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FRESHWATER RESOURCE ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED HAGA HAGA WIND ENERGY FACILITY, EASTERN CAPE PROVINCE

Prepared for

CES – Environmental and Social Advisory services

November 2017
(Updated August 2020)

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Report Reference: SAS 216158
Date: November 2017
Updated: August 2020

EXECUTIVE SUMMARY

The Haga Haga Wind Energy Facility (WEF) entails the construction of wind turbines and associated hardstands linked via underground cabling to an onsite substation. New internal road crossings over watercourses are proposed as well as the upgrading of existing roads where necessary. A large drainage network of perennial and non-perrenial watercourses, considered to be in a moderately modified state, were identified within the development site.

No turbines or hardstands are located in watercourses. Only the proposed watercourse road crossings (new and existing) and cable crossings were determined to pose a direct negative impact to the watercourses, which resulted in a 'Medium' risk significance. Should the upgrading of the roads, construction of new road crossings and installation of underground cables be undertaken in the dry season when no surface flow is present in the watercourses and the recommended mitigation measures as presented in this report be adhered to, the risk significance for the construction and operation for these components can be reduced to a 'Low' risk significance. The proposed substation, laydown area and Battery

Based on the findings of the assessment, no fatal flaws in terms of freshwater ecological aspects were identified. With the adherence to cogent, well-conceived and ecologically sensitive construction plans and the implementation of the mitigation measures provided in this report and providing that general good construction practice is adhered to, from a freshwater conservation perspective the proposed WEF development is considered acceptable.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the environmental assessment and authorisation process for the proposed Haga Haga Wind Energy Facility (WEF) located near the small village of Haga Haga in the Eastern Cape, which will be known as the Haga Haga Wind Farm (RF) (Pty) Ltd, hereafter referred to as the "Area of Interest" (AOI). The proposed development would entail the following activities:

- 36 Wind turbines (with associated hardstand);
- Overhead grid connection (not assessed as part of this report);
- Underground cables (mostly routed along existing roads);
- Upgrading of existing roads (to approximately 8 m) and construction of limited number of new roads; and
- Construction of a substation, WEF offices, contractor laydown area, storage area and a Battery Energy Storage System (BESS)[1].

The majority of the AOI falls within the Mzimvubu to Kieskamma Water Management Area (WMA) and the Amatola subWMA, with the northern most area of the AOI falling within the Kei subWMA;

- The AOI falls within the Eastern Coastal Belt aquatic ecoregion;
- The AOI falls within quaternary catchments R30A and S70F;
- The mean Ecological Importance of the sub-quaternary reaches is considered to be high.
- The subWMAs is not considered important in terms of fish conservation;
- The Quko River traverses the central portion of the AOI, while the headwaters of the Mtendwe, Haga-Haga and Nyarha Rivers are located within the southern portion of the AOI. These rivers are considered to be in an unmodified, natural or largely natural state with few modifications (RIVCON AB) and intact ecologically.

[1] The proposed Battery Energy Storage System (BESS) will be included in the remainder footprint of the storage area

The following table summarises the findings from the relevant databases:

FEPACODE	➢ The AOI is located within a subWMA not considered important in terms of fish conservation FEPACODE = 0
NFEPA Wetlands	➢ According to the NFEPA database, various wetland features are associated with the AOI, however all are considered artificial, except for one feature in the north western portion considered to be natural. All of the wetlands features are considered to be in a heavily to critically modified ecological condition. [Artificial wetlands: WETCON Z3 (Less than 25% natural vegetation cover), Natural wetland: WETCON Z2 (Majority of the wetland unit is classified as "artificial)]
WET Veg	➢ The southern and eastern portions of the AOI are located within the Albany Thicket Valley (CR) wetland vegetation type, while the remaining portion is located within the Sub-Escarpment Savanna (EN) wetland vegetation type according to the NFEPA database.
Critical Biodiversity Area	➢ The northern most portion of the AOI, coinciding with the Kei River Catchment is considered to be an Aquatic CBA 1, as this subcatchment is considered an irreplaceable river sub-catchment for Ecoregion level 2 representation, endemic fish, terrestrial priorities and estuaries. Free flowing/ fish migratory systems have also been identified within this area. ➢ The majority of the AOI is located within an area considered to be an Estuary CBA 2, and is considered to be an important hydrological primary catchment. These are hydrological primary catchments for CBA level 2 (E2) estuaries. The total transformation of the catchment should be limited to less than 15% and mean annual runoff reduction to 25%.
NFEPA Rivers	➢ The Quko River traverses the central portion of the AOI, while the headwaters of the Mtendwe, Haga-Haga and Nyarha Rivers are located within the southern portion of the AOI. All of these rivers are considered to be in an unmodified, natural or largely natural with few modifications (RIVCON AB) ecological condition.

During the course of the assessment, it was determined that two main hydrogeomorphic (HGM) units occur within the areas being traversed by the proposed WEF infrastructure, namely perennial rivers with an associated riparian zone (the Quko River and associated tributaries), and non-perrenial watercourses (including headwaters) of the Quko, Haga-Haga, Mtendwe and Nyarha river systems, with their associated riparian vegetation.

The Quko River has been impacted upon to some degree, mainly by the surrounding agricultural activities and by the construction of roads and bridges over this river. This has resulted in localised vegetation removal within the non-marginal riparian zone. The non-perrenial watercourses/headwaters of the Quko, Haga-Haga, Mtendwe and Nyarha river systems have mainly been impacted by the construction of artificial farm dams. These features have also experienced some sedimentation due to the inflow of sediment from upgradient sources and the trampling of livestock within these smaller freshwater features, as well as the invasion of alien species within the marginal and non-marginal riparian zones.

Following the assessment of the ecological status of the watercourses, the DWS risk assessment was applied to ascertain the significance of perceived impacts arising from the construction and operation of the proposed WEF infrastructure components on the watercourses. The results of the risk assessment are summarised in the table below:

Table A: A summary of the risk assessment relating to the construction and operation of the proposed WEF infrastructure development within the assessed watercourses.

Phases	Activity		Aspect	Impact	Risk Rating	*Borderline LOW MODERATE Rating Classes
CONSTRUCTION PHASE	Site clearing prior to commencement of construction activities.		Removal of vegetation and associated disturbances to soils.	*Exposure of soils, leading to increased runoff and erosion, and thus increased sedimentation of the watercourses; *Increased sedimentation of watercourses, leading to smothering of biota and potentially altering surface water quality; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	M	L (-1)
	Groundbreaking and excavation activities	Excavation of pits for the foundations of the turbine towers within close proximity to watercourses	Removal of topsoil and creation of soil stockpiles	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered freshwater habitat; and *Altered runoff patterns, leading to increased erosion and sedimentation of the freshwater habitat.	L	NA
		Excavation of trenches for the underground cabling through watercourses			M	L (-14)
	Construction of hardstands associated with Turbines 3, 30 and 31 and the proposed substation, laydown area and BESS area within the 32 m ZoR of the watercourses		Over compaction of surrounding soils during the construction activities and levelling of the surface within close proximity to the watercourses; and Potential of edge effects to impact on the watercourses	*Degradation of the surrounding natural buffer to the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Potential of concentrated flows to enter the watercourses from the construction footprint area.	L	NA
	Upgrading of existing internal gravel roads and construction of four new watercourse crossings		Indiscriminate movement of construction vehicles within the freshwater features	*Altering the beds and banks of the watercourses; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	M	L (-8)
			Over compaction of surrounding soils during the upgrading/construction activities and levelling of the road surface within watercourses		M	L (-14)
			Stockpiling of gravel within delineated freshwater features		M	L (-7)
	Infrastructure transportation and storage		Potential for in discriminant movement of vehicles through the watercourses	*Altering the beds and banks of the watercourses; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and	M	L (-16)
			Potential stockpiling of turbine infrastructure within watercourses		L	NA

Phases	Activity	Aspect	Impact	Risk Rating	*Borderline LOW MODERATE Rating Classes
		Potential poor placement of construction site within watercourses	*Impacts on hydrological function and sediment balance.	L	NA
	Potential indiscriminate waste disposal	Disposal of construction-related wastes (such as rubble, hazardous chemicals and litter)	Altered flow regime as a result of solid wastes within the freshwater resource Altered water quality due to chemical waste disposal	M	L (-7)
	Potential spillage from construction vehicles	Spills / chemical leaks from construction vehicles	Possible contamination of freshwater soils and surface water, leading to reduced ability to support biodiversity	M	L (-7)
OPERATIONAL PHASE	Maintenance activities	Vegetation maintenance within the watercourses	*Altering the beds and banks of the watercourses; *Disturbance of soils and on-going erosion as part of maintenance activities; and *Impeding the flow of water.	L	NA
		Maintenance of roads crossing the watercourses			
	Loss of surrounding ecosystem services	In discriminant driving of maintenance vehicles within the watercourses			

*Subject to only undertaking the watercourse road construction activities during the dry period and the strict implementation of the provided mitigation measures as per Section 7.

The overall construction activities related to the proposed WEF infrastructure components are deemed to pose a 'Low' risk significance to the watercourses, with the implementation of the recommended mitigation measures. It was determined that the excavation of the trenches for the underground cabling and new road crossings through watercourses would pose a 'Medium' risk significance to the watercourses. Taking the effects of the surrounding agricultural practices and the presence of alien invasive species into account, with the proviso of implementing the set-out mitigation measures, with specific mention of preventing the sedimentation and erosion of the watercourses and limiting the diversion of flow (specifically within the Quko River), this impact rating can be reduced to be of 'Low' risk significance. The proposed substation, laydown area and BESS area is also located within the 32m Zone of Regulation; should the proposed construction areas be suitably rehabilitated (i.e. ripped and revegetated with suitable indigenous vegetation) and the stormwater runoff from the area be suitably managed, the construction and operation thereof was determined to be of 'Low' risk significance.

Upgrading of the existing roads could also be considered to pose a 'Medium' risk to the watercourses it is crossing. However, this risk rating can be justified to be reduced to 'Low' significance, since these roads are existing roads which have historically impacted on these watercourses, from which it is expected that these features have already hydrologically adjusted the initial impact thereof.

It is the opinion of the freshwater ecologist that the proposed WEF development will have an overall 'low' impact on the freshwater habitat and ecology, ecological and socio-cultural service provision and on hydrological function and sediment balance during the construction and operational phases, provided that well-conceived, implemented and managed impact minimisation takes place. It is also recommended that an alien vegetation control plan be implemented specifically within the footprint area of the proposed project.

Provided appropriate impact mitigation measures are taken, it is the opinion of the ecologist that the system is unlikely to be altered significantly by the proposed WEF development. This development benefits from an already existing road network (under which the majority of the cable network would be located) and historical localised impact of the local watercourses. Furthermore, the freshwater systems in this region are highly connected and have numerous tributaries, suggesting that a small impact to a small portion of these watercourses within the zone of influence of the development, is unlikely to have significant impacts to the greater drainage network of the region.

DOCUMENT GUIDE

The table below provides the specialist report requirements for the assessment and reporting of impacts on aquatic biodiversity in terms of Government Notice 320 as promulgated in Government Gazette 43110 of 20 March 2020 in line with the Department of Environmental Affairs screening tool requirements, as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998).

No.	Requirements	
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Cover Page and Annexure F.
2.2	Description of the preferred development site, including the following aspects-	
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns	Section 3: Table 1
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified	Section 3: Table 1
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status	Section 3: Table 1
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater)	Section 3: Table 1
2.3	Identify any alternative development footprints within the preferred development site which would be of a "low" sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification	None. Areas of high aquatic sensitivity is located in the AOI.
2.4	Assessment of impacts – a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 6
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Yes, with implementation of the proposed mitigation measures
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.) and d. Assessment of the risks associated with water use/s and related activities.	Section 4: Table 3 and 4
2.4.4	How will the development impact on the functionality of the aquatic feature including:	Section 4: Table 3 and 4

	a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system); b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over abstraction or instream or off-stream impoundment of a wetland or river); c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchanneled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and f. Loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc).	
2.4.5	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 4: Table 3 and 4
2.4.6	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 4: Table 3 and 4
2.4.7	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: size of the estuary; availability of sediment; wave action in the mouth; protection of the mouth; beach slope; volume of mean annual runoff; and extent of saline intrusion (especially relevant to permanently open systems).	NA
3.	The report must contain as a minimum the following information:	
3.1	Contact detail of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae.	Annexure F
3.2	A signed statement of independence by the specialist.	Annexure F
3.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment.	Section 2.3
3.4	The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant.	Section 1.1
3.5	A description of the assumptions made, any uncertainties or gaps in knowledge or data.	Section 1.3
3.6	The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant.	Section 5
3.7	Additional environmental impacts expected from the proposed development.	Section 6
3.8	Any direct, indirect and cumulative impacts of the proposed development on site.	Section 6
3.9	The degree to which impacts, and risks can be mitigated.	Section 6
3.10	The degree to which impacts, and risks can be reversed.	Section 6
3.11	The degree to which the impacts and risks can cause loss of irreplaceable resources.	Section 6
3.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 5
3.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 6
3.14	A motivation must be provided if there were development footprints identified as per paragraph 2.3 for reporting in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) that were identified as having a “low” aquatic biodiversity and sensitivity and that were not considered appropriate.	Section 5
3.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 7
3.16	Any conditions to which this statement is subjected.	Section 5

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Base flow:	Long-term flow in a river that continues after storm flow has passed.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Ephemeral stream:	Ephemeral systems flow for less time than they are dry. Flow or flood for short periods of most years in a five-year period, in response to unpredictable high rainfall events. Support a series of pools in parts of the channel.
Episodic stream:	Highly flashy systems that flow or flood only in response to extreme rainfall events, usually high in their catchments. May not flow in a five-year period, or may flow only once in several years**.**
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Perennial:	Flows all year round.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake 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; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
AOI	Area of Interest
BAR	Basic Assessment Report
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
m	Meter
MAP	Mean Annual Precipitation
MC	Management Classes
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NPW	Non-perrenial watercourse
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
NWCS	National Wetland Classification System
PES	Present Ecological State
REC	Recommended Ecological Category
RHP	River Health Program
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WEF	Wind Energy Facility
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WRC	Water Research Commission
WTG	Wind Turbine Generator
WULA	Water Use License Application

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation and Water Use Licence Application processes for the proposed Haga Haga Wind Energy Facility (WEF) located near the small village of Haga Haga in the Eastern Cape, which will be known as the Haga Haga Wind Farm (RF) (Pty) Ltd, hereafter referred to as the "Area of Interest" (AOI) (Figures 1 and 2).

In order to identify all possible watercourses that may potentially be impacted by the proposed WEF development, a 500 m "zone of investigation" around the AOI, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act (Act No. 36 of 1998), was used as a guide in which to assess possible sensitivities of the receiving environment. This area – i.e. the 500m zone of investigation around the AOI - will henceforth be referred to as the "investigation area".

The proposed development would entail the following activities:

- 36 Wind turbines (with associated turbine base and crane pad);
- Overhead grid connection (not assessed as part of this report);
- Underground cables (mostly routed along existing roads);
- Upgrading of existing roads (to approximately 8 m) and construction of limited number of new roads); and
- Construction of a substation, WEF offices, contractor laydown area, storage area and a Battery Energy Storage System (BESS)[2].

The purpose of this report is to define the ecology of the AOI in terms of watercourse characteristics, including mapping of the watercourses, discuss key ecological drivers and to define the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), as well as the socio-cultural and ecological service provision of the watercourses utilising current industry "best practice" assessment methods, in order to ascertain what, if any, impact the proposed development poses to the watercourses associated with the study and investigation area. Additionally, this report aims to define the Recommended Ecological Category (REC) for the watercourses. It is a further objective of this study to provide detailed information pertaining to the watercourses to allow for informed decision-making by all stakeholders, including the relevant competent authorities.

The Department of Water and Sanitation (DWS) Risk Assessment Matrix as promulgated in Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) was applied to determine the significance of the impacts associated with the proposed WEF construction and operation, and mitigatory measures were identified which aim to minimise the potential impacts.

This report, after consideration and a description of the ecological integrity of the AOI, must guide the proponent, Environmental Assessment Practitioner (EAP) and authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed WEF development activities in relation to the watercourses. The report also presents management and mitigation measures which should be implemented to appropriately mitigate the impacts on the receiving watercourses in order to achieve the goals of water resource conservation and sustainable development.

[2] The proposed Battery Energy Storage System (BESS) will be included in the remainder footprint of the storage area.

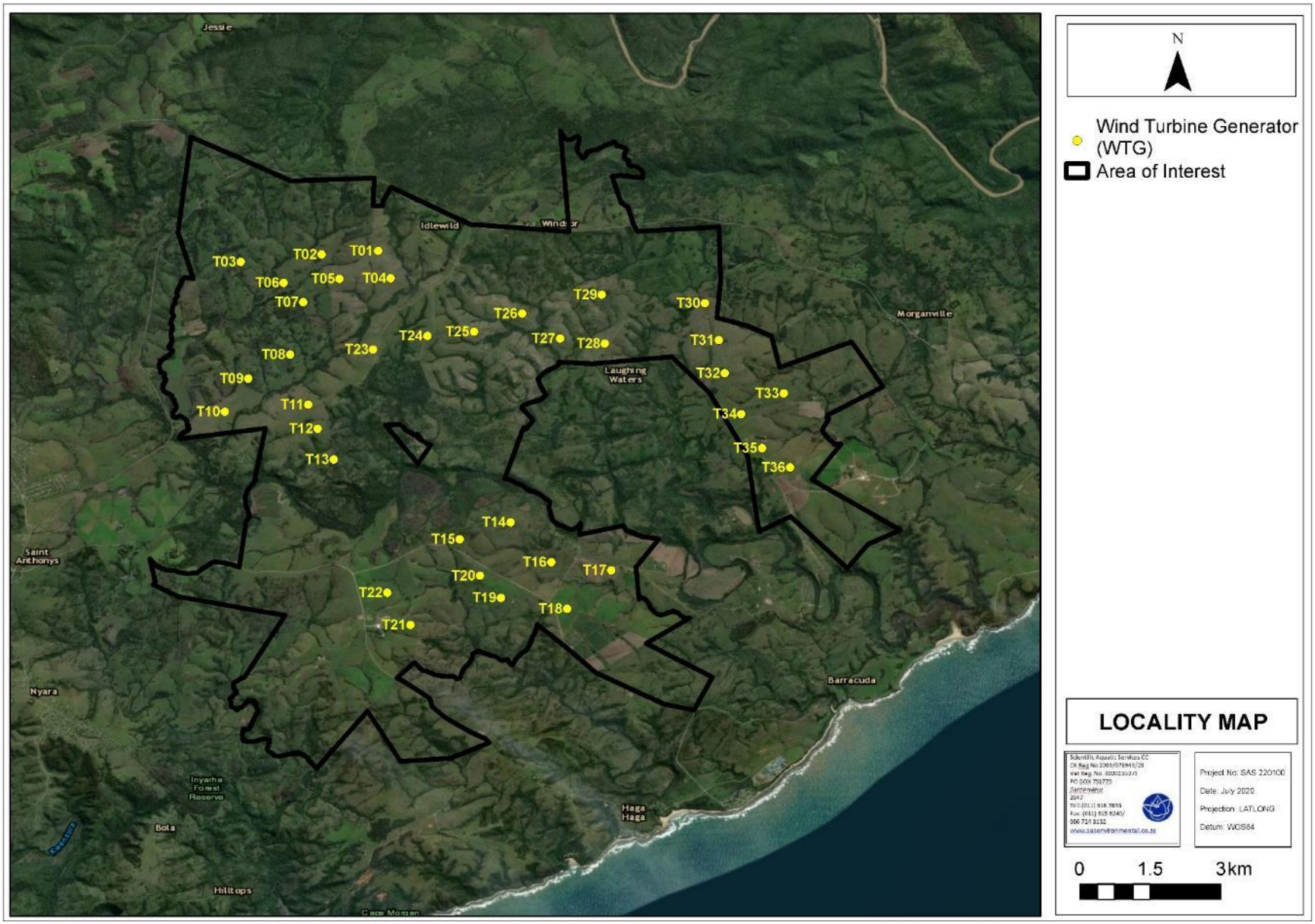

Figure 1: Digital satellite image depicting the AOI and the locality of the Wind Turbine Generators (WTG) in relation to surrounding areas.

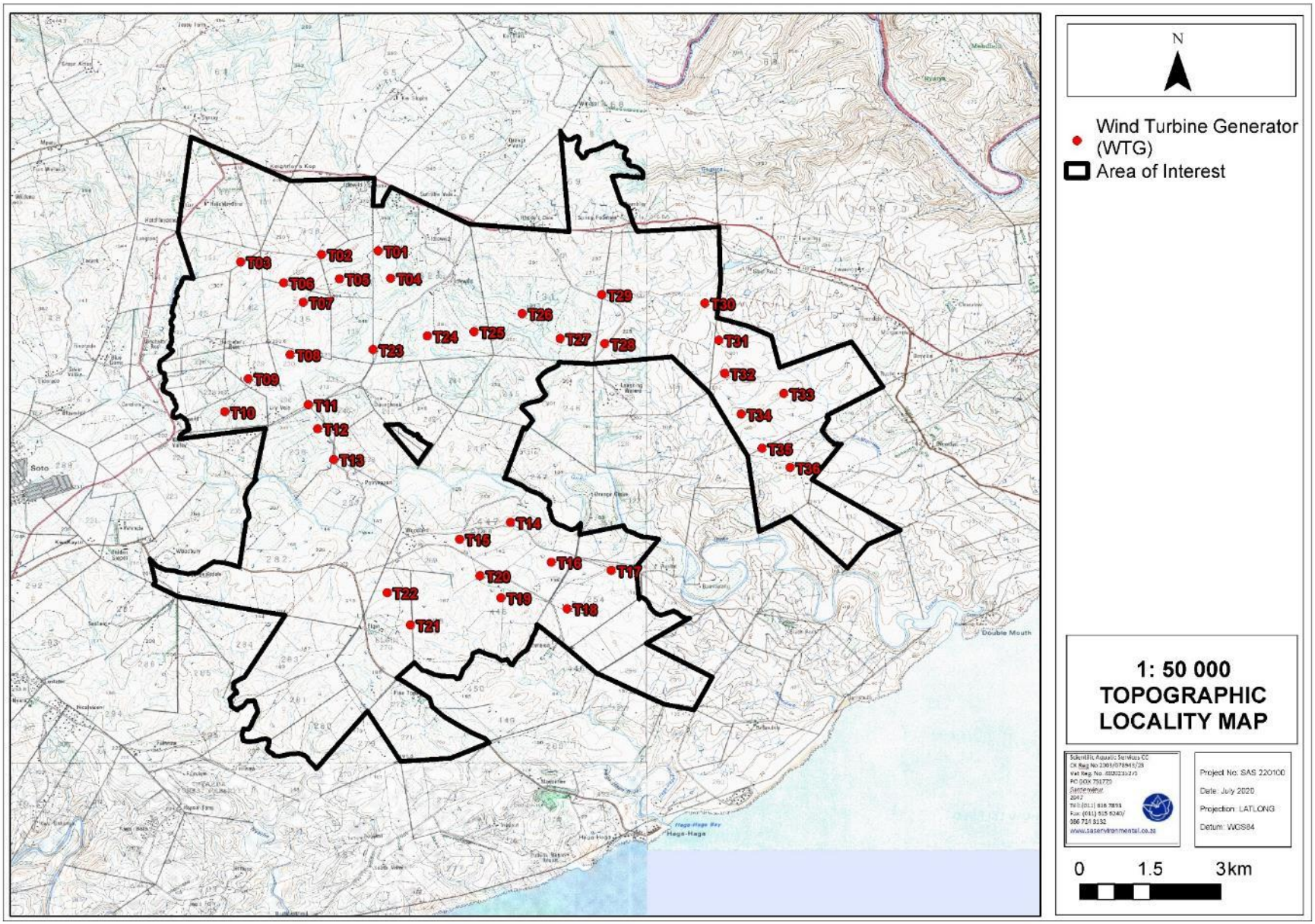

Figure 2: Location of the AOI depicted on a 1:50 000 topographical map in relation to surrounding areas.

1.1 Project Scope

Specific outcomes in terms of this report are outlined below:

- Assess the watercourses associated with the WEF using the following methods:
  - Points of interest were selected by analysing digital satellite imagery to identify potential watercourses. These points of interest were then verified during the field assessment and where necessary, delineations undertaken on a desktop basis were refined;
  - Delineation of all watercourses located in the AOI according to "Department of Water Affairs and Forestry (DWAF)[3] (2008): A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones";
  - The classification of the watercourses according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis et al., 2013);
  - The EIS of the watercourses according to the method described by Rountree and Kotze (2013);
  - The services provided by the watercourses associated with the AOI were assessed according to the method of Kotze et al. (2009);
  - The Present Ecological State (PES) of the watercourses was assessed according to the resource directed measures guideline as advocated by Macfarlane *et al*., (2008) and DWA (2007) respectively;
  - The general habitat integrity of the site was assessed based on the application of the Index of Habitat Integrity (IHI) based on the protocol of Kleynhans *et al.* (2008);
  - The Riparian Vegetation Response Assessment Index (VEGRAI) was used as a qualitative assessment to assess the integrity of the riparian vegetation of the aquatic resources present and its response to current impacts in the area;
  - Watercourses were mapped according to the ecological sensitivity of each watercourse hydrogeomorphic (HGM) unit in relation to the AOI. In addition to the watercourse boundaries, buffers were generated and the applicable zones of regulation applied;
  - The PES, EIS, and ecoservices of the watercourses were highlighted, and expected impacts on the systems were assessed according to the risk assessment methodology; and
  - A REC for the watercourses were recommended based on the findings of the EIS assessment.
- The DWS Risk Assessment Matrix was applied to identify potential impacts that may affect the watercourses as a result of the proposed WEF development, and to aim to quantify the significance thereof; and
- Develop recommendations on management and mitigation measures (including opportunities and constraints) with regards to the development and operation of the proposed WEF development in order to improve, manage and mitigate impacts on the freshwater ecology of the area. This was presented in line with the impact mitigation hierarchy as advocated by the Department of Mineral Resources (DMR), the Department of Environmental Affairs (DEA) and the Department of Water and Sanitation (DWS).

[3] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The freshwater assessment was confined to the AOI as per Figure 1 and 2, and does not include the neighbouring and adjacent areas. The surrounding areas were, however, considered as part of the desktop study;
- With ecology being dynamic and complex and due to the extent of the proposed WEF development, some aspects of the ecology of these systems (some of which may be important) may have been overlooked. The assessment as presented in this report are based on site visits undertaken in January and July 2017, during a period in which very little rainfall had occurred in the region. The data gathered in these two periods is considered sufficient to ensure an appropriate level of confidence in the assessment and appropriate for the decision-making process;
- The identification of the outer boundary of the temporary zone of some freshwater features proved difficult in some areas as a result of trampling and grazing of livestock within the freshwater systems. The on-site delineation was therefore supplemented with the use of digital satellite imagery in order to assist in the delineation of disturbed freshwater features. The delineation as presented in this report is regarded as a best estimate of the freshwater feature boundaries based on the site conditions present at the time of assessment;
- The supplementation of the onsite delineations with desktop delineations was conducted with the use of the available satellite imagery available at the time of the field assessment. Thus, the possibility of some discrepancies in the delineations might exist, which will differ when it is overlaid on the latest available satellite imagery and must therefore be interpreted with caution;
- Due to the landscape in some areas being rugged, remote and inaccessible, some freshwater features could not be accessed at the proposed localities of the wind turbines or crossing points of the linear infrastructures. Therefore, verification points for some freshwater features were located at points as close to the freshwater feature to be verified as possible and where necessary the conditions at the exact point required were inferred or extrapolated. The observations made are deemed sufficient to ensure that informed decision making can be undertaken;
- Freshwater features and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative and obligate wetland species. Within this transition zone some variation of opinion on the freshwater feature boundary may occur, however, if the DWA 2005 method is followed, all assessors should get largely similar results;
- The delineations as presented in this report is regarded as a best estimate of the boundaries of the freshwater features based on the site conditions present at the time of assessment. Limitations in the accuracy of the delineation due to low water levels within the certain systems, existing development and anthropogenic disturbances are deemed possible;
- The delineations presented in this report do not consider floodlines which may define the extent of the watercourse under certain circumstances. Should the floodlines be greater than the extent of the wetland or riparian zone, the 1:100 year floodline must be used as the extent of the watercourse for planning and authorisation purposes; and
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater features will need to be surveyed and pegged according to surveying principles.

Notwithstanding the limitations listed above, the level of detail undertaken in the study is considered sufficient to ensure that the results of this assessment accurately define the EIS, PES and characterisation of the drivers and receptors applicable to the freshwater features within the AOI and to

provide the relevant planners and decision makers with sufficient information to formulate an opinion on the viability of the proposed WEF development from an ecological conservation viewpoint.

1.3 Legislative Requirements

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in **Appendix B**:

- Constitution of the Republic of South Africa, 1996;
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);
- The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA); and
- The National Environmental Management: Biodiversity Act, 2014 (Alien and Invasive Species Regulations, 2014).

2 ASSESSMENT APPROACH

2.1 Watercourse Field Verification

For the purposes of this investigation, the definitions of a watercourse, riparian and wetland habitat were taken as per that in the National Water Act, 1998 (Act No. 36 of 1998). The definitions are as follows:

A **watercourse** means:
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare a watercourse.
*and a reference to a watercourse includes where relevant, its bed and banks.

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

Wetland habitat is “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.”

Where limitations to on-site delineations were experienced due to access constraints, use was made of historical and current digital satellite imagery, topographic maps and available provincial and national databases to aid in the delineation of the watercourses, following the field assessment. The following were taken into consideration when utilising the above desktop methods:

- Linear features: since water flows/moves through the landscape, watercourses often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;

- Vegetation associated with watercourses: a distinct increase in density as well as shrub size near flow paths;
- Hue: with water flow paths often showing as white/grey or black and outcrops or bare soils displaying varying chroma created by varying vegetation cover, geology and soil conditions. Changes in the hue of vegetation, with watercourse vegetation often indicated on black and white images as areas of darker hue (dark grey and black). In colour imagery, these areas mostly show up as darker green and olive colours or brighter green colours in relation to adjacent areas, where there is less soil moisture or surface water present; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

A site visit was undertaken in January and July 2017 in order to assess as many of the points of interest as possible. The presence of any freshwater feature characteristics as defined by the DWAF (2008) was noted at each of these points to determine if features can be considered to contain areas displaying watercourse characteristics. Factors influencing the habitat integrity of each feature group identified during the field survey were noted, and the functioning and the environmental and socio-cultural services provided by the various features were determined.

In addition to the delineation of the watercourses, a detailed assessment of the systems was undertaken in order to define the important aspects of the freshwater feature ecology. A detailed explanation of the method of assessment is provided in **Appendix C** of this report.

2.2 Sensitivity Mapping

All the watercourse associated with the proposed infrastructure components of the WEF were considered and ecologically sensitive areas were delineated with the use of a Global Positioning System (GPS) as well as digital satellite imagery. A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map provided in Section 4.4 of this report must guide the final layout of the proposed WEF infrastructure components.

2.3 Risk Assessment and Recommendations

Following the completion of the assessment, the DWS risk assessment matrix was conducted (please refer to **Appendix C** for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed WEF infrastructure development. These recommendations also include general management measures, which apply to the proposed WEF infrastructure development as a whole. Mitigation measures have been developed to address issues in all phases throughout the life of the operation including planning, construction and operation through to after care and maintenance. The detailed site-specific mitigation measures are outlined in Section 5 of this report, whilst the general management measures which are considered best practice mitigation applicable to this project, are outlined in **Appendix E**.

3 RESULTS OF THE DESKTOP ANALYSIS

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard” report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible in order to allow for integration of results by the reader to take place. Where required, further discussion and interpretation are provided.

It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics associated with the proposed WEF development at the scale required to inform the environmental authorisation and/or water use authorisation processes. Given these limitations, this information is considered useful as background information to the study, is important in legislative contextualisation of the risks and impacts, and was thus used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance during the field survey. It must however be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision making process.

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Table 1: Desktop data relating to the characteristics of the watercourses associated with the AOI

Aquatic ecoregion and sub-regions in which the AOI is located		
Ecoregion	Eastern Coastal Belt	
Catchment	Keiskamma (majority), and Kei (northern most area)	
Quaternary Catchment	R30A (Keiskamma), and S70F (Kei) (Figure 3)	
WMA	Mzimvubu to Kieskamma	
subWMA	Amatola (majority) and Kei (northern most area) (Figure 4)	
Dominant characteristics of the Eastern Coastal Belt Ecoregion Level 2 (31.01 and 31.02) (Kleynhans *et al.*, 2007)		
Level 2 Ecoregion	31.01	31.02
Dominant primary terrain morphology	Closed Hills, Mountains; moderate and high relief. Low Mountains	Closed Hills, Mountains; moderate and high relief. Highly Dissected Hills
Dominant primary vegetation types	Coastal Grassland, Coastal Bushveld/Grassland, Afromontane forest, Coastal Forest, Dune Thicket, Eastern Thorn Bushveld, Moist Upland Grassland	Coastal Bushveld/Grassland, Valley Thicket, Afromontane forest, Coastal Forest, Coastal Grassland, Dune Thicket
Altitude (m a.m.s.l)	0-700	0-700
MAP (mm)	500 - 1000	400 - 1000
Coefficient of Variation (% of MAP)	<20 to 35	<20 to 30
Rainfall concentration index	15 - 45	<15 - 45
Rainfall seasonality (dominant)	Early Summer, Mid-Summer	Early Summer
Mean annual temp. (°C)	16-20	18-20
Winter temperature (July)	6 – 22 °C	8 – 22 °C
Summer temperature (Feb)	14 – 26 °C	16 – 26 °C
Median annual simulated runoff (mm)	20 to > 250	20 to > 250

Detail of the AOI in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The AOI is located within a subWMA not considered important in terms of fish conservation FEPACODE = 0
NFEPA Wetlands (Figure 5)	According to the NFEPA database, various wetland features are associated with the AOI, however all are considered artificial, except for one feature in the northwestern portion considered to be natural. All of the wetlands features are considered to be in a heavily to critically modified ecological condition. [Artificial wetlands: WETCON Z3 (Less than 25% natural vegetation cover), Natural wetland: WETCON Z2 (Majority of the wetland unit is classified as "artificial)]
Wetland Vegetation Type (Figure 6)	The southern and eastern portions of the AOI are located within the Albany Thicket Valley (CR) wetland vegetation type, while the remaining portion is located within the Sub-Escarpment Savanna (EN) wetland vegetation type according to the NFEPA database.
NFEPA Rivers (Figure 7)	The Quko River traverses the central portion of the AOI, while the headwaters of the Mtendwe, Haga-Haga and Nyarha Rivers are located within the southern portion of the AOI. All of these Rivers are considered to be in an unmodified, natural or largely natural with few modifications (RIVCON AB) ecological condition.
Detail of the AOI in terms of the Eastern Cape Biodiversity Conservation Plan (ECBCP, 2007) (Figure 8)	
Critical Biodiversity Area (CBA) 1 (Figure 8)	The northern most portion, coinciding with the Kei River Catchment is considered to be an Aquatic CBA 1, as this subcatchment is considered an irreplaceable river sub-catchment for Ecoregion level 2 representation, endemic fish, terrestrial priorities and estuaries. Free flowing/ fish migratory systems have also been identified within this area.
CBA 2 (Figure 8)	The majority of the AOI is located within an area considered to be an Estuary CBA 2, and is considered to be an important hydrological primary catchment. These are hydrological primary catchments for CBA level 2 (E2) estuaries. The total transformation of the catchment should be limited to less than 15% and mean annual runoff reduction to 25%.
Detail of the AOI in terms of the Municipal Biodiversity Summary Project (MBSP, 2009)	
The AOI is located within the Great Kei Local Municipality. The dataset for this municipality coincide with the NFEPA wetlands (2011) database.	

Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)				
Sub-quaternary reach	R30A - 07744 (Quko River)	R30A – 07836 (Unnamed)	R30A – 07837 (Haga-Haga River)	R30A – 07861 (Mtendwe River)
Assessed by expert?	Yes	Yes	Yes	Yes
PES Category Median	B	B	A	A
Mean Ecological Importance (EI) Class	High	High	Moderate	High
Mean Ecological Sensitivity (ES) Class	High	High	High	High
Stream Order	1.0	1.0	4.0	3.0
Default Ecological Class (based on median PES and highest EI or ES mean)	B (High)	B (High)	B (High)	B (High)

Detail of the AOI in terms of the National Biodiveristy Assessment (NBA, 2018) (Figure 9)
Numerous artificial impoundments are located in the AOI. Several other watercourses are also identified by the NBA within the AOI, which includes: • A channelled valley bottom wetland (affected by an artificial feature) located in the eastern portion of the AOI is considered to be moderately modified (class C) and critically endangered; • A channelled valley bottom wetland located on the north eastern boundary of the AOI, is considered to be natural or good (Class AB) and critically endangered; • Two seep wetlands located in the eastern portion of the AOI, is considered to be natural or good (Class AB) and critically endangered; • The Quko and Nyarha Rivers is considered to be largely natural (Class B) and least threatened; and • Mtendwe River is considered to be Natural or good (Class A) and least threatened.
National Web Based Environmental Screening Tool (2020): Aquatic Biodiversity sensitivity
Based on the Aquatic Biodiversity Sensitivity of the AOI as per the National Web Based Environmental Screening Tool (2020), the Quoko, Nyarha and Mtendwe Rivers are considered of very high aquatic biodiversity sensitivity.

WMA = Water Management Area; m.a.m.s.l = Metres above mean sea level; MAP = Mean Annual Precipitation; PES = Present Ecological State; EI = Ecological Importance; ES = Ecological Sensitivity; NFEPA = National Freshwater Ecosystem Priority Area; CBA = Critical Biodiversity Area; CR = Critically Endangered; EN = Endangered; WETCON = Wetland Condition; RIVCON = River Condition

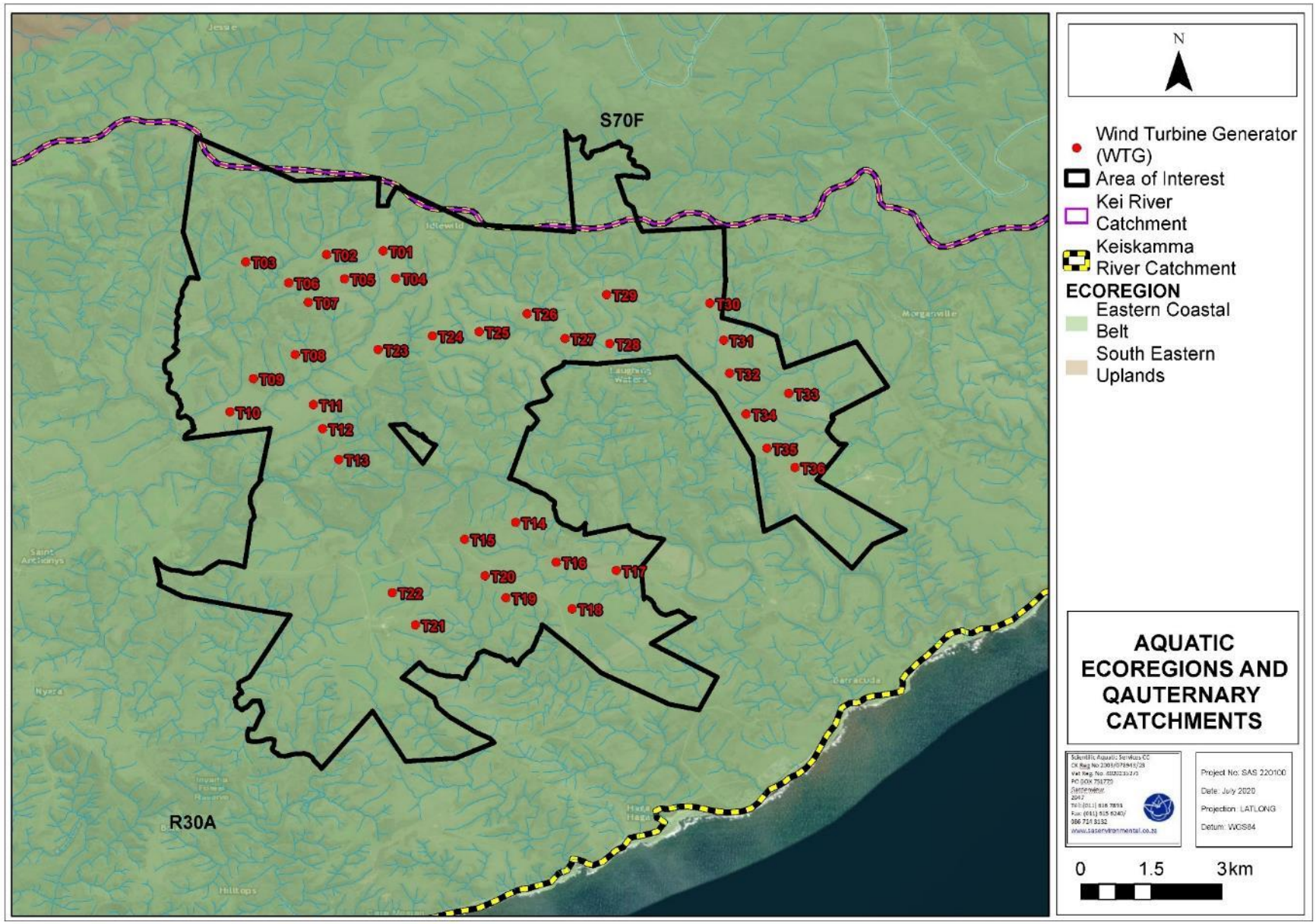


Figure 3: Aquatic Ecoregion and quaternary catchments associated with the AOI.

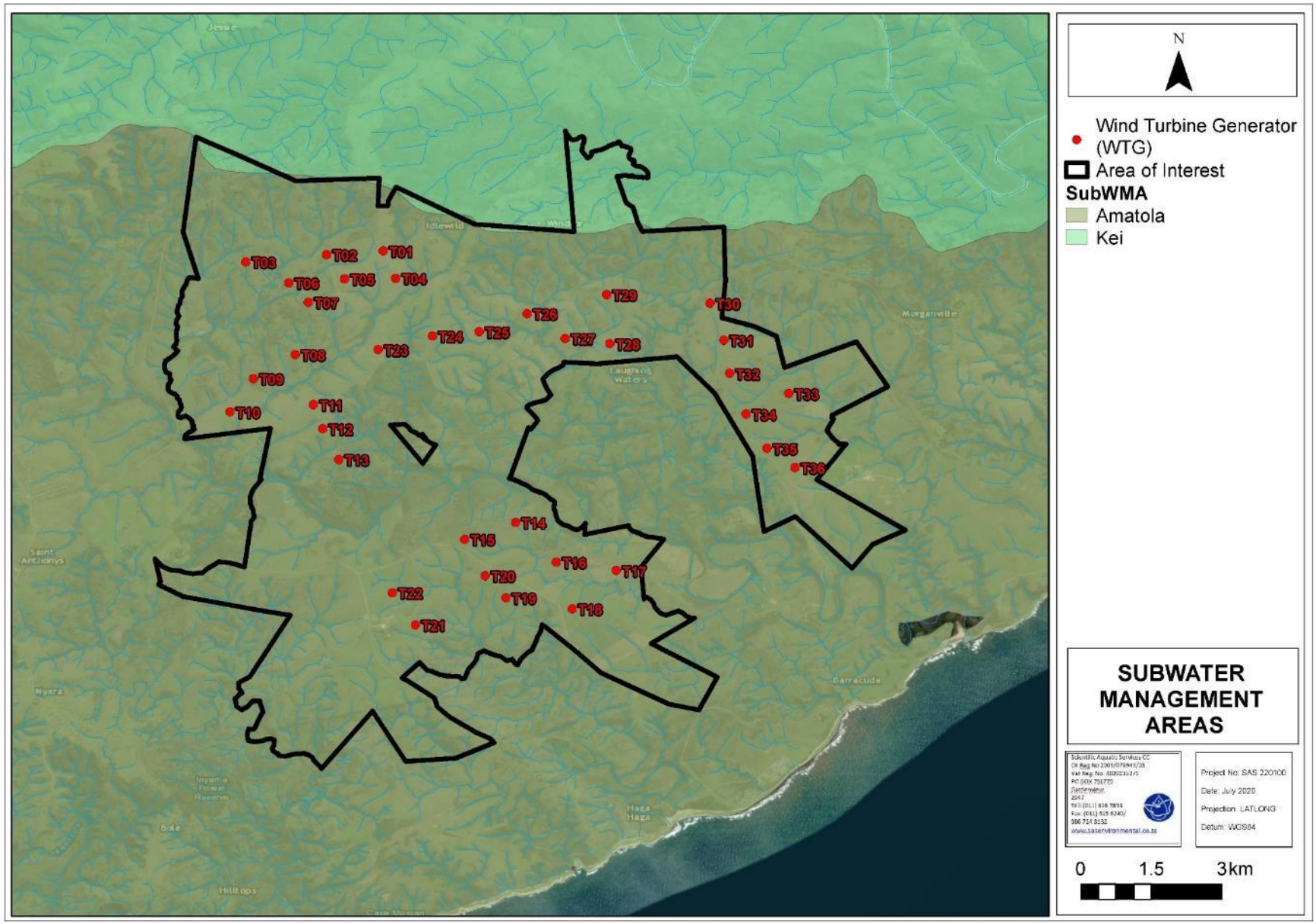


Figure 4: Sub Water Management Areas associated with the AOI.

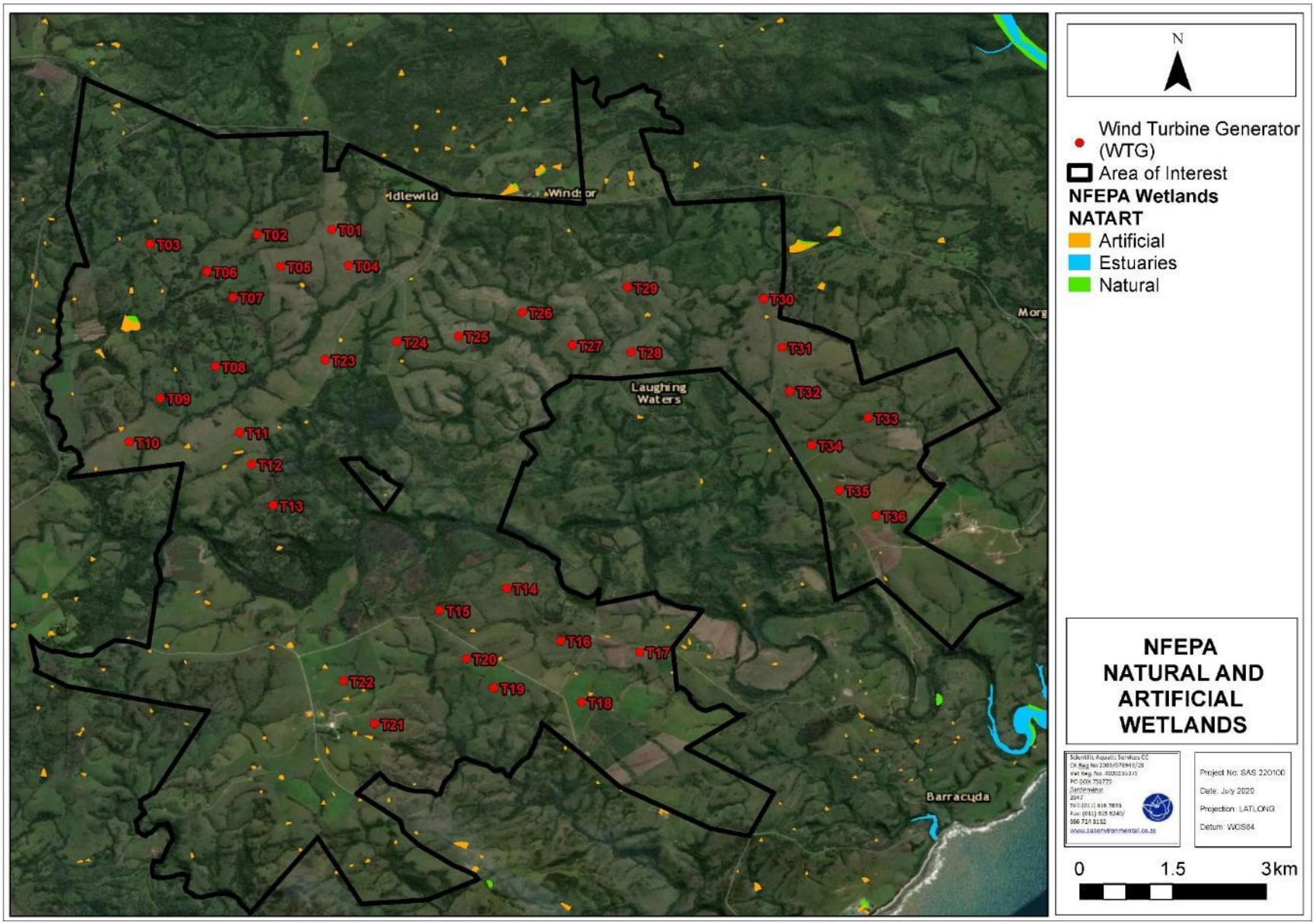


Figure 5: Natural and artificial wetland associated with the AOI as indicated by the NFEPA (2011) database.

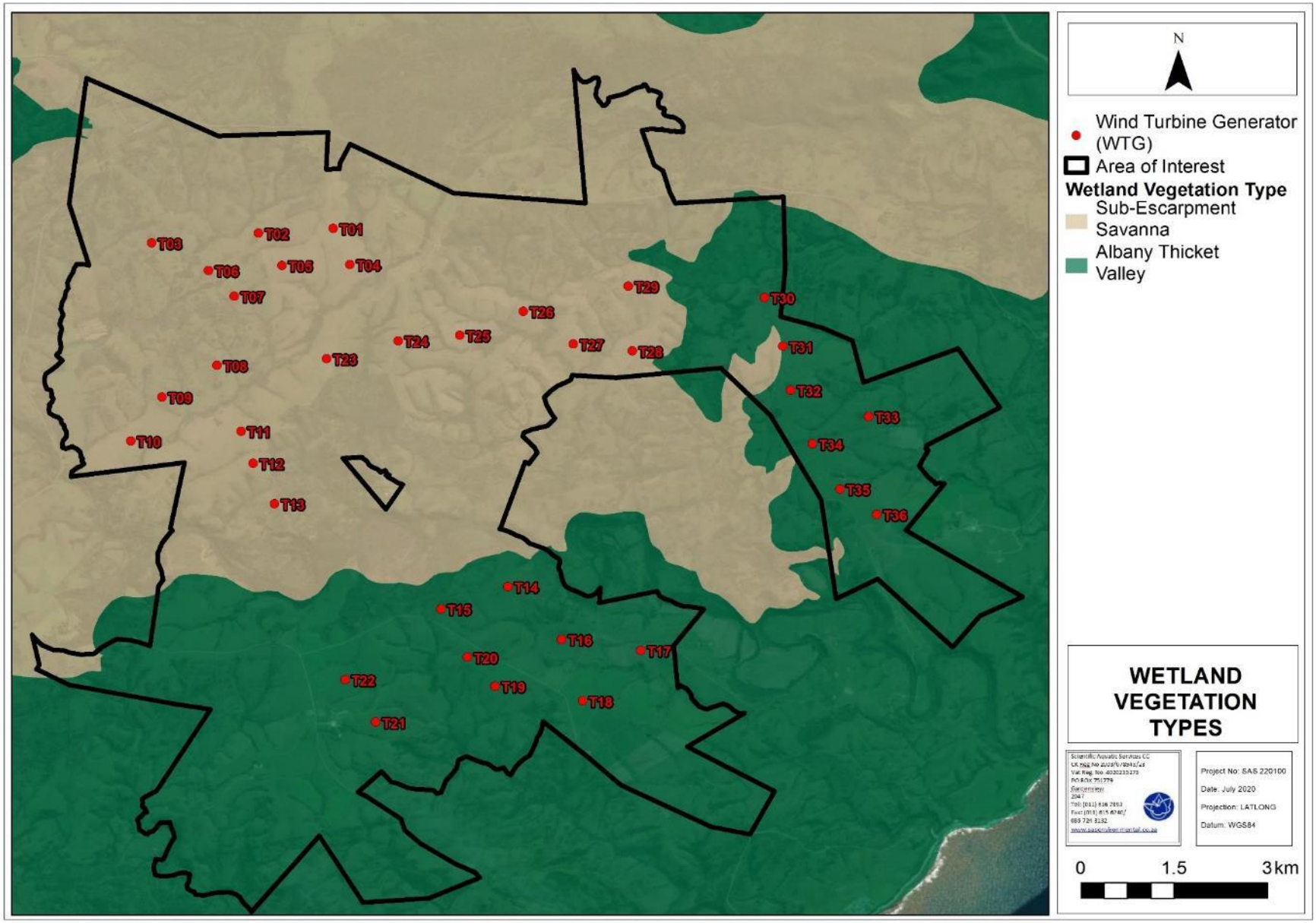


Figure 6: Wetland vegetation types found occurring within the AOI.

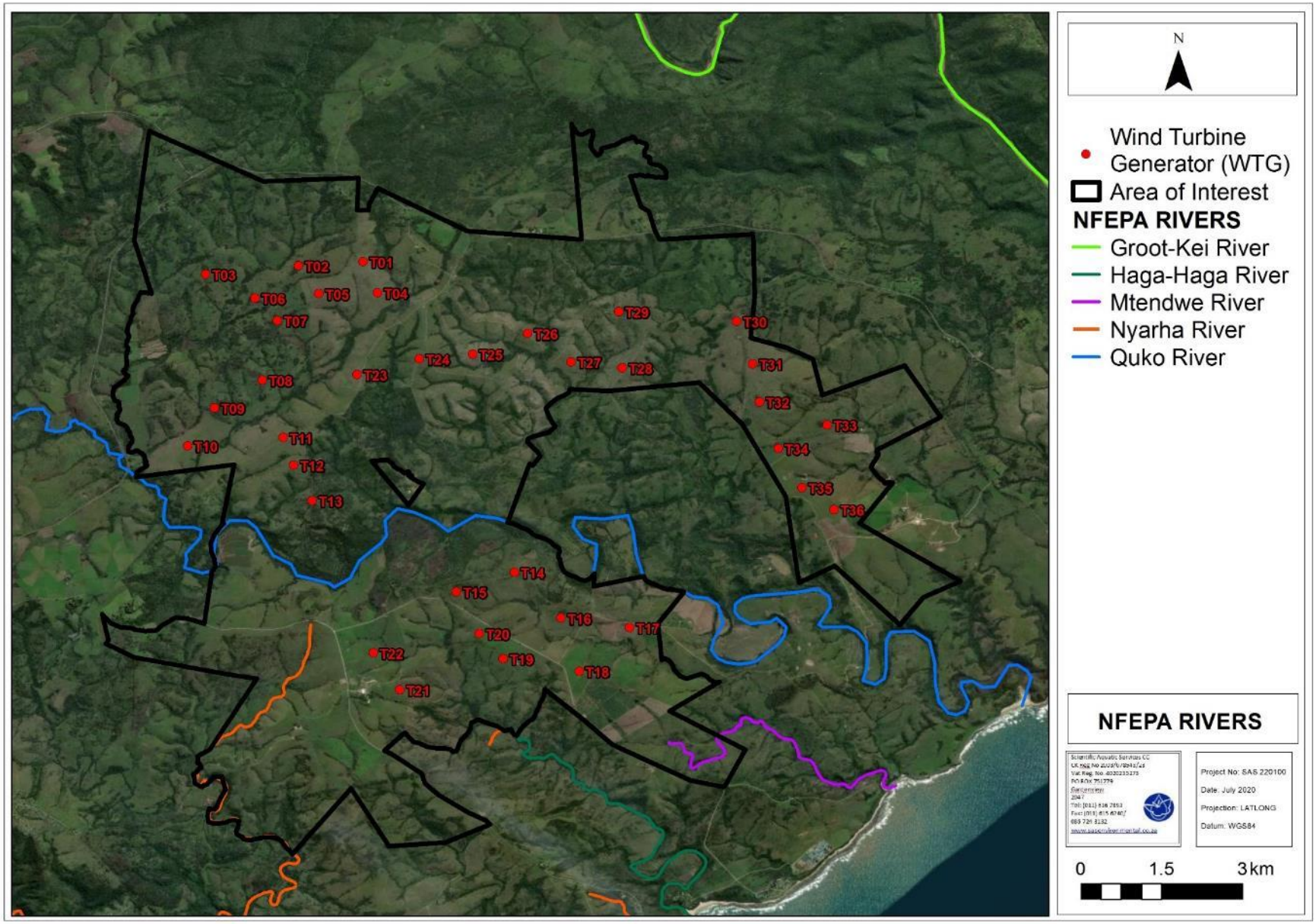


Figure 7: NFEPA (2011) Rivers represented in the AOI.

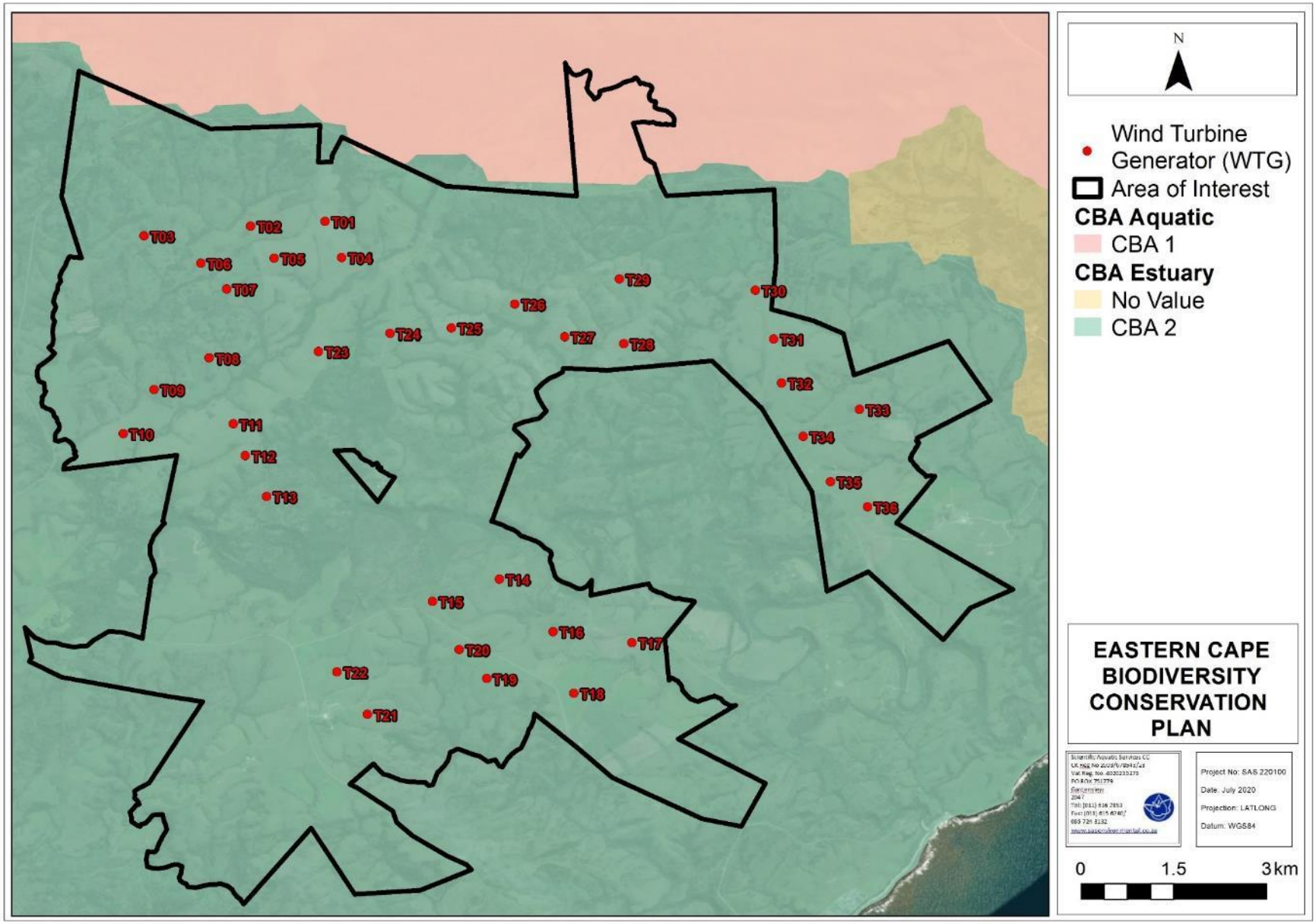


Figure 8: Importance of the AOI in terms of wetland conservation as defined by the Eastern Cape Biodiversity Conservation Plan (2007).

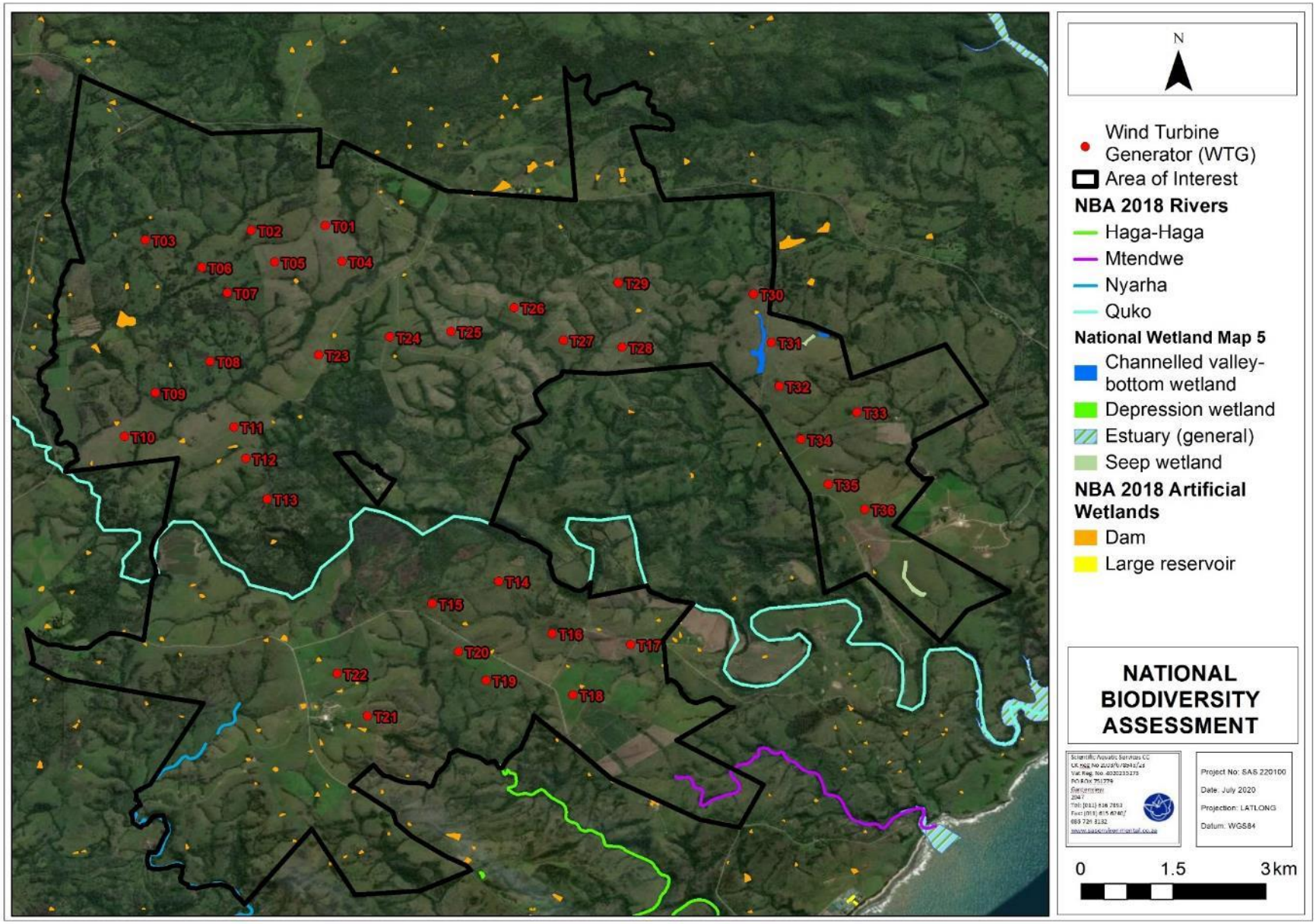


Figure 9: Rivers and wetlands identified by the National Biodiversity Assessment (2018) in the AOI.

4 RESULTS: WATERCOURSE ASSESSMENT

4.1 Watercourse Characterisation

Use was made of topographical maps and digital satellite imagery as well as provincial and national wetland databases to identify areas of interest prior to the field survey, and any additional freshwater features noted during the field survey were also assessed and added to the number of survey points. Although all possible measures were undertaken to ensure that all watercourse systems as well as smaller non-perennial watercourses were assessed and, where necessary from a freshwater ecological resource point of view, were delineated, some smaller poorly defined, episodic features may have been overlooked within the AOI, particularly as a result of the lack of significant rains during both times of the site investigation.

The field assessment was undertaken by SAS within January and July 2017, in order to determine the extent and characteristics of watercourses associated with the WEF which display watercourse characteristics. Due to the extent of the AOI, the numerous watercourses which were encountered throughout the AOI, and some access limitations experienced (due to inaccessible farm portions or freshwater features located within game farms), not all systems were assessed in detail, although every effort was made to ensure that data was collected at key representative points throughout the areas covered by the AOI. The freshwater systems were thus delineated using digital satellite imagery, with field verification where possible; however, when field verification of features delineated using desktop methods took place, delineations proved to be accurate in most instances.

In addition to the use of topographical maps and digital satellite imagery, provincial and national databases were used to identify areas of interest prior to the field survey. It was evident from the 1:50 000 topographical maps, that the AOI is characterised by undulating hills and an extensive network of non-perrenial watercourses with riparian vegetation connected to larger river systems. The non-perrenial watercourses located within the AOI are connected to at least four different rivers located within and outside of the boundaries of the AOI. These non-perrenial drainage systems form part of the Quko, Haga-Haga, and Mtendwe and Nyarha river systems.

The NFEPA (2011) database identified few natural wetlands located within the AOI. During the site assessment, some of these features which could be accessed, were identified as dams, created mostly within the upper reaches of the non-perrenial watercourses/tributaries, in order to collect water for livestock watering and other agricultural purposes. Thus, these impoundments were not assessed, since these are considered man-made structures which do not contribute significantly to provincial watercourse conservation targets nor to the ecological service provision of freshwater resource or riparian systems which may be affected by the proposed WEF infrastructure components.

It should also be noted that although the watercourses identified may extend beyond the boundaries of the AOI, only portions associated with the proposed WEF were assessed and ground truthed. Nonetheless, the potential impacts of activities such as agricultural activities, erosion, and construction of other infrastructure and clearing of natural vegetation within the greater catchment were taken into consideration during the assessment. The AOI itself has in some parts been disturbed mostly by the trampling and grazing by livestock, and to some degree by agricultural practices, which has resulted in the loss of natural vegetation and proliferation of alien and invasive floral species within certain areas. Other impacts that have previously affected the freshwater environment include the construction of internal gravel roads, tarred access roads and bridges, and the construction of existing electrical infrastructures and associated impacts within the servitude area.

During the course of the assessment, it was determined that two main hydrogeomorphic (HGM) units occur within the areas being traversed by the proposed WEF infrastructure, namely perennial rivers with an associated riparian zone (the Quko River and associated tributaries), and non-perrenial watercourses (including headwaters) of the Quko, Haga-Haga, Mtendwe and Nyarha river systems, with their associated riparian vegetation, on the steeper areas. Since it is considered that the non-perrenial watercourses and headwaters of the Haga-Haga, Nyarha and Mtendwe River systems have similar characteristics, the affected features associated with these watercourses were assessed together in Section 4.2.

Episodic preferential flow paths were identified within some portions of the AOI, but are considered to not receive and retain sufficient water to support wetland or riparian characteristics (such as facultative or obligate wetland vegetation; soils with prolonged and frequent saturation; and no indication of a fluctuating water table within 50 cm of the soil surface and no significant change in structure and composition of bankside vegetation due to hydromorphological drivers). However, in certain areas, vegetation growth was more prominent, due to thicket vegetation propagating in these flow paths, mainly due to ideal microclimatic conditions, protection from fires etc. that these ravine areas provide, especially in gullies that provide protection from adverse weather conditions and reduce evaporation potential as a result of canopy cover. Although these flow paths cannot be classified as riparian resources in the traditional sense thereof due to the lack of saturated soils and wetland/riparian vegetation, they do still function as a waterway, through episodic conveying of water, and therefore potentially enjoys protection in terms of the National Water Act, 1998 (Act 36 of 1998), if a 1:100 floodline is determined.

The above-mentioned features were classified (according to the Classification System outlined in **Appendix C** of this report) as Inland Systems falling within the Drought Corridor and Southern Folded Mountains Ecoregions, and within the Albany Thicket Valley, Lower Nama Karoo and Sub-Escarpment Grassland Wetland Vegetation groups. The table below presents the classification of the freshwater features identified within the AOI from level 3 to 4 of the Wetland Classification System.

Table 2: Characterisation of the riparian features identified within the AOI.

Feature	Level 3: Landscape unit	Level 4: HGM Type
Quko river and associated tributaries	**Valley floor:** the base of a valley, situated between two distinct valley side-slopes, where alluvial or fluvial processes typically dominate.	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water (It should be noted that the above-mentioned description applies only to true riparian systems/true watercourses. Since the episodic preferential flow paths identified within the AOI are not true watercourses, this description does not strictly apply)
Non-perrenial watercourses, including headwaters	**Slope**: an inclined stretch of ground typically located on the side of a mountain, hill or valley, not forming part of a valley floor. Includes scarp slope, mid-slopes and foot-slopes.	

The locality of all the above-mentioned features in relation to the AOI, are depicted in Figures 10 to 13 below. All other watercourses within the investigation area were delineated using desktop methods.

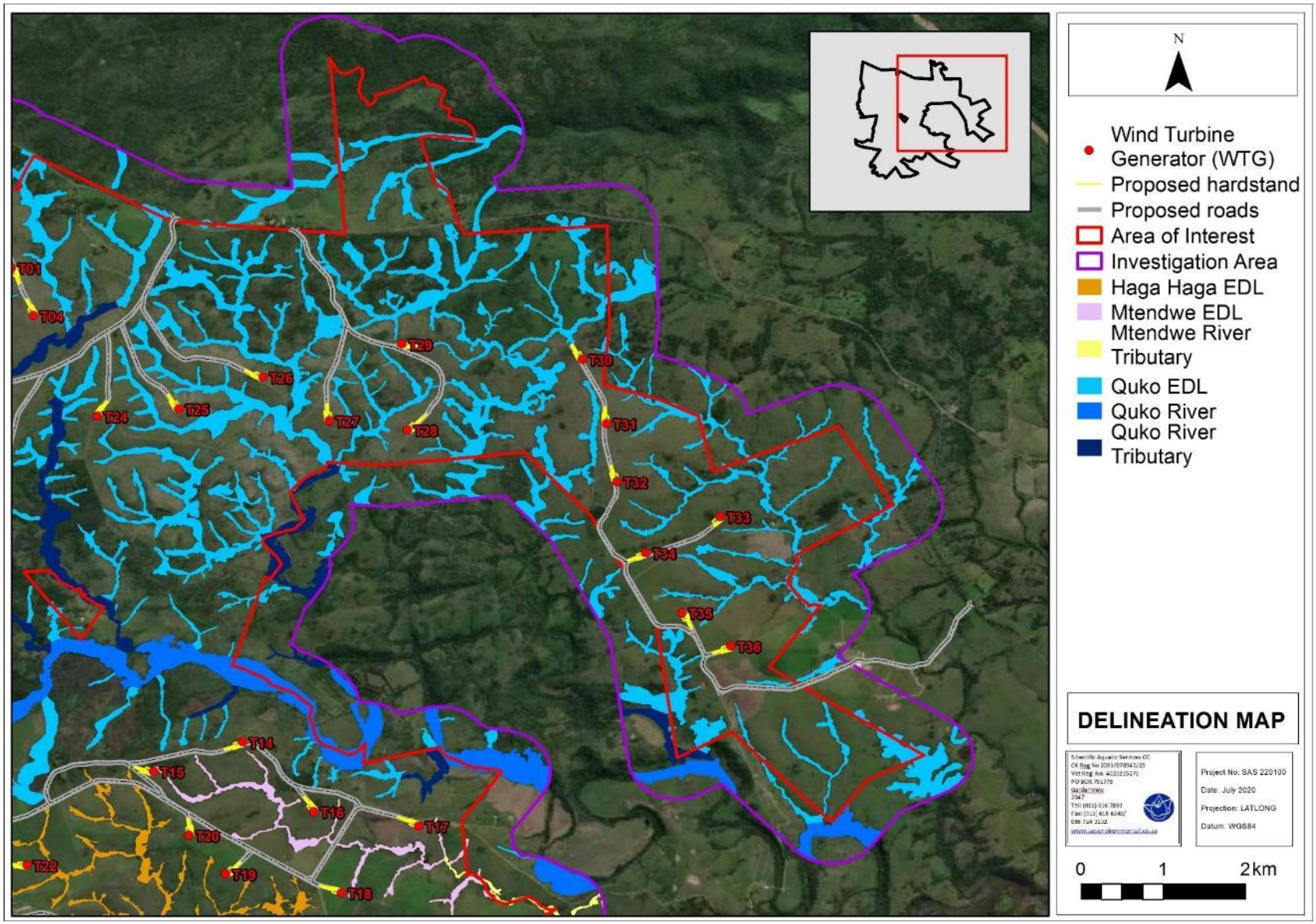


Figure 10: The locality of the delineated watercourses (rivers, tributaries and the non-perennial watercourses (NPW) with riparian vegetation) located within the north-eastern portion of the AOI.

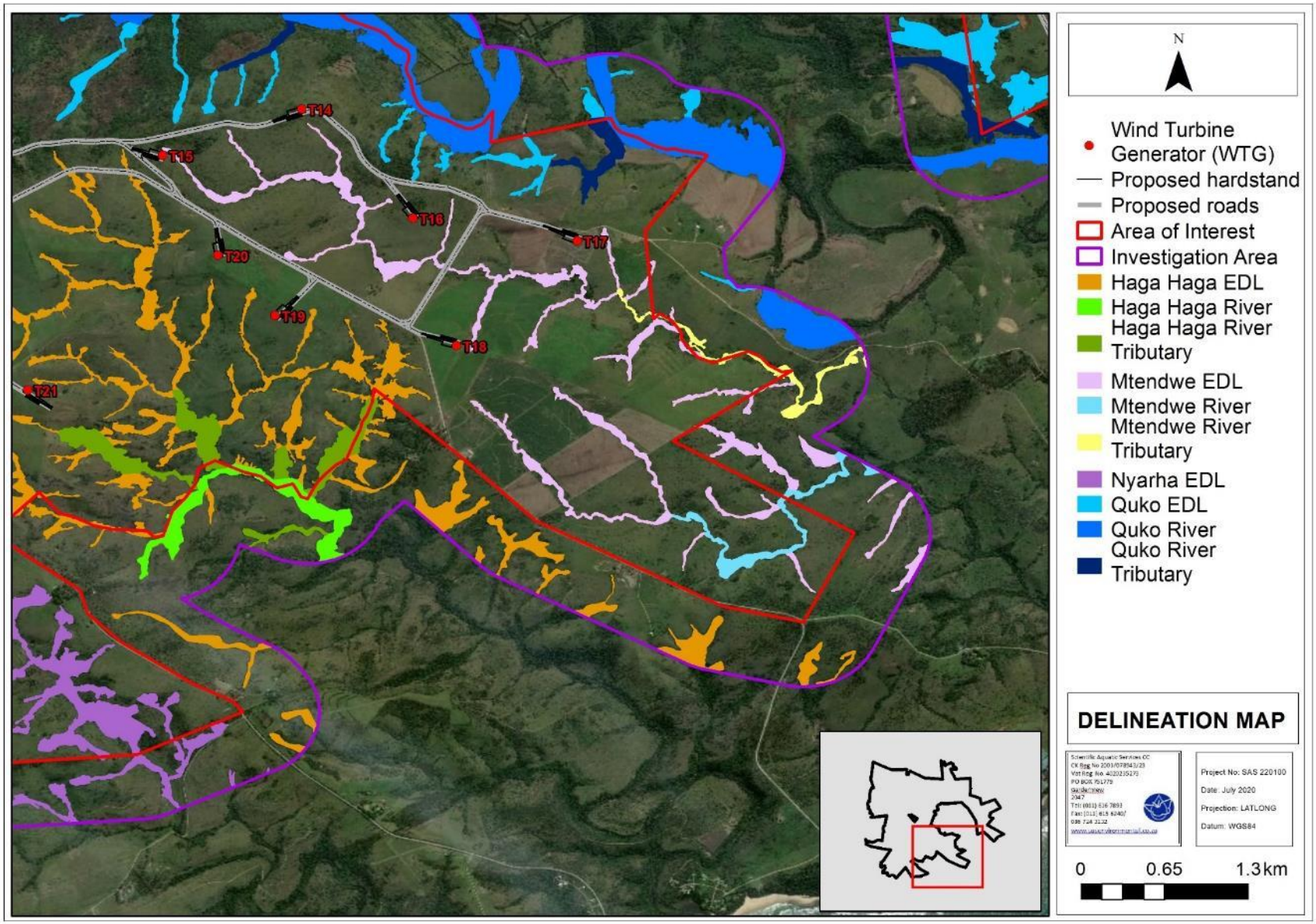


Figure 11: The locality of the delineated watercourses (rivers, tributaries and the non-perennial watercourses (NPW) with riparian vegetation) located within the south-eastern portion of the AOI.

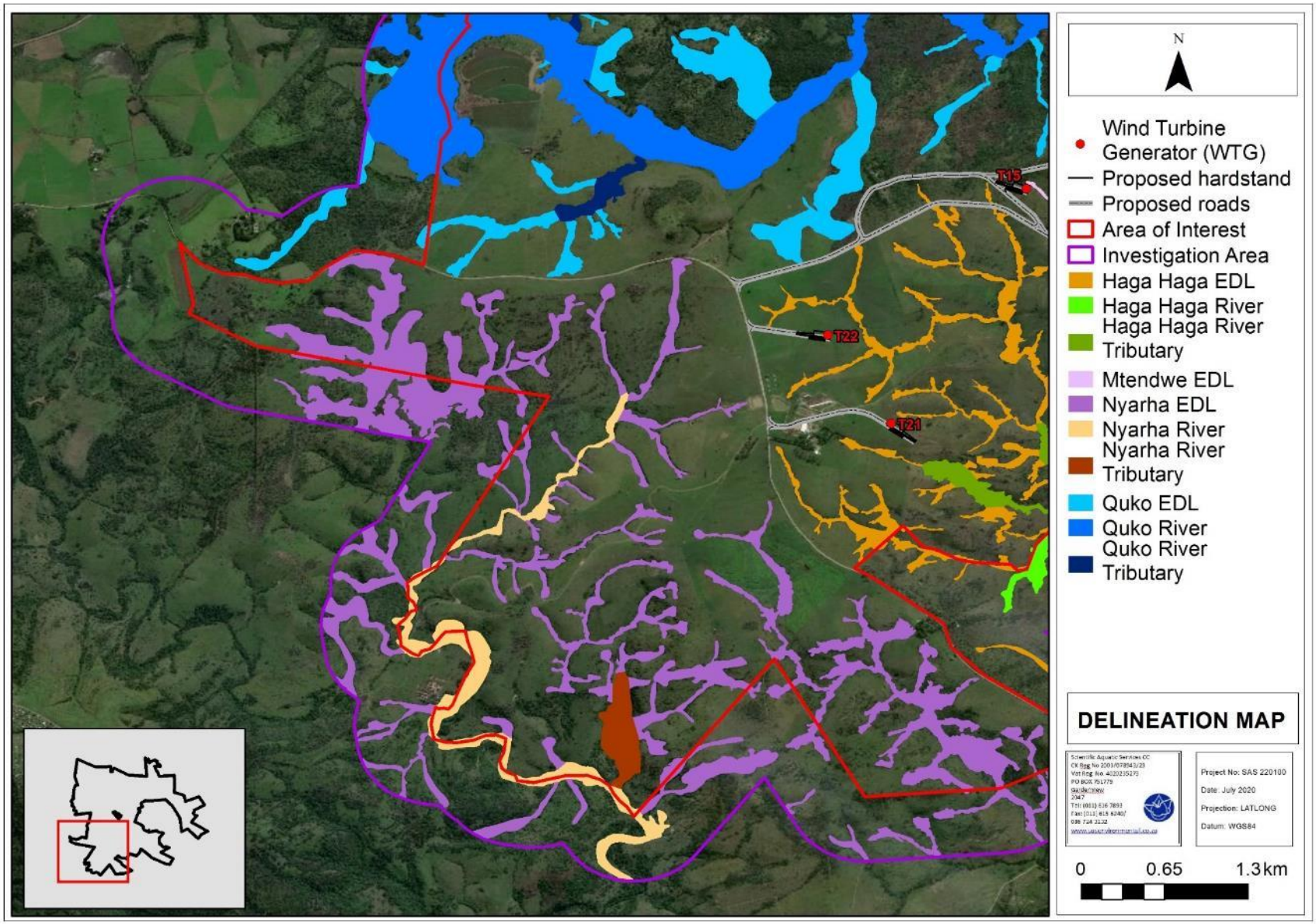


Figure 12: The locality of the delineated watercourses (rivers, tributaries and the non-perennial watercourses (NPW) with riparian vegetation) located within the south-western portion of the AOI.

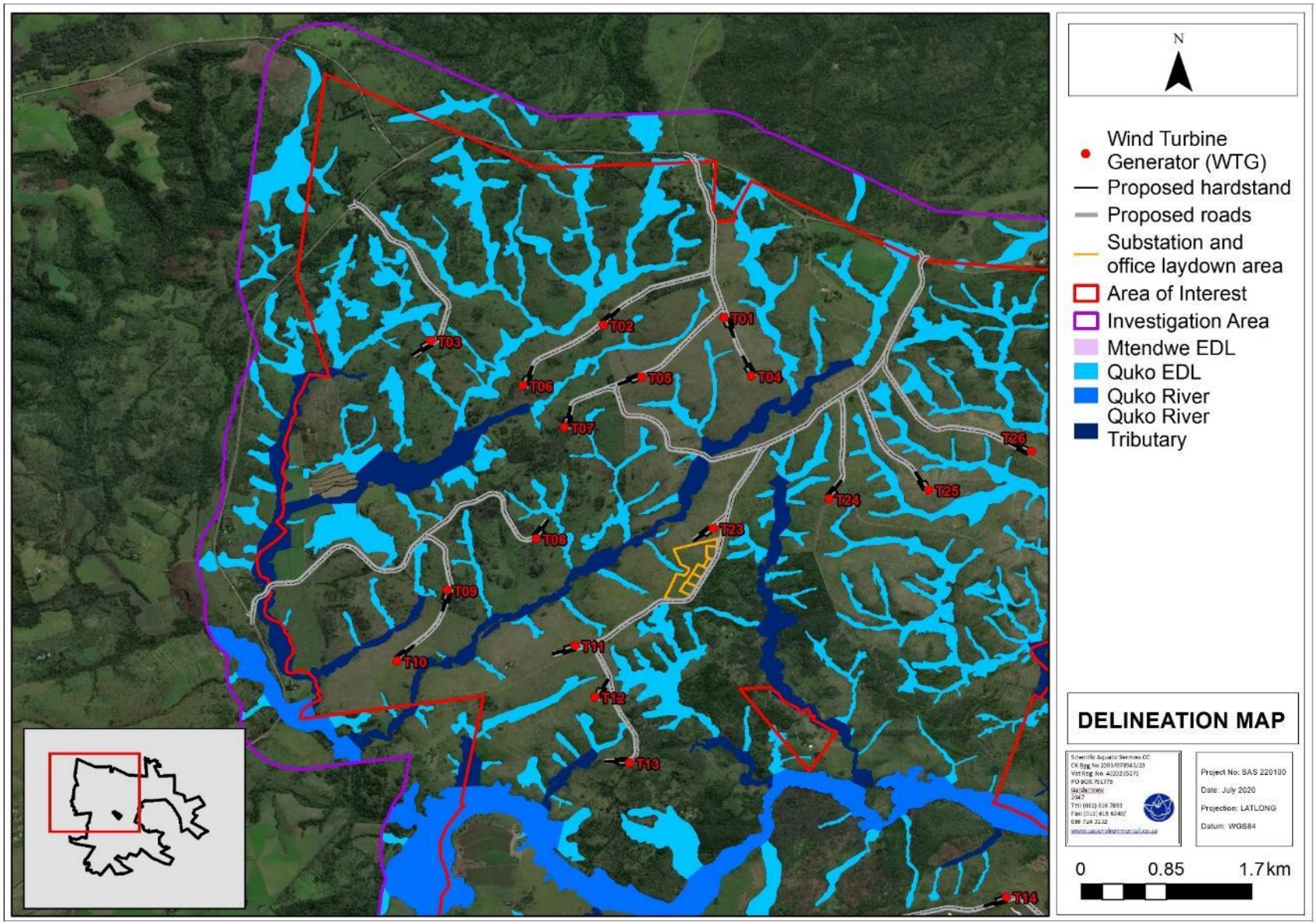


Figure 13: The locality of the delineated watercourses (rivers, tributaries and the non-perennial watercourses (NPW) with riparian vegetation) located within the north-western portion of the AOI.

4.2 Results of Field Verification

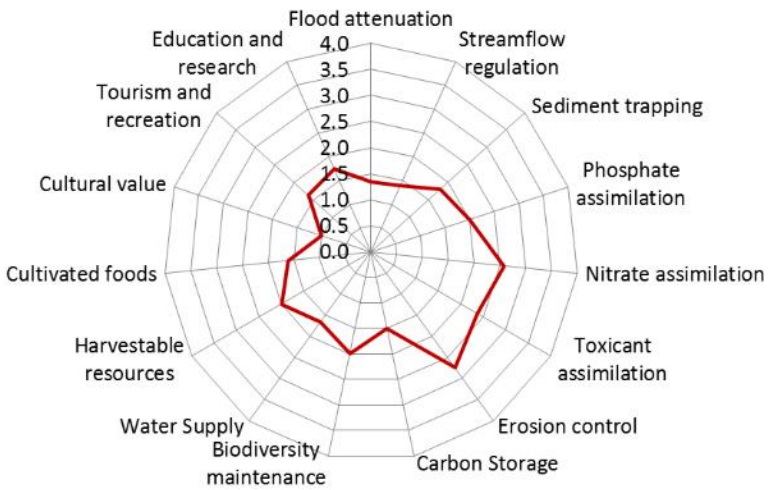
Following the site visit, various assessments were undertaken in order to determine the following:

- PES, incorporating aspects such as hydrology, vegetation and geomorphology;
- Service provision of the watercourses, which incorporates biodiversity maintenance, flood attenuation, streamflow regulation and assimilation, to name a few;
- The EIS is guided by the results obtained from the assessment of PES and service provision of the watercourses;
- An appropriate REC to guide the management of the resources with the intent of enhancing the ecological integrity of the watercourses where feasible;
- Assessment of impacts of the construction and operation of the proposed development on the resources; and
- Presentation of mitigatory measures to minimise impacts of the proposed WEF activities on the watercourses.

The results of the assessments are presented in the dashboard reports below.

Table 3: Summary of the assessment of the Quko River and associated unnamed tributaries which intersect with the AOI.

Ecological & socio-cultural service provision graph:

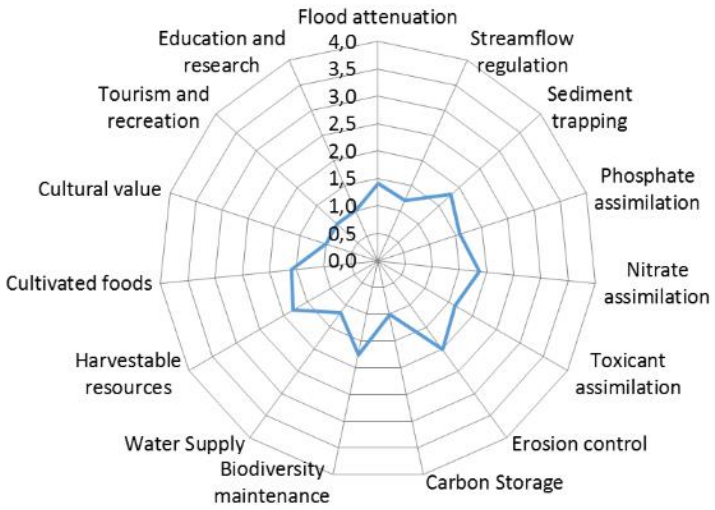


Feature HGM Unit Description	Quko River with associated tributaries with riparian vegetation	**Photograph notes**	Left: An existing crossing over an unnamed tributary of the Quko River. Right: The bridge crossing of the R349 road over the Quko River, where bankside vegetation mainly consists of large woody species.
Integrated Habitat Integrity Ecostatus	**IHI Category: B (Largely Natural with few modifications)** Riparian zone impacts include the construction of a few off-channel dams, erosion as a result of increased base-flow as well as trampling from livestock farmed in the region. Despite several roads (formal bridge crossings and informal gravel crossings) crossing the river, these crossings are considered well-constructed, however, some streambank erosion is visible at downstream of instream supporting structures. The overall bank structure of the river is fairly intact, aided by the presence of private game-ranches/reserves within the AOI that limit any activities to occur within the river. The riparian zone integrity of the Quko river and its associated tributaries may be regarded as an Ecological Category B.	**Watercourse characteristics:** **a) Hydraulic regime** Agricultural activities, in the form of cattle farming are dominant land uses surrounding this portion of the river. Water abstraction for pivot irrigation systems and return flows are seasonal impacts on the hydrological regime of this river. Due to the extensive drainage network this river is associated with, water from upgradient/upstream areas are constantly being conveyed into the river, therefore increasing the water level of the river during the wet season. Culverts and the artificial impoundment of the river along particular portions of its channel will have influenced the flow pattern/hydraulic regime of the system, albeit only moderately. Abstraction and redirection of water for agricultural purposes is evident and has resulted in a minor to moderate reduction in flow. **b) Water quality** Detailed assessment of water quality was not within the scope of this study, however water quality appeared good, and is likely, especially given the limited input of pollutants and lack of industry or urban development in the region. However, runoff from cultivated areas, and faecal input from cattle may contribute adversely to water quality via the addition of fertiliser, organic matter and pesticides, the latter which may bio-accumulate in aquatic fauna. Crop cultivation is not extensive (primarily sugarcane) and thus this impact is likely isolated.	

Ecoservice provision	Intermediate: Considered important for nitrate, phosphate and toxicant assimilation as well as erosion control and biodiversity maintenance. Due to its high degree of connectivity to other natural areas, this river is ecologically important in terms of providing mitigatory corridors and habitat for a variety of biota. This river provides some water for agricultural activities, especially cattle farming and some form of harvestable resources to local communities. This river is not considered of cultural importance or of high importance for flood attenuation.	**c) Geomorphology and sediment balance** Impacts on the geomorphology of the feature are moderately low overall given the extent of erosional features relative to the total size of the unit. However, where present, erosion, usually in the form of gullies, are fairly highly incised. This will result in the transport of additional sediment downstream. Soil in the region is composed predominantly of clayey loam, and hence is fairly resistant to movement through the landscape, ameliorating the adverse effects of these incisions. Surface roughness, largely from the substantial woody component of the bankside vegetation, is predominantly intact. In the long-term, there is likely low to moderate transport of sediment from higher to lower lying regions and the deposition of alluvial soils. Thus, despite limited erosion, geomorphology and sediment balance of this system has not been substantially modified and is likely to remain unchanged in the foreseeable future.	
EIS discussion	EIS Category C (Moderate): The EIS of this river and its associated tributaries falls within Category C, which are features that are considered to be ecologically important and sensitive at a local scale. This is mainly because this river and its larger drainage network is considered to be a CBA (2) estuary region by the Eastern Cape Biodiversity Plan (2007). Even though modifications to the river has occurred, it still provides habitat to a variety of biota, given the high degree of connectedness of this feature with the surrounding landscape.	**d) Habitat and biota** Impacts such as the construction of bridges, roads and localised grazing and trampling has caused the loss of vegetation on the bankside of certain portions of this river. These disturbances have made the bankside susceptible to a variety of invasive alien plant species (*Acacia mearnsii*) which have been able to establish. However, despite these impacts, vegetation was found to be mostly intact at surveyed sites, with largely natural vegetation and sufficient connectivity to other areas via migration corridors, making this drainage network an important movement corridor for fauna.	
REC Category	Category B: Despite some modifications to the river, it has the potential to provide important ecological functions and habitat to a variety of fauna and flora species. Thus, the Present State of the river system should not be permitted to degrade any further.	**VEGETATION ECOSTATUS (VEGRAI)**	Ecological Category: B (Largely natural with few modifications) This river and its tributaries serves as an important source of riparian habitat for biota, and aided by the rural nature of the majority of its active channel, is relatively unmodified. Some usage of water and impoundment by farmers is present (mainly within the upper reaches of the tributaries) and as such this has altered patterns of vegetation composition, primarily through the creation of wooded areas adjacent to these small-scale impoundments.
Possible significant Impacts on the system	The Quko River and some of its tributaries will be traversed by the proposed cabling and thus some impacts to these sections of the watercourses are likely to occur as a result of the development unless the final route planning avoids development within these resources. Expected impacts include: Vegetation losses or alteration (invasion of alien species) due to clearing, potential risk of increased erosion as a result of soil disturbances within the active channel, possible movement of vehicles within the active channel and potential disposal of waste materials within the riparian zone or active channel. Implementation of the set-out mitigation measures as provided in this report would greatly reduce the risk of impact to the watercourses.	**Business case, Conclusion and Mitigation Requirements:**	The results of the risk assessment matrix indicate that potential impacts from the construction of the WEF infrastructure components on the Quko river and its tributaries are expected. However, with the strict implementation of cogent, well-developed, activity-specific mitigation measures, these impacts could be considered to pose a 'Low' risk significance. Recommended mitigation measures applicable to this project are provided in Section 5 and **Appendix E** of this report; however key mitigation measures include limiting the sedimentation of the freshwater environment, minimising vegetation clearing and implementing alien vegetation control, demarcating the riparian zone as no-go areas to all but essential personnel and where crossings are authorised and not permitting the movement of vehicles within the riparian zone or active channels, and strict erosion control measures such as erosion berms, and protection of exposed soils.

Table 4: Summary of the assessment of the non-perrenial watercourses and headwaters of the Haga-Haga, Nyarha and Mtendwe river systems which intersect with the AOI.

Ecological & socio-cultural service provision graph:



Feature HGM Unit Description	Non-perrenial watercourses and headwaters of the Quko, Haga-Haga, Nyarha and Mtendwe river system	**Photograph notes**	Top: Representative photographs of the non-perrenial watercourses showing the significant woody component that distinguish them from the surrounding terrestrial grass areas. Prolific invasion of alien vegetation species such as *Acacia mearnsii* were found to be prominent in these watercourses. Bottom left: An example of a non-perrenial watercourse which forms part of the Quko river system, in which impoundments (dams) are constructed for the collection of water. Bottom right: An existing crossing over a non-perrenial watercourse, indicating that shrub like and woody vegetation (albeit mostly alien species) mainly persists in these watercourses.
Present Ecological State	**PES Category: C (Moderately Modified)** Impacts associated with these non-perennial watercourses include erosion (origination from upgradient sources) mostly due to informal road crossings and the trampling of vegetation by livestock. Transformed bankside vegetation was evident at areas of disturbance (at instream artificial dams and informal road crossings) which has decreased the ecological integrity of these areas, however in areas where very little disturbance has occurred, the ecological integrity is expected to be more intact.	**Watercourse characteristics:** **a) Hydraulic regime** The hydrological regime of these non-perennial watercourses is most significantly impacted by the construction of artificial impoundments constructed in the most upstream portions of these features. Thus, where impoundment occurs, this may have more significant impacts on up- and downstream features due to changes in the level of soil saturation. Where road crossings occur, this may result in small changes to existing flow patterns, especially where crossings have been hardened. Where changes in the topography occur in the channel, small, localised pools may form following rain events. Overall, changes to the hydrological functioning of the system are not pronounced, with a moderately high channel competency.	

Ecoservice provision	**Intermediate**: The overall non-perrenial drainage network associated with the Quko, Haga-Haga, Nyarha and Mtendwe river systems are considered important in terms of erosion control and biodiversity maintenance. Seasonal dependence on the system for water provision is evidenced by the numerous artificial impoundments within the headwaters and upstream areas, however these systems are not considered important in terms of harvestable resources, nor do they have great cultural importance, streamflow regulation or the capacity to store carbon.	**b) Water quality** For the most part, surface water within these non-perrenial watercourses was limited at the time of the study, although localised pools and regions of impoundment were encountered. A detailed assessment of water quality was not within the scope of this study, however given the limited development and potential adverse modifiers, it is expected to be of relatively high quality. **c) Geomorphology and sediment balance** Minor erosion in the form of gullies was apparent, mainly surrounding anthropogenic impacts (road crossings, artificial impoundments). Further evidence for erosion was provided in the form of unvegetated banks. Sediment from eroded surfaces is transported downstream, where this deposition may marginally impact local channel integrity. Trampling by livestock (i.e., cattle) was observed during the assessment, which may contribute to increased sediment loads. This may have a significant impact given that large herbivores are uncommon in this region, although they may have been historically numerous prior to human occupation. **d) Habitat and biota** Bankside vegetation has been impacted by the trampling of cattle, artificial impoundments and the construction informal roads/fences over these non-perrenial watercourses. This has resulted in a loss of natural vegetation and the establishment of stands of alien vegetation species (i.e. *Acacia mearnsii, Solanum mauritianum* and *Lantana camara*). Despite this, channel vegetation is dominated by mostly small woody species, albeit in some areas dominated by woody alien invasive species	
EIS discussion	**EIS Category C (Moderate):** The EIS of these non-perrenial watercourses falls within Category C, which are features that are considered to be ecologically important and sensitive at a local or regional scale. This is primarily because these non-perrenial watercourses feed into larger systems (which ultimately drains into the Indian ocean), which is largely unmodified and important in maintaining habitat and ecological integrity through its connectedness. This region is also identified as a CBA (2) by the Eastern cape biodiversity plan (2007).		
REC Category	**Category C:** Whilst some modifications to the overall drainage system have occurred as a result of the artificial impoundment of water sources and trampling by cattle, further degradation of these areas should not be permitted.		
Possible significant Impacts on the system	Roads to be upgraded and several underground cables are proposed to traverse over the non-perennial watercourses of Haga, Nyahra and Quko river systems. Impacts regarding these proposed activities is expected to occur within the immediate area of these infrastructures. It is however expected that these impacts are unlikely to affect the greater system as a whole. Possible impacts to these features may include: Vegetation losses or alteration due to clearing, potential risk of increased erosion as a result of soil disturbances (with specific mention of open trenching) and possible indiscriminate movement of vehicles within these features.	**Business case, Conclusion and Mitigation Requirements:**	The results of the risk assessment matrix indicate that potential impacts from the construction of the WEF infrastructure components on the non-perennial watercourses of the Quko, Haga-Haga, and Nyarha and Mtendwe river systems are expected. Due to the lowered ecological state and limited ecological importance of these features, and with the strict implementation of cogent, well-developed, activity-specific mitigation measures, with specific mention of rather installing the underground cabling through directional drilling underneath the watercourses rather than open trenching, these impacts could be considered to pose a 'Low' risk significance. Recommended mitigation measures applicable to this project are provided in Section 5 and **Appendix E** of this report; however key mitigation measures include limiting the sedimentation and erosion of the watercourses and minimising vegetation clearing.

4.3 Delineation of Watercourses

The watercourses were delineated according to the guidelines advocated by DWA (2008). Onsite delineation was supplemented with the use of digital satellite imagery in order to assist in the delineation of disturbed watercourses. The delineations as presented in this report are regarded as a best estimate of the watercourse boundaries based on the site conditions present at the time of assessment.

During the assessment, the following indicators were used to ascertain the boundaries of the temporary zones of the watercourses:

- Terrain units were used to determine in which parts of the landscape the riparian resources were most likely to occur. Watercourses are usually located at the valley bottom position in-between sloped hills (Figure 14); and
- The vegetation indicator, particularly the vegetation community structure (woody vegetation), was extensively utilised to determine the riparian zone boundaries, as generally, this was a well-defined indicator between the riparian zone and the surrounding terrestrial ecosystems. In particular, the density and structure of vegetation differed between the riparian and terrestrial zones, as can be seen in Figure 15.

Figure 14: Terrain units used to identify the locality of watercourses within the landscape, usually at the valley position in between sloped hills; Prominent vegetation in between slopes indicates the flow of water through the landscape

Figure 15: Photograph depicting the changes in vegetation density and structure between the riparian (tree and shrub species) and terrestrial zones (grass species).

5 Legislative Requirements and Sensitivity Mapping

The following legislative requirements were considered during the assessment. A detailed description of these legislative requirements is presented in **Appendix B** of this report:

- The Constitution of the Republic of South Africa, 1996[4];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA); and
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered to be "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on watercourses arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al*, 2015). It should be noted, however that buffer zones are not considered to be

[4] Since 1996, the Constitution has been amended by seventeen amendments acts. The Constitution is formally entitled the 'Constitution of the Republic of South Africa, 19996". It was previously also numbered as if it were an Act of Parliament – Act No. 108 of 1996 – but since the passage of the Citation of Constitutional Laws Act, neither it nor the acts amending it are allocated act numbers.

effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

The definition and motivation for a regulated zone of activity for the protection of the assessed watercourses can be summarised as follows:

Table 5: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998). **Department of Water and Sanitation (DWS)**	**Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)** In accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21c and 21i is defined as: • the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the **absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse** where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation.
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended. **Department of Environmental Affairs**	**Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended) states that: *The development of:* *(xii) Infrastructure or structures with a physical footprint of 100 square meters or more;* *Where such development occurs—* *a) Within a watercourse;* *b) In front of a development setback; or* *c) If no development setback has been adopted, within **32 meters of a watercourse**, measured from the edge of a watercourse.* **Activity 19** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA regulations, 2014 (as amended) states "*The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse.*"

A 32 m Zone of Regulation (ZoR) in accordance with the National Environmental Management Act, 1998 (Act No. 107 of 1998) and, in the absence of a defined 1 in 100 year floodline, a 100 m Zone of Regulation in accordance with Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) were applied to the watercourses as depicted in Figure 16 to 19. Due to the resolution of these figures and the markers used in order to depict the locality of these turbines on the figures, it might appear that some turbine positions are within the allocated zones of regulation within some areas. However, no turbines are located inside any of the zones of regulation, however some hardstands and the proposed substation/laydown/BESS area does encroach on this zone.

The NEMA and GN509 ZoRs are not considered to be no-go areas, however, should infrastructure be located in these zones, they should be authorised by the relevant legislative authority. All proposed infrastructure in these ZoRs were included as part of the DWS Risk Assessment (Section 6).

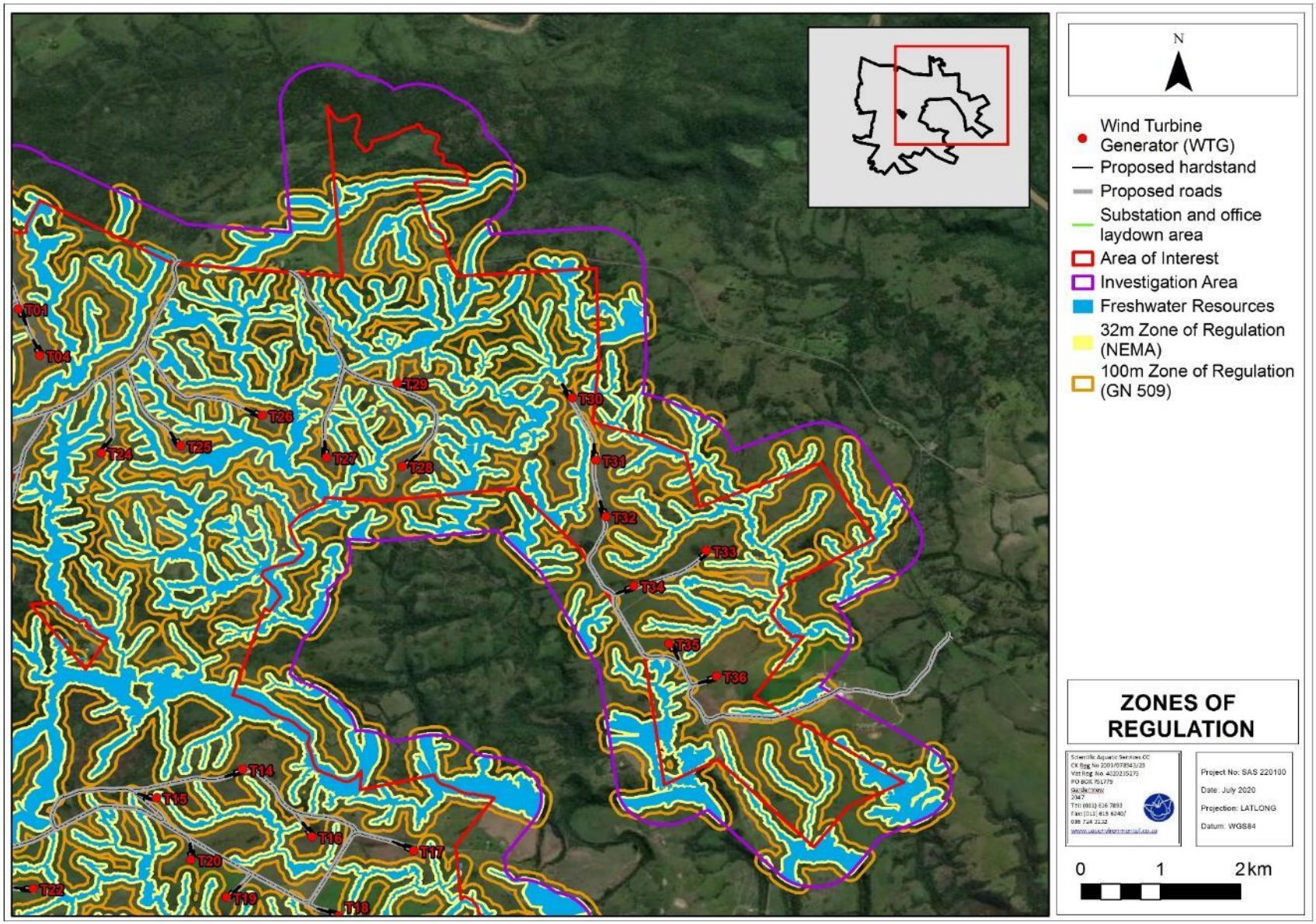


Figure 16: Conceptual presentation of the watercourses within the north-eastern portion of the AOI and the associated zones of regulation in terms of NEMA and of Regulation GN509 as it relates to the NWA.

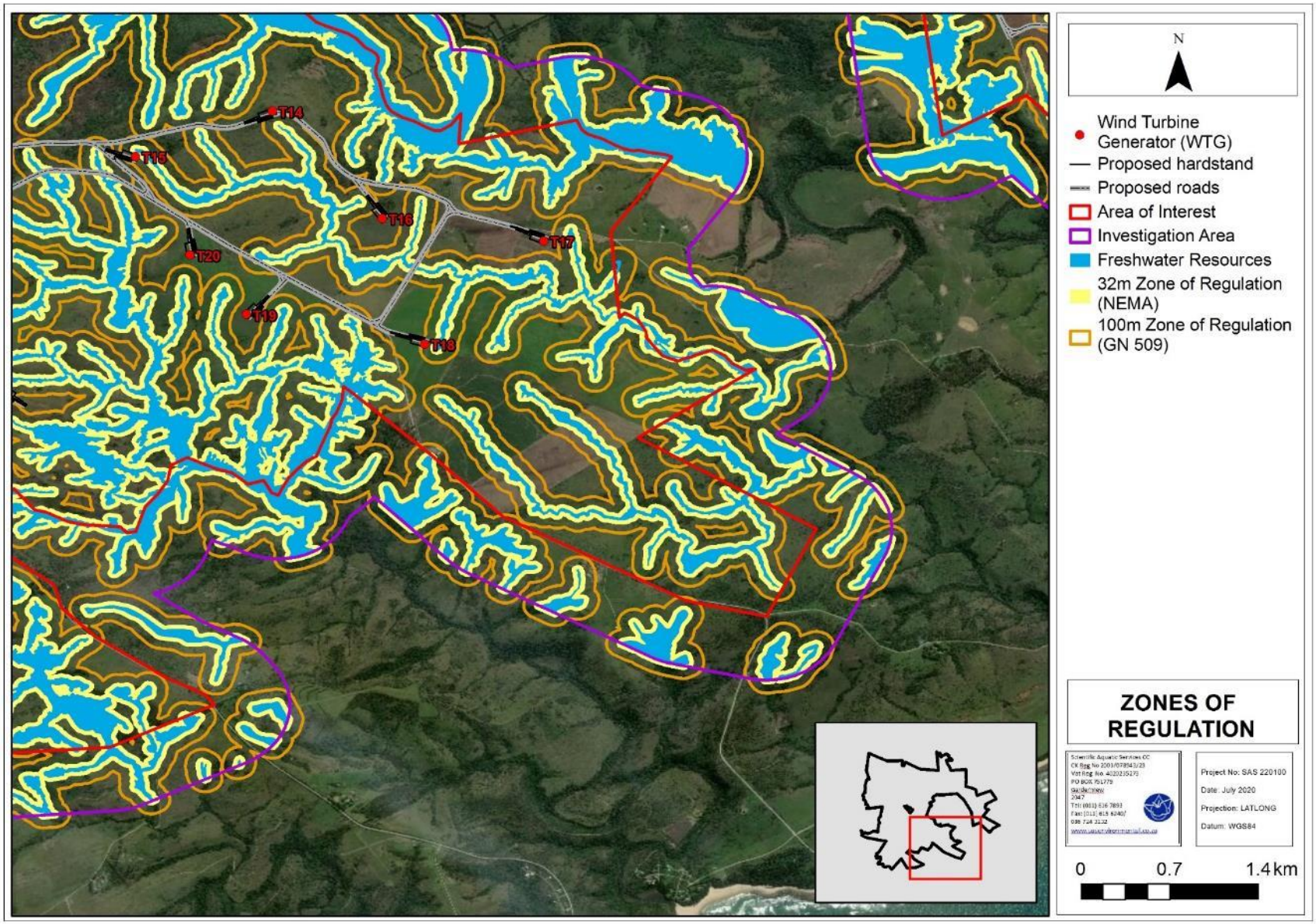


Figure 17: Conceptual presentation of the watercourses within the south-eastern portion of the AOI and the associated zones of regulation in terms of NEMA and of Regulation GN509 as it relates to the NWA.

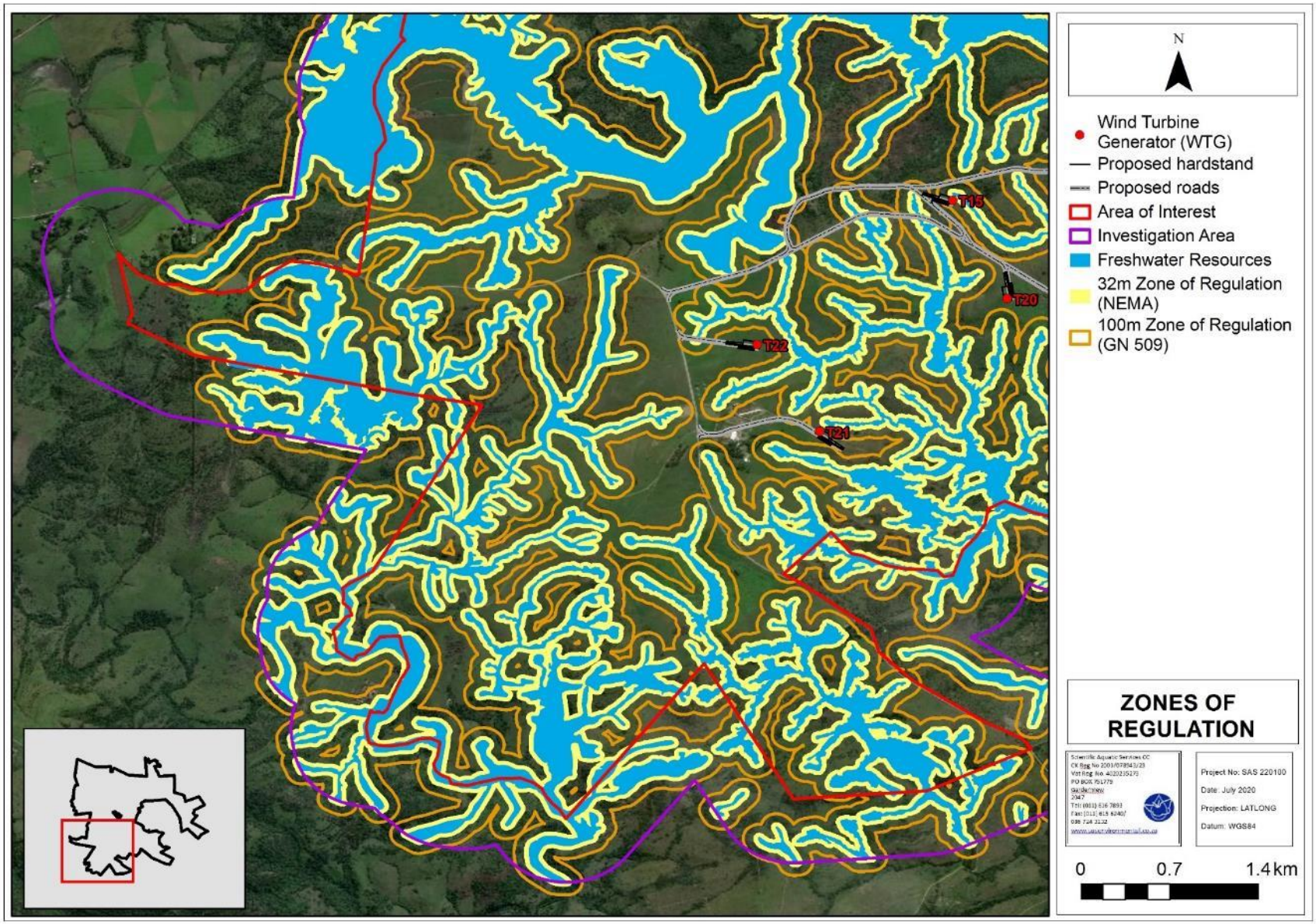


Figure 18: Conceptual presentation of the watercourses within the south-western portion of the AOI and the associated zones of regulation in terms of NEMA and of Regulation GN509 as it relates to the NWA.

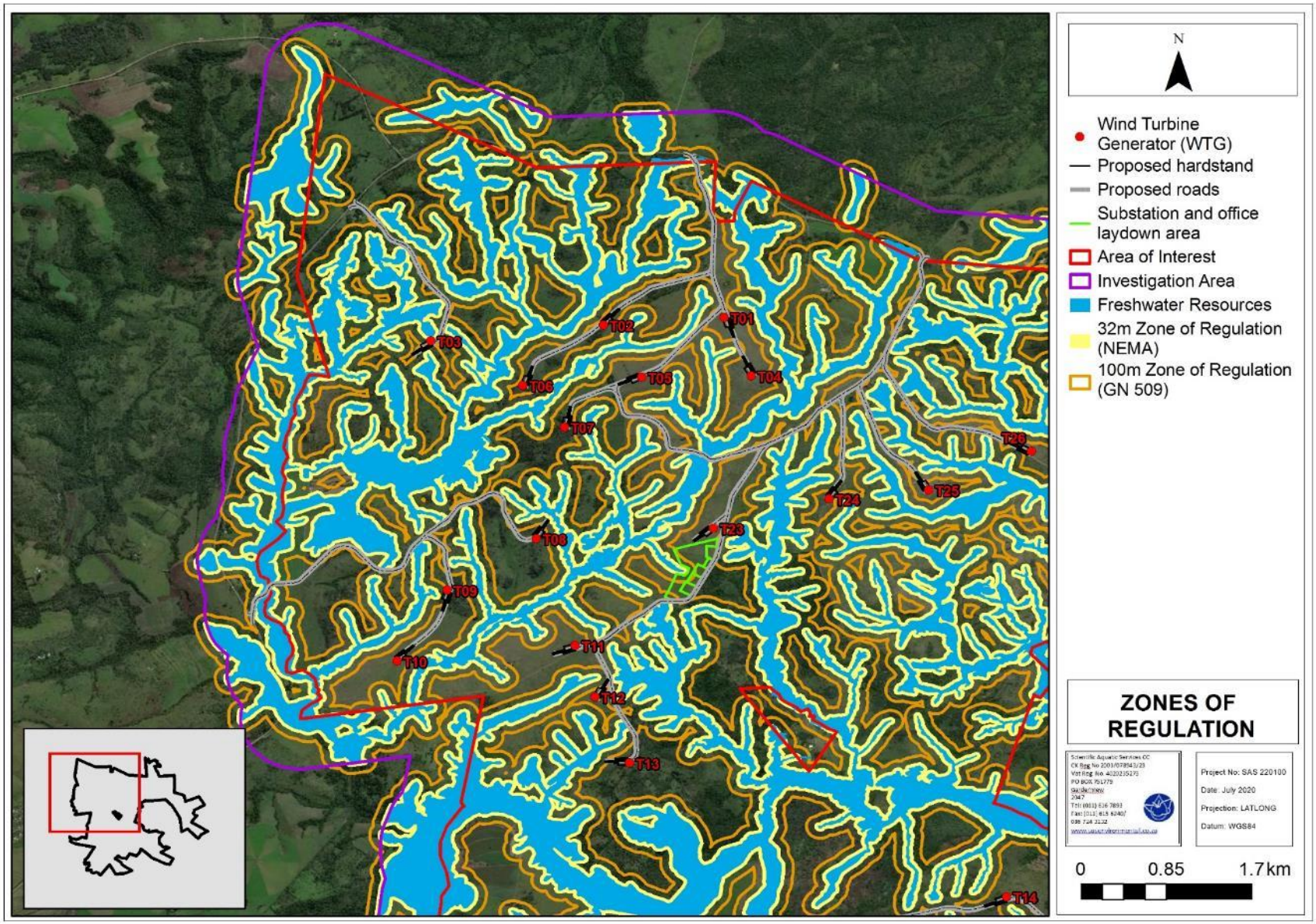


Figure 19: Conceptual presentation of the watercourses within the north-western portion of the AOI and the associated zones of regulation in terms of NEMA and of Regulation GN509 as it relates to the NWA.

6 RISK ASSESSMENT

Following the assessment of the watercourses in the AOI, the DWS specified Risk Assessment Matrix (as promulgated in GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)) was applied to ascertain the significance of risk associated with the proposed WEF development on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the watercourses.

When evaluating the potential impacts of the proposed WEF development on the watercourses, the following aspects were taken into consideration:

- No wind turbines, nor their associated hardstands are located within any watercourses;
- Since all turbine are located at least 50 m from the delineated extent of a watercourse, the potential of edge effects impacting on these watercourses during the construction phase is unlikely;
- The proposed hardstand of Turbines 3, 30 and 31 and the proposed substation and office laydown area encroaches on the 32 m NEMA Zone of Regulation. However, due to the distance all other turbines are from any watercourses and the distance of the hardstanding infrastructure of the abovementioned turbines from such watercourses, negligible impacts from the operation of these infrastructure components is expected;
- The road layout proposed as part of the WEF project includes eleven (11) existing watercourse crossings. Since these roads are proposed to be upgraded, impacts (albeit limited) are expected to occur on these watercourses. Four (4) new roads are proposed to traverse watercourses. Even though limited impact with regards to road construction is expected to occur on the watercourses, care should nevertheless be taken to prevent any edge effects from the road construction within the vicinity of watercourses to occur;
- The proposed layout of the underground cabling would entail the crossing of several watercourses, which would be impacted by the construction activities, since the cables would be installed by means of open trenching;
- All activities related to the construction of the infrastructure components which form part of the proposed WEF development are all highly site specific, not of a significant extent relative to the area of the watercourses assessed, and therefore have a limited spatial extent;
- While the operation of the wind turbines and use of the roads will be a permanent activity, the construction thereof is envisioned to take between 18 – 30 months. However, the frequency of intensive construction impacts may only take a few months during this time;
- All impacts are considered to be easily detectable and the mitigation measures thereof are considered to be easily practicably implementable; and
- It is highly recommended that the proponent make provision for small-scale rehabilitation of the areas of the watercourses which may be impacted upon by edge effects relating to construction activities, as this will aid in restoring the ecology of any affected systems, thereby improving ecological service provision and aiding in minimising risks such as further erosion or flooding. During such rehabilitation, focus should take place on biodiversity reinstatement (i.e. remove invasive alien vegetation and reinstate indigenous freshwater vegetation) and functionality of the watercourses. The area must then be rehabilitated to conditions as close as possible to the original or pre-construction state.

6.1 Risk Analyses

5.1.1 Consideration of impacts and application of mitigation measures

The results of the risk assessment are summarised in Table 5 below, including key mitigation measures for each activity. There are four key ecological impacts on the watercourses that are anticipated to occur namely:

- Loss of riparian habitat and ecological structure;
- Changes to the sociocultural and service provision;
- Impacts on the hydrology and sediment balance of the riparian system; and
- Impacts on water quality.

The risk assessment was applied once for all the identified watercourses (Quko River its tributaries, and the headwaters/non-perrenial watercourses of the Quko, Haga-Haga, Mtendwe and Nyarha river systems). The sensitivity of these systems does not vary to a large extent and are considered to be in a relatively good ecological state with only a few modifications to these systems, thus the risk assessment matrix was only applied once for the construction of the proposed infrastructure components on all the watercourses. However, it should be noted that the results of the risk assessment are focused on that of the larger riparian features (rivers and large tributaries), since the risk to the non-perrenial watercourses is expected to be lower than that of these larger resources. This is due to the fact that the construction of the WEF infrastructure components across the smaller non-perrenial watercourses would lead to lower level of disturbance to the freshwater environment.

Due to the fact that some of the proposed infrastructure components of the WEF directly traverse several watercourses (i.e. internal roads and proposed underground cables), the default score for impacts on flow connectivity, geomorphology, biota and habitat is '5' ('extremely harmful') as per the risk assessment methodology. Similarly, the default score for legal issues is also '5' ('fully covered by legislation') since the activity is within the 100 m Zone of Regulation in terms of GN509. However, the construction of the proposed WEF is considered to be a relatively low impact activity of a relatively short duration in isolated localities with strict implementation of cogent, well-developed, activity-specific mitigation measures (see Appendix E) are implemented. Therefore, the manual adjustment of the risk ratings from 'Medium' to 'Low' is considered justifiable. Allowance for this has been made for scores which are just outside the Low risk class, which can be manually amended (to a maximum of 25), after considering additional mitigation measures, alternatives (methods) or specific activities, in order to reduce the risk rating class.

The overall construction activities related to the proposed WEF infrastructure components is deemed to pose a 'Low' risk significance to the watercourses. This is due to the locality of most of the proposed infrastructure components (i.e. the wind turbines and associated hardstands and the office/laydown area/BESS) located outside of the watercourses (with the exception of several cable/road crossings). Nevertheless, edge effects from the construction activities could possibly have an influence on the freshwater environment, however, if the set-out mitigation measures as recommended in Appendix E, are implemented and adhered to, these activities would only pose a 'Low', if not a negligible risk significance. Care should specifically be taken with the construction activities of the hardstanding infrastructure associated with Turbines 3, 30 and 31, as these crane pads are located within the 32 m Zone of Regulation, and edge effects are considered more likely to occur (albeit still of 'Low' risk significance) than with the above-mentioned infrastructure component.

It was determined that the excavation of the trenches for installation of the underground cabling would pose a 'Medium' risk significance to the watercourses. These cables would cross several non-perrenial watercourses of the Quko River system as well as the Quko River itself. It is recommended that the installation of the underground cabling rather be installed by means of directional drilling underneath

the watercourses rather than through open trenching. Taking the effects of the surrounding agricultural practices and the presence of alien invasive species into account and implementing this specific mitigation measure, the manual adjustment of the risk rating of this activity from 'Medium' to 'Low' significance could be justified. Other mitigation measures would also include preventing the sedimentation and erosion of the watercourses and limiting the diversion of flow (specifically of the Quko River) during the installation of the cables.

The construction of four (4) new road crossings and the upgrading of the existing watercourse road crossings could also be considered to pose a 'Medium' risk to the watercourses. Since most of these roads are existing road crossings which have historically impacted on the watercourses, from which it is expected that these features have already hydrologically adjusted the initial impact thereof, the risk rating can be justified to be reduced to a 'Low' significance, with the proviso that the upgrading activities is to remain in the existing disturbance footprint and the road not extend beyond the road servitude. Also, it is recommended that the construction activities take place in the dry season, applicable erosion prevention measures are implemented, and the compacted areas (due to the upgrading activities) are ripped and revegetated with indigenous vegetation. Should the construction of the new watercourse road crossings be undertaken in the dry period when no surface flow is present and the recommended mitigation measures are applied, the risk significance thereof can be reduced to a 'Low'.

During the operational phase of the WEF development, all infrastructure is considered to pose a 'Low' risk significance to the watercourses. It is however recommended that alien vegetation would establish in disturbed areas even though revegetation of indigenous species was implemented. Therefore, an alien vegetation control plan should be implemented in order to ensure the growth of indigenous vegetation in areas where alien vegetation have previously been identified. Pro-active monitoring of infrastructure components within the watercourses (with specific mention to the road crossings) should be undertaken, in order to identify areas prone to erosion and implement appropriate erosion rehabilitation measures to limit any further sedimentation of the downstream freshwater environment.

Since some of the proposed WEF infrastructure components are located within some of the watercourses and within the 100 m Zone of Regulation thereof, authorisation in terms of Government Notice 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998), would be needed. If the installation of the underground cabling can be installed by means of directional drilling (thus no construction footprint within the watercourses) rather than through open trenching, the impact significance of the installation of the cables would be reduced from a 'Medium' to 'Low' risk significance. If all of the proposed activities would pose a 'Low' risk significance to the watercourses (with the proviso of implementing the specified mitigation measures), these activities could be motivated with the DWS to be authorised in terms of a General Authorisation (GA). However, the regional DWS officer should be consulted and should guide the process to follow in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

The table below provides a summary of the outcomes from the applied DWS Risk Assessment:

Table 6: A summary of the risk assessment relating to the construction and operation of the proposed WEF infrastructure development within the assessed watercourses.

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Reversibility
1	CONSTRUCTION PHASE	Site clearing prior to commencement of construction activities.	Removal of vegetation and associated disturbances to soils.	*Exposure of soils, leading to increased runoff and erosion, and thus increased sedimentation of the watercourses; *Increased sedimentation of watercourses, leading to smothering of biota and potentially altering surface water quality; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	7	8	**56**	**H**	*All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is essential; *Retain as much indigenous vegetation as possible; *All vegetation removed as part of the site clearing activities (specifically where large areas need to be cleared) should be transported from the construction site (may not be stockpiled) and disposed of at a registered waste disposal facility; *The watercourses outside the construction footprint with approved crossings must be considered as no-go areas; *No construction vehicles, nor construction personnel or vehicles may traverse through these watercourses (except on approved road crossings); *Existing roads must be utilised to gain access to sites, and no new access roads may be developed (other than that which are approved) that traverse or are located within the 32 m ZoR; *Contractor laydown areas, and material storage facilities to remain outside of the 32 m ZoR *All vehicle re-fuelling is to take place outside of the 32 m ZoR; and *No vegetation may be removed from the 32 m ZoR surrounding the watercourse where no infrastructure is planned, as this provides a natural buffer zone around the watercourses which disperse surface runoff into the watercourses, and thus prevents sedimentation and erosion thereof.	L (-1)	Fully reversable

No.	Phases	Activity		Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Reversibility
2		Ground-breaking and excavation activities	Excavation of pits for the foundations of the turbine towers within close proximity to watercourses.	Removal of topsoil and creation of soil stockpiles	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered freshwater habitat; and *Altered runoff patterns, leading to increased erosion and sedimentation of the freshwater habitat.	1	4	4	**16**	**L**	*During excavation activities, no stockpiling of soils is to take place within the watercourses and its 32 m ZoR zone of regulation, and stockpiles may not exceed 2 m in height; *Soils excavated from the cable trench must be stockpiled immediately upstream of the trench. Once the cable is installed the trench must be infilled with the removed material and suitably compacted to avoid any erosion and preferential flow paths from forming *All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the watercourses; and *Soil must be recompacted and all construction material must be removed from site upon the completion of construction.	NA	Fully reversable
			Excavation of trenches for the underground cabling through watercourses.			5	7	10	**70**	**M**		L (-14)	Fully reversable
3		Construction of hardstands associated with Turbines 3, 29, 30 and 31 and the substation, laydown area and BESS within the 32 m ZoR of the watercourses		Over compaction of surrounding soils during the construction activities and levelling of the surface within close proximity to the watercourses	*Degradation of the surrounding natural buffer to the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Potential of concentrated flows to enter the watercourses from the construction footprint area.	1,5	4,5	10	**45**	**L**	*Suitable drainage should be insured along the crane pads, in order to ensure that water does not pool on the crane pad or drain in a concentrated manner into the watercourses. This must be considered as part of the stormwater management plan and be overseen by a freshwater ecologist, specifically where hardstand infrastructure is within at least 15 m of a watercourse; *A 10 m construction buffer is allocated surrounding the proposed turbine and hardstanding infrastructure and substation, laydown area and BESS area. Construction activities must be limited to only this area and may not disturb the buffer area surrounding the watercourses, with specific mention of the construction of the hardstand associated with Turbine 30; *No indiscriminate movement of personnel and construction vehicles may be permitted within the 32m NEMA ZoR surrounding the watercourses, in order to prevent degradation on the surrounding natural buffer and keep the habitat intact.	NA	Fully reversable
4				Potential of edge effects to impact on the watercourses		1,5	3,5	10	**35**	**L**		NA	

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Reversibility
5		Upgrading of existing internal gravel roads and construction of four new watercourse crossings	Indiscriminate movement of construction vehicles within the watercourses	*Altering the beds and banks of the watercourses; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	8	8	**64**	**M**	It is considered imperative that watercourse road construction works be undertaken during the dry period to limit surface water contamination and the need for any surface water diversion during the construction works (diverting the flow of water through a pipe or an excavated channel was not included as part of this risk assessment). In so doing, the severity scoring (specifically pertaining to the flow regime) will be significantly reduced as would the frequency of an impact. Should this specific mitigation measure be implemented and with implementation of the below mitigation measures it is the opinion of the freshwater ecologist that the risk of the proposed road crossing construction in the watercourses be deemed 'low': *The design of the new road crossings and the upgrading of existing roads should ensure that no erosion occurs, specifically along the embankments of the watercourse. As such, vegetation must be established in the construction footprint immediately after the construction of the road/ installation of cables is complete; *Material to be used (gravel – if applicable) as part of the upgrading of the existing roads must be stockpiled outside the 32 m NEMA ZoR of the watercourses to prevent sedimentation thereof and to avoid any other vegetation being impacted by the construction activities. These stockpiles may not exceed a height of 2 m and should be protected from wind using tarpaulins *New road crossings must intersect the watercourse at a right angle (perpendicular) to minimise disturbance to the watercourse; and *During the construction of roads that may potentially traverse watercourses/upgrading of existing roads, a buffer of no more than 5 m on either side of the proposed road crossing footprint through the watercourses may be impacted. This area must be cordoned off, and no vehicles or personnel are permitted outside of the authorised construction area.	L (-8)	Fully reversable
			Over compaction of surrounding soils during the upgrading/construction activities and levelling of the road surface within watercourses.		5	7	10	**70**	**M**		L (-14)	Fully reversable
			Stockpiling of gravel within delineated watercourses.		5	7	9	**63**	**M**		L (-7)	Fully reversable

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Reversibility
6		Infrastructure transportation and storage	Potential for in discriminant movement of vehicles through the watercourses.	*Altering the beds and banks of the watercourses; *Impeding the flow of water; *Compaction of soil within the watercourses; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	8	9	**72**	**M**	*All roads should be designed in accordance to turbine requirements as well as anticipated weight restrictions; *Laydown areas, stockpiling and construction camps will be located outside of any watercourses and any associated buffers.	L (-16)	Fully reversable
			Stockpiling of turbine infrastructure within watercourses.		5	7	8	**56**	**H**		L (-1)	
			Potential poor placement of construction site within watercourses.		5	7	8	**56**	**H**		L (-1)	
7		Potential indiscriminate waste disposal	Disposal of construction-related wastes (such as rubble, hazardous chemicals and litter).	*Altered flow regime as a result of solid wastes within the freshwater resource; and *Altered water quality due to chemical waste disposal.	5	7	9	**63**	**M**	*All waste must be removed from site and disposed of at a licensed landfill site; and *Any waste concrete and other foreign material used or generated during construction must be demolished and removed from site. All rubble and waste will be disposed of at a suitably registered landfill site.	L (-7)	Fully reversable
8		Potential spillage from construction vehicles	Spills / chemical leaks from construction vehicles	Possible contamination of freshwater soils and surface water, leading to reduced ability to support biodiversity.	5	7	9	**63**	**M**	Dedicated parking area for construction vehicles must be located away from sensitive areas, and drip trays must be located beneath any leaking equipment and lubricant/fuel absorbing media (moss/peat type products) within drip trays must be used to contain spilled material. The absorbing material in the drip trays must be replaced regularly as to prevent over-saturation and potential spillage. This hazardous waste must be collected by an approved contractor/delivered to an approved waste disposal site.	L (-7)	Fully reversable

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Reversibility
9	OPERATIONAL PHASE	Maintenance activities	Vegetation maintenance within the watercourses	*Altering the beds and banks of the watercourses; *Disturbance of soils and on-going erosion as part of maintenance activities; and *Impeding the flow of water.	5	7	7	**49**	**L**	*No indiscriminate movement of construction equipment through the watercourses may be permitted during standard operational activities or maintenance activities. Use must be made of the existing watercourse crossings only; *Unnecessary disturbances surrounding the perimeter of the surface infrastructure must be avoided; *Vehicles used in the development site must be regularly washed (on a non-permeable surface or off-site) to avoid the dispersal of seeds on any alien or invasive species into the watercourses *Ensure that routine inspections and monitoring of any instream infrastructure are undertaken to monitor any build-up of debris that will impact on structure integrity or lead to erosion and sedimentation. Furthermore, monitoring to determine the establishment of indigenous vegetation and the presence of any alien or invasive plant species; *The surface infrastructure areas must be inspected to ensure that no concentrated runoff from these areas forms erosion gullies leading to erosion and sedimentation of receiving watercourses. Should these impacts be noted, these gullies/preferential flow paths must be infilled with in situ material and appropriately stabilised and/or revegetated; and *Monitoring for the establishment for alien and invasive vegetation species must be undertaken, specifically at the road crossings and surface infrastructures. Should alien and invasive plant species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation.	NA	Fully reversable
			Maintenance of roads crossing the watercourses									Fully reversable
10		Loss of surrounding ecosystem services	In discriminant driving of maintenance vehicles within the watercourses							Maintenance vehicles must use existing roads only and not be allowed to indiscriminately drive through the rivers or their buffer zones.		Fully reversable

5.1.2 Impact Mitigation

General "good practice" mitigation measures applicable to the proposed WEF development activities are provided in **Appendix E**, and these should be implemented in conjunction with those stipulated below.

a) Construction Phase

- Areas which are to be cleared of vegetation, including contractor lay-down areas which should be located outside of any watercourses and its 32m NEMA ZoR and must remain as small as possible in order to reduce the risk of proliferation of alien vegetation. It is highly recommended that an alien and invasive vegetation management plan be compiled during the planning phase and implemented concurrently with the commencement of construction;
- All storage of construction materials should remain out of all the watercourses;
- Construction vehicles must only make use of existing and new roads (those which are approved) and not be allowed to indiscriminately drive through watercourses;
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration (see Section 4.4), and wherever possible, existing roads should be utilised. If crossings are required they should cross the system at right angles, as far as possible to minimise impacts on the receiving environment, and any areas where bank failure is observed due to the effects of such crossings should be immediately repaired by reducing the gradient of the banks to a 1:3 slope and where necessary, installing support structures. This should only be necessary if existing access roads are not utilised;
- Crossing structures must ensure that no concentration of flow occurs and that downstream scouring does not take place;
- All alien and invasive vegetation should be removed within the footprint area of the proposed project. Any vegetation removed should be taken to a registered landfill site so as to prevent proliferation of alien and invasive species;
- Avoid unnecessary site clearing/vegetation clearing as far as possible;
- All exposed soils should be revegetated as soon as possible in order to prevent erosion and loss of topsoil;
- Any cement mixing should be done within the designated batching area only and must not be mixed within close proximity to the rivers or its associated buffer zones; and
- Concurrent rehabilitation of the freshwater areas impacted by the proposed Haga Haga WEF is to take place and footprint areas should be minimised as far as possible.

b) Rehabilitation upon completion of Construction Activities

- Any waste concrete and other foreign material used during construction must be demolished and removed from site. All rubble and waste will be disposed of at a suitably registered landfill site;
- Any soil excavated (i.e. for trenches for installation of underground cabling) should be reinstated and re-profiled as much as possible. Any remaining soil is to be removed from the site to a registered landfill site; and
- Implementation of an alien vegetation control program is recommended for the watercourses impacted by construction activities.

c) Operational Phase Activities

- Any area where active erosion was observed within the impacted on watercourses must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible;
- Implementation of an alien vegetation control program should be done for the bankside of the affected freshwater, which may possibly be traversed by the proposed WEF infrastructures; and

- All impacted features within the AOI should be continuously monitored for any further erosion and incision from construction activities.

6.2 Cumulative Impacts

Other activities within the vicinity of the proposed Haga Haga WEF project include a proposed grid connection which is associated with the Haga Haga WEF. A dolerite mine is also proposed in between Morgans Bay and Kei Mouth (located to the south east of the AOI, outside the AOI). Existing infrastructure include roads, road crossings, surrounding small-scale agricultural activities, bridges and rural developed areas/villages.

Aspects pertaining to the impacts of most activities include:

- Site clearing, compaction and disturbance of soils in the vicinity of watercourses;
- Changes to biodiversity maintenance, streamflow regulation capabilities, sediment balance etc. of the watercourses catchment runoff; and
- Erosion, canalisation, increased runoff and sedimentation of features.

The proposed WEF infrastructure components would contribute to the cumulative impacts on the natural environment in the vicinity of the proposed project together with existing and proposed future infrastructure. The proposed WEF traverses a vast area (as indicated in Figure 1), where impacts are expected to occur upon several watercourses. If the mitigation measures, as set out in this report are adhered to, impacts from the proposed WEF construction activities will not exceed the boundaries of the AOI and the cumulative impact on the larger catchment will be limited.

6.3 No Go Alternative

It is assumed that a no-go alternative will not result in impacts on the watercourses within the AOI and will not result in any additional disturbance to the watercourses as a result of direct construction related activities. However, the watercourses may be somewhat impacted as a result of continued alien and invasive vegetation proliferation, and as a result of small scale surrounding agricultural activities and rural development. The impact of a no-go alternative is therefore considered to be of a very low to negligible significance.

7 CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater resource assessment as part of the environmental assessment and authorisation process for the proposed Haga Wind Energy Facility (WEF) and its associated infrastructure components, located in the vicinity of Komga and Soto in the Eastern Cape.

The background information available from the national and provincial databases indicated that several wetlands and rivers occurred within the AOI. However, upon assessment during the site visit, the wetlands indicated were identified to be artificial farm dams/ impoundments. An extensive drainage network was identified within the AOI, in which non-perrenial watercourses and tributaries drain into several rivers (Quko, Haga-Haga, Mtendwe and Nyarha rivers) within and outside the boundary of the AOI. Despite to the surrounding agricultural activities and existing road infrastructures, the overall freshwater environment is considered to only be marginally affected and in good ecological condition.

The proposed WEF layout indicated that some of the roads (new and existing) and underground cables would cross the assessed watercourses. Even though the risk assessment indicated the risk rating to be of 'Medium' for these specific activities during the operational phase, it is the opinion of the freshwater ecologist that the risk rating could be adjusted to a 'Low' risk significance, with the proviso that the stipulated mitigation measures as recommended in this report, are implemented.

Provided that appropriate impact assessment measures are taken, it is the opinion of the ecologist that the watercourse systems are unlikely to be altered significantly by the WEF infrastructure components and the construction thereof will benefit from the already existing road network and historical localised impact of the local watercourses. Furthermore, the freshwater environment in this region are highly connected and have numerous tributaries, suggesting that a small impact to a small portion of these watercourses within the zone of influence of the development, is unlikely to have significant impacts to the greater drainage network of the region.

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APPENDIX A: INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS CC and its staff reserve the right, at their sole discretion, to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

APPENDIX B: LEGISLATIVE REQUIREMENTS

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act (Act No. 107 of 1998) (NEMA)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Environmental Management: Biodiversity Act (2004) (Act 10 of 2004) (NEMBA)	**Ecosystems that are threatened or in need of protection** (1) (a) The Minister may, by notice in the Gazette, publish a national list of ecosystems that are threatened and in need of protection. *(b)* An MEC for environmental affairs in a province may, by notice in *the Gazette,* publish a provincial list of ecosystems in the province that are threatened and in need of protection. (2) The following categories of ecosystems may be listed in terms of subsection (1): *(a)* critically endangered ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation; *(b)* endangered ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems; (c) vulnerable ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and *(d)* protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed in terms of paragraphs *(a), (b)* or (c).
The National Water Act 1998 (Act No. 36 of 1998) (NWA)	The National Water Act (NWA) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: ➢ The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; ➢ In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or ➢ A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation;

	ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.

APPENDIX C: METHOD OF ASSESSMENT

Literature Review

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the area of interest included:

- National Freshwater Ecosystem Priority Areas (NFEPAs, 2011);
- Sub water catchment area FEPAs;
- Water management area FEPAs;
- Fish sanctuaries; and
- Wetland ecosystem types.

National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), Department of Water Affairs (DWA), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).
The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present within the area of interest.

Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

The river encountered during site assessment was assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table C1: Classification System for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4:HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the classification system, Inland Systems are defined as **aquatic ecosystems that have no existing connection to the ocean**[5] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et. al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions

[5] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.
The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups' vegetation types across the country, according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting
At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units
Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table C2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for

example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et. al*., 2008) and WET-EcoServices (Kotze *et. al*., 2009).

Index of Habitat integrity

To assess the PES of the river identified, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the wetland or riparian system being examined.

Table C3: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

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

Habitat Integrity (IHIA)

It is important to assess the habitat of each site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site should be discussed based on the application of the Intermediate Habitat Integrity Assessment (IHIA) for (Kemper, 1999) which can be considered a regional best practice tool for site specific assessments. The IHIA protocol, as described by Kemper (1999), should be used for site specific assessments. The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site should be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones should be analysed separately, and the final assessment should be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data should be carried out by weighting each of the criteria according to Kemper (1999). By

calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site and for the overall system according to the 6 Category Ecostatus classification method.

Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[6]. Results are defensible because their generation can be traced through an outlined process. The latter pertains to a suite of rules that convert assessor estimates into ratings and converts multiple ratings into an Ecological Category.

Table C4: Descriptions of the A-F ecological categories.

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 have occurred, but the basic ecosystem functions are still predominately 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

Wet-Ecoservices (2009)

"The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class" (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;

[6] Kleynhans et al, 2007b

- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purposed of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C6) of the wetland system being assessed.

Table C6: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure" (DWA, 1999).

The REC (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above), and is followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Table C7: Description of REC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

Freshwater resource delineation

The riparian delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" published by DWAF in 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).
According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators, and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material

Risk Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[7]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as freshwater features, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for

[7] The definition has been aligned with that used in the ISO 14001 Standard.

likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[8].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table C8: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat).

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table C9: Spatial Scale (How big is the area that the aspect is impacting on).

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table C10: Duration (How long does the aspect impact on the resource quality).

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table C11: Frequency of the activity (How often do you do the specific activity).

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table C12: The frequency of the incident or impact (How often does the activity impact on the resource quality).

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

[8] Some risks/impacts that have low significance will however still require mitigation

Table C13: Legal issues (How is the activity governed by legislation).

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table C14: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource).

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table C15: Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

Table C16: Calculations.

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence x Likelihood

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for construction phase and operational phase; and
- Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[9] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and

[9] Mitigation measures should address both positive and negative impacts

- Offsetting.

- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the wetland ecology of the resources in traversed or in close proximity of the proposed pipelines.

APPENDIX D: FRESHWATER ASSESSMENT RESULTS

PRESENT ECOLOGICAL STATE (PES), ECOSERVICES AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table D1: The Riparian IHI present ecological condition calculated for the Quko River and its tributaries.

RIPARIAN IHI	
Base Flows	-0,5
Zero Flows	0,0
Moderate Floods	0,5
Large Floods	0,0
HYDROLOGY RATING	**0,2**
Substrate Exposure (marginal)	1,5
Substrate Exposure (non-marginal)	1,0
Invasive Alien Vegetation (marginal)	0,5
Invasive Alien Vegetation (non-marginal)	0,5
Erosion (marginal)	1,0
Erosion (non-marginal)	1,0
Physico-Chemical (marginal)	0,0
Physico-Chemical (non-marginal)	0,0
Marginal	1,5
Non-marginal	1,0
BANK STRUCTURE RATING	**1,3**
Longitudinal Connectivity	0,0
Lateral Connectivity	0,0
CONNECTIVITY RATING	**0,0**
RIPARIAN IHI %	**87,3**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**3,0**

Table D2: The overall VEGRAI score of the portion of the Quko River and its tributaries, within the AOI.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	73,3	45,8	3,3	1,0	100,0
NON MARGINAL	80,0	30,0	0,0	2,0	60,0
	2,0				160,0
LEVEL 3 VEGRAI (%)				75,8	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				1,7	

Table D3: PES calculated for the non-perrenial watercourses.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,8**		
Hydrology	1	100	1,8	*3,2*	**C**
Geomorphology	2	80	2,0	*3,8*	**C/D**
Water Quality	3	30	1,5	*2,0*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**1,6**	***4,0***	
Vegetation Alteration Score	1	100	1,6	*4,0*	**C**
OVERALL SCORE:			**1,7**		
	PES %		**65,6**		
	PES Category:		**C**		

Table D4: Presentation of the EIS assessment applied to the watercourses.

FRESHWATER FEATURE:			Quko River and tributaries	Non-perrenial watercourses
Ecological Importance and Sensitivity			**Score (0-4)**	
Biodiversity support			**A (average)**	
			1,67	1,33
Presence of Red Data species			1	1
Populations of unique species			2	2
Migration/breeding/feeding sites			2	1
Landscape scale			**B (average)**	
			1,80	1,60
Protection status of the wetland			2	2
Protection status of the vegetation type			3	2
Regional context of the ecological integrity			1	1
Size and rarity of the wetland type/s present			1	1
Diversity of habitat types			2	2
Sensitivity of the wetland			**C (average)**	
			1,67	1,00
Sensitivity to changes in floods			2	1
Sensitivity to changes in low flows/dry season			2	1
Sensitivity to changes in water quality			1	1
ECOLOGICAL IMPORTANCE & SENSITIVITY (max of A,B or C)			**B**	**B**
Hydro-Functional Importance			**Score (0-4)**	
Regulating & supporting benefits	**Flood attenuation**		1	1
	Streamflow regulation		1	1
	Water Quality Enhanc	**Sediment trapping**	2	2

		Phosphate assimilation	2	2
		Nitrate assimilation	2	1
		Toxicant assimilation	2	1
		Erosion control	2	1
	Carbon storage		0	0
HYDRO-FUNCTIONAL IMPORTANCE (average score)			2	1
Direct Human Benefits			Score (0-4)	
Subsistence benefits	Water for human use		1	0
	Harvestable resources		1	1
	Cultivated foods		0	0
Cultural benefits	Cultural heritage		1	1
	Tourism and recreation		1	1
	Education and research		1	0
DIRECT HUMAN BENEFITS (average score)			0,83	0,50

Table D5: Watercourses functions and service provision scores.

Ecosystem service	Quko River and tributaries	Non-perennial watercourses
Flood attenuation	1,3	1,4
Streamflow regulation	1,4	1,2
Sediment trapping	1,8	1,8
Phosphate assimilation	2,0	1,6
Nitrate assimilation	2,6	1,9
Toxicant assimilation	2,4	1,6
Erosion control	2,8	2,0
Carbon Storage	1,5	1,0
Biodiversity maintenance	2,0	1,8
Water Supply	1,7	1,2
Harvestable resources	2,0	1,8
Cultivated foods	1,6	1,6
Cultural value	1,0	1,0
Tourism and recreation	1,6	1,0
Education and research	1,8	1,0
SUM	**27,4**	**21,8**
Average score	**1,8**	**1,5**

APPENDIX E: RISK ANALYSIS

General management and good housekeeping practices
The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the proposed Haga WEF.

Development and operational footprint

- Sensitivity maps have been developed for the AOI, indicating the freshwater environments, and the applicable regulatory zones in accordance with NEMA (Act 107 of 1998), as shown in Figures 15 to 18. It is recommended that these sensitivity maps be considered during all phases of the development and with special mention of the planning of infrastructure layout and positioning of the turbines, to aid in the conservation of the freshwater habitats within the AOI;
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive areas. It must be ensured that the watercourses, and their associated regulatory zones are off-limits to construction vehicles and personnel;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Planning of temporary and maintenance roads and access routes should take the site sensitivity plan into consideration, and wherever possible, existing roads should be utilised. If additional roads are required, then wherever feasible such roads should be constructed a distance from the more sensitive riparian areas and not directly adjacent thereto. If crossings are required they should cross the system at right angles, as far as possible to minimise impacts in the receiving environment, and any areas where bank failure is observed due to the effects of such crossings should be immediately repaired by reducing the gradient of the banks to a maximum of a 1:3 slope and where needed necessary, installing support structures. This should only be necessary if existing access roads are not utilised;
- All areas of increased ecological sensitivity should be marked as such and be off limits to all unauthorised construction and maintenance vehicles and personnel;
- The duration of possible impacts on the freshwater system should be minimised as far as possible by ensuring that the duration of time in which possible flow alteration and sedimentation will take place is minimised;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;
- All hazardous chemicals should be stored on bunded surfaces and no storage of such chemicals should be permitted within the riparian buffer zones;
- No informal fires should be permitted in or near the construction areas;
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills; and
- Edge effects of activities, particularly erosion and alien/weed control need to be strictly managed.

Vehicle access

- All areas of increased ecological sensitivity should be marked as such and kept off limits to all unauthorised construction and maintenance vehicles as well as personnel;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- All spills, should they occur, should be immediately cleaned up and treated accordingly; and
- During maintenance activities, vehicles must only be driven on existing, maintained access roads and not drive indiscriminately through natural areas.

Alien plant species

- Proliferation of alien and invasive species is expected within any disturbed area, even though there were only a few localised areas where alien and invasive species were identified within the AOI at the time of the assessment. These species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers

of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, decommissioning and rehabilitation/ maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species; and
  - No vehicles should be allowed to drive through designated sensitive watercourses and riparian areas during the eradication of alien and weed species.

Freshwater resource habitat

- Ensure that as far as possible all infrastructure is placed outside of freshwater resource areas and their respective buffer zones. If these measures cannot be adhered to, strict mitigation measures, will be required to minimise the impact on the receiving watercourses;
- Permit only essential construction personnel within 32m of the freshwater habitat, if absolutely necessary that they enter the regulatory zone;
- Limit the footprint area of the construction activities to what is only essential in order to minimise environmental damage;
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the freshwater resource areas; and
- Implement effective waste management in order to prevent construction related waste from entering the freshwater environments.

Soils

- Incorporate adequate erosion and stormwater management measures during all phases of the project, in order to prevent erosion and the associated sedimentation of the watercourses. Management measures may include berms, silt fences, hessian curtains, stormwater diversion away from areas susceptible to erosion and stormwater attenuation. Care should however be taken so as to avoid additional disturbance during the implementation of these measures. In this regard, specific attention should be given to the attenuation of stormwater in order to prevent erosion;
- Strategic installation of erosion berms should be implemented during construction to slow down runoff from compacted surfaces (such as the gravel roads), prevent gully formation and slow down sheet runoff. Berms every 50 m should be installed where any disturbed soils have a slope of less than 2 %, every 25 m where the track slopes between 2 % and 10 %, every 20 m where the track slopes between 10 % and 15 % and every 10 m where the track slope is greater than 15 %;
- Any areas where active erosion is observed must be immediately rehabilitated (re-shaping of slopes, revegetation with indigenous species where necessary, etc.) in such a way as to ensure that the hydrology and geomorphological characteristics of the area are re-instated to conditions which are as natural as possible;
- A soil management plan, including erosion / run-off control for construction phase should be developed and implemented;
- Concurrent rehabilitation of the non-perrenial watercourses being crossed, should take place throughout the construction and operational phases of this development, in order to limit further erosion and thus sedimentation of the downgradient freshwater system;
- Any areas where bank failure is observed, due to the effects of the crossings, should be immediately repaired by employing one of the individual techniques below or a combination thereof, including:
  - Re-sloping of banks to a maximum of a 1:3 slope;
  - Revegetation of re-profiled slopes; and
  - Temporary stabilisation of slopes using geotextiles
- No stockpiles must be permitted within the watercourses or its associated 32 m buffer zone. All soil stockpiles must be protected by water diversion berms on the upgradient edge of the

stockpile and a suitable geotextile such as Geojute or hessian sheeting, to avoid runoff and sediment from the stockpiles reaching the freshwater resource and/or riparian habitat;

- Such stockpiles must either be removed or levelled following the completion of construction activities;
- As it is unavoidable that the watercourses will be affected, disturbance to the watercourses must be minimised and suitably rehabilitated. The design of the maintenance interventions should allow for the watercourses soil conditions to be maintained both upstream and downstream to such a degree that the freshwater resource vegetation community structures are maintained;
- Storm water must be managed accordingly to ensure that no sediment deposits occur within the freshwater resource; and
- Monitor areas close to the freshwater resource for further erosion and incision, during site clearing in the pre-construction phase and throughout the construction phase.
-

Rehabilitation

- All soils compacted as a result of construction activities falling outside of the project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive vegetation control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat to the freshwater feature that would possibly be impacted on by the proposed Haga WEF construction;
- Rehabilitate all freshwater habitat areas possibly affected by the proposed Haga WEF operations and continuous road usage to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these affected areas;
- As far as possible, all rehabilitation activities should occur in the low flow season, during the drier summer months;
- As much vegetation growth as possible should be promoted within the proposed wind turbine and road construction area in order to protect soils;
- All alien vegetation identified should be removed from rehabilitated areas and reseeded with indigenous vegetation as specified by a suitably qualified specialist (ecologist);
- All areas affected by the wind turbine and road construction should be rehabilitated upon completion of the construction activities; and
- The proposed activities footprints and rehabilitated construction areas must be inspected every six months for erosion and measures must be implemented to curb erosion

Table E1: Outcome of the DWS Risk Assessment.

No.	Phases	Activity	Aspect	Impact	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Borderline LOW MODERATE Rating Classes
1	CONSTRUCTION PHASE	Site clearing prior to commencement of construction activities.	Removal of vegetation and associated disturbances to soils.	*Exposure of soils, leading to increased runoff and erosion, and thus increased sedimentation of the freshwater resources; *Increased sedimentation of freshwater resources, leading to smothering of biota and potentially altering surface water quality; *Impeding the flow of water; *Compaction of soil within the freshwater resources; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	1	1	7	1	1	5	1	8	**56**	**H**	80	L (-1)
2		Groundbreaking and excavation activities: Excavation of pits for the foundations of the turbine towers within close proximity to freshwater resources	Removal of topsoil and creation of soil stockpiles	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered freshwater habitat; and *Altered runoff patterns, leading to increased erosion and sedimentation of the freshwater habitat.	1	1	2	4	1	1	1	1	4	**16**	**L**	80	NA
		Groundbreaking and excavation activities: Excavation of trenches for the underground cabling through freshwater resources			5	1	1	7	2	2	5	1	10	**70**	**M**	80	L (-14)
		Construction of hardstands associated with Turbines 3, 30 and 31 within the 32 m ZoR of the watercourses	Over compaction of surrounding soils during the upgrading/construction activities and levelling of the road surface within freshwater resources	*Altering the beds and banks of the freshwater resources; *Impeding the flow of water; *Compaction of soil within the freshwater resources; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and	1,5	1	2	4,5	2	2	5	1	10	**45**	**L**	80	NA

No.	Phases	Activity	Aspect	Impact	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Borderline LOW MODERATE Rating Classes
			Stockpiling of gravel and topsoil within delineated freshwater features	*Impacts on hydrological function and sediment balance.	1,5	1	1	3,5	2	2	5	1	10	**35**	**L**	80	NA
3		Upgrading of existing internal gravel roads and construction of three new watercourse crossings	Indiscriminate movement of construction vehicles within the freshwater features	*Altering the beds and banks of the freshwater resources; *Impeding the flow of water; *Compaction of soil within the freshwater resources; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	2	1	8	1	1	5	1	8	**64**	**M**	80	L (-8)
			Over compaction of surrounding soils during the upgrading/construction activities and levelling of the road surface within freshwater resources		5	1	1	7	2	2	5	1	10	**70**	**M**	80	L (-14)
			Stockpiling of gravel within delineated freshwater features		5	1	1	7	2	1	5	1	9	**63**	**M**	80	L (-7)
4		Infrastructure Transportation and Storage	Potential for in discriminant movement of vehicles through the freshwater resources	*Altering the beds and banks of the freshwater resources; *Impeding the flow of water; *Compaction of soil within the freshwater resources; *Loss of habitat and ecological structure; *Changes to ecological and socio-cultural service provision; and *Impacts on hydrological function and sediment balance.	5	2	1	8	2	1	5	1	9	**72**	**M**	80	L (-16)
			Stockpiling of turbine infrastructure within freshwater resources		5	1	1	7	1	1	5	1	8	**56**	**M**	80	L (-1)
			Potential poor placement of construction site within freshwater resources		5	1	1	7	1	1	5	1	8	**56**	**M**	80	L (-1)
5		Potential indiscriminate waste disposal	Disposal of construction-related wastes (such as rubble, hazardous chemicals and litter)	Altered flow regime as a result of solid wastes within the freshwater resource Altered water quality due to chemical waste disposal	5	1	1	7	2	1	5	1	9	**63**	**M**	80	L (-7)

No.	Phases	Activity	Aspect	Impact	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Borderline LOW MODERATE Rating Classes
6		Potential spillage from construction vehicles	Spills / chemical leaks from construction vehicles	Possible contamination of freshwater soils and surface water, leading to reduced ability to support biodiversity	5	1	1	7	2	1	5	1	9	**63**	**M**	80	L (-7)
7	OPERATIONAL PHASE	Maintenance activities	Vegetation maintenance within the freshwater resources	*Altering the beds and banks of the freshwater resources; *Disturbance of soils and on-going erosion as part of maintenance activities; and *Impeding the flow of water.	5	1	1	7	2	2	1	2	7	**49**	**L**	80	NA
			Maintenance of roads crossing the freshwater resources														
8		Loss of surrounding ecosystem services	In discriminant driving of maintenance vehicles within the freshwater resources														

APPENDIX F: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Christel du Preez	MSc Environmental Sciences (North West University)
Stephen van Staden	MSc Environmental Management (University of Johannesburg)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	SAS Environmental Gorup of Companies		
Name / Contact person:	Christel du Preez		
Postal address:	221 Riverside Lofts, Tygerfalls Boulevard, Bellville,		
Postal code:	7539	Cell:	074 580 6823
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	christel@sasenvgroup.co.za		
Qualifications	MSc Environmental Sciences (North West University)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Christel du Preez, declare that -

- I act as the independent specialist in this application;
- I 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 declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my 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 for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

C du Preez

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1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I 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 declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my 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 for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

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SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Senior Scientist (Watercourse ecology)
Joined SAS Environmental Group of Companies	2016

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional member of the South African Council for Natural Scientific Professions (SACNASP) (SACNASP – Reg No. 120240/19)
Member of the Western Cape Wetland Forum (WCF)
Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2017
BSc Hons Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

Short Courses

Wetland and Aquatic plant Identification presented by Carin van Ginkel (Crispis Environmental)	2019
Wetland Management: Introduction and Delineation presented by the Centre of Environmental Management University of the Free State	2018
Tools for Wetland Assessment presented by Prof. F. Ellery and Rhodes University	2017
Basic Principles of ecological rehabilitation and mine closure presented by the Centre for Environmental Management North West University	2015

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Limpopo, Western Cape, Northern Cape, Eastern Cape

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan

SAS ENVIRONMENTAL GROUP OF COMPANIES
SPECIALIST CONSULTANT INFORMATION –

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing Member, Group CEO, Water Resource Discipline Lead, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SEGC	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health Practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018
Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy)	2018

CORE FIELDS OF EXPERTISE

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

Freshwater Assessments

- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant Species and Landscape Plans
- Freshwater Offset Plans
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Biodiversity Offset Plan

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments