SURFACE WATER & HYDROLOGICAL ASSESSMENT REPORT

10MVA 132/11KV OLIFANTSHOEK SUBSTATION

August 2017

Prepared by:

Gerhard Botha (Pri Sci Nat: Ecology & Botany)

ECO-CARE CONSULTANCY
ENVIRONMENTAL & BIODIVERSITY CONSULTANTS

PO Box 12500, Brandhof, 9324

Cell: 084 2073454

Email: gabotha11@gmail.com

Prepared for:

Savannah Environmental (Pty) Ltd

1st Floor, Block 2, 5 Woodlands Drive

Office Park

Cnr Woodlands Drive & Western Service Road

Woodmead

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DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

» act/ed as the independent specialist in this application;
» regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
» do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
» will not have any vested interest in the proposed activity proceeding;
» have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
» am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
» have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
» am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 982.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
August 2017

1 INTRODUCTION

1.1 Applicant

Eskom Holdings SoC Limited.

1.2 Project

The project will be referred to as the 10MVA 132/11kV Olifantshoek 10MVA 132/11kV substation.

1.3 Proposed Activity

The Olifantshoek Substation will be comprised of the following:

» A new 10MVA on-site substation (100m X 100m) to be constructed in close proximity to the existing 22/11kV Olifantshoek substation.
» The decommissioning of the existing 22/11kV Olifantshoek Substation.

The proposed substation will have a footprint of approximately of 100m x 100m. The footprint of the substation may include a metering station, control building, admin building, workshop and associated infrastructure. The table below provides an overview of the technical details of the substation components to be constructed:

Table 1: Summary of components associated with the proposed substation.

Project Component	Specification
Mega Volt Ampere	10
Size of the substation	71m x 49m within a footprint of 100m x 100m
Distance between equipment	9m
Footprint of the development	100m x 100m
Number of transformers	One 10 MVA transformer

Two alternative locations have been identified for the proposed substation, including;

» Approximately 500m east of the urban area of Olifantshoek and 50m south of the N14. This is considered to be the **preferred substation location**.
» Approximately 30m to the east of the existing Olifantshoek substation. This is considered to be the **alternative substation location.**

The existing Olifantshoek substation will be decommissioned on completion of the new proposed substation.

The new substation will be connected to the Emil switching station via a new 132kV Olifantshoek overhead power line.

1.4 Location

The project is located in the Olifantshoek region, which falls within the Ga-mogara Local Municipality and the John Taolo Gaetsewe District Municipality. The study area for the proposed new substation is located around the eastern edge of the town of Olifantshoek (Figure 1). Two alternative substation locations are being considered for the development.

The approximate location (farm properties and geographic coordinates) for the proposed project is as follows:

» **Proposed location of substation**
  Farm Property:
  - Preferred Location: Portion 1 of the Farm Neylan 574
  - Alternative Location: Erf 155

  Geographical Coordinates:
  - Preferred Location: -27.931425°; 22.748489°
  - Alternative Location: -27.936425°; 22.741388°

1.5 Terms of reference

To conduct a Surface Water & Hydrological impact assessment of the development area.

The following terms of references are associated with this Surface Water & Hydrological investigation:

» The identification and demarcation of watercourses and wetlands present within the study area that are consistent with the definition of a watercourse in terms of the National Water Act, 1998 (NWA), Act No. 36 of 1998. The specific watercourse definitions focused on include:
  - A river or spring.

- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which, or from which water flows.

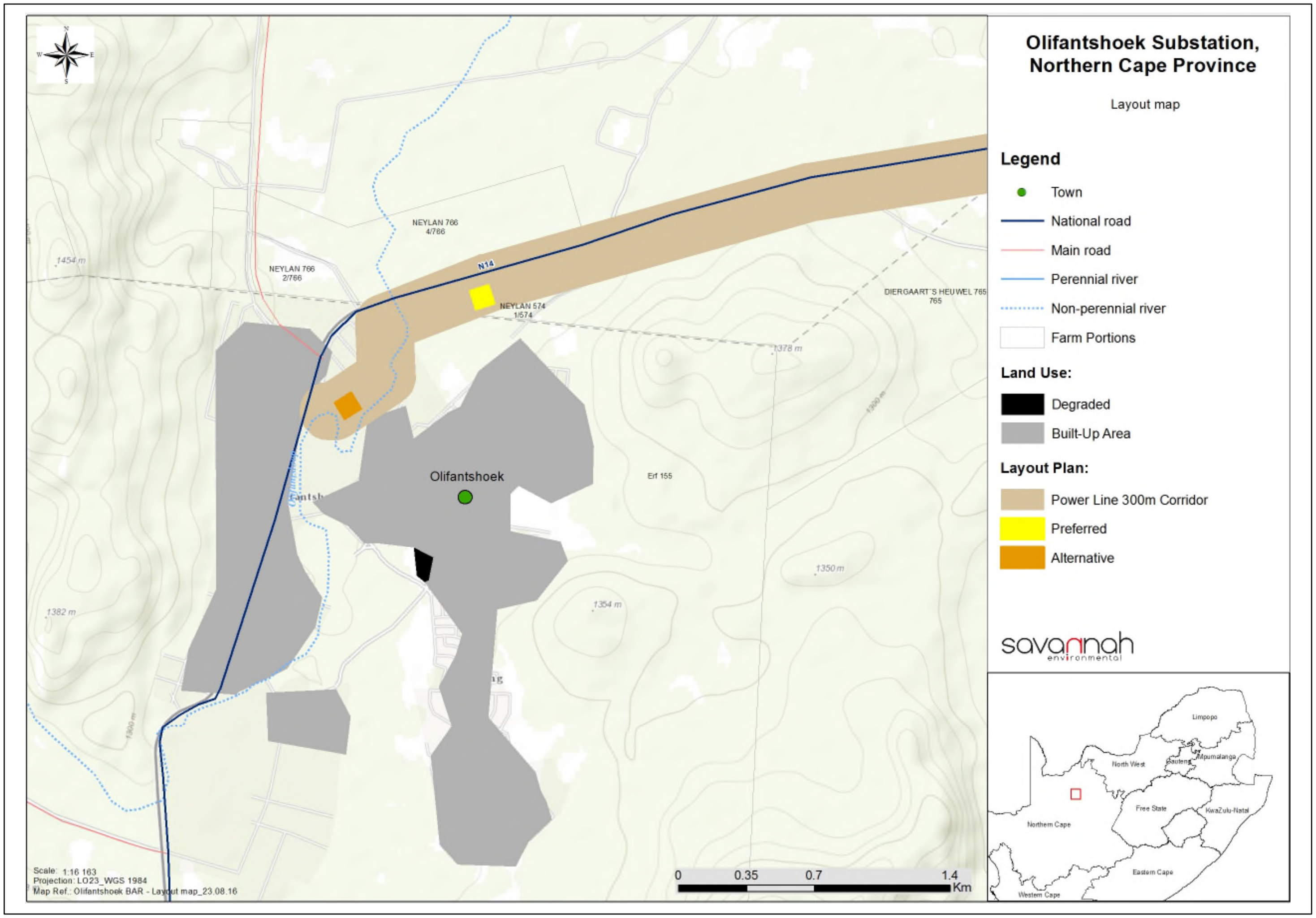

Figure 1: Layout of the substation alternatives.

1.6 General assumptions and limitations

1.6.1 *General assumptions*

- This study assumes that the project proponent will always strive to avoid, mitigate and/or offset potentially negative project related impacts on the environment, with impact avoidance being considered the most successful approach, followed by mitigation and offset. It is further assumed that the project proponent will seek to enhance potential positive impacts on the environment.
- GIS spatial datasets used as part of the field surveys (site demarcation) and analyses are accurate.
- The project proponent will commission an additional study to assess the impact(s) if there is a change in the size, location and/or extent of the study area that is likely to have a potentially highly significant and/ or unavoidable impact on the natural environment

1.6.2 Limitations

The following refers to general limitations that affect the applicability of information represented within this report (also refer to the conditions of the Report):

- This report specifically focuses on the identification, delineation, and classification of the various hydrological features characterising the study area.
- Accuracy of the maps, routes and desktop assessments is based on the current 1:50 000 topographical map series of South Africa;
- Accuracy of Global Positioning System (GPS) coordinates was limited to 8m accuracy in the field.
- A single survey limited the amount of flora identified at the site;
- While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that that is possible. The nature of the vegetation, seasonality, human intervention etc. limits the veracity of the material presented.
- Hydrological assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS) as well as the Water Research Council (WRC) based on site conditions and applicability. These techniques are however largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration.
- Most of the wetland and watercourse systems located within the study area form part of larger systems expanding well beyond the focus area. Although their extent and down- / upstream nature and functions were taken into

account, the focus of the study was restricted to the affected farm properties and the immediate surrounding landscape.

» This specific study area is affected by a variety of disturbances (historic and active) which restricts the use of available wetland indicators such as hydrophytic vegetation or soil indicators. Hence, a wide range of available indicators including historic aerial photographs are considered to help determine boundaries as accurately as possible.

1.7 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

2 WATERBODY DELINEATION & CLASSIFICATION

The water body delineation and classification was conducted using the standards and guidelines produced by the DWA (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance and Present Ecological State (PES) assessment methods used in this report.

For reference the following definitions are applicable:

» **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.

» **Perennial and non-perennial**: Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and therefore contain flows for short periods, such as a few hours or days in the case of drainage lines.

» **Riparian**: The area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered as wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).

» **Wetland**: Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin et al., 1979).
» **Watercourse**: as per the National Water Act 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 to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

3 DESCRIPTION OF THE STUDY AREA

3.1 Climate and rainfall

The Olifantshoek/Kathu area is characterised by an arid summer rainfall climate with an average annual temperature of 18.6°C and an average rainfall of 395mm falling predominantly in late summer (highest in March: 74mm). The driest month is July with only 3mm of precipitation. With an average temperature of 25.3°C, January is the warmest month, whilst July is the coldest month with an average of 10.8°C (https://en.climate-data.org/location/27075/).

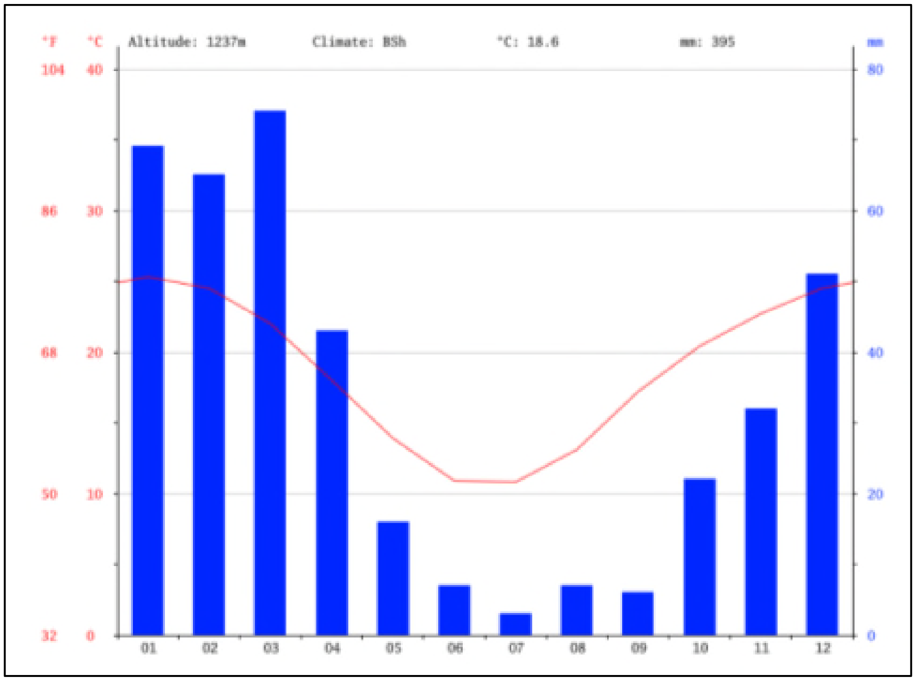

Figure 2: Climate graph of the Olifantshoek/Kathu region (https://en.climate-data.org/location/27075/).

month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
mm	69	65	74	43	16	7	3	7	6	22	32	51
°C	25.3	24.5	22.0	18.0	13.9	10.9	10.8	13.1	17.2	20.4	22.7	24.5
°C (min)	18.0	17.4	15.2	10.5	5.8	2.4	2.1	4.2	8.4	12.1	14.8	16.9
°C (max)	32.6	31.6	28.9	25.6	22.1	19.5	19.5	22.0	26.0	28.7	30.7	32.2
°F	77.5	76.1	71.6	64.4	57.0	51.6	51.4	55.6	63.0	68.7	72.9	76.1
°F (min)	64.4	63.3	59.4	50.9	42.4	36.3	35.8	39.6	47.1	53.8	58.6	62.4
°F (max)	90.7	88.9	84.0	78.1	71.8	67.1	67.1	71.6	78.8	83.7	87.3	90.0

Figure 3: Climate table of the Olifantshoek/Kathu region (https://en.climate-data.org/location/27075/).

3.2 Physiography and soils

Landscape Features

According to Mucina and Rutherford (2006) the region can be described as a largely flat (to very slightly undulating) sandy plain usually covered with open tree and shrub layers, for example, *Acacia luederitzii, Boscia albitrunca* and *Rhus tenuinervis* and with a usually sparse grass layer.

According to AGIS, 2007 the bulk of the affected landscape is classified as A2 terrain type (>80% has a slope less than 8% with a local relief of 30 – 90m) and is situated within a footlsope/valley bottom landscape setting with a straight slope shape (Z). Percentage slope is generally between 0 and 2%.

At a finer scale using a Google elevation profile for the study area and immediate surroundings the area can be described as a largely flat (to very slightly undulating) sandy plain. According to site geomorphology and slope direction, the study area and surrounding landscape can be described as follows:

» The typographical position of the greater area is regarded as a footslope region, largely sloping in a south to north direction. To the west the Langeberg Mountains stretch in narrow south to north band. The southern portion is situated between a maximum elevation of 1281m and 1222m with the highest portion being the section crossing the andesitic lava outcroppings of Harley Hill. The average slope is between 1.6 and 2% with a maximum slope of 11%. The undulating nature can be attributed to the moderate to steep dipping Quartzite footslopes of the Langeberg Mountains to the west as well the hills and outcroppings located to the south (including the slopes of Harley Hill), the upper slopes of Harvey Hill as well as the Olifantsloop River with its moderately deep (eroded) active channels and associated riparian fringe. The site for the proposed alternative substation is situated just west (~45m) of this channel with the riparian fringe at an elevation between 1264m and 1261m and slightly sloping in a south-eastern and eastern direction (avg slope: 0.9%; max slope: 1.9%). The preferred site for the substation is located within a flat portion of landscape (elevation: 1265 - 1264; avg slope: 1.7% & max slope: 2.2%) and more than 320m west of the riparian fringe.

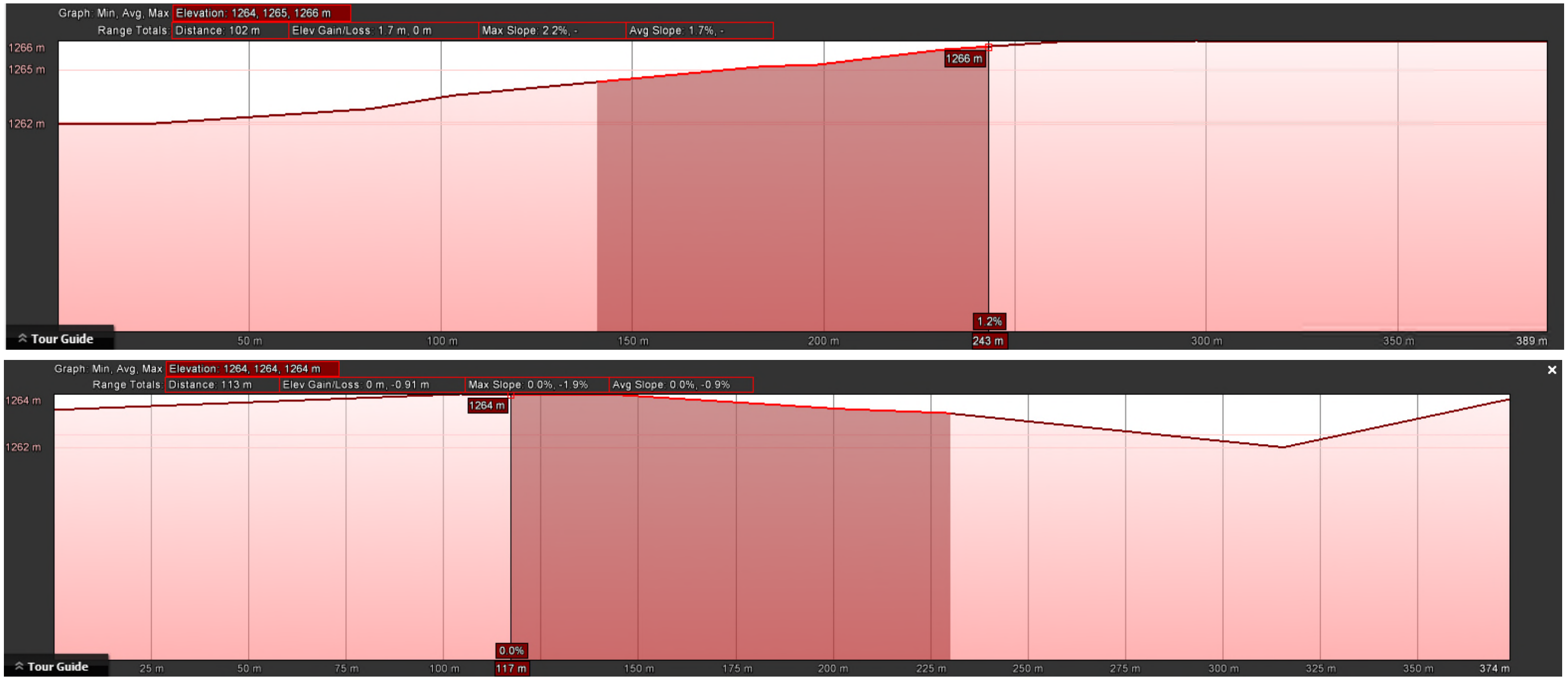

Figure 4: Elevation profile (Google) of the substation option (preferred option on top and alternative option below).

Geology

Regional Geology

The basement consists of porphyritic granite. The Ventersdorp Super Group overlies the porphyritic granite and consists of green andesitic lava with amygdaloids in places, occurs in the north east and attains a geologically estimated thickness of 60m. Griqualand West Super Group: At its base is the Vryburg Formation consisting of arkose (occasionally mica rich) and quartzite and lies unconformable on either the granite or the Ventersdorp Super Group rocks.

The Schmidsdrift Formation overlies the Vryburg Formation and forms the lowest unit of the Campbell Group. It is divided into 3 members each being approximately 10m thick. The lowest member consists of alternating layers of oolitic and stromatolitic dolomite with thin interbedded layers of shale and quartzite. The shale becomes more prominent higher up in the succession with the result that the middle member consists mainly of ferruginous shale with siltstone and interbedded thin dolomite. The upper member consists mainly of calcitic dolomite with few stromatolites and thin interbedded shale and siltstone.

The Ghaap Plateau Formation: Very similar to the Schmidsdrift Formation and there is a gradational contact between the Ghaap Plateau Formation and the underlying Schmidsdrift Formation and can only be distinguished where the quartzite is present on the latter. A brown ferruginous jasper layer, up to 12m thick, separates the lowest part of the formation from the overlying grey coarse-grained dolomite. The upper part, contains lenses and breccia of chert and a prominent layer of chert which tops the succession.

The Asbestos Hills Formation forms part of the Griquatown Group and lies conformably on the Ghaap Plateau Formation. The formation is subdivided into the Kuruman and Danielskuil Members. The uppermost chert of the Ghaap Plateau Formation grades into banded iron stone of the Kuruman Member which varies in thickness from 180 to 240m. It consists of a succession of thin alternating layers of light coloured chert and jasper and dark-coloured ferruginous jaspilite. The jaspilite contains mainly magnetite, haematite and limonite. The rock also contains several crocidolite-bearing zones. The “blinkklip breccia”, a basal layer of banded iron stone, lies on the Ghaap Plateau Formation in the Maremane Anticline. The Danielskuil Member has an undulating structure and consists of brown jaspilite with thin magnetite layers and lenticular breccia and chert nodules. The overlying jaspilite attains a thickness of 150m and several marker layers.

The Gamagara Formation was deposited on the Maremane Anticline and rests unconformable on dolomite and banded iron stone of the underlying formations. It consists of a basal conglomerate with pebbles of jasper, ironstone, shale with lenses of conglomerate, iron-rich flagstone and quartzite. The formation has a thickness of 300m and when resting on banded ironstone are ferruginised and manganised where they lie on dolomite.

The Makganyane Formation lies unconformable on the Gamagara Formation, where the latter is developed and elsewhere it overlies the Asbestos Hills Formation conformably. The maximum thickness is less than 470m. A tillite occurs at the base of the formation and contains fragments of chert and jasper. Higher up in the succession alternating layers of grit, tillite, silicified mudstone and felspathic quartzite occur. Dolomite or limestone occurs interbedded in the mudstone.

The Ongeluk Formation forms the lower part of the Olifantshoek Group. Andesitic lava belonging to this formation crops out in the Dimoten Syncline and west of the Maremane Anticline and disappears under the sand cover further north. The formation consists of grey-green lava with jasper amygdales and lenses of red jasper.

The Voëlwater Formation overlies the Ongeluk Formation and has a thickness of 450m. The lower beds are banded ironstone and banded red jasper with chert, dolomite and lava. In the north, there is a manganiferous jaspilite near the base of the formation. The upper portion of the succession consists predominantly of dolomite with chert, banded jasper and lava.

The Lucknow Formation occurs east of Olifantshoek and also in the Koranaberg where the strata are disturbed by a number of faults. It lies unconformable on the Voëlwater Formation. The formation has a maximum thickness of 1500 m. The lower portion consists of mainly shale with subordinate layers of quartzite and lava and the upper portion of whitish quartzite with lenses of flagstone and dolomitic limestone.

The bedrock geology is mainly covered by Tertiary and younger deposits known as Kalahari Group sediments. The pre-tertiary topography of the area controlled deposition of these sediments. The total thickness of the Kalahari Beds was reported by Smit (1977) to exceed 100m.

Several sub-outcropping dykes (mainly magnetic with some low to non-magnetic) occur in the area. These dyke structures are mainly visible on aerial photos and remote sensing images where the soil or sediment cover is less than 15 metres. These linear structures mostly represent intrusive dykes, which are generally near vertical (85 to 90 degrees) and have strike lengths in excess of 100 km. The general strike directions are WSW – ENE, SSW –NNE, and ESE – WNW.

Local Geology and Hydrogeology

The local geology consists mainly of the Banded Iron Formation of the Asbestos Hills Formation and Andesitic Lava of the Ongeluks Formation. The bulk of the basement geology is concealed beneath the partially consolidated sediments of the Kalahari Group (Figure 8). South of the N14, within and around the proposed substation locations, the Kalahari sediments becomes thin and patchy and large areas of bedrock are exposed belonging to the Olifantshoek Subergroup (refer to Figure 5).

Outcroppings and hills (e.g. Hartley Hill to the west of the preferred substation location) comprise of this supergroup and can be divided into two unconformity-bounded sequences. The oldest of these sequences is named the Elim Group and consists of the Mapedi and Lucknow formations, an upward coarsening shale to quartzite succession with interbedded carbonate rocks. The second sequence is taken from the regional unconformity at the base of the overlying Harley Formation, which is composed of basal conglomerate and quartzite, followed by dominantly volcanic rocks. The Hartley Formation is overlain conformably by light grey to white sandstone, forming the top of the Volop Group.

The Kalahari Group Sediments is subdivided into 4 formations, i.e. Wessels Gravel Formation, overlain by the Budin Clay Formation and the Eden Sandstone Formation and followed by the Mokalanen Limestone Formation at the top.

» **Wessels Gravel Formation**
  The Wessels Formation consists of brown clayey gravel with gravel beds, which as a rule contains a large percentage of clay (30%). It occupies some of the deeper troughs and channels of the pre-Kalahari surface, and reaches a maximum thickness of 100m.

» **Budin Clay Formation**
  The Budin Formation reaches a maximum thickness of 100m and consists predominantly of red and brown clay, marl and micaceous shale. The clay often contains fine grained (<2mm) gravel material. Cross-bedded gravels occur near the base, where they apparently grade into the Wessels Formation. The environment of deposition is probably lacustrine or low-energy fluvial.

» **Eden Sandstone Formation**
  The Eden Formation consists of greenish generally rather loosely consolidated sandstones, grits and minor intra-formational conglomerates. The sediments show a gradation downwards into the Budin Formation, and upwards into sandy limestone. The maximum thickness is about 80m.

» **Mokalanen Calcrete Formation**
The calcrete of the Mokalanen Formation forms the boundary between the Tertiary and Quaternary rocks. It occurs extensively on the Dwyka Formation. The formation consists of hardpan calcrete (generally thick and of Quaternary Age) with underlying white diatomaceous limestone (fossiliferous), loosely consolidated with a very low density. The maximum thickness of the formation is 50m. The depositional environment is probably one of a sluggish flowing river or a still freshwater lake.

» Intrusive diabase and dolerite dykes (mainly magnetic with some low magnetic to non-magnetic) represent the youngest rocks in the study area. The dykes generally intruded along major faults, are mostly impervious (with low to impervious hydraulic conductivity) and compartmentalise the dolomite aquifer into sub-units. These dykes are only present in the bedrock below the Kalahari sediments.

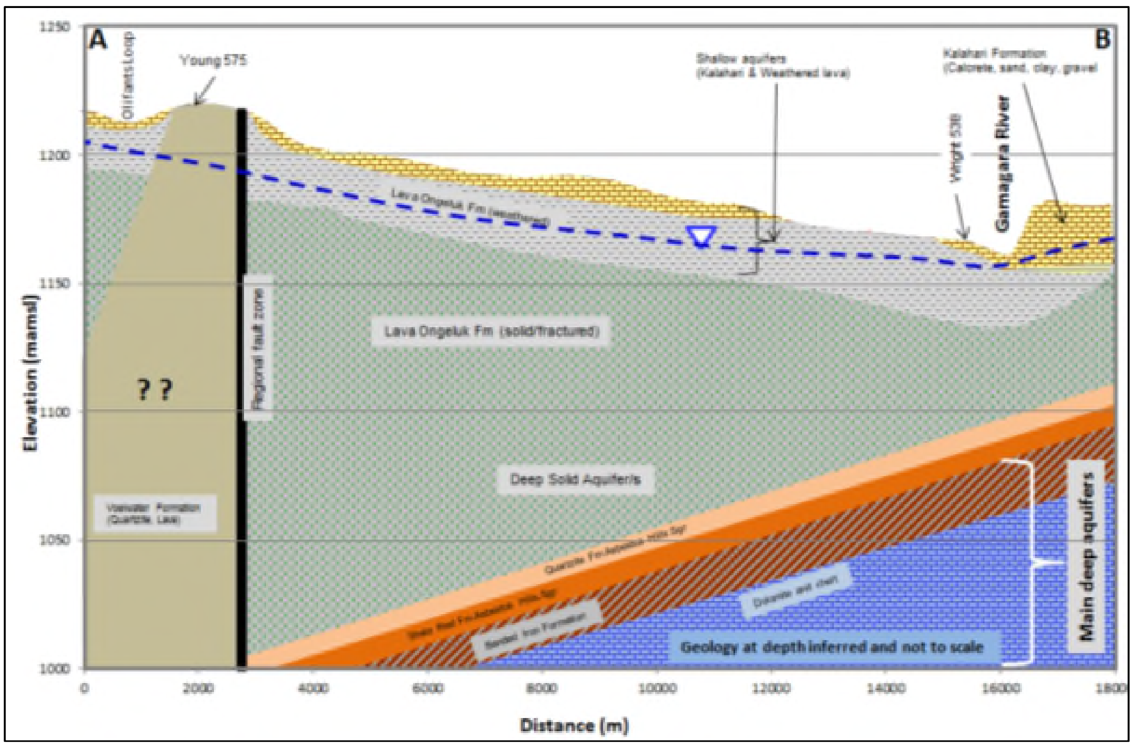

Figure 5: Conceptual west-east hydrological cross-section of the study area provided by Vivier (2016)**.**

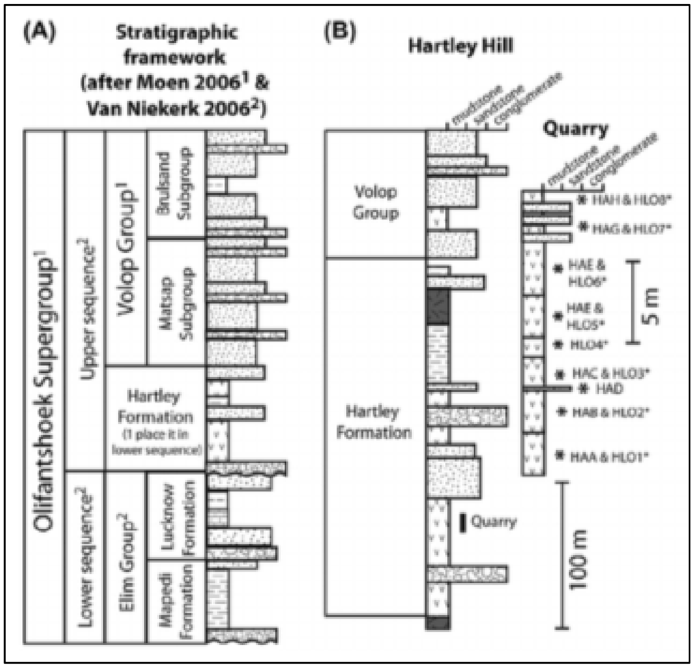

Figure 6: Lithostratigraphy of the Olifantshoek Supergroup. A) Stratigraphic framework of the Olifantshoek Supergroup after Moen (2006) and Van Niekerk (2006). B) Lithostratigraphy at Hartley Hill (modified after Cornell, 1987).

Groundwater is the only reliable resource of water supply in the area. According to Viviers (2016) there are a number of important hydrogeological zones with the affected landscape namely:

- The Gamagara River Alluvial Aquifer that consists of sediments containing gravel, calcrete and clay. The riverbed is underlain by clay in some sections.
- The surficial Kalahari beds that consists of clacrete, sand and clay as well as gravel. The Kalahari beds are underlain by a thick clay layer towards the west where the Sishen Mine is located.
- The weathered/fractured and solid/fractured lava underlies the Kalahari Beds and forms weathered basins where groundwater was historically developed.
- The lava formations are underlain by quartzite, shale, banded iron formation and dolomite. The banded iron formation forms the major regional aquifer in the area.
- The lava contains geological structures that are inferred as dolerite dykes and/or fault zones that strike mainly north-east to south-west.

The water levels according to the study conducted by Viviers (2016) indicated that water levels in the Gamagara River Alluvial Aquifer were historically much shallower at 1m to 2m as it was recharged by flooding from the river every 5 – 8 years.

These water levels are now around 6m to 8m deep. The cause of the deeper water levels in the Gamagara River Alluvial Aquifer has been confirmed to be due to leakage of the river into the Sishen Compartment that is partially dewatered by mining. Concerns were also raised within the study that the Olifantsloop drainage could also be affected by the impact on the Gamagara River.

The same situation was recorded for water levels in the lava formation which declined from 10m to 15m deep in the hand dug wells in the 1960's to around 20m to 40m since around 2005.

Soil and Land Types

Detailed soil information is not available for broad areas of the country. A surrogate land type data was used to provide a general description of soil in the study area (land types are areas with largely uniform soils, typography and climate). Both substation options are situated within the Ae6 land type with the Ic2 land type found to the east and west where the landscape becomes more undulating and rugged.

- Ae land type refers to areas characterised by red-yellow apedal, freely drained soils (Red, high base status soils, deeper than 300mm without dunes). These moderately deep red, freely drained apedal soils occur in areas associated with low to moderate rainfall (300-700mm per annum) in the interior of South Africa and have a high fertility status. A wide range of texture occurs (usually sandy loam to sandy clay loam). Dominant soil forms include Hutton and Oakleaf. Isolated areas with shallow soils are characterised by the Mispah soil form.
- The Ic group of land types refers to land types with a soil pattern difficult to accommodate elsewhere. Diagnostic of this land type is that 60-80% of the surface is occupied by exposed rock and stones/boulders and the slopes are usually steep. The rest of the area comprises mostly shallow soils, directly underlain by hard or weathered rock. Dominant soil forms include Hutton (deep soils), Mispah (shallow soils) and exposed rock where soil is largely absent.

Hydrology

The study area is located within the Lower Vaal River Water Management Area and within the D41J quaternary catchment area. The most prominent river system within the region is the ephemeral (non-perennial) Gamagara River which is a tributary of the Kuruman River (also non-perennial). According to the Present Ecological State (DWS PES, 1999) the condition of the Gamagara River is classified as Class B, which indicates that the river is still largely in a natural state. The same PES classification (Class B) was provided for the Olifantsloop River, a non-perennial tributary of the Gamagara River.

The entire study area is drained by the Olifantsloop River (42.492km). The Olifantsloop River originates within Langeberg Mountain range, west of the town of Olifantshoek. The watercourse flows in an eastern direction until reaching Olifantshoek, after which it flows in a north-eastern direction to terminate into the Gamagara River (~1.1km south-east of the point where the proposed powerline will cross the Gamagara River). The Gamagara River originates as smaller tributaries within the Asbestos Mountains north-east of the town of Danielskuil and flows in a north-western direction past smaller settlements as well as the southern portion of the Sishen mining area (Dingelton). The entire system is endorheic with the Gamagara River flowing into the Kuruman River close to Hotazel, after which the Kuruman River flows into the Molopo River at Andriesvale south of the Kgalagadi Transfontier Park. From there, the Molopo flows into the Abiekswasputs pans north of the town of Noenieput. There is hence no outflow into the sea.

The only natural wetlands within the larger landscape are small, endorheic, closed depressions) pans. *A depression is 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. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. Dominant hydrodynamics (primarily seasonal) are vertical fluctuations. Pans such as in the study area are flat-bottomed and lack in- and outlets. For this 'endorheic depression', water exits by means of evaporation and infiltration.*

These depressions form due to micro-topography variations of the underlying substrates (shallower soils over calcrete), giving rise to low grasslands on pan bottoms (may even be devoid of vegetation). The outer belt of these pans comprises of a mixture of tall shrubs and trees. The pan-like alluvium consists of sandy loam with a fairly high content of Calcium and Phosphate. The pan soils consist of white (washed) sand and is exposed for most of the year and carry shallow pools for a short period of time following sufficient rains.

The natural topography of the site has been significantly altered (especially to the east) as a result of historic and on-going mining activities. Currently, the existing mine infrastructure and activities dominate the landscape at Sishen, and the natural, relatively flat topography has been replaced by man-made topographical features.

Numerous of these depression wetlands have been listed within the NFEPA spatial data is indicated in Figure 9.

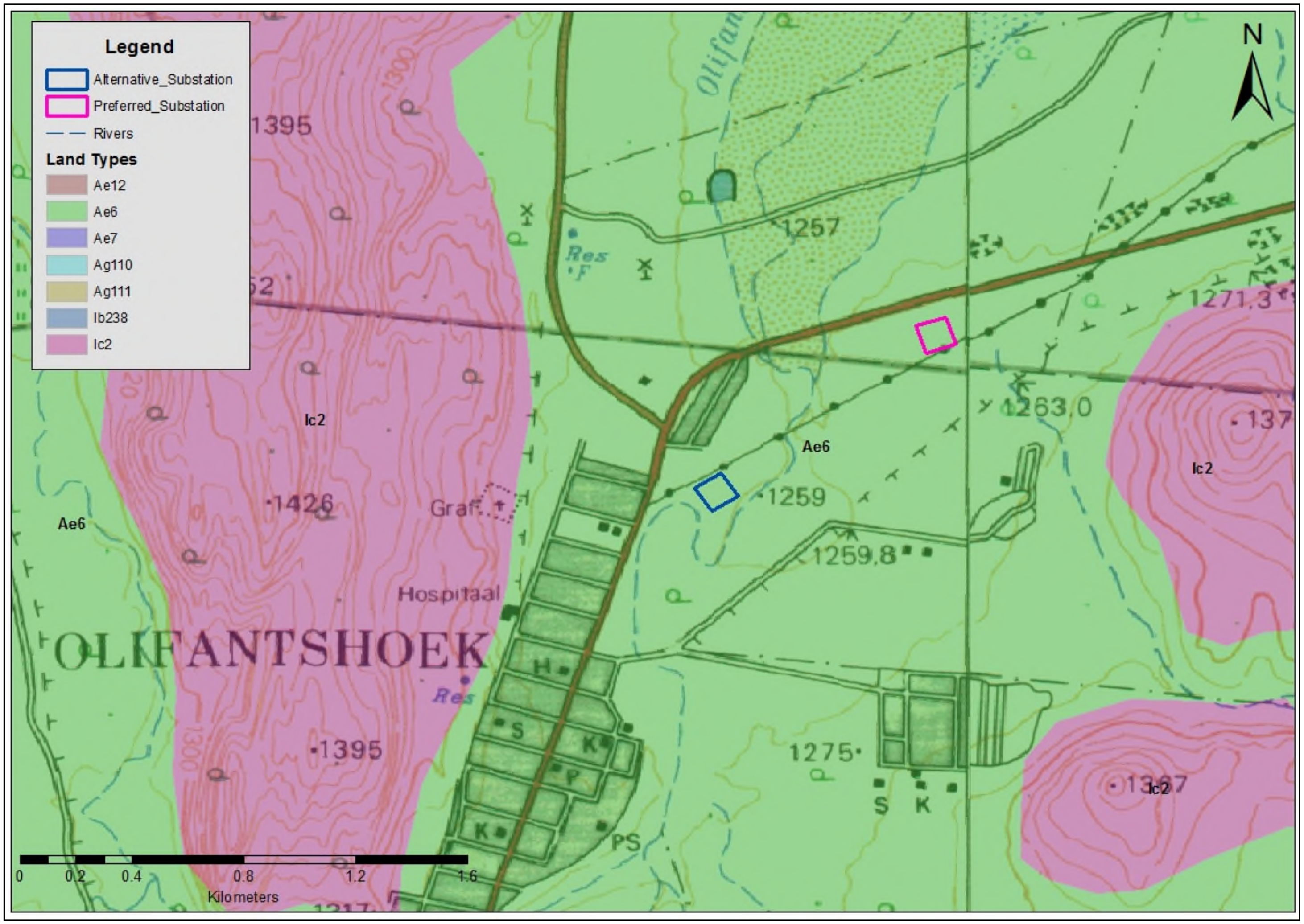

Figure 7: Land types found within the study area as well as the surrounding environment.

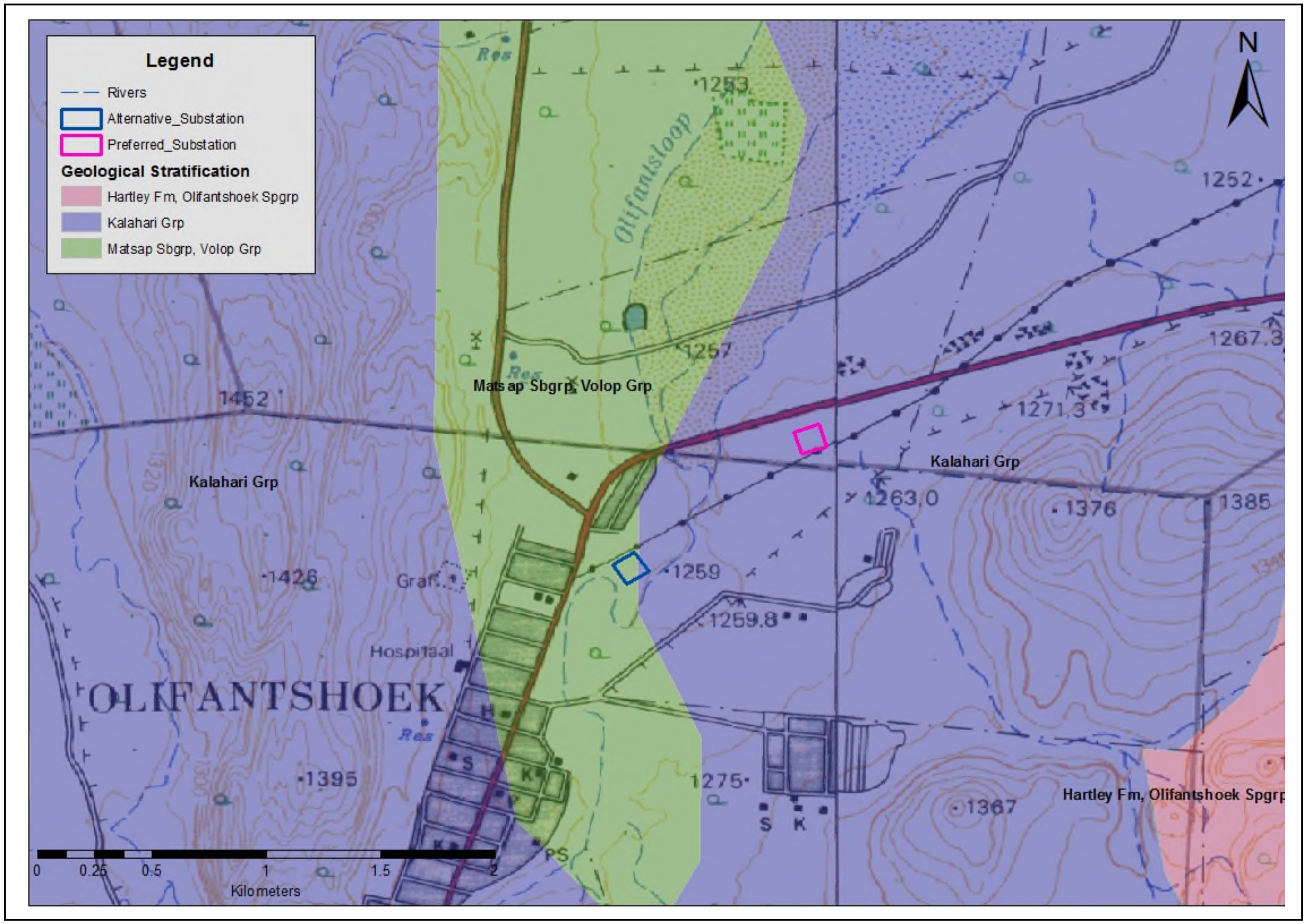

Figure 8: Geological Stratification of the study area and surrounding environment (Kleynhans, 1999).

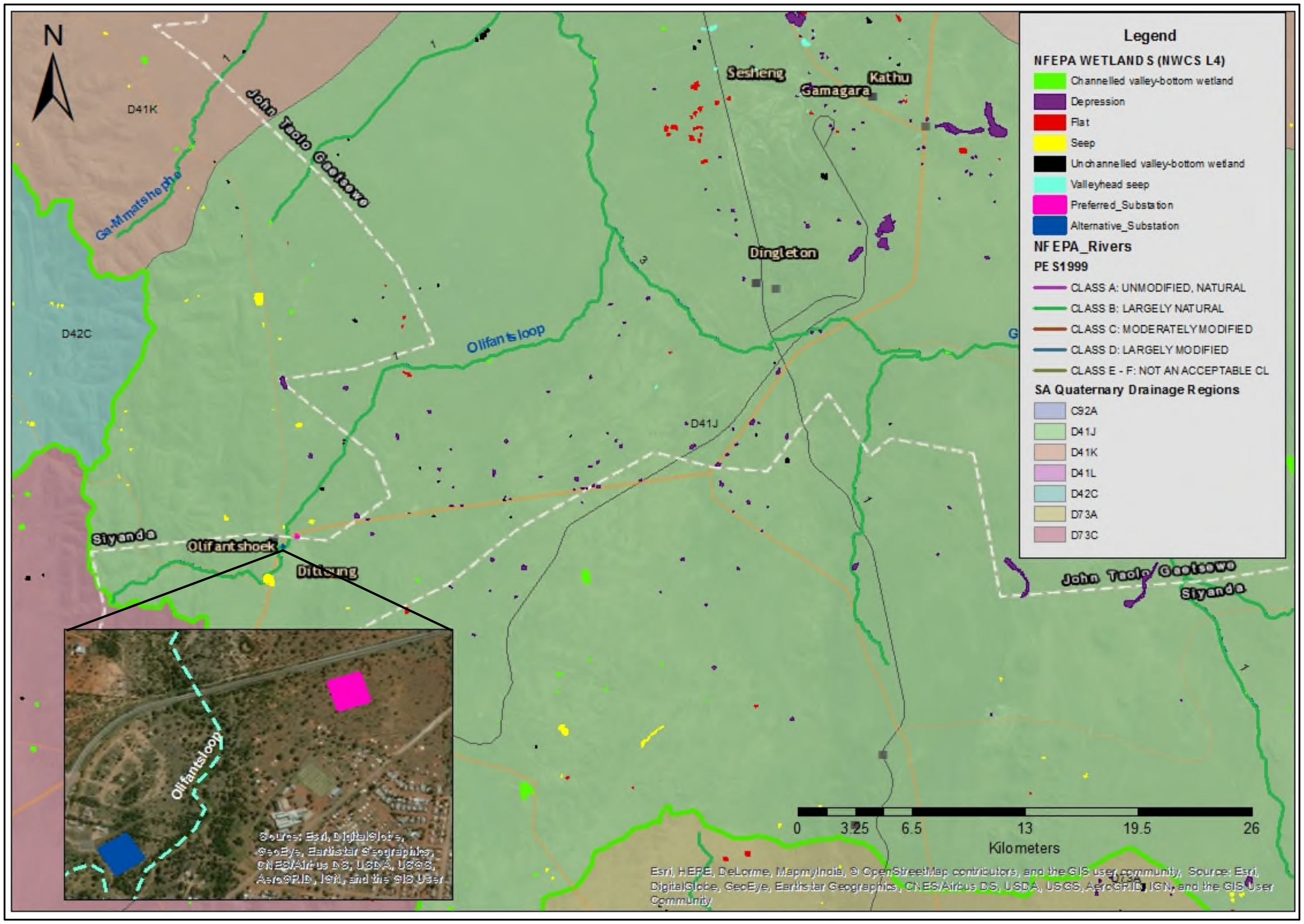

Figure 9: NFEPA wetlands and streams within the study area as well as the surrounding environment.

3.3 Existing Land Use

The preferred substation location is situated just outside of the urban boundary of the town of Olifantshoek on land used mostly for farming. Farming practises consist mainly of livestock farming (cattle and goats). The preferred location is furthermore located just south of the N14.

The alternative substation is located within an open space between the formal part of the town to the west and the informal part to the east. This location is adjacent to the existing substation to be decommissioned.

4 RESULTS

4.1 Wetland classification, delineation and description

4.1.1 Olifantsloop Non-Perennial Watercourse & Riparian Fringe

(a) *Upstream Portion (Deep channel & Riparian Fringe)*

The Olifantsloop River is a non-perennial or ephemeral system (42.492km long) which originates in the Langeberg Mountains west of the town of Olifantshoek and terminates into the Gamagara River (also non-perennial). The portion of the watercourse flowing through the urban area is characterised by a developed channel which may become relatively deep in areas (over 3m). These deep channels normally consist out of fine sand and silt and are normally devoid of vegetation (unstable conditions due to high velocity streamflow during rainfall events and the effects of erosion). Where flow velocities are not so intense the channels are normally shallower and may not even be prominent. These areas are normally vegetated with a mixed grass and herb layer with numerous exotic plant species.

Plant species within these channels include:

- **Weeds & exotics**: *Chenopodium album, Chenopodium carinatum, Verbesina encelioides, Datura stramonium, Tribulus terrestris, Argemone ochroleuca*
- **Herbs**: *Heliotropium ciliatum, Acrotome inflate, Limeum agute-carinatum, Hybiscus spp., Chrysocoma ciliate & Pentzia incana*,
- **Seges**: *Kylinga alba, Schoenoplectus muricinux, Cyperus laevigatus*
- **Grasses**: *Chloris virgata, Cynodon dactylon, Eragrostis curvula, Tragus berteronianus, Tragus koelerioides, Urochloa panicoides, Leptochloa fusca, Aristida congesta, A. adscensionis, Enneapogon desvauxii, Eragrostis echinochloidea* and *E. lehmanniana*

As the river enters the town of Olifantshoek, flow has been altered through the presence of a gravel dam. Downstream of this dam structure (within the boundaries of the urban area and immediate downstream areas) the watercourse has undergone numerous alterations and transformations affecting the hydrology, geomorphology and vegetation structure.

Disturbances include:

- infringing urban expansion;
- road culverts;
- trampling (both by humans and by livestock from informal settlement);
- hard surfaces surrounding the watercourse;
- overgrazing and removal of vegetation (severe grazing of the grassy river beds and riparian fringes and collection wood from the woody riparian fringe);
- invasion of invasive alien plant;
- illegal dumping of building rubble and general household waste; and
- localised deep erosion of channel beds and banks.

Due to these disturbances, the following on site alterations have occurred within the non-perennial watercourse:

- **Erosion**: Areas with deep eroded channels and relatively high banks (prone to bank erosion)
- **Increase in flow velocities**: Due to the removal of vegetation and channelisation of flowing water (e.g. deep eroded channels and through road culverts)
- **Change in peak flows**: Due to the removal of vegetation and deep channels, surface water flows rapidly away from these areas and therefore inundation occurs for a very short period.
- **Invasion with weeds and invasive plants**: Disturbed and overgrazed areas have been severely invaded with such plants.

This section of the Olifantsloop River is characterised by a varying riparian fringe. Due to disturbances, much of this area has been transformed. Typically, this section is characterised by a relatively open tree cover (predominantly *Acacia karroo*) which may, where conditions are suitable, become very dense with an almost closed canopy (monotonous communities comprising out of almost only A. karroo), although such areas are small in extent and rather form isolated patches within the more open riparian fringe. Such a riparian fringe plays an important role in habitat diversity and buffer against severe flooding events. Due to the transformation of this habitat this area provides limited ecological functions.

Dominant vegetation of the riparian zone includes:

» **Trees**: *Acacia karroo, Searsia lancea, Ziziphus mucronate, Diospyros lycioides*
» **Weeds & Invading Plants**: *Eucalyptus camaldulensis, Nicotiana gluaca, Bidens pilosa*
» **Shrubs**: *Grewia flava, Asparagus suaveolens*
» **Dwaf Shrubs**: *Lycium hirsutum*
» **Herbs**: *Asclepias fruticose, Amaranthus spp., Chrysocoma ciliate & Pentzia incana*
» **Grasses**: *Cynodon dactylon, Setaria verticillata, Chloris virgata, Sporobolus fimbriatus, Tragus koelerioides, Urochloa panicoides, Aristida congesta, Eragrostis echinochloidea and E. lehmanniana*

Disturbances within the riparian habitat include:

» Severe trampling and overgrazing with numerous footpaths traversing the area;
» Collection of wood;
» Invasion with invasive alien plant species;
» Removal of vegetation exposing areas to erosion;
» The existing Olifantshoek substation is situated right on the border of this riparian habitat
» Infringing urban expansion.

The Present Ecological State scores (PES) for this portion of the watercourse and associated riparian fringe were rated as C/D (Largely modified) due to activities described above.

This portion of the Olifantsloop non-perennial watercourse as well as its associated riparian fringe will only be impacted on by the project if the alternative substation is selected as the final position. The preferred location for the substation is located outside these habitats and is therefore considered to be preferred. Due to the fact that further construction and development within the riparian habitat will lead to further degradation of this habitat type it is suggested that the alternative substation option should not be considered as the final location. Furthermore, even though the watercourse and riparian fringe in this section are highly degraded and transformed, these areas do still provide some valuable functions, such as habitat diversity, flow attenuation (although limited), grazing etc. and are subsequently regarded as High sensitivity areas.

4.2 Site Photos

 **Photo 1**: The deep eroded channels of the upper portion of the Olifantsloop watercourse.	 **Photo 2:** Relative broad active channel of the upper portion of the Olifantsloop watercourse. Bed is covered by invading herbaceous weeds and invasive plants.
 **Photo 3:** Dense thicket type of *Acacia karroo* riparian fringe of the upper portion of the Olifantsloop watercourse.	 **Photo 4:** Dense thicket type of the *Acacia karroo* riparian fringe of the upper portion of the Olifantsloop watercourse.

Photo 5*:* Highly altered channel bank and bed (south of the proposed alternative substation location).

Photo 6: Section of the riparian fringe that has been cleared and invaded within numerous invasive alien plants including Opuntia (a portion of riparian fringe just east of the proposed alternative substation location).

Photo 7: Some pools of standing water remaining after a rainfall event.

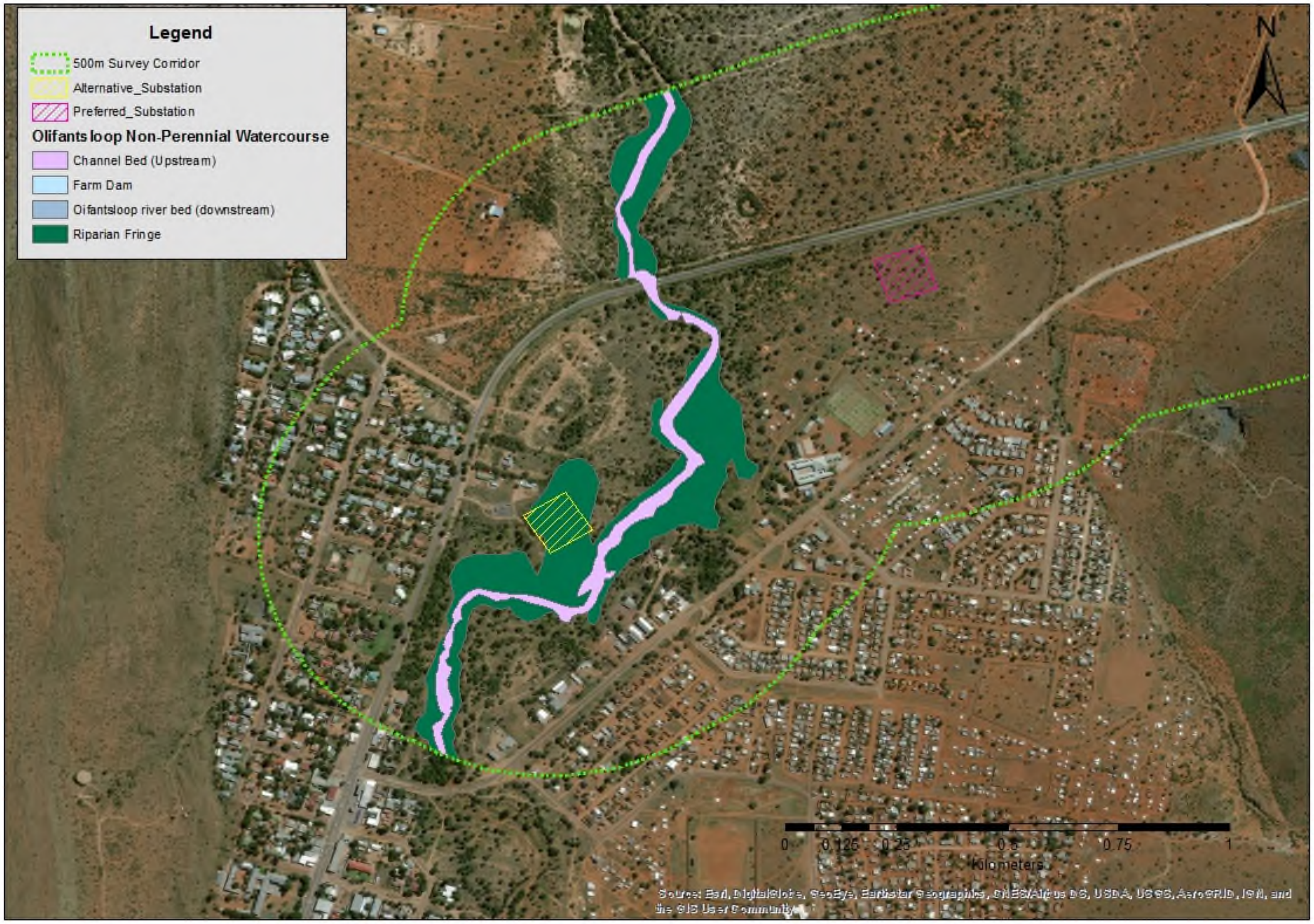

Figure 10: Upper portion of the Olifantsloop non-perennial watercourse and associated riparian fringe.

4.3 Surface Water & Hydrological Sensitivity Analysis

4.3.1 Olifantsloop Non-Perennial Watercourse & Riparian Fringe

Upstream Portion (Deep channel & Riparian Fringe)

Conservation status
- Moderate-High
- Relatively moderate diversity, presence of keystone species/individual trees
- Niche habitats
- Some are species restricted to these areas

Ecosystem function
- Limited absorption and reduction of occasional flash floods
- Important corridor for abiotic and biotic material transfer
- Keystone species maintain habitat and create specific microhabitats for a multitude of organisms
- Herbaceous vegetation helps slow down floods, 'catch' sediments, and retain nutrients
- Vegetation filters out possible pollutants to prevent their discharge into the Orange River
- A permanent vegetation cover is necessary to maintain the functionality and stability of this ecosystem

Stability
- Medium if the habitat is kept intact, despite the potential effect of occasional flash floods
- Excessive erosion, loss of seed resources, high undesirable invisibility and slow regeneration of natural vegetation will result from clearing this vegetation

Reversibility of degradation
- Limited, slow and will be subject to high inputs of erosion control and invasive species management

Levels of acceptable Change
- Minimal change in the riparian fringe may be allowed and may only include the decommissioning of the exisiting Olifantshoek substation. Appart from the decommissioning no additional activities and changes may be allowed within this riparian section. Therefore, the alternative substation option should be excluded and the preferred substation option should form part of the final layout as this option is located outside of the riparian fringe.

Rating
- ***High sensitivity***

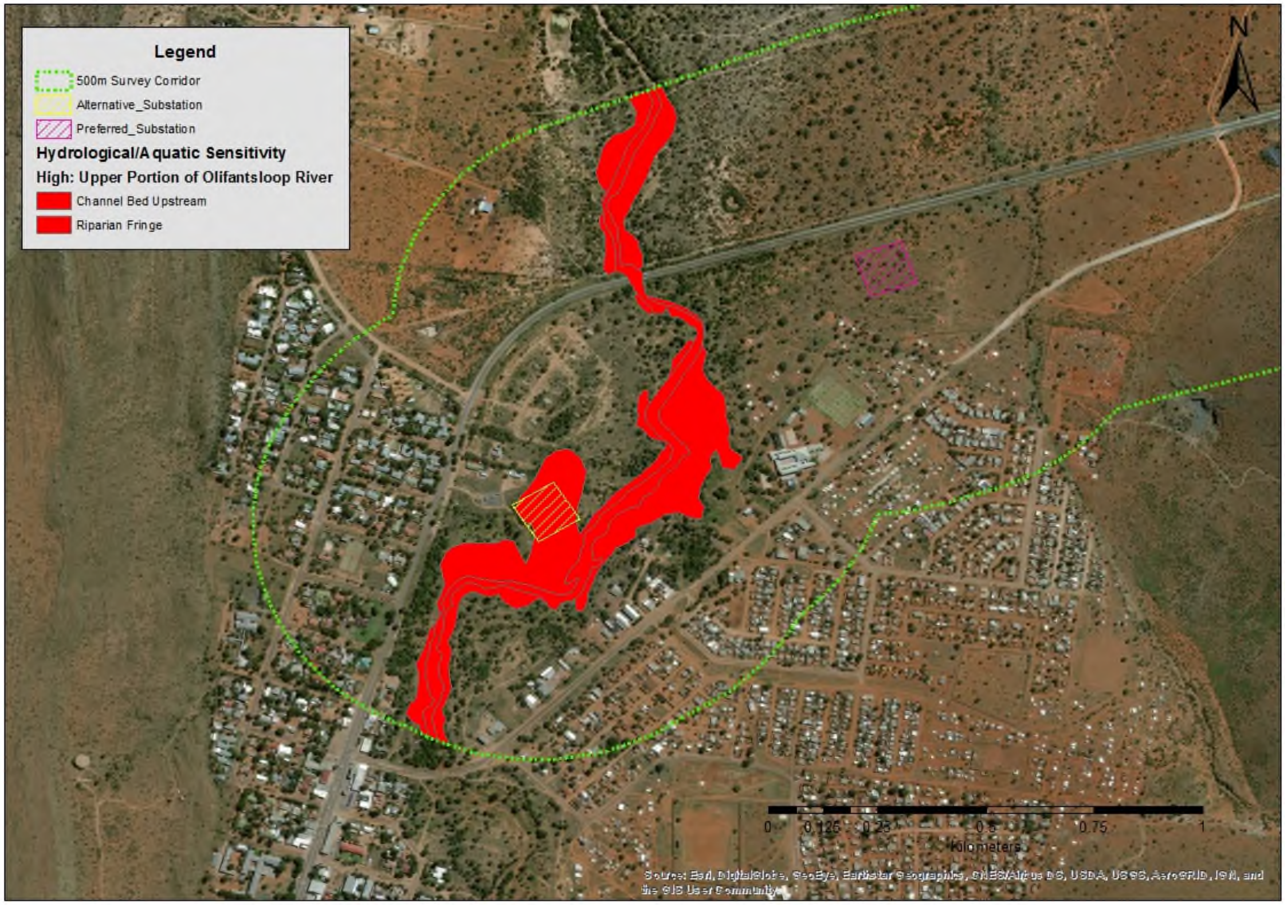

Figure 11: Surface Water & Hydrological Sensitivity Map compiled for the study area.

5 IMPACT ASSESSMENT

During the impact assessment study a number of potential key issues / impacts were identified and these were assessed based on the methodology supplied by Savannah Environmental (Pty) Ltd.

The following direct and indirect impacts were assessed with regard to construction, operation and decommissioning impacts on the riparian areas and watercourses:

- Impact 1: Loss of riparian systems and alluvial water courses
- Impact 2: Potential impact on localised surface water quality
- Impact 3: Impact on riparian systems through the possible increase in surface water runoff on riparian form and function
- Impact 4: Increase in sedimentation and erosion

The impacts were assessed as follows:

PROPOSED SUBSTATION OPTIONS

Take note that the existing substation is located outside of any watercourse or riparian zone and as such will not impact on the identified watercourses and riparian zones, subsequently no assessment was deemed necessary. Furthermore, the preferred substation option is located well beyond the boundaries of any watercourse and/or riparian zone and therefore no impacts have been assessed for this option. Subsequently, potential impacts assessed are only applicable to the alternative substation option

Construction & Decommissioning Phase Impacts

Impact Nature: Impact 1 – Loss of riparian systems and alluvial watercourses

The physical removal of riparian zones within the footprint area and disturbance of any alluvial watercourses, being replaced by hard engineered surfaces during construction.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Highly Probable (4)
Significance	**Medium (45)**	**Medium (36)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Yes	Yes

Can impacts be mitigated?	Yes, to a limited extent
Mitigation	» This potential impact can be avoided by selecting the preferred substation option as this option is located well outside of any watercourse and riparian boundary. » No vehicles to refuel within watercourses / riparian vegetation. » Ensure the vegetation removal is minimised to an absolute minimum, restricted only to the footprint area.
Cumulative Impacts	Increase in the surface run-off velocities, reduction in the potential for groundwater infiltration and the spread of erosion into downstream wetlands.
Residual Impacts	Possible impact on the remaining catchment due to changes in the run-off characteristics in the development site.

Impact Nature: Impact 2 – Impact on localised surface water quality

During preconstruction, construction and to a **limited degree** the operational activities, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery and construction activities could be washed downslope via the ephemeral systems.
Appropriate ablution facilities should be provided for the construction workers during the construction phase of the substation and on-site staff during the operation phase of the substation.

	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (21)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Medium	Low
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	» This potential impact can be avoided by selecting the preferred substation option as this option is located well outside of any watercourse and riparian boundary.	

	» Implement appropriate measures to ensure strict use and management of all hazardous materials used on site. » Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter hydrocarbons from vehicles and machinery, cement during construction etc.). » Implement appropriate measures to ensure the containment of all contaminated water by means of careful run-off management on the development site. » Implement appropriate measures to ensure strict control over the behavior of construction workers. » Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced.
Cumulative Impacts	None
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.

Impact Nature: Impact 3 - Increase in sedimentation and erosion within the development footprint. This may alter the local watercourse morphology and influence water quality downstream.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Very Short (1)
Magnitude	Low (2)	Small (0)
Probability	Probable (3)	Improbable (2)
Significance	**Low (21)**	**Low (4)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» This potential impact can be avoided by selecting the preferred substation option as this option is located well outside of any watercourse and riparian boundary. » Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as	

	possible and monitored thereafter to ensure that they do not re-occur. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Topsoil should be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas. » There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However due to low mean annual runoff within the region this is not anticipated due to the nature of the development together with the proposed layout.
Residual Impacts	Altered streambed morphology, howeverdue to the extent and nature of the development this residual impact is unlikely to occur.

Operation Phase Impacts

Impact Nature: Impact 4 - Impact on riparian systems during operation as a result of hard engineered surfaces and the removal of vegetation during construction. This could possibly increase the surface water runoff on the riparian form and function.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (33)**	**Low (27)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No

Can impacts be mitigated?	Yes, to a large extent
Mitigation	» Avoid the alternative substation option as this option will impact on the riparian habitat fringing the upper reaches (within the town boundary) of the Olifantsloop River. » If the alternative substation option is selected, any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduced flow velocities. » Ensure the vegetation removal is minimised to an absolute minimum, restricted only to the footprint area.
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However due to a low mean annual runoff within the region this is not anticipated due to the nature of the development together with the proposed layout.
Residual Impacts	Altered streambed morphology, however due to the extent and nature of the development this residual impact is unlikely to occur.

Cumulative Impacts

Cumulative Impact 1: *Compromised ecological processes as well as ecological functioning of important habitats*

Impact Nature: Transformation of intact habitats could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to habitat fragmentation and potentially disruption of the habitat connectivity and furthermore impair their ability to respond to environmental fluctuations. This is especially of relevance for larger watercourses and wetlands serving as important groundwater recharge and floodwater attenuation zones, important microhabitats for various organisms and important corridor zones for faunal movement (mostly located downstream, outside of study area and associated mainly with the Kuruman River).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Local (1)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (1)	Small (1)
Probability	Highly Improbable (1)	Highly Improbable (1)
Significance	**Low (6)**	**Low (6)**

Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	
Mitigation	» The development footprint should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. » Use existing service roads when crossing the watercourses. » Avoid placing pylons within the boundaries of the watercourses. » Avoid any activities within wetlands. » Avoid clearing the fringing shrubby vegetation associated with wetlands.	

5.1 Preferred VS. Alternative Options

Substation Options

The preferred substation option is considered as being the more favourable of the two options. The preferred option is located well outside of any watercourse and riparian boundaries and will subsequently have no impact on these habitats. Furthermore, the selection of this site as the final option will result in a shorter power line which will cross the Olifantsloop River and its associated riparian zone only once. Therefore, the upper reaches of the Olifantsloop River as described within this report will be avoided and therefore not be impacted on by the development.

On the other hand, the alternative substation option will result in the substation being constructed within the riparian zone of the Olifantsloop non-perennial River (upper portion of non-perennial watercourse) as well as the proposed power line crossing the Olifantsloop non-perennial River a second time. Construction within the riparian zone will lead to the loss of a section of this habitat which is characterised by a relatively dense *Acacia karroo* riparian thicket providing shelter for various faunal and avifaunal species. Furthermore, the development within this habitat (upper reaches of the Olifantsloop non-perennial River and associated Riparian Fringe) will result in the alteration of this habitat's ecosystem function which includes:

» Absorption and reduction of occasional flash floods.
» Important corridor for abiotic and biotic material transfer, as well as for wildlife.

» Keystone species maintain habitat and create specific microhabitats for a multitude of organisms.
» Herbaceous vegetation helps slow down floods, ‘catch’ sediments, and retain nutrients.
» Vegetation filters out possible pollutants to prevent their discharge into the Orange River.
» A permanent vegetation cover is necessary to maintain the functionality and stability of this ecosystem.

Therefore, from a surface water and hydrological perspective the alternative option should not be considered within the final layout and the position of the preferred substation option is considered as being the only viable option.

6 ASSESSMENT OF HYDROLOGICAL IMPACTS (RISK ASSESSMENT)

6.1 RISK ASSESSMENT ACCORDING TO DWA RISK MATRIX FOR GENERAL AUTHORISATIONS

The impacts identified above are assessed according to the activities and aspects that may cause them. This is done for the construction and operation phase of the development.

Activities: Construction of the new proposed Olifantshoek substation and decommissioning of the existing substation (Alternative substation option).

Phase: During the construction and operation phases.

Environmental Aspect: Generation of waste during construction and maintenance.

Environmental impact: This may lead to the pollution, eutrophication and general reduction in water quality and may potentially threaten downstream habitats and biota.

Aspect	Impact				Risk Rating	Borderline LOW MODERATE rating classes
	Severity	Consequence	Likelihood	Significance		
Hazardous wastes (Hydrocarbons and other chemicals)	2	7	7	49	**L**	N/A

Suspended solids (building rubble, concrete, stockpiled material)	2	6.75	7	47.25	**L**	N/A
Stockpiled topsoil	1	4.5	6	27	**L**	N/A
Sight Specific Mitigation: » Refer to mitigation provided in Impact Assessment (Section 5)						

Activities: Construction and maintenance of the substation (Alternative substation option).			
Phase: During the construction and operation phases.			
Environmental Aspect: Alteration and transformation of riparian fringe and catchment area			
Environmental impact: Removal of riparian vegetation may lead to a loss of niche specific habitats, nesting sites for avifaunal species and food sources for faunal and avifaunal species. It may lead to an unstable vegetation cover around the substation and furthermore, result in these areas becoming unstable and prone to soil erosion, the invasion of invasive alien plants and further loss of ground cover. The hard surfaces and compacted soils associated with the substation will furthermore contribute to the effect of erosion, loss of vegetation and topsoil. This may in turn reach watercourses and decrease the water quality within downstream aquatic habitats through siltation.			
Aspect	**Impact**		

	Severity	Consequence	Likelihood	Significance	Risk Rating	Borderline LOW MODERATE rating classes
Removal of riparian vegetation	2.75	7.75	6	46.5	**L**	N/A
Creation of hard surfaces & compacted soils	2.5	7.5	6	45	**L**	N/A
Sight Specific Mitigation: » Refer to mitigation provided in Impact Assessment (Section 5)						

Activities: Construction and maintenance of the substation (Preferred substation option)
Phase: During the construction and operation phases.
Environmental Aspect: Alteration and transformation of the riparian fringe and catchment area.
Environmental impact: Removal of vegetation may lead to an unstable vegetation cover around the substation and furthermore, result in these areas becoming unstable and prone to soil erosion, the invasion of invasive alien plants and further loss of ground cover. The hard surfaces and compacted soils associated with the substation will furthermore contribute to the effect of erosion, loss

of vegetation and topsoil. This may in turn reach watercourses and decrease the water quality within downstream aquatic habitats through siltation.

Aspect	**Impact**				**Risk Rating**	**Borderline LOW MODERATE rating classes**
	Severity	**Consequence**	**Likelihood**	**Significance**		
Removal of vegetation	1.25	5.25	4	21	**L**	N/A
Creation of hard surfaces & compacted soils	1.25	5.25	4	21	**L**	N/A

Sight Specific Mitigation:

» Refer to mitigation provided in Impact Assessment (Section 5)

7 DISCUSSION AND CONCLUSION

Based on the results obtained during this study the following conclusions can be drawn:

- » The entire study area is drained by a non-perennial watercourse namely the Olifantsloop River (42.492km) which in turns drains into the Gamagara River (88.037km).
- » The Olifantsloop river originates within the Langeberg Mountain range, west of the town of Olifantshoek. The watercourse flows in an eastern direction until reaching Olifantshoek, after which it flows in a north-eastern direction to terminate into the Gamagara River.
- » The entire system is endorheic with the Gamagara River flowing into the Kuruman River close to Hotazel, after which the Kuruman River flows into the Molopo River at Andriesvale south of the Kgalagadi Transfontier Park. From there, the Molopo River flows into the Abiekswasputs pans north of the town of Noenieput. There is hence no outflow into the sea.
- » The only natural wetlands within the larger environment are small, endorheic (closed depressions) pans. These depressions form due to micro-topography variations of the underlying substrates (shallower soils over calcrete), giving rise to low grasslands on pan bottoms (may even be devoid of vegetation). None of these depression (pan) structure were identified within the study area of the proposed substation.
- » An upstream portion (within the urban area of Olifantshoek) of the Olifantsloop watercourse may be affected if the alternative substation option is chosen as the final position for the new substation. The preferred option for the substation is located outside of the boundaries of the watercourse as well as its riparian fringe. This portion of the Olifantsloop watercourse as well as its associated riparian fringe (dominated by *Acacia karroo*) has been severely altered and transformed due to:
  - Severe trampling and overgrazing with numerous footpaths traversing the area;
  - Collection of wood;
  - Invasion with invasive alien plant species;
  - Removal of vegetation exposing areas to erosion;
  - The existing Olifantshoek substation is situated right on the border of this riparian habitat
  - Infringing urban expansion.
- » The Present Ecological State scores (PES) for this portion of the watercourse and associated riparian fringe were rated as C/D (Largely modified) due to the activities described above.

- Even though in a state of transformation and disturbance this portion of the Olifantsloop watercourse and associated riparian fringe still provide valuable habitat and other ecosystem functions.
- This portion of the Olifantsloop watercourse and its associated riparian fringe is regarded as High Sensitivity due to the following:
  - Conservation status
    - Moderate-High
    - Relatively high diversity, presence of keystone species/individual trees
    - Niche habitats
    - Some species restricted to these areas

  and
  - Ecosystem function
    - Limited absorption and reduction of occasional flash floods.
    - Important corridor for abiotic and biotic material transfer.
    - Keystone species maintain habitat and create specific microhabitats for a multitude of organisms.
    - Herbaceous vegetation helps slow down floods, 'catch' sediments, and retain nutrients.
    - Vegetation filters out possible pollutants to prevent their discharge into the Orange River.
    - A permanent vegetation cover is necessary to maintain the functionality and stability of this ecosystem
- Regarding the two substation options, there is a clear difference between the alternative and the preferred option. The alternative option is situated within a portion of the riparian thicket fringing the upper portion of the Olifantsloop watercourse and therefore poses a potential threat to the watercourse and the riparian habitat itself (e.g. create disturbed areas which may be prone to erosion, invasion with invasive species and subsequently results in these impacts spreading into the watercourse). The preferred option is located in a relatively flat terrestrial habitat, well beyond the boundaries of this watercourse and its associated riparian fringe. Therefore, it is clear from these results that the preferred location for the new substation is the best option from a hydrological perspective.
- From the Risk Assessment, the following results were obtained:

Activity	Phase	Environmental Aspect:	Risk Rating	Borderline LOW MODERATE rating classes
Construction of new substation and decommissioning of existing substation	Construction- & Decommissioning phase	Hazardous wastes (Hydrocarbons and other chemicals)	L	N/A
		Suspended solids (building rubble, concrete, stockpiled material)	L	N/A
		Stockpiled topsoil	L	N/A
		Application of herbicides	L	N/A
Construction and maintenance of substation (Alternative option) - Alteration and transformation of riparian fringe and catchment area	During the construction and operation phase.	Removal of riparian vegetation	L	N/A
		Creation of hard surfaces & compacted soils	L	N/A
Construction and maintenance of substation (Preferred option)	During the construction and operation phase.	Removal of vegetation	L	N/A
		Creation of hard surfaces & compacted soils	L	N/A

In terms of the substation options, the preferred option is regarded as the acceptable option as this option is located outside of the boundaries of any wetland and ripariain habitat. Eventhough, the alternative substation option is located within a riparian habitat the impacts posed is still relatively low in terms of the nature and extent.

From the Surface Water & Hydrological Study no objections or motives for the project not to proceed was determined, and therefore the development may occur within the proposed development boundaries.

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9 APPENDICES:

Appendix 1. Survey methods

The assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

A two-day site visit was then conducted (24th & 25th of January) to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts and delineating the wetland areas.

» The following equipment were utilized during field work.
- Canon EOS 450D Camera
- Garmin Etrex Legend GPS Receiver
- Bucket Soil Auger
- Munsell Soil Colour Chart (2000)
- Braun-Blanquet Data Form (for vegetation recording and general environmental recordings).

Wetland and riparian areas were then assessed on the following basis:

» Identification and delineation of wetlands and riparian areas according to the the procedures specified by DWAF (2005a)

» Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database.

» Plant species were further categorised as follows:
- Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall
- Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non-wetland) (DWAF, 2005)
- Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005)

» Assessment of the wetland type based on the NWCS method discussed below and the required buffers

» Mitigation or recommendations required

Data sources consulted

The following date sources and GIS spatial information provided in the table below was consulted to inform the assessment. The data type, relevance to the project and source of the information has been provided.

Table 2: Information and data coverage's used to inform the wetland assessment

Data/Coverage Type	Relevence	Source
Colour Aerial Photography (2009)	Mapping of wetlands and other features	National Geo-Spatial Information
Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
Proposed power line routes and substation locations.	Shows location to the porposed powerline routes and impacted zone	Client
NFEPA wetland Coverage	Shows location fo FEPA river and wetland sites.	CSIR (2011)
National Land-Cover	Shows the land-use and disturbances/transformations within and around the impacted zone.	DEA (2015)
SA National Land-Cover	Shows the expected land caracteristics including land form & shape, geology, soil types and slope gradients.	AGIS (2014)
Quaternary Drainage Regions	Indicates the drainage region and major tributaries and water sources.	DWS (2009)
Present Ecological State of watersources	Shows the present ecological state of the affected non-perennial watercourses	Kleynhans (1999)

National Wetland Classification System (NWCS 2010)

Since the late 1960's, wetland classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith et al., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with a number of specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS 2010). This system comprises a hierarchical classification process of defining a wetland based on the principles of the Hydrogeomorphic (HGM) approach at higher levels, with including structural features at the finer or lower levels of classification (SANBI 2009).

Wetlands develop in a response to elevated water tables, linked either to rivers, groundwater flows or seepage from aquifers (Parsons, 2004). These water levels or flows then interact with localised geology and soil forms, which then determines the form and function of the respective wetlands. Water is thus the common driving force, in the formation of wetlands (DWAF, 2005). It is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs.

The NWCS process is provided in more detail in the methods section of the report, but some of the terms and definitions used in this document are present below:

Definition Box Present

Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State. Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES is determined per component - for rivers and wetlands this would be for the drivers: flow, water quality and geomorphology; and the biotic response indicators: fish, macroinvertebrates, riparian vegetation and diatoms. PES categories for every component would be integrated into an overall PES for the river reach or wetland being investigated. This integrated PES is called the EcoStatus of the reach or wetland.

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES

findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality). **Reserve**: The quantity and quality of water needed to sustain basic human needs and ecosystems (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The Ecological Reserve pertains specifically to aquatic ecosystems. Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements). **Ecological Reserve determination study**: The study undertaken to determine Ecological Reserve requirements. **Licensing applications**: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment. **Ecological Water Requirements**: This is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the Reserve Template. **Water allocation process** (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements. **Ecoregions** are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans et al. 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form), but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as "**areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not**

exceed six metres" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard et al., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are defined as "land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a water course (SANBI, 2009). The DWA is however reconsidering this position with regard the management of estuaries due to the ecological needs of these systems with regard to water allocation. Table 3 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open waterbodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands in order to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must therefore have one or more of the following attributes to meet the above definition (DWAF, 2005):

» A high-water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
» Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
» The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 3: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	**NWCS "wetland"**	**National Water Act wetland**	**DWAF (2005) delineation manual**
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describe as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[1]	NO
Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[2] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES3
Riparian areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[3]

[1] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act
[2] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.
[3] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources they could provide. Wetland conservation is now driven by the South African National Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

Wetlands are among the most valuable and productive ecosystems on earth, providing important opportunities for sustainable development (Davies and Day, 1998). However, wetlands in South Africa are still rapidly being lost or degraded through direct human induced pressures (Nel et al., 2004).

The most common attributes or goods and services provided by wetlands include:

» Improve water quality;
» Impede flow and reduce the occurrence of floods;
» Reeds and sedges used in construction and traditional crafts;
» Bulbs and tubers, a source of food and natural medicine;
» Store water and maintain base flow of rivers;
» Trap sediments; and
» Reduce the number of water borne diseases.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Table 4 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze et al., 2008). One such example is emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 4: Summary of direct and indirect ecoservices provided by wetlands from Kotze et al., 2008.

<table>
<tr><td rowspan="12">Wetland benefits (goods and services)</td><td rowspan="7">Indirect benefits</td><td rowspan="5">Hydrological benefits</td><td>Water purification</td></tr>
<tr><td>Sustained stream flow</td></tr>
<tr><td>Flood reduction</td></tr>
<tr><td>Ground water recharge/discharge</td></tr>
<tr><td>Erosion control</td></tr>
<tr><td colspan="2">Biodiversity conservation – integrity & irreplaceability</td></tr>
<tr><td colspan="2">Chemical cycling</td></tr>
<tr><td rowspan="5">Direct benefits</td><td colspan="2">Water supply</td></tr>
<tr><td colspan="2">Provision of harvestable resources</td></tr>
<tr><td colspan="2">Socio-cultural significance</td></tr>
<tr><td colspan="2">Tourism and recreation</td></tr>
<tr><td colspan="2">Education and research</td></tr>
</table>

Relevant wetland legislation and policy

Locally the South African Constitution, seven (7) Acts and two (2) international treaties allow for the protection of wetlands and rivers. These systems are protected from the destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act, 1998 (Act No. 36 of 1998);
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983); and
- Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
- Nature and Environmental Conservation Ordinance (No. 19 of 1974)
- National Forest Act (No. 84 of 1998)
- National Heritage Resources Act (No. 25 of 1999)

Apart from NEMA, the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) will also apply to this project. The CARA has categorised a large number of invasive plants together with associated obligations of the land owner. A number of Category 1 & 2 plants were found at all of the sites investigated, thus the contractors must take extreme care further spread of these plants doesn't occur. This should be done through proper stockpile management (topsoil) and suitable rehabilitation of disturbed areas after construction.

An amendment of the National Environmental Management was promulgated late December 2011, namely the Biodiversity Act or NEM:BA (Act No 10 of 2004), which lists 225 threatened ecosystems based on vegetation type (Vegmap, 2006 as amended). Should a vegetation type or ecosystem be listed, actions in terms of NEM:BA are triggered.

Other policies that are relevant include:

- Provincial Nature Conservation Ordinance (PNCO) – Protected Flora. Any plants found within the sites are described in the ecological assessment.
- National Freshwater Ecosystems Priority Areas – CSIR 2011 draft. This mapping product highlights potential rivers and wetlands that should be earmarked for conservation on a national basis.

National Wetland Classification System method

During this study, due to the nature of the wetlands and watercourses observed, it was decided that the newly accepted National Wetlands Classification System (NWCS) be adopted. This classification approach has integrated aspects of the HGM approached used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (SANBI, 2009) as stated previously, uses hydrological and geomorphological traits to distinguish the primary wetland units, i.e. direct factors that influence wetland function. Other wetland assessment techniques, such as the DWAF (2005) delineation method, only infer wetland function based on abiotic and biotic descriptors (size, soils & vegetation) stemming from the Cowardin approach (SANBI, 2009).

The classification system used in this study is thus based on SANBI (2009) and is summarised below:
The NWCS has a six-tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 15). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). **Level 2** then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

- Inshore bioregions (marine)
- Biogeographic zones (estuaries)
- Ecoregions (Inland)

Level 3 of the NWCS assess the topographical position of inland wetlands as this factor broadly defines certain hydrological characteristics of the inland systems. Four landscape units based on topographical position are used in distinguishing between Inland systems at this level. No subsystems are recognised for Marine systems, but estuaries are grouped according to their periodicity of connection with the marine environment, as this would affect the biotic characteristics of the estuary.

Level 4 classifies the hydrogeomorphic (HGM) units discussed earlier. The HGM units are defined as follows:

(i) Landform – shape and localised setting of wetland
(ii) Hydrological characteristics – nature of water movement into, through and out of the wetland
(iii) Hydrodynamics – the direction and strength of flow through the wetland.

These factors characterise the geomorphological processes within the wetland, such as erosion and deposition, as well as the biogeochemical processes.

Level 5 of the assessment pertains to the classification of the tidal regime within the marine and estuarine environments, while the hydrological and inundation depth classes are determined for the inland wetlands. Classes are based on frequency and depth of inundation, which are used to determine the functional unit of the wetlands and are considered secondary discriminators within the NWCS.

Level 6 uses of six descriptors to characterise the wetland types on the basis of biophysical features. As with Level 5, these are non-hierarchal in relation to each other and are applied in any order, dependent on the availability of information.

The descriptors include:

(i) Geology;
(ii) Natural vs. Artificial;
(iii) Vegetation cover type;
(iv) Substratum;
(v) Salinity; and
(vi) Acidity or Alkalinity.

It should be noted that where sub-categories exist within the above descriptors, hierarchical systems are employed, thus are nested in relation to each other.

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 15 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Level 1:
System » Connectivity to open ocean

WETLAND/AQUATIC ECOSYSTEM CONTEXT	
LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
DWA Level 1 Ecoregions or NFEPA WetVeg Groups or Other spatial frameworks	Valley floor
	Slope
	Plain
	Bench (Hilltop/Saddle/Shelf)

FUNCTIONAL UNIT	
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT	LEVEL 5: HYDROLOGICAL REGIME
River	Perenniality
Floodplain wetland	Period and depth of inundation and Period of saturation
Channelled valley-bottom wetland	
Unchannelled valley-bottom wetland	
Depression	
Seep	
Wetland flat	

WETLAND/AQUATIC ECOSYSTEM CHARACTERISTICS
LEVEL 6: DESCRIPTORS
Natural vs. Artificial Salinity Ph Substratum type Vegetation type Geology

Figure 12: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at

Level 5 to classify the hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 15 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.
In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Wetland condition and conservation importance assessment

To assess the Present Ecological State (PES) or condition of the observed wetlands, a modified Wetland Index of Habitat Integrity (DWAF, 2007) was used. The Wetland Index of Habitat Integrity (WETLAND-IHI) is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The output scores from the WETLAND-IHI model are presented in the standard DWAF A-F ecological categories (Table 4), and provide a score of the Present Ecological State of the habitat integrity of the wetland system being examined. The author has included additional criteria into the model based system to include additional wetland types. This system is preferred when compared to systems such as WET-Health – wetland management series (WRC 2009), as WET-Health (Level 1) was developed with wetland rehabilitation in mind, and is not always suitable for impact assessments. This coupled to degraded state of the wetlands in the study area, a complex study approach was not warranted, i.e. conduct a Wet-Health Level 2 and WET-Ecosystems Services study required for an impact assessment.

Table 5: Description of A – F ecological categories based on Kleynhans et al., (2005).

ECOLOGICAL CATEGORY	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A	Unmodified, natural.	Protected systems; relatively untouched by human hands; no discharges or impoundments allowed
B	Largely natural with few modifications. A small change in natural habitats and biota	Some human-related disturbance, but mostly of low impact potential

	may have taken place but the ecosystem functions are essentially unchanged.	
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality
F	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.	

The WETLAND-IHI model is composed of four modules. The "Hydrology", "Geomorphology" and "Water Quality" modules all assess the contemporary driving processes behind wetland formation and maintenance. The last module, "Vegetation Alteration", provides an indication of the intensity of human land use activities on the wetland surface itself and how these may have modified the condition of the wetland. The integration of the scores from these 4 modules provides an overall Present Ecological State (PES) score for the wetland system being examined. The WETLAND-IHI model is an MS Excel-based model, and the data required for the assessment are generated during a rapid site visit.

Additional data may be obtained from remotely sensed imagery (aerial photos; maps and/or satellite imagery) to assist with the assessment. The interface of the WETLAND-IHI has been developed in a format which is similar to DWAF's River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Conservation importance of the individual wetlands was based on the following criteria:

» Habitat uniqueness
» Species of conservation concern

- Habitat fragmentation with regard ecological corridors
- Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a Species of conservation concern was observed (HIGH). Any systems that was highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating.

Appendix 2. Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

- The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it was indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 -15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or
  - permanent – assigned a score of 5;
- The **magnitude**, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most

likely) and 5 is definite (impact will occur regardless of any prevention measures).

- The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and
- the **status**, which was described as either positive, negative or neutral.
- the degree of which the impact can be reversed,
- the degree to which the impact may cause irreplaceable loss of resources,
- the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

- S = Significance weighting
- E = Extent
- D = Duration
- M = Magnitude
- P = Probability

The significance weightings for each potential impact are as follows;

- < 30 points: **LOW** (i.e. where the impact would not have a direct influence on the decision to develop in the area),
- 30 – 60 points: **MEDIUM** (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: **HIGH** (i.e. where the impact must have an influence on the decision process to develop in the area).

Appendix 3. Ecological Risk Assessment

The National Water Act (Act 36 of 1998) and its regulations call for the issue of a Water Use Licence under certain conditions where a development or other activity may impact on a water resource. Two key Sections in this regard are Section 21(c) which covers activities which may "impede or divert" the flow of water in a watercourse. The key trigger distances for consideration of an activity are 32m for a watercourse and 500m for a wetland.

In order for the potential ecological impacts of the proposed development to be assessed use was made of the Department of Water and Sanitation's Risk Assessment model to determine whether any streams of wetlands were likely to be placed at risk as a result of the construction process. This tool is a spread sheet-based model which considers the possible impacts of any activity on a water resource. Risks or other relevant conditions are assigned a numeric score and these scores are then manipulated to produce a final rating. See next few paragraphs for a brief description of this scoring system and how it is applied to the final rating. The ratings vary in value from 1 to 300 and are divided into three classes as shown in Table 9.

» ***Risk Assessment Matrix (Based on DWS 2015 publication: Section 21(c) and (1) water use Risk Assessment Protocol)***

The Risk Rating Table (Table 6) takes into account the nature of an impact and the potential severity of the described impact on the resource quality of the affected system expressed in terms of a combination of the following features: Flow Regime, Water Quality (Physiological & Chemical), Habitat (Geomorphological & Vegetation) and Biota.
The potential Consequence, Likelihood and finally Significance scores are then automatically calculated with the rest of the parameters according to respective Risk Rating Tables

Table 6: The Risk Rating Table.

					Severity								
No.	Phases	Activity	Aspect	Impact	Flow Regime		Physico & Chemical (Water Quality)		Habitat (Geomorph + Vegetation)		Biota		Sensitivity

Severity	Spatial Scale	Duration		Consequence		Frequency of activity	Frequency of impact	Legal issues	Detection		Likelihood	Significance	Risk rating	Confidence Level	Control Measures	Borderline LOW/MODERATE Rating Classes	PES & EIS of Watercourse

» ***The Risk Assessment Key (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

- The **severity** is an expression of how the mentioned aspects will impact on the quality (flow regime, water quality, geomorphology, biota and habitat) and a value of 1 to 5 is assigned as appropriate (with 1 being Insignificant/non-harmful and 5 being Disastrous/extremely harmful and/or wetland(s) involved)

* 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.

- The **spatial scale** is an estimation of how big the area is that is impacted on by the relevant aspect. A value of 1 to 5 is assigned as appropriate, where 1 is indicative of an area specific impact (at impact site) and 5 indicates that the impact is of a Global size (impacting beyond SA boundary).
- The **duration**, wherein the aspect's proposed impact on the environment and resource quality is:
  - On day to one month, PES, EIS and/or REC not impacted – assigned a score of 1;
  - One month to one year, PES, EIS and/or REC impacted but no change in status – assigned a score of 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 – assigned a score of 3;
  - Life of the activity, PES, EIS and/or REC permanently lowered – assigned a score of 4; and
  - More than life of the organisation/facility, PES and EIS scores, an E or F – assigned a score of 5.

    * PES and EIS (Sensitivity) must be considered.
- The **frequency of the activity** (how often is the activity executed?) is estimated on a scale of 1 to 5, where 1 is annually or less, 2 is six monthly, 3 is monthly, 4 is weekly and 5 is daily.
- **Frequency of the incident/impact** (how often does the activity impact on the environment?) is estimated on a scale of 1 to 5 where 1 is almost never / almost impossible / >20%; 2 is very seldom / highly unlikely / >40%; 3 is infrequent / unlikely / seldom / 60%; 4 is often / regularly / likely / possible / 80% and 5 is daily / highly likely / definitely / >100%.
- **Legal issues** refer to any activities which are governed by legislation. Where no legislation is applicable a value of 1 is assigned, whereas in the case where any form of legislation is applicable for the specified activity, a value of 5 should be assigned.
- The **detection of an impact/risk** refers to the time / degree of difficulty required to identify the impacts/risk (on resource quality etc.) caused by the specified activity. A value of 1 to 5 is assigned, depending on the time and difficulty, where:
  - 1 is immediately;
  - 2 is without much effort;
  - 3 is with some effort;
  - 4 is where observation is remote and difficult; and
  - 5 is for Covered

» ***The Risk Assessment Calculations and Formulas (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

- **Consequence**
  = Severity + Spatial Scale + Duration
- **Likelihood**
  = frequency of Activity + Frequency of Incident + Legal Issues + Detection
- **Significance/Risk**
  = Consequence X Likelihood

» ***The Calculated Risk/Significance (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

As mentioned the ratings vary in value from 1 to 300 and are divided into three classes, as shown in Table 7.

* In the case where a LOW risk class have been obtained for all mentioned activities a GA can be considered.

Table 7: Department of Water and Sanitation rating table for impacts on water resources.

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. Wetlands may be excluded.
56 - 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which cost more and require specialist input. Wetlands are excluded.
170 - 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.