NYAMANE FOODS:

Wetland and Riparian Assessment

Prepared for:

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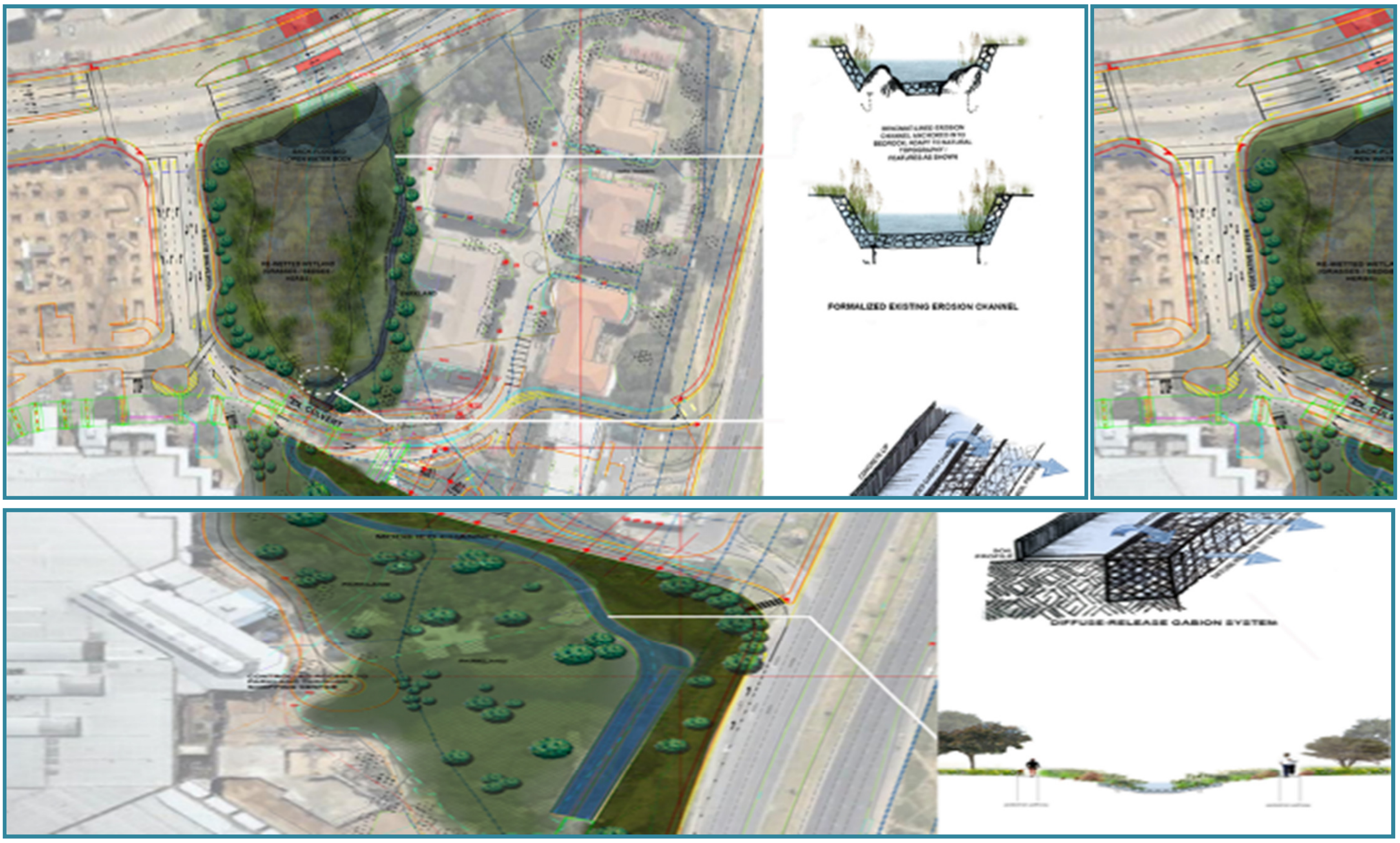

September 2019

Declaration of Independence by Specialist

I, **WILLEM LUBBE**, in my capacity as a specialist consultant, hereby declare that I -

- act as an independent consultant;
- 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;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability;
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered; and
- as a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member.

11/09/2019

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Willem Lubbe Pr.Sci.Nat
Wetland Specialist
SACNASP Reg. No. 004750

Date

EXECUTIVE SUMMARY

Nyamane Foods JV is considering investing in a new tomato farming and processing facilities in Lebowakgomo Region, Limpopo Province, South Africa. The project entails the preparation of approximately 1700 hectare (ha) for the planting of tomatoes and approximately 4ha for a tomato processing facility. Nsovo Environmental Consulting was contracted to review the area and conduct the Environmental Impact Assessment (EIA) on their behalf. Subsequently, WaterMakers was appointed by Nsovo Environmental Consulting as independent specialists to conduct the relevant wetland and riparian related studies in order to assist the facilitation of the required environmental authorisation and water use licence processes. The present study represents the baseline and wetland impact assessment of the study and aims to inform responsible decision making with regards to the project. In order to enable an adequate description of potential wetland habitat and so as to ensure that the wetland study conducted is applicable for both an Environmental Authorisation as well as a Water Use Licence Application, the following approach was to be undertaken:

- Desktop assessment;
- Site assessment for Identification and delineation of wetland habitat;
- Classification of identified wetland habitat;
- Identification of wetland goods and services by means of the Wet-EcoServices approach;
- Determination of the Present Ecological State of identified wetlands by means of the Wet-Health approach;
- Determination of the Ecological Importance and Sensitivity of identified wetlands; and
- Determination of appropriate buffer zones for the protection of the associated wetland systems.

In total ten sections of riparian habitat were delineated within the study area and within 500m from the study area as well as sections further downstream of the study area. In addition, one wetland type, floodplain depression wetlands was associated with the Olifants River. However, due to the dominance and greater extent occupied by the riverine riparian habitat associated with the Olifants River, these wetland features were not separated and thus included under Riparian 1 (Olifants River). The perennial Olifants River were regarded as the only A section riparian channel within the study area with the remaining nine sections of riparian habitat regarded as B section channels as baseflow was regarded as sometimes being present.

Findings of the VEGRAI vegetation assessment conducted on riparian units identified within the study area revealed that riparian habitat associated with the study area were regarded as being in a moderately modified to largely modified state (i.e. Ecological Category C and D). Riparian habitat was modified as a result of heavy grazing regimes causing vegetative successional changes, reduced basal cover and consequently changes to the hydrological regime. This has subsequently led to sheet, rill and gully erosion in especially the C and some B section channels associated with the study area. Alien invasive plants although rather limited, were observed within the marginal and non-marginal zones of the riparian habitat

In terms of ecological importance and sensitivity, all A and B channel section riparian habitat within the study area was designated as sensitive as a result of the ecological and functional values attributed to

riparian areas in general, legal regulations and requirements as well as the supporting ecological services afforded to the downstream ecosystems

Determination of the preliminary buffer requirements for riparian features associated with the proposed study area followed the approach of Macfarlane & Bredin (2016), whereby the preliminary required buffers were developed based on various factors, including assumed agricultural impacts, slope, annual precipitation, rainfall intensity, channel width, catchment to wetland ratio, etc. Accordingly, preliminary buffer requirements for the identified riparian habitat were determined to be 30m from the edge of the delineated riparian areas for B section channels and 65m from the edge of the A section channel (Olifants River).

The impact assessment identified surface water pollution including sedimentation as well as increased erosion, loss of wetland functionality and decreased downstream water quality as the major potential impacts during the construction and operational phase. Several general and specific mitigation measures were proposed in order to reduce negative impacts and incorporate some potentially positive impacts from the proposed development. Some of the most pertinent recommendations include:

- A riparian channel rehabilitation program must be designed and implemented prior to the start of the construction phase and continue during the operational phase. This must include veld restoration approaches, prevention of and rehabilitation of rill and gully erosion. A 30 m buffer (exclusion) and rehabilitation zone around each riparian habitat must be implemented through fencing of the buffers (thus keeping cattle and goats out) and reseeding programs to establish a functional buffer for the riparian habitat.
- An ecologically-sound stormwater management plan must be implemented at the onset of the construction phase. This must include sustainable and sensitive stormwater design for the new agricultural fields to ensure that A and B section channels are not negatively affected. Stormwater run-off must reach the B section channels in a diffuse manner;
- The above guidelines can be achieved through diffuse release of stromwater flows utilising the natural topography and associated contours, vegetated channels, riprarian buffers and veld restoration techniques, gabion baskets etc;

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ACRONYMS

CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DWA	Department of Water and Sanitation
DWS	Department of Water and Sanitation
EC	Ecological Category
FEPA	Freshwater Ecosystem Priority Area
GPS	Global Positioning System
HGM	Hydrogeomorphic
NBA	National Biodiversity Assessment
NFEPA	National Freshwater Ecosystem Priority Areas project
NWRS	National Water Resource Strategy
PES	Present Ecological State
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
VEGRAI	Vegetation Reponses Assessment Index
WMA	Water Management Areas
WRC	Water Research Commission
WWF	Worldwide Fund for Nature

1. INTRODUCTION

1.1 Project Description

Nyamane Foods JV is considering investing in a new tomato farming and processing facilities in Lebowakgomo Region, Limpopo Province, South Africa. The project entails the preparation of approximately 1700 hectare (ha) for the planting of tomatoes and approximately 4ha for a tomato processing facility. Nsovo Environmental Consulting was contracted to review the area and conduct the Environmental Impact Assessment (EIA) on their behalf. Subsequently, WaterMakers was appointed by Nsovo Environmental Consulting as independent specialists to conduct the relevant wetland and riparian related studies in order to assist the facilitation of the required environmental authorisation and water use licence processes. The present study represents the baseline and wetland impact assessment of the study and aims to inform responsible decision making with regards to the project.

1.2 Scope of Work

In order to enable an adequate description of potential wetland habitat and so as to ensure that the wetland study conducted is applicable for both an Environmental Authorisation as well as a Water Use Licence Application, the following approach was to be undertaken:

- Desktop assessment;
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A site visit to the area to be affected by the proposed activity was undertaken from the 14th to the 17th of August 2019. A detailed description of the methodology used to address the above Terms of Reference is provided in Appendix A.

1.3 Assumptions and Limitations

During the course of the present study, the following limitations were experienced:

- In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years. The current study relied on information gained during a single field survey conducted during a single season, desktop information for the area, as well as professional judgment and experience;
- Wetland and riparian areas within transformed landscapes, such as urban and/or agricultural settings, especially areas that have undergone several successional changes due to repeated and prolonged overgrazing practices, are often affected by disturbances that restrict the use of available wetland indicators, such as hydrophytic vegetation or soil indicators (e.g. as a result of dense stands of alien vegetation, dumping, sedimentation, infrastructure encroachment and infilling). Hence, a wide range of available indicators were considered in order to aid in determining wetland and riparian boundaries more accurately;

- Wetland and riparian assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS). These methods are, however, largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration. Current and historic anthropogenic disturbance within and surrounding the study area has resulted in soil profile disturbances (especially through erosional processes) as well as successional changes in species composition in relation to its original /expected benchmark condition;
- Determination of the preliminary buffer requirements for watercourse features associated with the proposed study area followed the approach of Macfarlane & Bredin (2016), this methodology was adapted to be used for riparian buffers;
- Delineations of wetland areas were largely dependent on the extrapolation of field indicator data obtained during field surveys, 1m contour data for the study area, and from interpretation of geo-referenced orthophotos and satellite imagery as well as historic aerial imagery data sets received from the National Department of Rural Development and Land Reform. As such, inherent ortho-rectification errors associated with data capture and transfer to electronic format are likely to decrease the accuracy of wetland boundaries in many instances.
- The author reserves the right to change impact ratings and mitigation measures as information surfaces.

2. GENERAL CHARACTERISTICS

2.1 Location

The proposed site is located at 24°26'29.5"S and 29°39'22.7"E in the Limpopo Province and comprises of three farms, namely: Platdoorns, Davidspoort and Graslaagte a (Figure 1). The site is located north of the Olifants River, south of Dithabaneng and Lekurung. The site falls within the Lepelle-Nkumpi Local Municipality located in the Capricorn District Municipality. The site shares its border with the Olifants River and the Sekhukhune District Municipality (Figure 2).

2.2 Biophysical Attributes

2.2.1 Climate

According to climate.data.org (2019), there is little rainfall throughout the year in the Lebowakgomo region. According to Köppen and Geiger, this climate is classified as BSh. The temperature here averages 19.1 °C. About 626 mm of precipitation falls annually (Figure 1). At an average temperature of 23.5 °C, January is the hottest month of the year. The lowest average temperatures in the year occur in June, when it is around 12.9 °C. Precipitation is the lowest in July, with an average of 4 mm. The greatest amount of precipitation occurs in December, with an average of 112 mm (climate.data.org, 2019)

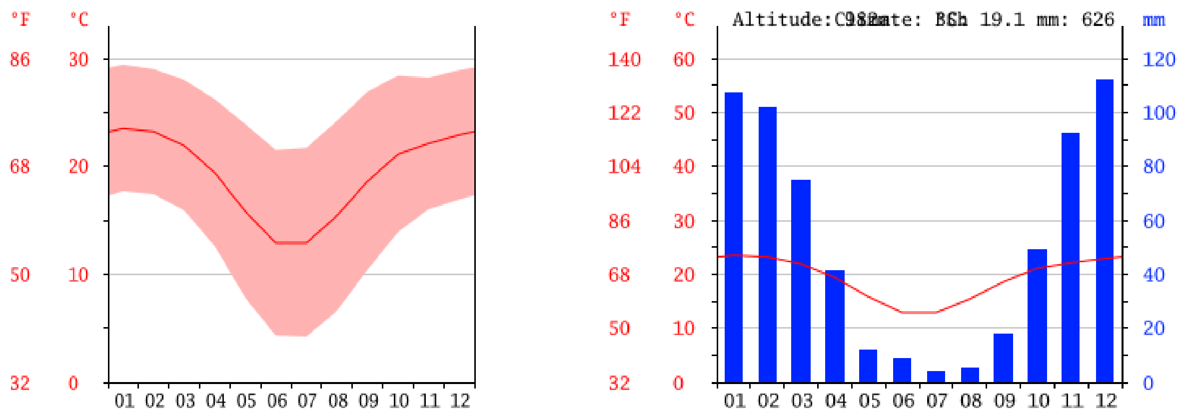

Figure 1, Average annual temperature and climate graph by month for the Lebowakgomo region (climate.data.org)

2.2.2 Geology

Geology underlying the study area is made up of igneous columns of ferrogabbro, troctolite, anorthosite, magnetite layers and pipes as well as diorite from the Pretoria Group of the Vaalian era (Figure 3). The northern boundary of the study areas border quartzite's from the Magaliesberg Formation while the southern boundary is bordered by alluvium associated with the Olifants River.

2.2.3 Associated Aquatic Ecosystems

The NWRS-1 (National Water Resource Strategy, Version 1) originally established 19 Water Management Areas (WMA) within South Africa, and proposed the establishment of the 19 Catchment Management Agencies to correspond to these areas. In rethinking the management model, and based on viability assessments with respect to water resources management, available funding, capacity, skills and expertise in regulation and oversight, as well as to improve integrated water systems management, the original 19 designated WMAs have been consolidated into nine WMAs.

As such, the present study is located on revised Olifants WMA which now also includes the Letaba River catchment. More specifically, the majority of the study area drains southwards directly into the Middle Olifants.

According to DWA (2013), the study area falls within Management Class IUA 7: Middle Olifants below the Flag Boshielo Dam to the Steelpoort River confluence. IUA 7 consists primarily of dryland agriculture and rural subsistence farmers. It encompasses the Local Municipalities of Polokwane, Lepele-Nkumpi, Fetakgomo Makhuduthamaga. Some platinum mining occurs within the IUA. The population of IUA 7 is approximately 550 871 and has approximately 123 234 households. The large majority of the households fall within the very poor and poor income categories (DWA, 2011b). Ecological condition and the Ecological Reserve A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 16. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 1IUA 7 Middle Olifants below Flag Boshielo Dam: Summary of Eco-classification and EWR (DWA, 2013)

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC [1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN67	B51F	Upper Nkumpi (outlet of quaternary)	High	Moderate	C		B	3.8	10.73	III
HN68	B51G	Olifants (EWR site – EWR7) (existing)	EIS=Moderate		E	D		726.5	3.84 (D)	
HN69	B52E	Palangwe (confluence with Olifants)	High	High	C		B	-	-	
HN70	B52F	Hlakaro (outlet)	High	High	C		B	-	-	
HN71	B52J	Mphogodima (confluence with Olifants)	High	High	C		B	-	-	
HN72	B52A, E, G, J	Olifants (outlet of quaternary – outlet of IUA7)	Modera te	High	D	D		799.7	3.88	

The ecological importance of main stem Olifants river is low to moderate, with the small tributaries being moderate to high. The present state of the main stem is in an E category that is mainly due to changes in flows as a results of Flag Boshielo Dam upstream and from agricultural impacts. The IUA includes one Comprehensive EWR site on the Oilfants River, EWR site 7, below Flag Boshielo Dam (B51G) and 5 nodes. The REC of the EWR site is a D (DWA, 2013).

While the tributaries are in a good state the present ecological condition at EWR site 7 is unacceptable and requires improvement. This is due to both flow and non-flow related impacts. The non-flow impacts are water quality related and primarily the deterioration of geormorphology and the river habitat (DWA, 2013).

2.2.4 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or DWS), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development. The second aim comprises a national and sub-national component. The national component aims to align DWS and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level (Driver et al., 2011). The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project (Nel et al., 2011; Figure 4), it was determined that there are no FEPA wetland or wetland clusters within the study area or within several kilometres from the study area. Further, the study area falls within the Central Bushveld Group 3 and Central Bushveld Group 7 wetland vegetation group, which are Endangered and Least Threatened respectively (Macfarlane *et al*, 2014)

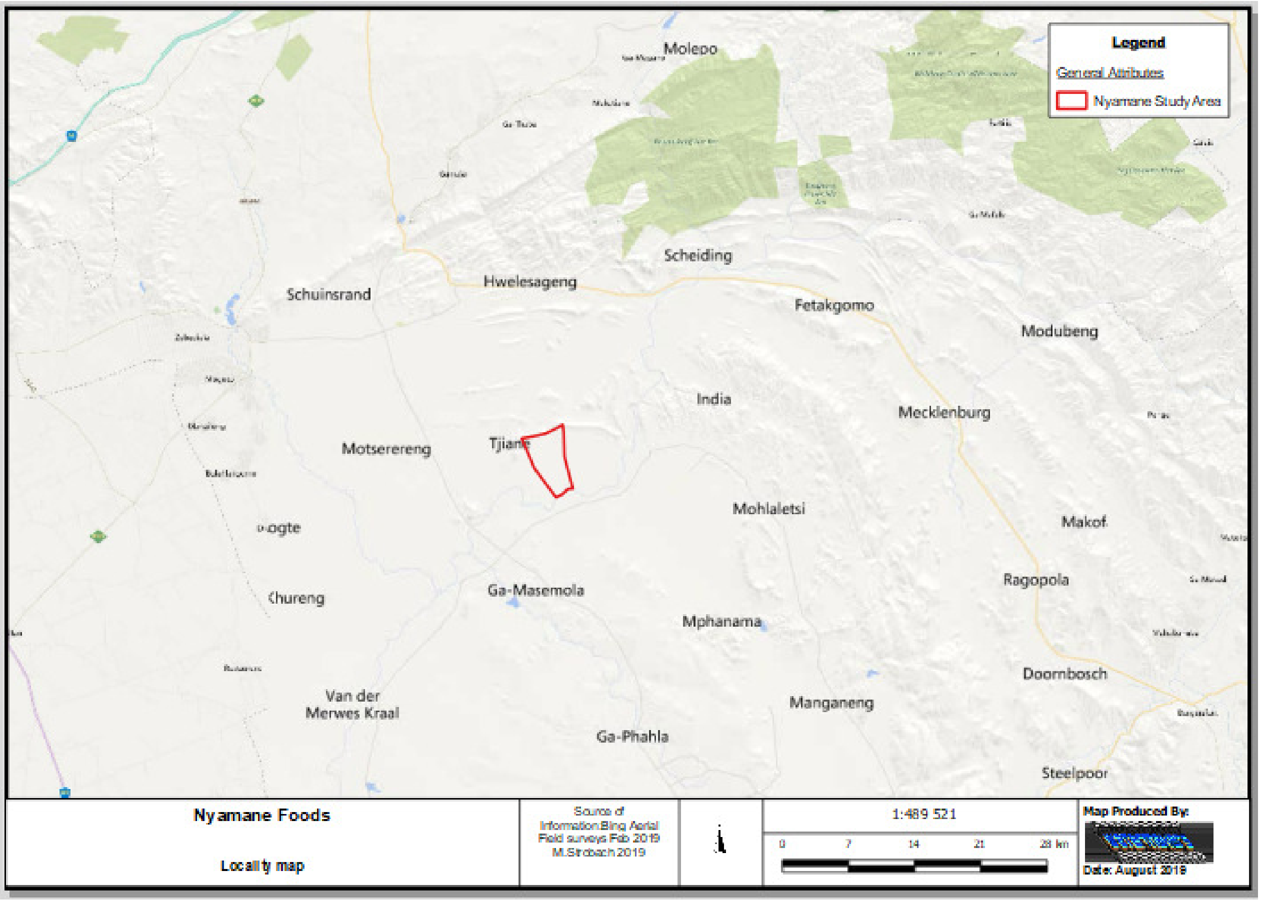

Figure 2: Locality Map

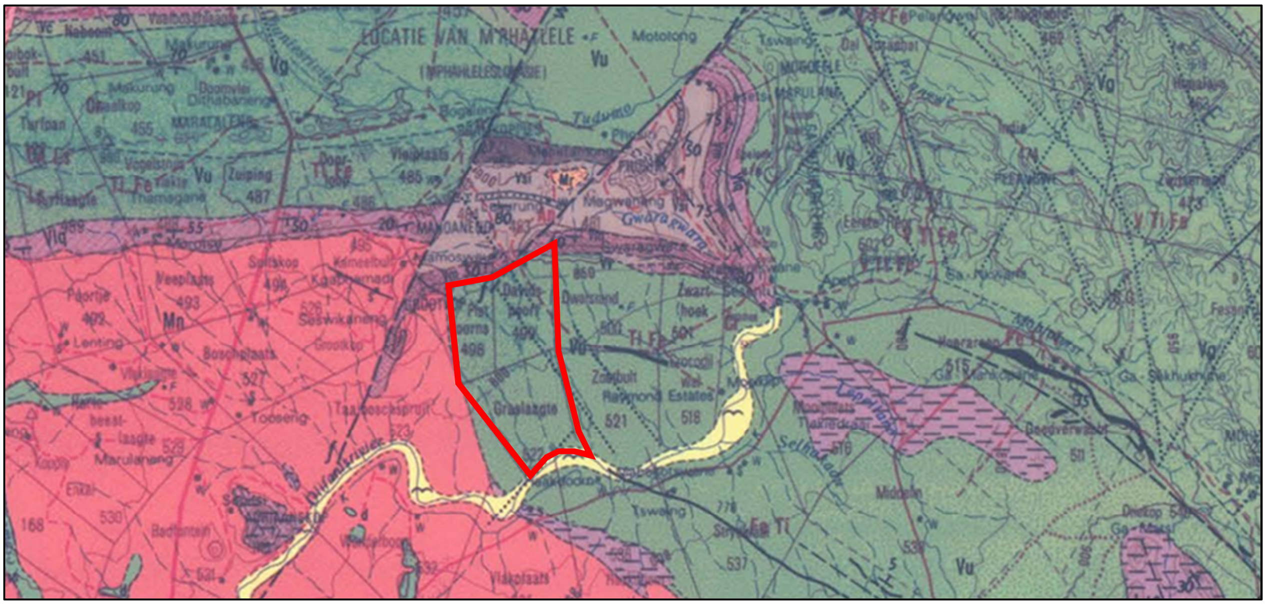

Figure 3: Geology underling the study area (based on 1:250,000 geological map series)

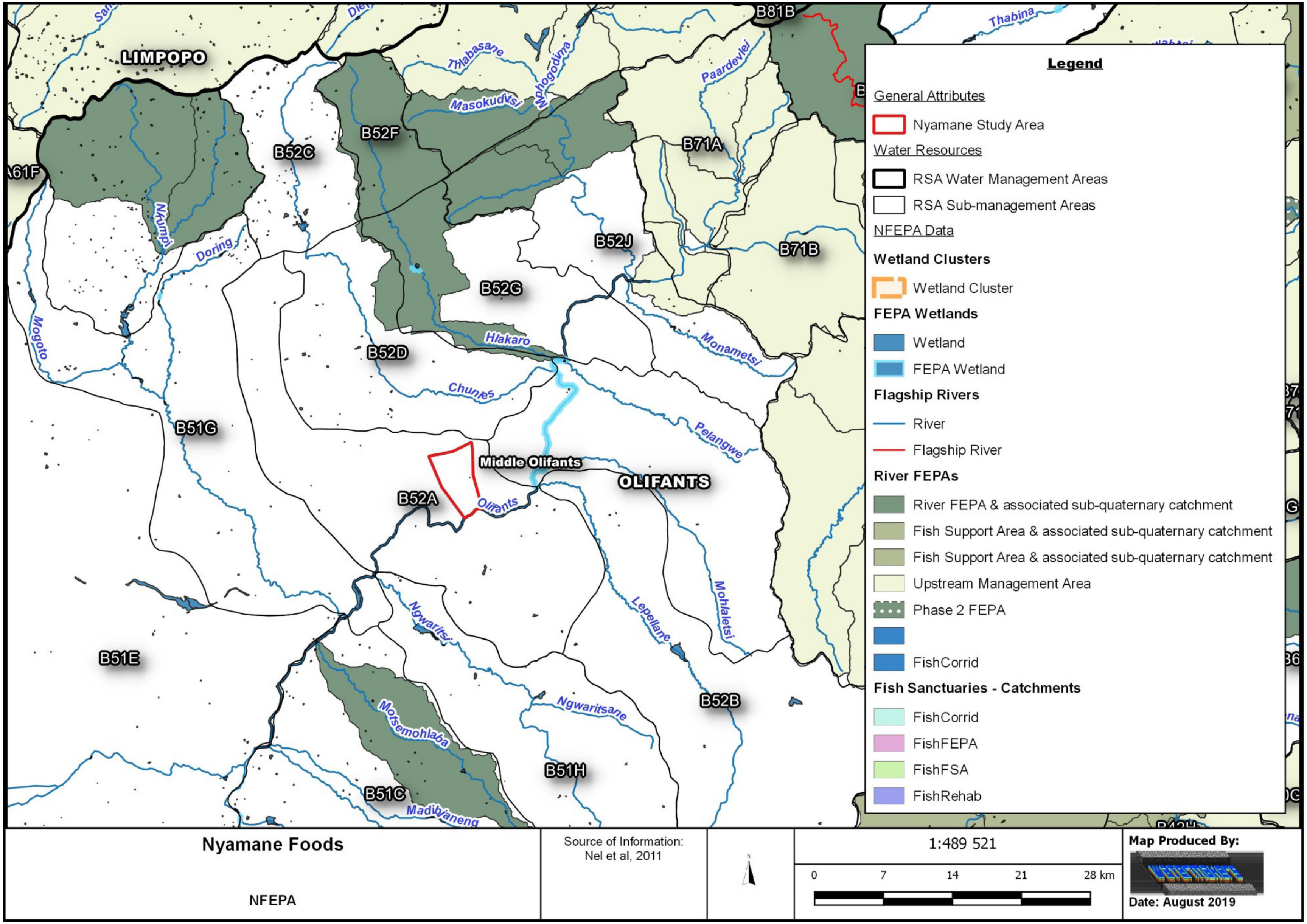

Figure 4: National Freshwater Ecosystem Priority Areas associated with the study area

3. ASSOCIATED WETLANDS/RIPARIAN AREAS

3.1 Wetland and Riparian soils

According to the Department of Water Affairs and Forestry (DWAF) (2005), the permanent zone of a wetland will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991). The seasonal and temporary zones of the wetlands will have one or more of the following soil forms present (signs of wetness incorporated at the form level): Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu. Alternatively, the seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the family level): Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee (Department of Water Affairs and Forestry, 2005).

The site's geology comprises igneous type rocks which dominates the site and gives rise to medium to well-structured soils, although a secondary influence of some overlying sandy soils was also observed in a few localities, indicating weathered material from a secondary geological influence, likely the quarzites from the northern boundary. Topsoil horizons were dominated by Orthic topsoils horizons with prismacutanic, neocutanic and peducatunic subsoils. Some red structured and apedal sub-soil horisons were also present with typically deeper profiles. In general watercourses were dominated by alluvium depositis including the Dundee soil form with stratified alluvium deposits were identified within the proximity of the Olifants River as well as within secondary drainage lines situated in lower terrain unit positions towards the Olifants River (Figure 5).

Figure 5: Alluvium deposits associated with the Olifants River, the Dundee soil form

Poorly drained soils were observed within the lower lying positions of the landscape which included floodplain wetlands containing mostly the Tukulu, Sepane and Willowbrook soil forms. Terrestrial soil forms included the Mispah, Nkonkoni, Nshawu, Hutton, Spioenberg and Glenrosa soil forms (Figure 6). Areas associated with riparian habitat included the Dundee and Queenstown soil forms (Figure 7).

Figure 6: Drainage channel higher up in the landscape with exposed red structured subsoil horison on hard rock, Nshawu soil form.

Figure 7: Riparian section with pedocutanic subsoil horison on top of alluvial material, the Queenstown soil form

The traversed catena within the study area itself produced none of the recognised hydromorphic soil forms according to DWAF (2005; 2008), with the excpetion of floodplain wetlands associated with the Olifants River . Several traversed catenas within the study area revealed the terrain to be dominated by shallow and deep soil forms as well as exposed rock intermittently, mostly on the norther n periphery. From a hydro-pedological viewpoint the majority of soil forms within the study area and associated catchment which was all designated as recharge soils (Table 3 and Table 4).

Hillslopes where recharge is dominant as in the study area are represented by Class 3 hillslopes (van Tol *et al*, 2015). These hillslopes are dominated by high chroma soils with redoximorphic properties limited to the valley bottom, indicating that the underlying bedrock is permeable. On these hillslopes, the infiltration and vertical redistribution rate is generally higher than the precipitation rate, thereby promoting sustained oxidized soil chemistry. Interflow and responsive soils are scarce. This class is commonly associated with sand deposits (aeolian deposits, coastal plains, and quartzitic sandstones) and karst landscapes, among others (van Tol *et al*, 2015).

Table 2: Hydroppedological grouping of South-African soil forms according to van Tol and Le Roux (2018)

Recharge		Interflow		Responsive		Stagnating
Deep	Shallow	A/B horizon	Soil/bedrock	Shallow[*]	Saturated	
Kranskop	Nomanci[#]	Kroonstad	Lamotte	Nomanci[€]	Champagne	Steendal
Magwa	Mayo[#]	Longlands	Fernwood	Arcadia	Rensburg	Immerpan
Inanda	Milkwood[#]	Wasbank	Westleigh	Mayo[€]	Willowbrook	Dresden
Lusiki	Jonkersberg	Klapmuts	Avalon	Milkwood	Katspruit	Glencoe
Sweetwater	Glenrosa[#]	Villafontes	Pinedene	Glenrosa[€]		Molopo
Bonheim	Mispah[#]	Kinkelbos	Bainsvlei	Mispah[€]		Askham
Inhoek	Witbank	Cartref	Bloemdal			Kimberley
Constantia			Witfontein			Plooysburg
Tsitsikamma			Sepane			Garries
Concordia			Tukulu			Etosha
Houwhoek			Montagu			Gamoep
Griffin						Oudtshoorn
Clovelly						Addo
Hutton						Prieska
Shortlands						Trawal
Pinegrove						Augrabies
Groenkop						Brandvlei
Valsrivier						Coega
Swartland						Knersvlakte
Dundee						
Namib						

* Includes soils with very low infiltration rates

[#] Soils overlying fractured bedrock (e.g. soil families with lithocutanic B horizons that are 'not hard' and soil families where A horizons are 'not bleached')

[€] Soils overlying relatively impermeable bedrock (e.g. soil families where lithocutanic B horizons are 'hard' and soil families with bleached A horizon

Table 3: Hydrological soil types of the studied hillslopes in South Africa

Hydrological soil type	Description	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out of the profile into the underlying bedrock is the dominant flow direction. These soils can either be shallow on fractured rock with limited contribution to evapotranspiration or deep freely drained soils with significant contribution to evapotranspiration.	
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates buildup of water in the topsoil. Duration of drainable water depends on rate of ET, position in the hillslope (lateral addition/release), and slope (discharge in a predominantly lateral direction).	
Interflow (soil/ bedrock)	Soils overlying relatively impermeable bedrock. Hydromorphic properties signify temporal build of water on the soil/bedrock interface and slow discharge in a predominantly lateral direction.	
Responsive (shallow)	Shallow soils overlying relatively impermeable bedrock. Limited storage capacity results in the generation of overland flow after rain events.	
Responsive (saturated)	Soils with morphological evidence of long periods of saturation. These soils are close to saturation during rainy seasons and promote the generation of overland flow due to saturation excess.	

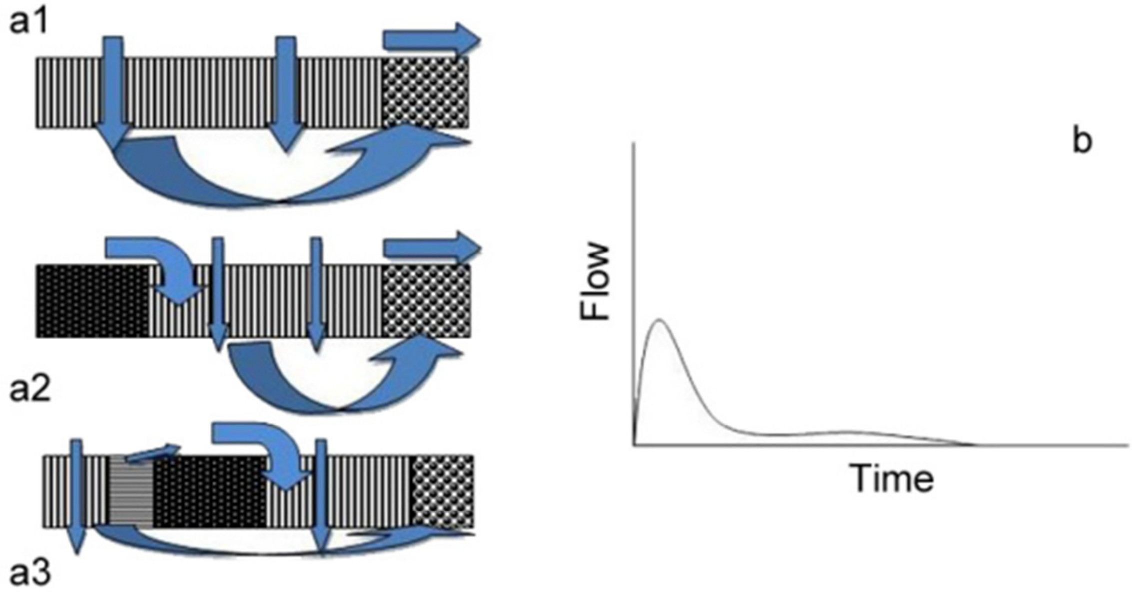

Figure 8: Perceptual flow models of hillslope class 4 (a1 most representative although a small band of interflow could potentially be included between recharge and responsive soils) and b, anticipated hillslope hydrograph.

According to the Department of Water Affairs and Forestry (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators remain in wetland soils in most instances, even if they are degraded or desiccated. It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil), or non-hydric (non-wetland soil) (Collins, 2005). In general, redoximorphic features were scarce within soil profiles of the study area, limited to orange and red mottles, and rhizospheres within the floodplain wetlands. Some redoximorphic signs were noticed within riparian habitat's saprolites that were indicative of intermittent wetness likely through subsurface return pathways.

Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of iron and manganese oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Redoximorphic features typically occur in three types (Collins, 2005):

- **A reduced matrix** - i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe^3+ ions which are characterised by "grey" colours of the soil matrix (Photograph 4).
- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe - Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
  - Concretions - harder, regular shaped bodies;
  - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; and,
  - Pore linings – zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognised as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres

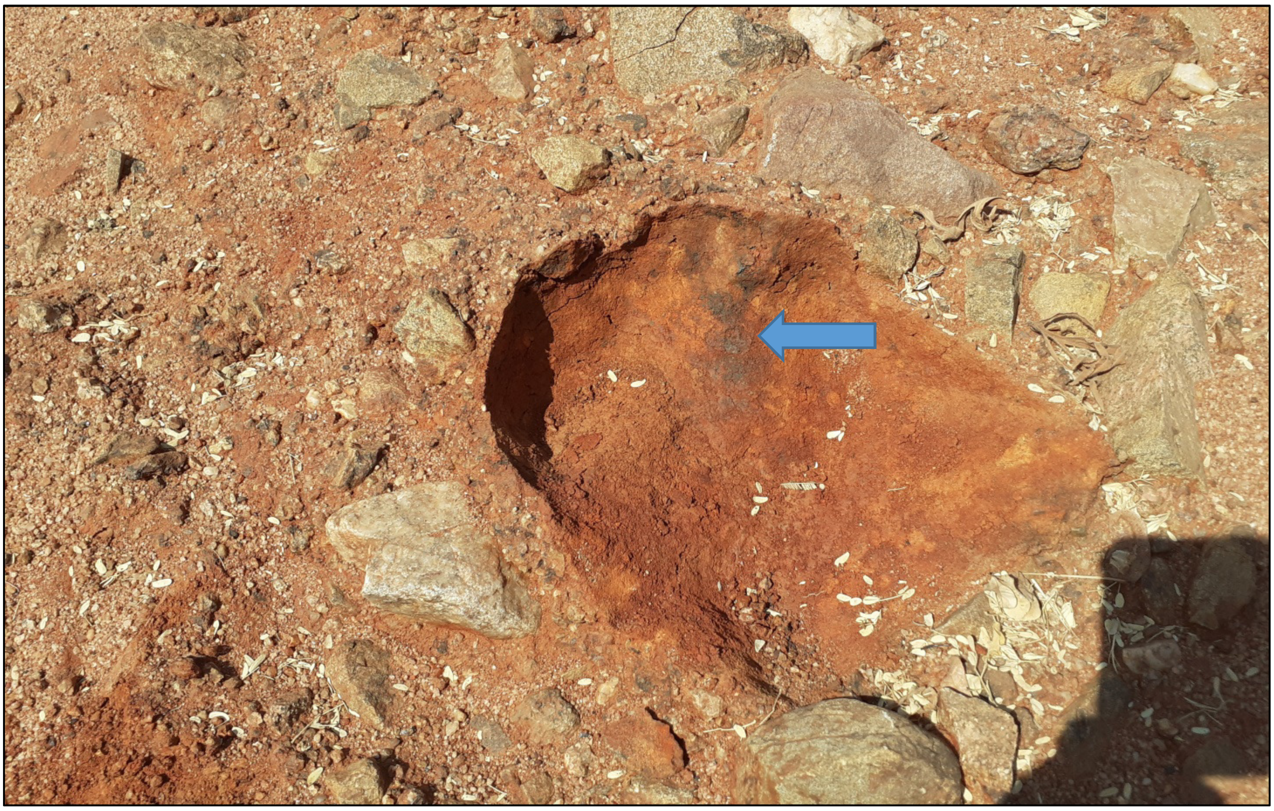

Figure 6: Redoximorphic signs (manganese concentrations, blue arrow) within saprolite of a drainage channel indicating intermittent wetness

3.2 Wetland and Riparian Vegetation

According to the Department of Water Affairs and Forestry (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. Using vegetation as a primary wetland indicator however, requires undisturbed conditions (Department of Water Affairs and Forestry, 2005). A cautionary approach must be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterized by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (Department of Water Affairs and Forestry, 2005). It is important to identify the vegetative indicators which determine the three wetness zones (temporary, seasonal and permanent) which characterize wetlands. Each zone is characterized by different plant species which are uniquely suited to the soil wetness within that zone.

The majority of the study area had been disturbed through various historic and current anthropogenic practices. The most profound impact with the largest extent in the study area was considered to be past and present heavy grazing regimes which have led to vegetative successional changes and reduced basal cover. The majority of wetland habitats (floodplain wetlands associated with the Olifants River) within the study area were considered to be temporary in nature with a few small seasonal sections. Differentiation between the different zones were cryptic as the majority of wetland habitat were dominated by a mixture of facultative wetland and terrestrial species including *Phragmites australis* and *Persicaria* sp. (the only two obligatory wetland species found in the wetter sections), *Agrostis lachnantha*, *Imperata cylindrica, Heteropogon contortus, Eragrostis plana, Arisitada junciformis, Eragrostis* spp.*, Paspalum dilatum, Verbena bonariensis, Themeda triandra*, *Andropogon eucomus.*

Identified riparian habitats (majority of watercourse within the study area) were dominated by shrubs and trees such as *Senegalia galpinii, Ziziphus micronata, Combretum erythrophyllum, Senegalia caffra, Vachellia karroo, Combretum sp., Ficus abutilifolia Grewia* sp. (Figure 10) Graimnoids included species such as*, Agrostis* sp.*, Eragrostis plana, Arisitada junciformis, Eragrostis curvula, Erogrostis chloromelas Eragrostis* spp., and *Themeda triandra.* Although some of the above species was also found within terrestrial habitat, individuals within the riparian habitat grew with a lot more vigour than their terrestrial counterparts.

Figure 7: Typical dense riparian habitat associated with the lower reaches of watercourses before joining the Olifants River downstream

3.3 Delineated Wetland and Riparian Areas

According to the National Water Act (Act no 36 of 1998) a wetland is 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*." Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Hydrophytes and hydric soils are subsequently used as the two main wetland indicators. The presence of these two indicators is symptomatic of an area that has sufficient saturation to classify the area as a wetland. Terrain unit, which is another indicator of wetland areas, refers to the land unit in which the wetland is found.

In practice all indicators should be used in any wetland assessment/delineation exercise, the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to Department of Water Affairs and Forestry (2005), the more wetland indicators that are present the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present.

The disturbance caused by anthropogenic impacts and resulting vegetation changes made using vegetation indicators complex in various circumstances, especially on the temporary boundaries of wetlands. Therefore, identifying wetland features on site was primarily done by identifying terrain unit, soil forms and soil wetness features such as the presence of mottling, a gleyed matrix and/or Fe and Mg concretions.

One wetland type, floodplain depression wetlands was associated with the Olifants River. However, due to the dominance and greater extent occupied by the riverine riparian habitat associated with the Olifants River, these wetland features were not separated and thus included under Riparian 1 (Olifants River) during the present study (Figure 8).

In total ten sections of riparian habitat were delineated within the study area and within 500m from the study area as well as sections further downstream of the study area (Figure 8). According to Department of Water Affairs and Forestry (2005), riparian zones can be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas. Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel Department of Water Affairs and Forestry (2005).

Channel differentiation should be based on the classification of river channels outlined in the DWAF delineation guideline for wetlands and riparian areas Department of Water Affairs and Forestry (2005). The channel network is divided into three types of channel, which are referred to as A Section, B Section or C Section channels. The essential difference between the “A”, “B” and “C” Sections is their position relative to the zone of saturation in the riparian area. The zone of saturation must be in contact with the channel network for base flow to take place at any point in the channel and the classification separates the channel sections that do not have base flow (A Sections) from those that sometimes have base flow (B Sections) and those that always have base flow (C Sections). The perennial Olifants River were regarded as the only A

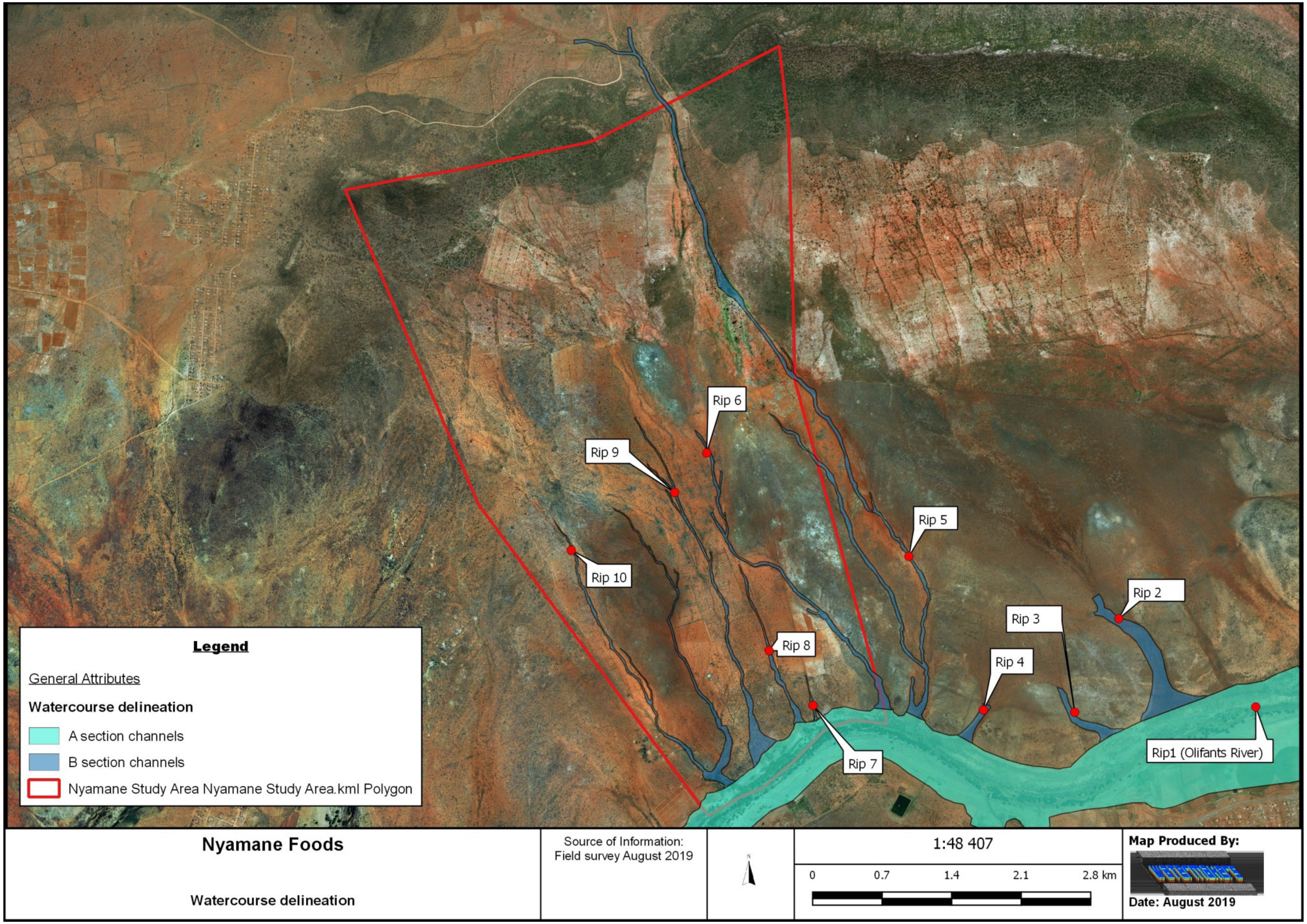

Figure 8: Watercourse delineation for the study area

section riparian channel within the study area with the remaining nine sections of riparian habitat regarded as B section channels as baseflow was regarded as sometimes being present. A clear indication of these likely seasonal baseflows were observed in a number of localities which included redoximorphic signs as well as the formation of precipitates such as soft and hard carbonates (Figure 9). In addition to the A and B type channels, numerous C section channels were also observed within the study area, especially on the higher lying terrain units. These however did not show any signs of baseflow and served as drainage channels feeding into the B section channels during precipitation events.

Figure 9: Exposed hard carbonate layer due to precipitation driven through baseflow, likely seasonal

3.4 Functional and Present Ecological State Assessment

3.4.1 Riparian habitat

The Present Ecological State of the riparian zone was assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) Level 3 approach (Kleynhans et al., 2007). Riparian vegetation areas were divided into two sub-zones which included marginal and non-marginal zones. Recognition of the different zones are important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area (Kleynhans et al., 2007). This was done (in part) before going into the field using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. According to Kleynhans et al. (2007), the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond.

Findings of the VEGRAI vegetation assessment conducted on riparian units identified within the study area revealed that riparian habitat associated with the study area were regarded as being in a moderately modified to largely modified state (i.e. Ecological Category C and D; Table 5). Riparian habitat was modified as a result of heavy grazing regimes causing vegetative successional changes, reduced basal cover and consequently changes to the hydrological regime. This has subsequently led to sheet, rill and gully erosion in especially the C and some B section channels associated with the study area (Figure 10). Alien invasive plants although rather limited, were observed within the marginal and non-marginal zones of the riparian habitat, including *Lantana camara* and *Eucalyptus* spp.,

Figure 10: Gully erosion advancing a C section channel within the study area due to over utilisation and subsequent reduced basal cover

Table 4: VEGRAI score for the riparian vegetation calculated for riparian habitat associated with the various riparian areas associated with the present study area

Riparian Unit	VEGRAI Score	Ecological Category
Riparian 1	65.8	C
Riparian 2	62.1	C
Riparian 3	61.9	C
Riparian 4	57.2	D
Riparian 5	51.3	D
Riparian 6	54.4	D
Riparian 7	47.2	D
Riparian 8	49.0	D
Riparian 9	54.5	D
Riparian 10	49.6	D

3.5 Ecological Importance and Sensitivity

All wetlands, rivers, their flood zones and their riparian areas are protected by law and no development is allowed to negatively impact on rivers and river vegetation. The vegetation in and around rivers and drainage lines play an important role in water catchments, assimilation of phosphates, nitrates and toxins as well as flood attenuation. Quality, quantity and sustainability of water resources are fully dependent on good land management practices within the catchment. All flood lines, riparian zones and wetlands along with corresponding buffer zones must be designated as sensitive.

The Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank water resources in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree et al., 2013). The Ecological Importance and Sensitivity of the riprian habitat in the study area were dertermined using the River Ecological Importance & Sensitivity (EIS) DWAF riverine EIS tool (Kleynhans, 1999). A Summary of results are displayed in Table 6 below.

Table 5: Ecological Importance and Sensitivity scores for Riparian habitat within the study area

Riparian Unit	EIS Score (0 – 5)	Class
Riparian 1	3.2	**High**

Riparian 2	2.6	**Moderate**
Riparian 3	2.2	**Moderate**
Riparian 4	2.5	**Moderate**
Riparian 5	2.3	**Moderate**
Riparian 6	2.1	**Moderate**
Riparian 7	2.1	**Moderate**
Riparian 8	2.4	**Moderate**
Riparian 9	2.6	**Moderate**
Riparian 10	2.6	**Moderate**

In terms of ecological importance and sensitivity, all A and B section riparian habitat (Riparian 1 to Riparian 10) within the study area was designated as sensitive as a result of the ecological and functional values attributed to riparian areas in general, legal regulations and requirements as well as the supporting ecological services afforded to the downstream ecosystems.

4. FRESHWATER ECOSYSTEM BUFFERS

Buffer zones associated with water resources have been shown to perform a wide range of functions, and have been proposed as a standard measure to protect water resources and associated biodiversity on this basis. These functions can include (Macfarlane & Bredin, 2016):

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

However, despite the range of functions potentially provided by buffer zones, buffer zones are unable to address all water resource-related problems. For example, buffers can do little to address impacts such as hydrological changes caused by for example stream flow reduction activities or changes in flow brought about by abstractions or upstream impoundments. Buffer zones are also not the appropriate tool for mitigating against point-source discharges (e.g. sewage outflows), which can be more effectively managed by targeting these areas through specific source-directed controls (Macfarlane & Bredin, 2016).

Nevertheless, buffer zones are well suited to perform functions such as sediment trapping and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts linked with diffuse storm water runoff from land-uses / activities planned adjacent to water resources. These must, however, be considered in conjunction with other mitigation measures which may be required to address specific impacts for which buffer zones are not well suited (Macfarlane & Bredin, 2016).

Determination of the preliminary buffer requirements for riparian features associated with the proposed study area followed the approach of Macfarlane & Bredin (2016), whereby the preliminary required buffers were developed based on various factors, including assumed agricultural impacts, slope, annual precipitation, rainfall intensity, channel width, catchment to wetland ratio, etc. Accordingly, preliminary buffer requirements for the identified riparian habitat were determined to be 30m from the edge of the delineated riparian areas for B section channels and 65m from the edge of the A section channel (Olifants River). It should however be noted that the importance of other functions associated with riverine and wetland features such as the provision of habitat necessary for wetland-dependant species needing both aquatic and terrestrial habitats, was not catered for within the present study, as the present study was done in isolation to the ecological assessment. As such, the results obtained for the ecological assessment associated with the proposed agricultural development (i.e. species-specific buffers) will need to be incorporated within the final buffer zone requirements of the proposed development if necessitated.

5. IMPACT ASSESSMENT

Any developmental activities in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed activity and to provide a description of the mitigation required so as to limit the perceived impacts on the natural environment.

The environmental impacts are assessed with mitigation measures (WMM) and without mitigation measures (WOMM) and the results presented in impact tables which summarise the assessment. Mitigation and management actions are also recommended with the aim of enhancing positive impacts and minimising negative impacts.

In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operational phase. The criteria against which these activities were assessed are discussed below.

Nature of the Impact

This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Extent of the Impact

A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.

Duration of the Impact

This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.

Intensity

This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.

Probability of Occurrence

This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

Degree of Confidence
This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

The following risk assessment was used to determine the significance of impacts:

Significance = (Magnitude + Duration + Scale) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts can thus be rated as high, medium or low significance on the following basis:

- High environmental significance 60 – 100 points
- Medium environmental significance 30 – 59 points
- Low environmental significance 0 – 29 points

Table 9 illustrates the scale used to determine the overall ranking.

Table 6: Scale used to determine significance ranking

Magnitude (M)		**Duration (D)**	
Description	**Numerical value**	**Description**	**Numerical value**
Very high	10	Permanent	5
High	8	Long-term (ceases at end of operation)	4
Moderate	6	Medium-term	5-15 years
Low	4	Short-term	0 – 5 years
Minor	2	Immediate	1
Scale (S)		**Probability (P)**	
Description	**Numerical value**	**Description**	**Numerical value**
International	5	Definite (or unknown)	5
National	4	High	4
Regional	3	Medium	3
Local	2	Low	2
Site	1	Improbable	1
None	0	None	0

6.1 Impact Assessment

Possible impacts and their sources associated with the proposed activities are provided in 6 (construction phase) and Table 7 (operational phase) (Figure 11). Some of the impacts are relevant during more than one phase and has therefore only been described once under the initial phase.

Table 6: Possible impacts arising during the construction phase

Possible impact	Source of impact
Sedimentation of watercourse	Runoff from construction and agricultural activities associated with clearing of natural vegetation
Increased erosion and increased run-off received by water courses	Heavy machines clearing vegetation for construction and agricultural activities
Introduction and spread of invasive vegetation	Disturbance / destruction of indigenous vegetation making ecosystem vulnerable to invasions
Impacts on ground and surface water quality as well as soils	Activities of workforce, e.g., concrete mixing and sediment release including hydrocarbon spillages

Table 7: Possible additional impacts arising during the operational phase

Possible impact	Source of impact
Altered hydrological regime	The establishment of hard surfaces and increases in hard surfaces into the area leads to increased stormwater runoff volume and intensity and reduced subsurface flow supporting slow release mechanism, could potentially negatively affect wetland systems downstream. In addition the possibility of water and sewage infrastructure leaks should also be considered.

6.1.1 Construction phase

6.1.1.a Sedimentation of watercourse

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	National (5)	Short-term (2)	Low (4)	Medium (3)	Medium (33)	Moderate
With mitigation measures	Local (2)	Short-term (2)	Low (4)	Low (2)	Low (16)	Moderate

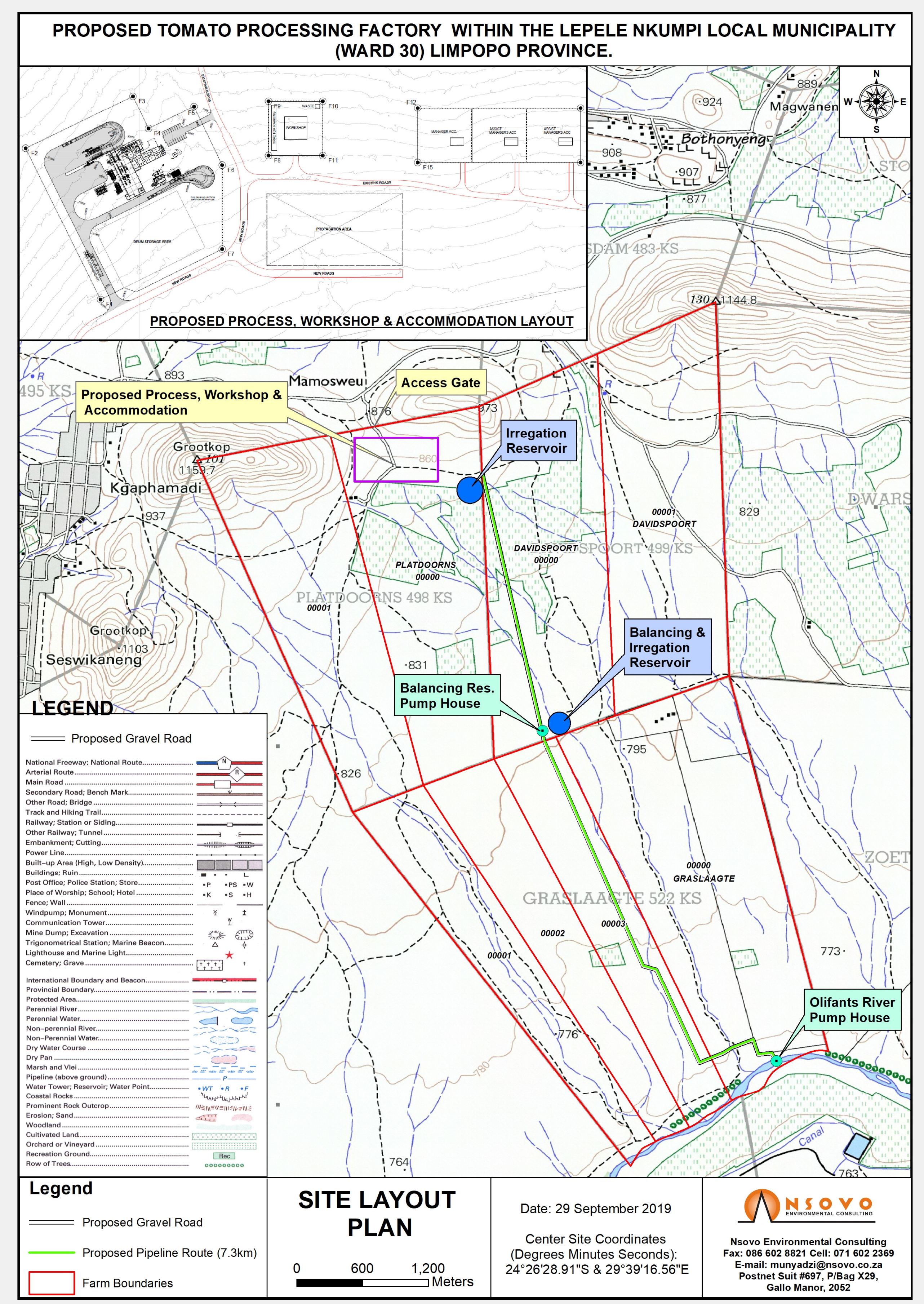

Figure 11: Preliminary site plan with infrastructure in the northern quadrant

Description of Impact

The clearing of natural vegetation and the stripping of topsoil will result in increased runoff of sediment from the site into watercourses downstream of the study area, particularly during times of high rainfall. Water flowing down trenches and access roads, as well as movement of construction vehicles and personnel, could cause additional sediment to accumulate within downstream areas. The potential siltation of riparian and wetland systems downstream would alter geomorphologic functioning, the movement of water through the system (hydrological functioning) as well as having an impact on water quality within the resource.

Mitigation Measures

- Management has a responsibility to inform staff of the need to be vigilant against any practice that will have a harmful effect on riparian habitat and associated watercourses.
- An effective Buffer Control Zone must be established prior to any construction activities taking place which include wetland and or riparian habitat, freshwater ecosystem buffers and open space areas, No person or vehicle will be allowed within the Buffer Control Zone, management should be vigilant in preventing personnel taking short-cuts across the Buffer Control Zone between construction sites.
- All cattle should be removed from the site prior to the initiation of rehabilitation or construction activities. This would increase veld condition and thereby afford the study area higher basal coverages with associated higher sediment and erosion control properties. The removal of cattle is also essential to realise successful rehabilitation initiatives which should be implemented prior to construction. Further, no veld fires should be allowed for the next 3 years in order to aid veld restoration processes.
- It is recommended that a site-specific rehabilitation plan be designed in conjunction with the stormwater management plan, environmental management plan and wetland monitoring plan. The rehabilitation plan should also investigate veld reclamation approaches that would be viable in the study area, wetland and riparian habitat for the medium and long term, including recommendations on possible grazing, fire and other required management regimes.
- Topsoil preparation and bush clearing must be done in a phased approach, only strip what is needed immediately prior to construction / field preparation.
- The construction of surface stormwater drainage systems during the construction phase must be done in a manner that would protect the quality and quantity of the downstream system. Where applicable, the use of swales, which could then be grassed for the operational phase, is recommended as the swales would attenuate run-off water and facilitate the settling of sediment within the swale rather than within wetlands or watercourses. For example, on the downslope edge of the infrastructure camp before vegetation clearing commences.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimized, and be surrounded by bunds. It should also only be stored for the minimum amount of time necessary.
- Erosion control of all banks must take place so as to reduce erosion and sedimentation processes.
- Topsoil, leaf and plant litter as well as subsoil must be stockpiled separately in low heaps.
- Do not strip topsoil when it is wet.
- In the absence of a recognizable topsoil layer, strip the upper most 500mm of soil.

- If possible, re-position the topsoil stockpile upslope of any infrastructure within the surface infrastructure footprint so as to prevent contaminated surface water coming into contact with topsoil.
- Ensure that all topsoil is stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself;
- Protect topsoil stockpiles from erosion.
- Develop soil management measures for the entire surface area of the proposed development area that will prevent runoff of sediment into the associated watercourses.
- Any additional topsoil stockpile areas required by the contractor must be approved by the Environmental Control Officer (ECO) in the form of an amended EMP indicating the position and extent of thereof.
- The ECO must be vigilant to detect any negative impacts on wetlands and consult with a wetland specialist if erosion or other negative impacts within wetlands are noticed.

6.1.1.b Exposure to erosion

	Scale	**Duration**	**Magnitude**	**Probability of occurrence**	**Significance**	**Confidence**
Without mitigation measures	Local (2)	Medium-term (3)	Moderate (6)	Medium (3)	Medium (33)	Moderate
With mitigation measures	Site (1)	Short term (2)	Low (4)	Low (2)	Low (12)	Moderate

Description of Impact

The removal of surface vegetation will cause exposed soil conditions where rainfall and high winds can cause mechanical erosion. Rainfall and inadequate drainage systems would lead to sediments washing down into wetlands and rivers, causing sedimentation. In addition, hardened surfaces and bare areas are likely to increase surface run off velocities and peak flows received by riparian habitat and wetlands.

Mitigation Measures

- A riparian channel rehabilitation program must be designed and implemented prior to the start of the construction phase and continue during the operational phase. This must include veld restoration approaches, prevention of and rehabilitation of rill and gully erosion. A 30 m buffer (exclusion) and rehabilitation zone around each riparian habitat must be implemented through fencing of the buffers (thus keeping cattle and goats out) and reseeding programs to establish a functional buffer for the riprian habitat.
- An ecologically-sound stormwater management plan must be implemented at the onset of the construction phase. This must include sustainable and sensitive stormwater design for the new agricultural fields to ensure that A and B section channels are not negatively affected. Stormwater run-off must reach the B section channels in a diffuse manner;

- The above guidelines can be achieved through diffuse release of stromwater flows utilising the natural topography and associated contours, vegetated channels, riparian buffers and veld restoration techniques, gabion baskets etc;
- The natural veld that are not being utilised by agricultural fields must be rehabilitated to increase basal cover and reduce erosion processes prevelant at the moment;
- Erosion must not be allowed to develop on a large scale before effecting repairs;
- A riparian monitoring program should be initiated at the start of the construction phase.
- Make use of existing roads and tracks where feasible, rather than creating new routes through vegetated areas;
- Vegetation and soil must be retained in position for as long as possible, and removed immediately ahead of construction / earthworks in that area (DWAF, 2005);
- Runoff from roads must be managed to avoid erosion and pollution problems;
- During the construction and operational phases, measures must be put in place to control the flow of surface water so that it does not impact on the vegetation, i.e., energy dissipaters and canal flow designs must be used to prevent scouring and erosion;
- All areas susceptible to erosion must be protected and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas;
- Natural trees, shrubbery and grass species must be retained wherever possible;
- Areas exposed to erosion due to construction should be vegetated with species naturally occurring in the area; and
- Surface water or storm water must not be allowed to concentrate, or flow down cut or fill slopes without erosion protection measures being in place.

6.1.1.c Potential increase in invasive vegetation

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Local (2)	Long-term (4)	Moderate (6)	High (5)	High (60)	Medium
With mitigation measures	Site (1)	Medium-term (3)	Low (2)	Medium (3)	Low (24)	Medium

<u>Description of Impact</u>

During construction, vegetation will be removed and soil disturbed. The seed of alien invasive species that occur on and in the vicinity of the construction area could spread into the disturbed and stockpiled soil. In addition, the construction vehicles and equipment were likely used on various other sites and could introduce alien invasive plant seeds or indigenous plants not belonging to this vegetation unit to the construction site. Alien vegetation could easily disperse into the watercourses through stormwater infrastructure located on site.

<u>Mitigation Measures</u>

- During construction, the construction area and immediate surroundings should be monitored regularly for emergent invasive vegetation;
- Surrounding natural vegetation should not be disturbed to minimize chances of invasion by alien vegetation;
- All alien seedlings and saplings must be removed as they become evident for the duration of construction and operational phase;
- Manual / mechanical removal is preferred to chemical control;
- All construction vehicles and equipment, as well as construction material should be free of plant material. Therefore, all equipment and vehicles should be thoroughly cleaned prior to access on to the construction site. This should be verified by the ECO;
- An alien invasive eradication and monitoring plan must be compiled and implemented whereby all emergent invasive species are removed during construction. The monitoring plan must also ensure that the re-emergence of invasive species is monitored continuously during the operational and decommissioning phases and that monitoring and eradication continues post decommissioning.

6.1.1.d Pollution of water resources

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	National (5)	Long-term (2)	Moderate (6)	Medium (3)	Medium (39)	High
With mitigation measures	Local (2)	Short-term (2)	Low (4)	Low (2)	Low (16)	High

Description of Impact

Hydrocarbon-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by raw sewage. The utilisation of stormwater infrastructure for disposal of water used for washing could decrease the abundance and diversity of aquatic macro-invertebrates inhabiting the section of the wetland and riparian areas further downstream. Contaminated runoff from concrete mixing and sediment release including hydrocarbon spillages may lead to the infiltration of toxicants into the groundwater.

Mitigation Measures

- Construction vehicles are to be maintained in good working order so as to reduce the probability of leakage of fuels and lubricants;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should take place far away from preferential flow paths and or stormwater infrastructure. These materials include fuel, oil, cement, bitumen etc.;

- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- Concrete is to be mixed on mixing trays only, not on exposed soil;
- Concrete and tar shall be mixed only in areas which have been specially demarcated for this purpose;
- After all the concrete / tar mixing is complete all waste concrete / tar shall be removed from the batching area and disposed of at an approved dumpsite;
- Stormwater shall not be allowed to flow through the batching area. Cement sediment shall be removed from time to time and disposed of in a manner as instructed by the Consulting Engineer;
- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs must be informed immediately;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed;
- Conduct ongoing staff awareness programs so as to reinforce the need to avoid littering; and
- Backfill must be compacted to form a stabilised and durable blanket and the current load above the sewer lines must at no time be exceeded.

6.1.2 Operational phase

Impacts described in the construction phase are in most instances also applicable to the operational phase. The following are additional impacts during the operational phase.

6.1.2.a Altered Hydrologic Regime

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Regional (3)	Long-term (4)	Moderate (6)	High (4)	Medium (52)	Medium
With mitigation measures	Local (2)	Long-term (3)	Low (4)	Low (2)	Low (16)	Medium

Description of impact

The presence of hard impermeable surfaces such as roads, parking areas and roofs, will result in an increase in stormwater runoff volume and velocity. The size of the production facilities are rather small and would therefore likely only constitute a very small impact. However the construction of roads and agricultural fields with altered surface run-off regimes could have a significant impact if not well managed. Erosional process should not be allowed to develop and current process haltered and rehabilitated. The cumulative impacts of developments within the catchments could cause an increase of surface water runoff and the decrease of infiltration which will potentially result in an increase in erosion potential and sedimentation to the riparian habitat and wetlands downstream.

Mitigation Measures

- In order to minimize artificially generated surface stormwater runoff, roads should have stormwater berms at regular intervals to prevent large volumes from building up. Stormwater channels next to fields should be vegetated and have a similar approach as the roads in intermittently allow stormwater into natural veld and not build up along preferential induced flow paths.
- Water should enter the B section channels diffusely and in accordance with natural historic run-off rates. It is highly recommended that the B section channels should be continuously be rehabilitated throughout the operational phase. If necessary attenuation and diffuse release mechanisms should be designed as part of the development in order to prevent increased flood peaks from damaging the riparian habitat.

6. CONCLUSION AND RECOMMENDATIONS

In total ten sections of riparian habitat were delineated within the study area and within 500m from the study area as well as sections further downstream of the study area. In addition, one wetland type, floodplain depression wetlands was associated with the Olifants River. However, due to the dominance and greater extent occupied by the riverine riparian habitat associated with the Olifants River, these wetland features were not separated and thus included under Riparian 1 (Olifants River). The perennial Olifants River were regarded as the only A section riparian channel within the study area with the remaining nine sections of riparian habitat regarded as B section channels as baseflow was regarded as sometimes being present.

Findings of the VEGRAI vegetation assessment conducted on riparian units identified within the study area revealed that riparian habitat associated with the study area were regarded as being in a moderately modified to largely modified state (i.e. Ecological Category C and D). Riparian habitat was modified as a result of heavy grazing regimes causing vegetative successional changes, reduced basal cover and consequently changes to the hydrological regime. This has subsequently led to sheet, rill and gully erosion in especially the C and some B section channels associated with the study area. Alien invasive plants although rather limited, were observed within the marginal and non-marginal zones of the riparian habitat

In terms of ecological importance and sensitivity, all A and B channel section riparian habitat within the study area was designated as sensitive as a result of the ecological and functional values attributed to riparian areas in general, legal regulations and requirements as well as the supporting ecological services afforded to the downstream ecosystems

Determination of the preliminary buffer requirements for riparian features associated with the proposed study area followed the approach of Macfarlane & Bredin (2016), whereby the preliminary required buffers were developed based on various factors, including assumed agricultural impacts, slope, annual precipitation, rainfall intensity, channel width, catchment to wetland ratio, etc. Accordingly, preliminary buffer requirements for the identified riparian habitat were determined to be 30m from the edge of the delineated riparian areas for B section channels and 65m from the edge of the A section channel (Olifants River).

The impact assessment identified surface water pollution including sedimentation as well as increased erosion, loss of wetland functionality and decreased downstream water quality as the major potential impacts during the construction and operational phase. Several general and specific mitigation measures were proposed in order to reduce negative impacts and incorporate some potentially positive impacts from the proposed development. Some of the most pertinent recommendations include:

- A riparian channel rehabilitation program must be designed and implemented prior to the start of the construction phase and continue during the operational phase. This must include veld restoration approaches, prevention of and rehabilitation of rill and gully erosion. A 30 m buffer (exclusion) and rehabilitation zone around each riparian habitat must be implemented through fencing of the buffers (thus keeping cattle and goats out) and reseeding programs to establish a functional buffer for the riparian habitat.

- An ecologically-sound stormwater management plan must be implemented at the onset of the construction phase. This must include sustainable and sensitive stormwater design for the new agricultural fields to ensure that A and B section channels are not negatively affected. Stormwater run-off must reach the B section channels in a diffuse manner;
- The above guidelines can be achieved through diffuse release of stromwater flows utilising the natural topography and associated contours, vegetated channels, riparian buffers and veld restoration techniques, gabion baskets etc;

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APPENDIX A – Methodology

Wetland Delineation

The report incorporated a desktop study, as well as field surveys, with site visits conducted during August 2019. Additional data sources that were incorporated into the investigation for further reliability included:

- Google Earth images;
- 1:50 000 cadastral maps;
- ortho-rectified aerial photographs;
- Historic imagery from NGI; and
- 1m contour data.

A pre-survey wetland delineation was performed in order to assist the field survey. Identified wetland areas during the field survey were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). These potential wetland areas were confirmed or dismissed and delineation lines and boundaries were imposed accordingly after the field surveys.

The wetland delineation was based on the legislatively required methodology as described by Department of Water Affairs and Forestry (2005). The DWAF delineation guide uses four field indicators to confirm the presence of wetlands, namely:

- terrain unit indicator (i.e. an area in the landscape where water is likely to collect and a wetland to be present);
- soil form indicator (i.e. the soils of South Africa have been grouped into classes / forms according to characteristic diagnostic soil horizons and soil structure);
- soil wetness indicator (i.e. characteristics such as gleying or mottles resulting from prolonged saturation); and
- vegetation indicator (i.e. presence of plants adapted to or tolerant of saturated soils).

The wetland delineation guide makes use of indirect indicators of prolonged saturation by water, namely wetland plants (hydrophytes) and (hydromorphic) soils. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. Hydrophytes were recorded during the site visit and hydromorphic soils in the top 0.5 m of the profile were identified by taking cored soil samples with a bucket soil auger and Dutch clay auger (photographs of the soils were taken). Each auger point was marked with a handheld Global Positioning System (GPS) device.

Wetland Functionality

The methodology "Wet-EcoServices" (Kotze et al., 2008) was adapted and used to assess the different benefit values of the wetland units. A level two assessment, including a desktop study and a field assessment were performed to determine the wetland functional benefits between the different hydro-geomorphological types within the study area. Other documents and guidelines used are referenced accordingly. During the field survey, all possible wetlands and drainage lines identified from maps and aerial photos were visited on foot. Where feasible, cross sections were taken to determine the state and boundaries of the wetlands. Following the field survey, the data was submitted to a GIS program for compilation of the map sets. Subsequently the field survey and desktop survey data were combined within a project report.

In order to gauge the Present Ecological State of various wetlands within the study area, a Level 2 Wet-Health assessment was applied in order to assign ecological categories to certain wetlands. Wet-Health (Macfarlane et al., 2008) is a tool which guides the rapid assessment of a wetland's environmental condition based on a site visit. This involves scoring a number of attributes connected to the geomorphology, hydrology and vegetation, and devising an overall score which gives a rating of environmental condition.

Wet-Health is useful when making decisions regarding wetland rehabilitation, as it identifies whether the wetland is beyond repair, whether rehabilitation would be beneficial, or whether intervention is unnecessary, as the wetland's functionality is still intact. Through this method, the cause of any wetland degradation is also identified, and this facilitates effective remediation of wetland damage. There is wide scope for the application of Wet-Health as it can also be used in assessing the Present Ecological State of wetlands and thereby assist in determining the Ecological Reserve as laid out under the National Water Act. Wet-Health offers two levels of assessment, one more rapid than the other.

For the assessments, an impact and indicator system was used. The wetland is first categorized into the different hydrogeomorphic (HGM) units and their associated catchments, and these are then assessed individually in terms of their hydrological, geomorphologic and vegetation health by examining the extent, intensity and magnitude of impacts, of activities such as grazing or draining. The extent of the impact is measured by estimating the proportion the wetland that is affected. The intensity of the impact is determined by looking at the amount of alteration that occurs in the wetland due to various activities. The magnitude is then calculated as the combination of the intensity and the extent of the impact and is translated into an impact score. This is rated on a scale of 1 to 10, which can be translated into six health classes (A to F – compatible with the EcoStatus categories used by DWAF, Table 8). Threats to the wetland and its overall vulnerability can also be assessed and expressed as a likely Trajectory of Change.

Determination of Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments, and the work conducted by Kotze et al. (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree et al., 2013). An example of the scoring sheet is attached as Table 9. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 10.

Table 7: Interpretation of scores for determining present ecological status (Kleynhans 1999)

Rating of Present Ecological State (Ecological Category)
CATEGORY A Score: 0-0.9; Unmodified, or approximates natural condition.
CATEGORY B Score: 1-1.9; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats.
CATEGORY D Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean

Table 8: Example of scoring sheet for Ecological Importance and sensitivity

Ecological Importance	**Score (0-4)**	***Confidence (1-5)***	Motivation
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			

Table 9: Category of score for the Ecological Importance and Sensitivity

Rating	Explanation
Very low (0-1)	Rarely sensitive to changes in water quality/hydrological regime.
Low (1-2)	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate (2-3)	Some elements sensitive to changes in water quality/hydrological regime.
High (3-3.5)	Many elements sensitive to changes in water quality/ hydrological regime.
Very high (+3.5)	Very many elements sensitive to changes in water quality/ hydrological regime.

Riparian Assessment

The Present Ecological State of the riparian zone was assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) Level 3 approach (Kleynhans et al., 2007). Riparian vegetation areas were divided into two sub-zones which included marginal and non-marginal zones. Recognition of the different zones are important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area (Kleynhans et al., 2007). This was done (in part) before going into the field, using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. According to Kleynhans et al. (2007), the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond.

Impacts on riparian vegetation at the site are then described and rated. Kleynhans et al. (2007) further states that it is important to distinguish between a visible / known impact (such as flow manipulation) and the response of riparian vegetation to other impacts such as erosion and sedimentation, alien invasive species and pollution. If there is no response to riparian vegetation, the impact is noted but not rated since it has no visible / known effect. These impacts are then rated as per a scale from 0 (No Impact) to 5 (Critical Impact). Once the riparian zone and sub- zones have been delineated, the reference and present states have been described and quantified (basal cover is used) and species description for the study area has been compiled, the VEGRAI metrics were rated and qualified. The riparian ecological integrity was assessed using the spreadsheet tool that is composed of a series of metrics and metric groups, each of which was rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian area:

- Removal of the riparian vegetation;

- Invasion by alien invasive species;
- Flow modification; and
- Impacts on water quality.

Results from the lower and upper zones of the riparian vegetation were then combined and weighted with a value that reflects the perceived importance of that criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. The score is then placed into one of six classes (Table 11).

Table 10: Allocation protocol for the determination of the Present Ecological State (or Ecological Category) for riparian habitat following the VEGRAI application (Kleynhans et al., 2007)

Score (% of Total)	Category	Description
90 - 100	A	Unmodified, natural.
80 - 89	B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
60-79	C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.
40-59	D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
20-39	E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
0 - 19	F	Critically modified. Modifications have reached a critical level and there has been 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.