipated, especially along the edges of the macro-channel. Woody species such as *Ficus sycomorus, F. sur, Syzygium cordatum, Bridelia micrantha, Gymnosporia senegalensis,* etc. could also occur more frequently. Graminoids such as *Bothriochloa insculpta, Panicum maximum, P. coloratum, Setaria sphacelata, S. megaphylla, Sporobolus africanus*, etc. are expected to occur in greater numbers. No exotic vegetation is anticipated, and with no road crossing, a more indigenous vegetation cover is expected.	3

PRESENT ECOLOGICAL STATE

Riparian vegetation

The Riparian Index of Habitat Integrity (RIHI) is a D/E (41.8%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation (*Tecoma stans* being the dominant species) and a housing development (Figure 13). Due to orchards in the catchment it is expected that the water will be enriched with nutrients (nitrates and

phosphates). The result of this can be seen in the lush vegetation growth and alluvial mud found at the lower end of this system (Figure 13).



Channel bank is infested with exotic vegetation such as this *Syngonium podophyllum* (arrow-head vine)

Eroded banks

Infrastructure along the edge of the riparian zone

Exotic vegetation
(*Lantana camara*)

Figure 13: Activities that contribute towards the degradation of the N01 riparian zone's integrity

PES causes and sources

The PES for the components, as well as the reasons for the PES are summarised in Table 10.

CAUSE: A stressor that occurs at an intensity, duration and frequency of exposure that results in a change in the ecological conditions.
SOURCE: A source is the origin of a stressor. It is an entity or action that releases or imposes a stressor on the water body (EPA, 2000).

Table 10: Causes and sources

	PES	Conf.	Causes	Sources	F[1]/NF[2] Flow related Non-Flow related	Conf.
Rip. Veg.	D/E	2.9	Road traversing area	Restricts hydrology and destroys wetland habitat	Non-Flow related NF	3
			Bank Erosion	Not enough vegetation cover		
			Exotic invasion	*Lantana camara, Tecoma stans* and non-woody weeds such as *Verbena bonariensis*, *Tagetes minuta*, etc. No eradication program in place.		
			Water quality	Historic cultivation, farming activities, etc.	Flow related F	
			Road traversing riparian	Restricts hydrology		

[1] Flow related [2] Non Flow related

PES TREND

An estimate was made of whether the components are responding to the main drivers (i.e. whether the quality and quantity are stable, or still changing). The results are summarised in Table 11.

Table 11: Trend

	PES	Trend	Trend PES	Reasons	Conf.
Rip. Veg.	D/E	Stable	D/E	The presence of the road crossing and the extent of the housing development will always have an impact on the habitat availability and integrity of this site. Historic cultivation, orchards upstream and exotic vegetation species impacts on the vegetation composition, cover and abundance. If these impacts are not managed their impact will stay the same.	3.0

PES ECOSTATUS

To determine the EcoStatus, the Vegetation Response Assessment Index (VEGRAI) EC and confidence is included in the EcoStatus assessment index (Table 12). The EcoStatus EC is a D/E (41.8%).

Table 12: EcoStatus

RIPARIAN VEGETATION	EC %	EC
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	**41.8**	**D/E**
Confidence rating for riparian vegetation zone information	2.9	
ECOSTATUS	**EC**	**D/E**

5.3.2 Site N02

This site is located at 25°22'51.18 S, 31°51'06.94 E. The riparian zone extends from the riparian edge of the Crocodile River upstream to the road between the R571 and the Tenbosch road. Visuals of this site can be seen in Figure 14 and Figure 15.

Figure 14: Google image of the delineated N02

Photo taken from road in the downstream direction towards the Crocodile River

Visual of the active channel environment (note the greywater)

Figure 15: Images indicating the nature of ephemeral Site N02

Marginal zone (Figure 16)**:**
The dominant vegetation consists of forb species with scattered shrubs and trees. Some of the marginal zone areas are subject to mud deposits which smothers portions of this zone. The substrate consists mainly of soils, with rocky features in places. Dominant woody species include *Phyllanthus reticulatus, Ficus sycomorus and Trichilia emetica*. The following grass and sedge species occur: *Setaria megaphylla, Commelina diffusa* subsp. *scandens*, *Cyperus sexangularis*, etc. Exotic vegetation such as *Tecoma stans, Verbena bonariensis, Tagetes minuta, Ricinus communis, Lantana camara*, etc. occurs.

Non-marginal zone (Figure 16)**:**
In this area trees are the dominant vegetation component with shrubs and forbs. Due to road crossings, a water treatment facility and eroded areas, sparse cover occurs in places. The substrate consists mainly of soils and rocky material. The following woody species occur: *Acacia xanthophloea, Phyllanthus reticulatus, Ficus sycomorus, Ziziphus mucronata, Syzygium cordatum, Grewia monticola, Pluchea dioscoridis,* etc. Understory plants such as *Setaria megaphylla, Panicum maximum, Hypoestes forskaolii, Jasminum fluminense,* etc. occur. Exotic vegetation such as *Ricinus communis, Tecoma stans, Achyranthes aspera* var. *aspera, Solanum mauritianum, Lantana camara,* etc. was also found. *Lantana* camara is the most dominant of the exotic species.

View of the marginal zone

View of the non-marginal zone

Figure 16: Photos of selected VEGRAI site

Reference Condition for Site N02

The reference condition for the components are summarised in Table 13.

Table 13: Reference conditions for Site N02

Component	Reference conditions	Confidence
Riparian vegetation	**Marginal zone:** A grass and herb-dominated state, with pockets of sedge. It is expected that woody species would also make out a large portion of this zone. Sedges such as *Cyperus sexangularis, Schoenoplectus brachyceras*, and *S. muricinux*, etc. could occur. Without the influence of a road crossing, water treatment facility and occurrence of exotic vegetation, more indigenous vegetation cover is expected. A better species composition and abundance is expected. **Non-marginal zone:** A more tree, sedge and grass-dominated state would be expected. More trees and shrubs are expected, especially along the edge of the macro-channel. Species such as *Ficus sycomorus, Acacia sieberiana, Ficus sur, Ziziphus mucronata, Gymnosporia buxifolia*, etc. could occur more frequently. Graminoids such as *Panicum maximum, Setaria sphacelata, Setaria megaphylla, Sporobolus africanus*, etc. are expected to occur in greater numbers. With no exotic vegetation more indigenous vegetation cover and abundance is expected in places.	4

PRESENT ECOLOGICAL STATE

Riparian vegetation

The Riparian Index of Habitat Integrity (RIHI) is a D/E (37.6%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation infestations (*Lantana camara* and *Tecoma stans* being the dominant species) and greywater being released into the system (Figure 13). Greywater can contain high levels of Chlorine, with additional pollutants in the form of sodium, phosphates, nitrates and other organic compounds. It is expected that this will have detrimental effects on the biota in this stream. Higher levels of flow occur which also contributes to an altered hydrology (Figure 13).

Surface area erosion

Donga erosion

Water treatment facility

Greywater pollution

Ash dump site on edge of the riparian zone

Figure 17: Activities that contribute towards the degradation of the N02 riparian zone's integrity

PES causes and sources

The PES for the components, as well as the reasons for the PES are summarised in Table 14.

CAUSE: A stressor that occurs at an intensity, duration and frequency of exposure that results in a change in the ecological conditions.
SOURCE: A source is the origin of a stressor. It is an entity or action that releases or imposes a stressor on the water body (EPA, 2000).

Table 14: Causes and sources for Site N02

	PES	Conf.	Causes	Sources	F[1]/NF[2] Flow related Non-Flow related	Conf.
Rip. Veg.	D/E	2.8	Road traversing area	Restricts hydrology and destroys riparian habitat	Non-Flow related NF	2.8
			Increased flows	Greywater from the water treatment facility		
			Exotic invasion	*Lantana camara, Tecoma stans* and non-woody weeds such as *Verbena bonariensis*, *Tagetes minuta*, etc. No eradication program in place.		
			Water quality	Historic cultivation, orchard farming, greywater, etc.	Flow related F	
			Water quantity	Water treatment facility.		

[1] Flow related [2] Non Flow related

PES TREND

An estimate was made of whether the components are responding to the main drivers (i.e. whether the quality and quantity are stable, or still changing). The results are summarised in Table 15.

Table 15: Trend estimate for Site N02

	PES	Trend	Trend PES	Reasons	Conf.
Rip. Veg.	D/E	Stable	D/E	The presence of the road crossing, water treatment facility and orchards will always have an impact on the habitat availability and integrity of this site. The water treatment facility and exotic vegetation species impacts on the vegetation composition, cover and abundance. If these impacts are not managed their impact will stay the same.	2.8

PES ECOSTATUS

To determine the EcoStatus, the Vegetation Response Assessment Index (VEGRAI) EC and confidence is included in the EcoStatus assessment index (Table 16). The EcoStatus EC is a D/E (37.6%).

Table 16: EcoStatus for Site N02

RIPARIAN VEGETATION	EC %	EC
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	37.6	D/E
Confidence rating for riparian vegetation zone information	2.8	
ECOSTATUS	EC	D/E

5.3.3 Site N03

This site is located at 25°22'48.95 S, 31°51'12.68 E. This site is an artificially created dam into which water is pumped from the Crocodile River (Herholdt, pers. comm.) and visuals of this site can be seen in Figure 18 and Figure 19.

This site is not assessed due to its artificial nature.

Figure 18: Google image of the delineated riparian area for Site N03

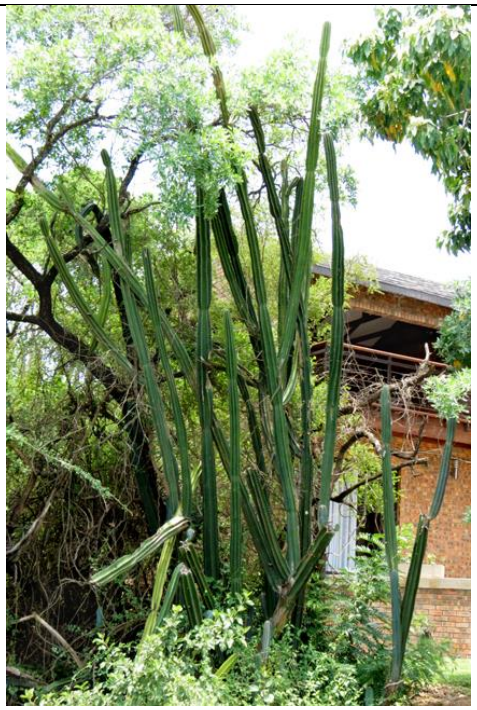
Upstream view from dam wall

Downstream from dam wall, note the climber *Ipomoea purpurea* smothering the system

Figure 19: Images indicating the unnatural state of this Site N03

The dominant vegetation in this artificial environment is mostly exotic species, such as *Ipomoea purpurea, Lantana camara, Tecoma stans*, *Pennisetum clandestinum,* etc. Woody species present include: *Ficus sycomorus, Rauvolfia caffra, Syzygium cordatum, Celtis africana, Phyllanthus reticulatus, Acacia xanthophloea,* etc*. Ficus lutea,* a tree which is not indigenous in Mpumalanga, but has been cultivated widely also occurs in this artificial

environment. The following grass and sedge species occur: *Cyperus esculentus, Persicaria decipiens*, *Commelina diffusa* subsp. *scandens*, *Cyperus sexangularis*, etc.



The presence of *Cereus jamacaru* (queen of the night) poses a serious, invasive threat and needs to be eradicated

Figure 20: The exotic species *Cereus jamacaru* (queen of the night) identified on site N03

5.3.4 Site N04

This site is located at 25°22’47.06 S, 31°51’06.30 E. The riparian zone of concern is demarcated within the area as provided by the client. The focus for this study will be on the right bank of the Crocodile River. In Figure 21 and Figure 22 a Google aerial photo indicates its location and other visuals indicate the current state of the site in question.

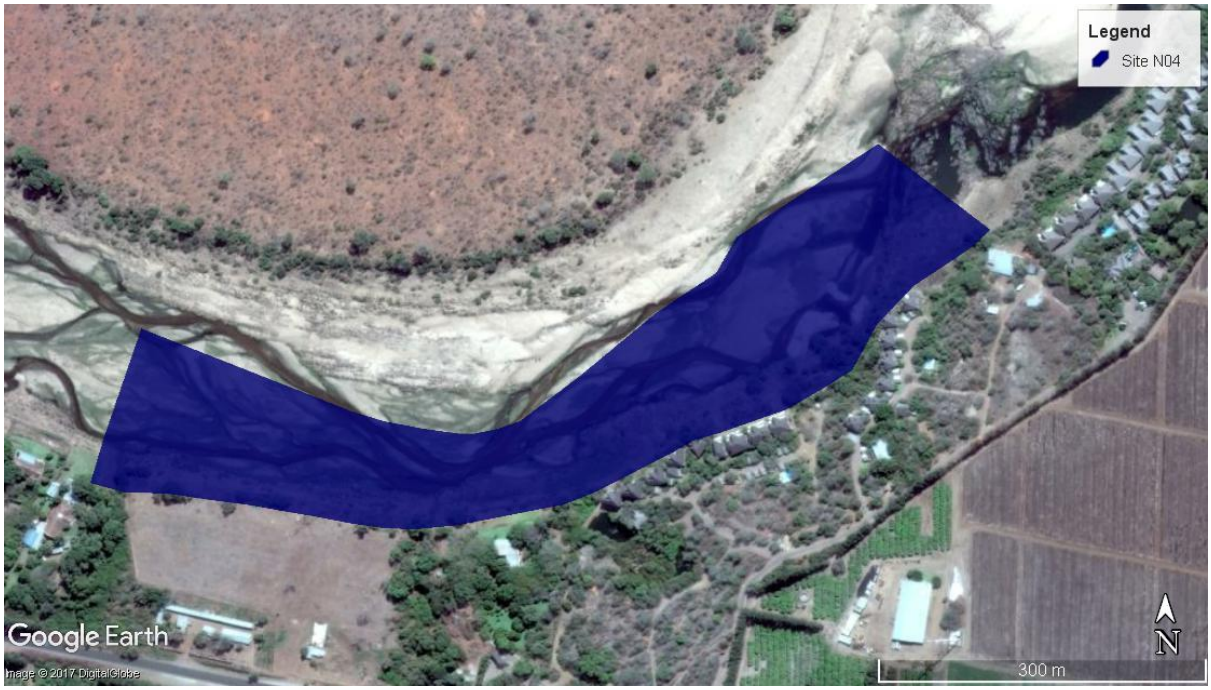


Figure 21: Google image of the delineated riparian zone of the Crocodile River (Site N04)

Active channel and related riparian vegetation

Panoramic view of the right-hand side macro channel bank

Figure 22: Images indicating the current state of ephemeral Site N04

Marginal zone (Figure 23)**:**
The dominant vegetation consists of reeds and sedges, with grasses. Some riparian areas are subject to erosion due to game paths which has also contributed towards areas with sparse vegetation cover. The substrate consists mainly of sandy alluvial material. Dominant woody species are *Phyllanthus reticulatus* and *Pluchea dioscoridis*. The following grass and sedge species occur: *Phragmites australis, Persicaria decipiens*, *Commelina diffusa* subsp. *scandens*, *Cyperus sexangularis*, *Cyperus dives, Leersia hexandra,* etc. Exotic vegetation such as the macrophyte *Eichhornia crassipes, Verbena bonariensis, Centella asiatica, Ricinus communis, Lantana camara*, *Sesbania bispinosa*, etc. occurs.

Non-marginal zone (Figure 23)**:**
In this area tree and grasses are the dominant vegetation components with inhibited shrubs occurring sporadically in vast numbers. There are indicators that this zone is overgrazed and trampled. The substrate consists mainly of alluvial soils and some exposed rock dykes. The following woody species occur: *Acacia nigrescens, Acacia xanthophloea, Philenoptera violacea, Trichilia emetica, Diospyros mespiliformis, Phyllanthus reticulatus, Dichrostachys cinerea, Lippia javanica, Ficus sycomorus, Ziziphus mucronata, Syzygium cordatum, Sclerocarya birrea subsp. caffra, Grewia monticola, Grewia flavescens, Gomphocarpus fruticosus, Gymnosporia senegalensis, Pluchea dioscoridis, Asparagus cooperi, Vernonia colorata,* etc. The species composition appears to be good, however, the abundance and cover is lower than expected. Non-woody species such as *Cyperus sexangularis, Schoenoplectus brachyceras, Setaria sphacelata, Eragrostis rotifer, Melinus repens, Cynodon dactylon, Panicum coloratum* and *Panicum maximum* occur. Some exotic vegetation such as *Solanum mauritianum, Centella asiatica, Parthenium hysterophorus, Ricinus communis, Lantana camara,* etc. was also found. Exotic vegetation occurs sporadically throughout this non-marginal zone.


View of the marginal zone

View of the non-marginal zone

Figure 23: Photos of selected VEGRAI for Site N04

Reference Condition for Site N04

The reference condition for the components are summarised in Table 17.

Table 17: Reference conditions for Site N04

Component	Reference conditions	Confidence
Riparian vegetation	**Marginal zone:** A grass and sedge-dominated state, with pockets of reeds is anticipated. It is expected that isolated woody species can occur. Sedges such as *Cyperus dives*, *Cyperus sexangularis, Schoenoplectus brachyceras*, and *S. muricinux*, etc. could occur. A better species composition and abundance is expected. **Non-marginal zone:** A woody, forb and grass-dominated state with pockets of sedge is expected. Species such as *Ficus sycomorus, Ficus sur, Trichilia emetica, Acacia sieberiana, Ziziphus mucronata, Nuxia oppositifolia* (close to the active channel), etc. could occur more frequently. Graminoids such as *Bothriochloa insculpta, Panicum maximum, Setaria sphacelata, Sporobolus africanus*, etc. are expected to occur in greater numbers. No exotic vegetation. Indications are that with time more trees and shrubs should survive, resulting in denser riparian vegetation habitat.	3

PRESENT ECOLOGICAL STATE

Riparian vegetation

The Riparian Index of Habitat Integrity (RIHI) is a C (63.1%). The main impacts are grazing and trampling, flood events, exotic species, dumped building material, historic cultivation and possible water abstraction (Figure 24).

Overgrazed and trampled macro-channel

Water being pumped from the Crocodile River

Building rubble dumped in the riparian zone

The exotic *Eichhornia crassipes*
(Water hyacinth)

Fence footprint with game paths adjacent to it

Figure 24: Activities that contribute towards the degradation of the N04 riparian zones integrity

PES causes and sources

The PES for the components, as well as the reasons for the PES are summarised in Table 18.

CAUSE: A stressor that occurs at an intensity, duration and frequency of exposure that results in a change in the ecological conditions.
SOURCE: A source is the origin of a stressor. It is an entity or action that releases or imposes a stressor on the water body (EPA, 2000).

Table 18: Causes and sources of Site N04

	PES	Conf.	Causes	Sources	F[1]/NF[2] Flow related Non-Flow related	Conf.
Rip. Veg.	D	3.1	Eroded macro channel bank	Historic cultivation	Non-Flow related NF	3
			Destruction of riparian habitat	Dumped building material		
			Exotic invasion	*Lantana camara, Melia azedarach* and non-woody weeds such as *Verbena bonariensis*, *Tagetes minuta*, *Centella asiatica,* etc. No eradication program in place.		
			Flood events	Flood events can be extreme due to catchment-related mismanagement.	Flow related F	
			Water quality	Historic cultivation, farming activities, housing developments, etc. release pollutants such as greywater		
			Water quantity	Water abstraction points occur at various locations along the river. Many of the tributaries have in-stream dams for irrigation purposes.		

[1] Flow related [2] Non Flow related

PES TREND

An estimate was made of whether the components are responding to the main drivers (i.e. whether the quality and quantity are stable, or still changing). The results are summarised in Table 19.

Table 19: PES Trend estimated for Site N04

	PES	Trend	Trend PES	Reasons	Conf.
Rip. Veg.	D	Stable	D	The presence of the historic cultivation, building rubble, trampling and grazing on the Kruger National Park side will always have an impact on the habitat availability and integrity of this site. With no exotic vegetation eradication plan in place this scenario will not change. It is unlikely that these impacts will change, and it is expected that the current situation will remain the same.	3

PES ECOSTATUS

To determine the EcoStatus, the Vegetation Response Assessment Index (VEGRAI) EC and confidence is included in the EcoStatus assessment index (Table 20). The EcoStatus EC is a D (56.8%).

Table 20: EcoStatus determined for Site N04

RIPARIAN VEGETATION	EC %	EC
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	**56.8**	**D**
Confidence rating for riparian vegetation zone information	3.1	
ECOSTATUS	**EC**	**D**

5.4 BUFFER ZONE

Buffer zones are strips of undeveloped, typically vegetated land (composed in many cases of riparian habitat or terrestrial plant communities) which separate development or adjacent land uses from aquatic ecosystems (rivers and wetlands). The primary purpose for establishing buffers in this case would be to reduce the impact of adjacent land uses on water quality and to provide habitat for aquatic and semi-aquatic species. The hydrology and the water quality of the riparian zones in the study area could change, both during the construction period and after development.

In order to assess and apply the width of any buffer, it is important to understand the role that buffer zones play in protecting aquatic resources with their associated biota, and in mitigating anthropogenic impacts. Thus, the proposed buffer will serve to provide a wide range of buffer functions and value including (Macfarlane, *et al.*, 2014):

- Sediment removal;

- Nutrient removal;
- Toxic removal;
- Control of microclimate and water temperature;
- Provision of habitat for wildlife;
- Screening of adjacent disturbances;
- Habitat connectivity;
- Channel stability and flood attenuation;
- Groundwater recharge; and
- Aesthetic appeal.

Despite the range of functions potentially provided by buffer zones, they are far from being a 'silver bullet' that addresses all water-resource-related problems. Indeed, buffers can do little to address some impacts, such as hydrological changes caused by streamflow reduction activities (i.e. changes in flow brought about by abstractions or upstream impoundments). Buffer zones are also not the appropriate tool for mitigating point-source discharges (e.g. sewage outflows), which can be more effectively managed by targeting these areas through specific source-directed controls. Contamination or use of groundwater is also not well addressed by buffer zones and requires complementary approaches such as controlling activities in sensitive groundwater zones (Macfarlane, *et al.*, 2014).

Anthropogenic impacts (dams, historic and current cultivation, orchards, water pollution, exotic vegetation, roads, lodge infrastructure, etc.) in and around this water course, emphasises the already increased impact from the larger catchment. To support the watercourses' integrity in an already disturbed environment, and with the proposed development still to come, an aquatic buffer is a necessity. However, it should be noted that an aquatic surface buffer of 20-30 m is highly unlikely to protect catchment-related hydrology support such as **groundwater** recharge. Therefore, the identification of mitigation and management measures of the proposed development in the greater catchment should compensate for the possible loss of catchment support.

The edge of the water resources (N01-N04) in the study area have been delineated, with the starting point for delineation of the aquatic impact buffer zones for rivers and streams, being on the outer edge of the active channel as visualised in Figure 25 (Macfarlane *et al.,* 2014).

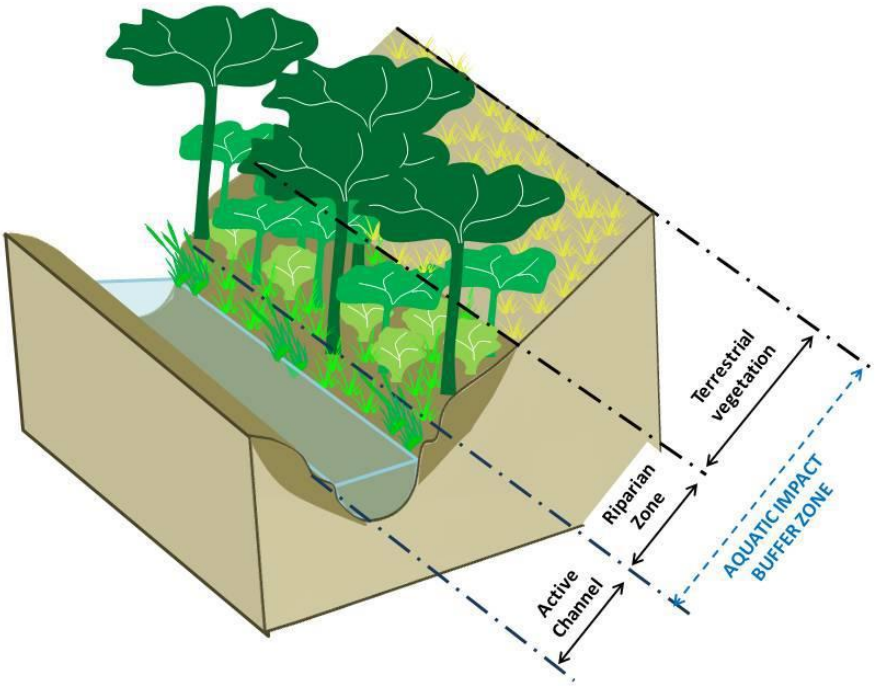


Figure 25: Schematic diagram indicating the boundary of the active channel and riparian habitat, and the areas potentially included in an aquatic impact buffer zone (Macfarlane *et al.,* 2014).

Due to their position adjacent to water bodies, buffer zones associated with streams and rivers will typically incorporate riparian habitat. Riparian habitat, as defined by the NWA, includes the physical structure and associated vegetation of the areas linked to a watercourse. These areas are commonly characterised by alluvial soils (deposited by the current river system), and are inundated or flooded to an extent and with a frequency sufficient to support vegetation with a composition and physical structure distinct from those of adjacent land areas. However, the riparian zone is not the only vegetation type that lies in the buffer zone as the zone may also incorporate stream banks and terrestrial habitats, depending on the width of the aquatic impact buffer zone applied. There may, however, be instances in which the riparian zone extends beyond the aquatic impact buffer zone. In such instances, setback requirements include the full extent of the riparian zone and any additional requirements that may apply to managing this area.

A buffer width of 30 m is recommended by the Mpumalanga Tourism and Parks Agency (2006) and a 100m buffer according to the MBSP (2014). However, according to the Preliminary Guidelines for the Determination of Buffer Zones for Rivers, the following buffer widths for the denominated riparian zone are as follows (Figure 26, Figure 27and Figure 28):

- N01 : 27 m
- N02 : 27 m
- N03 : -
- N04 : 49 m

Please take note that the calculated buffer widths are based on horizontal rather than diagonal distance.

Figure 26: Delineation of the N01 Riparian site's active channel edge, aquatic requirement, riparian edge and then the final setback requirement

Figure 27: Delineation of the N02 Riparian site's active channel edge, aquatic requirement, riparian edge and then the final setback requirement

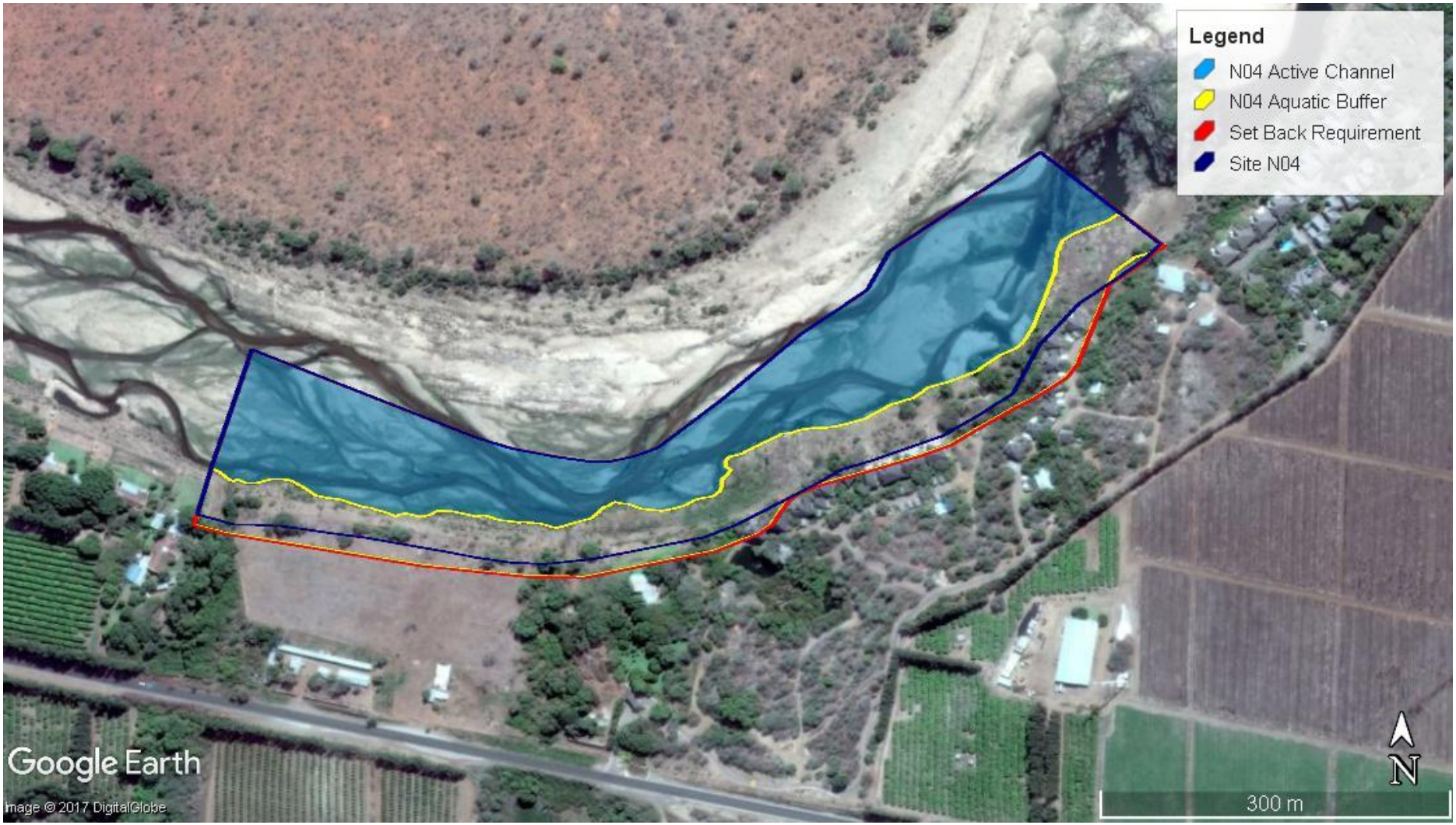


Figure 28: Delineation of the N04 Riparian site's active channel edge, aquatic requirement, riparian edge and then the final setback requirement

6 IMPACT ASSESSMENT AND MITIGATION

Any development in a natural system will have an impact on the environment, usually with adverse effects. From a technical, conceptual or philosophical perspective, the focus of an impact assessment ultimately boils down to a judgment on whether the predicted impacts are significant or not (DEAT, 2002). Alterations to the natural variation of water flow, either by decreasing or increasing it, could have an influence upon almost every aspect of the water source's ecological functioning (Davies & Day, 1998).

Current South African legislation, as indicated at the beginning of this report, requires that the necessary aquatic ecosystem impact assessment be conducted, and mitigation measures assessed, so as to reduce or prevent the degradation of aquatic habitats and biotic populations due to alterations to the water resource, that may have an impact on migration and ecosystem functioning.

This assessment was made after one visit to the study area. A single visit makes it difficult to identify and assess all species and/or species composition. Further assessment for the presence of threatened or protected species was thus handicapped. Thus, for this assessment, the riparian area should be regarded as sensitive from a biodiversity perspective.

6.1 Impacts

Based on evaluation tables (Table 2 and Table 3), the impact magnitude and significance of the development will depend on where it will take place. If the footprint extends into the riparian area, the impact can be significant due to the loss of a riparian area (and habitat) that is host to certain wetland services.

The most significant impact of development in riparian areas could involve the following effects:

- Destruction of riparian habitat that leads to habitat loss (and biodiversity loss)
- Initiation of erosion (increased flow volumes due to hardened surfaces)
- Increase in sediment due to the construction of buildings that can smother riparian habitat downstream
- Change in water quality.

Some of the negative impacts of development in riparian areas can be mitigated by controlling flow-rates by means of the following:

- Some erosion is already evident in the area and thus storm-water run-off into the riparian area should make use of energy dissipaters
- Remove all dumped and refuse material in riparian areas
- Remove invasive alien vegetation to establish and recreate riparian habitat
- Avoid the 1:100 flood line and proposed buffer zones

Because roads and/or pathways can be one of the biggest destroyers of riparian areas, care should be taken to construct adequate numbers of large culverts to cover the riparian area. However, culverts and/or storm-water pipes can initiate erosion, capable of destroying riparian areas, therefore sufficient numbers of energy dissipaters should be put in place.

Most of the impacts identified relate to water quality, riparian habitat and riparian biotic components:

Water quality impacts

Fluctuations in the *in situ* water quality parameters (pH, Electrical Conductivity (EC), TDS, DO, and temperature) may occur during the construction, operational, as well as the decommissioning and closure phases. These will impact the riparian ecosystem, biotic communities and vegetation.

Water quality may be adversely affected by the following proposed activities, which would impact the riparian area:

- Dust generation and transportation due to the clearing of vegetation prior to construction, during construction, as well as the decommissioning and closure phases, which would settle on the riparian habitat, leading to:
    - Reduced photosynthesis and transpiration in flora;
    - An increase in fine-particulate sediments in the water;
    - A decrease in visibility and light penetration;
    - An increase in potential EC and TDS;
    - Fluctuations in the pH values; as well as
    - Fluctuations in the surface water quality monitoring parameters.

  This impact would be greatly increased during the drier months of April through September;

Increased soil sediment loads via surface water run-off into the adjacent riparian areas owing to the clearing of vegetation prior to construction, the construction activities and the removal of topsoil, can lead to:

- Reduced photosynthesis and transpiration in the in-stream aquatic macrophytes;
- An increase in fine-particulate sediments in the water;
- A decrease in visibility and light penetration;
- An increase in potential EC and TDS;
- Fluctuations in the pH values; as well as
- Fluctuations in the surface water quality monitoring parameters.

This impact will be greatly increased in the wet months of October to March and during high flow events.

Cumulative impacts from existing, surrounding activities as well as the proposed development project, could lead to:

- Increased erosion, flooding, sedimentation and bank instability;
- Fluctuations in *in situ* water quality parameters; and
- Fluctuations in biodiversity parameters.

Habitat impacts

The habitat may be affected by the following proposed activities, which may impact the riparian areas:

Habitat loss or alteration

If construction is going to take place in or on the edge of a riparian area, the greatest impact is expected to occur during this period. The following activities could have an impact:

- Removal/destruction of riparian ecosystem habitat;
- Vegetation removal;
- Riparian edge disturbances; and
- Drainage pattern changes.

These activities may result in possible destabilisation, increased erosion potential and exotic vegetation encroachment.

Dust that enters the riparian area can have the following impact:

- Decreased visibility due to clouding of water column;
- Decreased light penetration;
- Siltation of fine sediment substrates, gravel substrates and inter-substrate spaces; and
- A decrease in habitat availability.

This impact will be greatly increased during the drier months of April through September.

Soil sediment loads entering the riparian ecosystem, via surface water, will lead to:

- An increase in fine-particulate sediments in the water;
- A decrease in visibility;
- A decrease in light penetration;
- Increased siltation; and
- Decreased habitat availability.

This impact will be greatly increased in the wet months of October to March and during flood events.

Cumulative impacts from existing, surrounding activities, as well as the proposed project, will lead to:

- Increased erosion, flooding, sedimentation and bank instability;
- Fluctuations in *in situ* water quality parameters; and
- Fluctuations in biodiversity parameters.

Biotic changes

Changes to the vegetation community structure of the riparian ecosystem may take place due to the likelihood of the following occurring as a result of the above-mentioned impacts:

- Fluctuations in water chemistry may directly impact on the ability of certain plant species to survive;
- Polluted water may be lethal to sensitive vegetation;
- Increased possibility for microbial growth and algae blooms;
- Sedimentation of marginal vegetation habitats; and
- Exotic riparian vegetation encroachment.

6.2 Mitigation

The construction, operation and maintenance of this development has the potential to cause some environmental damage to the physical, biological and chemical components of riparian ecosystems.

The construction activities should therefore apply methods and management practices that minimise and avoid the following impacts:

- Loss and disturbance of vegetation and habitat within its footprint;
- Soil compaction, increased risk of sediment transport and soil erosion during construction and routine maintenance during the operational phase;
- Flow modification due to concentrating flows and storm-water run-off from the road surfaces. This can lead to erosion and channel incision, and change the in-stream habitat;
- Water quality deterioration due to chemical spills during the construction and operational phases, and
- Riparian habitat fragmentation.

Riparian areas in particular can be very sensitive. This is due to the fact that riparian areas are low energy drainage lines in the landscape that are generally dependent on locally high-water tables and flows. These locally high-water tables and flows create the hydrological conditions of near-surface soil saturation that allows riparian areas to develop.

Hardened surfaces, and increased flow rates and volumes, can lead to the creation of preferential flow paths and possible concentration of flows into channels, which may cause further erosion and donga formation. That could result in degradation of the environmental resource, as well as effectively draining the riparian areas by lowering the local water table and subsequent desiccation of the riparian areas. Eroded riparian areas are difficult to rehabilitate to reference conditions due to the fact that both the water and soil required to support the riparian areas would then need to be reinstated.

To maintain the integrity of the riparian areas concerned, the following actions are recommended:

- Plan and develop outside riparian areas;

- Create the recommended buffer around riparian areas (it is likely that a buffer of <17m may adequately fulfil a number of functions and values such as biotic movement, protecting the edge of the riparian areas, and some water quality functions, etc.) (MacFarlane, Dickens, & Von Hase, 2009);
- Minimise the removal/damage to vegetation in riparian areas;
- The construction of pathways (disturbance zones) in or adjacent to the riparian areas is to be closely managed and strictly controlled to minimise damage to riparian areas;
- Operation and storage of equipment in the riparian areas must be prevented;
- If the riparian areas are disturbed during construction, they should be re-vegetated using site-appropriate indigenous vegetation and/or indigenous seed mixes;
- Alien vegetation should not be allowed to colonise the disturbed riparian areas;
- Rehabilitation of disturbed riparian habitat should commence immediately after construction is completed;
- No construction camps should be allowed in or within 20m of a riparian area;
- No stockpile areas should be located in or within 20m of a riparian area;
- Construction should preferably take place during the low flow/winter months in order to minimise the risk of sediment and debris being washed into riparian areas;
- Stockpiling of soil and of supplies for the construction camp must take place away (at least 20m where possible) from the edge of riparian areas to prevent soil being washed into the riparian habitat;
- During the construction and operational phases, erosion and siltation measures should be implemented (e.g. the use of temporary silt traps downstream of construction areas);
- Slope/bank stabilisation measures should be implemented where necessary to prevent erosion during the process;
- Debris and sediment trapping, as well as energy dissipation control structures, should be put in place where storm-water may enter riparian areas;
- Turbidity, sedimentation and chemical changes to the composition of the water must be limited; and
- Where vegetation removal has occurred adjacent to the pathways, monitoring should take place to ensure successful re-establishment of natural vegetation. Alien vegetation should be removed from these disturbed areas on an ongoing basis to ensure successful re-vegetation by indigenous species.

7 CONCLUSION

Four watercourses were identified and can be described as deeply incised channels with riverine features. The delineated riparian areas have been demarcated and indicated as N01-N04.

Site N01 Riparian Index of Habitat Integrity (RIHI) is a D/E (41.8%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation (*Tecoma stans* being the dominant species) and a housing development.

Site N02 Riparian Index of Habitat Integrity (RIHI) is a D/E (37.6%). The main impacts are the road crossing, historic cultivation and orchards in the catchment, exotic vegetation

infestation (*Lantana camara* and *Tecoma stans* being the dominant species) and greywater being released into the system.

Site N03 is an artificial dam site which was only briefly discussed and not assessed.

Site N04 the Crocodile River Riparian Index of Habitat Integrity (RIHI) is a D (56.8%), with the main impacts being dumping of building rubble, flood events, grazing and trampling, water abstraction and the presence of exotic species.

A buffer width from the edge of the riparian zone of 30 m is recommended by the Mpumalanga Tourism and Parks Agency (2006) and a 100m buffer according to the MBSP (2014).

The riparian edge of the water resources has been delineated. However, according to the Preliminary Guidelines for the Determination of Buffer Zones for Rivers the buffer starting point for the delineation of the aquatic impact buffer zones are on the outer edge of the active channel. Buffer widths for the denominated riparian zones are:

- N01 – 17m
- N02 – 17m
- N03 - NA
- N04 - 42m

The final buffer zone will then cover the riparian zone and the aquatic impact buffer zone.

The proposed development could result in the increase of hardened surfaces and subsequent storm water runoff, increased flows, decrease in water quality, etc.

The following is recommended:

- All activities should stay out of the 1:100-year flood line area;
- All activities should stay out of the riparian areas and recommended buffer zones;
- Greywater should be treated to remove contaminants, be it through physical, chemical and/or biological processes, so as to produce environmentally safer, treated greywater.
- Nutrient levels should be controlled.
- Chemical levels of Sodium, Nitrite, Phosphate and Chlorine should be monitored and managed.
- All storm water should be diverted to a point from where the water must be released in a controlled manner that will not initiate or enhance any erosion. The way storm water enters a natural waterway is important because high-energy flows can cause serious damage (especially to riparian zones);
- Energy dissipaters and smaller permeable gabion-structures covered with reeds can be constructed at the effluent discharge points of all storm water.
- To cater for the present and the proposed developments in the above-mentioned riparian areas, on-site and off-site mitigation is recommended to mitigate the negative effects thereof.

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Appendix A

Vegetation species observed during the field trip

Species	Family
Acacia ataxacantha	Fabaceae
Acacia karroo	Fabaceae
Acacia nigrescens	Fabaceae
Acacia robusta subsp. *clavigera*	Fabaceae
Acacia schweinfurthii	Fabaceae
Acacia sieberiana var. *woodii*	Fabaceae
Acacia xanthophloea	Fabaceae
Acalypha glabrata	Euphorbiaceae
Achyranthes aspera var. *aspera*	Amaranthaceae
*Ageratum houstonianum**	Asteraceae
Ampelopteris prolifera	Thelypteridaceae
Annona senegalensis	Annonaceae
Andropogon huillensis	Poaceae
Antidesma venosum	Aphyllanthaceae
*Arundo donax**	Poaceae
Asparagus setaceus	Asparagaceae
Bauhinia galpinii	Caesalpiniaceous
*Bauhinia variegata**	Caesalpiniaceous
Berchemia zeyheri	Rhamnaceae
*Bidens pilosa **	Asteraceae
Bothriochloa bladhii	Poaceae
Brachiaria brizantha	Poaceae
Breonadia salicina	Rubiaceae
*Caesalpinia decapetala**	Fabaceae
*Canna indica**	Cannaceae
*Cardiospermum grandiflorum**	Sapindaceae
*Casuarina cunninghamiana**	Casuarinaceae
Celtis africana	Celtidaceae
Combretum hereroense	Combretaceae
Combretum imberbe	Combretaceae

Species	Family
Combretum molle	Combretaceae
Commelina benghalensis	Commelinaceae
*Conyza canadensis**	Asteraceae
Croton gratissimus	Euphorbiaceae
*Cuscuta campestris**	Convolvulaceae
Cynodon dactylon	Poaceae
Cyperus dives	Cyperaceae
Cyperus sexangularis	Cyperaceae
Dalbergia melanoxylon	Fabaceae
*Datura stramonium**	Solanaceae
Dichrostachys cinerea	Mimosaceae
Diospyros mespiliformis	Ebenaceae
Dodonaea angustifolia	Sapindaceae
Eragrostis rotifer	Poaceae
Eriochloa meyeriana	Poaceae
Eucalyptus sp.*	Myrtaceae
Euclea natalensis	Ebenaceae
Ficus sur	Moraceae
Ficus sycomorus	Moraceae
Gymnosporia senegalensis	Celastraceae
Hippobromus pauciflorus	Sapindaceae
Hyparrhenia hirta	Poaceae
Hypoestes forskaolii	Acanthaceae
Imperata cylindrica	Poaceae
Indigofera colutea	Fabaceae
*Ipomoea alba**	Convolvulaceae
Jacaranda mimosifolia *	Bignoniaceae
Jasminum fluminense	Oleaceae
*Lantana camara**	Verbenaceae
Leonotis intermedia	Lamiaceae
Lippia javanica	Verbenaceae
*Melia azedarach**	Meliaceae

Species	Family
Melinis repens	Poaceae
*Nasturtium officinale**	Brassicaceae
Nuxia oppositifolia	Stilbaceae
Panicum coloratum	Poaceae
Panicum deustum	Poaceae
Panicum maximum	Poaceae
*Paspalum urvillei**	Poaceae
Pennisetum sphacelatum	Poaceae
*Persicaria lapathifolia**	Polygonaceae
Phragmites australis	Poaceae
Phyllanthus reticulatus	Aphyllanthaceae
Polygonum aviculare	Polygonaceae
*Psidium guajava**	Myrtaceae
Rhoicissus tridentata subsp. *cuneifolia*	Vitaceae
Richardia brasiliensis	Rubiaceae
*Ricinus communis**	Euphorbiaceae
Sansevieria hyacinthoides	Asparagaceae
Schoenoplectus brachyceras	Cyperaceae
Schoenoplectus muricinux	Cyperaceae
Sclerocarya birrea subsp. *cafra*	Anacardiaceae
Searsia dentata	Anacardiaceae
Searsia lancea	Anacardiaceae
*Sesbania bispinosa**	Fabaceae
*Sesbania punicea**	Fabaceae
Setaria megaphylla	Poaceae
Setaria sphacelata	Poaceae
*Solanum incanum**	Solanaceae
*Solanum mauritianum**	Solanaceae
Sorghum bicolor	Poaceae
Sporobolus africanus	Poaceae
*Spathodea campanulata**	Bignoniaceae
Syngonium podophyllum	Araceae

Species	Family
Syzygium cordatum	Myrtaceae
Tagetes minuta *	Asteraceae
*Tecoma stans**	Bignoniaceae
Terminalia prunoides	Combretaceae
Terminalia sericea	Combretaceae
Thelypteris confluens	Thelypteridaceae
Trema orientalis	Celtidaceae
Typha capensis	Typhaceae
Trichilia emetica	Meliaceae
*Verbena bonariense**	Verbenaceae
Vernonia colorata	Asteraceae
Zinia peruviana	Asteraceae
Ziziphus mucronata	Rhamnaceae