POWERING POSSIBILITY

WETLAND ASSESSMENT OF THE SUBLIME ROAD UPGRADE

J37158

Original

November 2017

GIBB
ENGINEERING & ARCHITECTURE
People • Expertise • Excellence

WETLAND ASSESSMENT OF THE SUBLIME ROAD UPGRADE

CONTENTS

Chapter	Description	Page

Revision Status

Rev No.	Issue Date	# Pages	Revision Description	Prepared By	Reviewed By	Approved By
0	10/11/2017	36	Draft	S. Gounden	L. Van Rooyen	R. David

Abbreviations / Acronyms / Definitions

CVB	Channelled Valley Bottom
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water Affairs and Sanitation
EC	Ecological Category
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
HGM	Hydrogeomorphic Unit
MAP	Mean Annual Precipitation
NBA	National Biodiversity Assessment
NFEPA	National Freshwater Ecosystem Protected Areas
NWA	National Water Act
OM	Organic Matter
PES	Present Ecological State
PET	Potential Evapotranspiration
UCVB	Unchannelled Valley Bottom
WWTW	Waste Water Treatment Works

List of Figures

List of Tables

Acknowledgements

GIBB (Pty) Ltd thanks Exxaro for the opportunity to provide a wetland assessment of the Matla Power Station for the upgrading of the Sublime Road.

Executive Summary

Internationally, wetlands are recognised as being valuable, natural ecosystems and are known to carry out important functions (Davies and Day, 1998). As a result of identifying the significance of wetlands, the Ramsar Convention was formed in 1971. The Ramsar Convention is a global treaty that aims to conserve wetland environments (Cowan, 1995). The treaty, of which South Africa was the fifth signatory member, binds its members to a set standard which promotes the conservation of wetland environments (Day and Malan, 2010).

Exxaro, on behalf of Matla Coal Mine has proposed the upgrading of the existing Sublime exit road. The road was initially meant for one directional traffic, however ESKOM has suggested upgrading the road to a dual carriage road. In addition to the upgrading of the road, it is understood that as a result of the road upgrade sufficient stormwater upgrades will also be required. As a result of the WULA process, Exxaro has therefore appointed GIBB (Pty) Ltd (hereafter referred to as GIBB) to undertake a wetland delineation, functional and ecological sensitivity assessment of all wetlands within a 500 m buffer of the proposed development.

From the assessment carried out, it was found that one Unchannelled Valley Bottom/seep wetland system is situated within the site of the proposed development within the Matla Power Station. These were separated into 4 HGM units since the road and historical agricultural practices resulted in four different segments of the system.

The wetlands were found to be unchannelled valley bottom systems with areas of 6.9 Ha, 6.9 Ha, 2.4 Ha and 3.2 Ha, respectively. The health status, EIS and risk matrix was determined by using the relevant assessment tools. It was thereby concluded that all the HGM units were currently in a moderately modified state, not sensitive and is of low risk to the proposed development occurring. However, these systems were recognised for their importance in providing a habitat and breeding site for protected species such as Marsh Owls, as well as various other species identified during field visits.

Although the proposed development was regarded to be a low risk to these wetland systems, severe degradation of these systems could occur if proper mitigation measures are not implemented. The following recommendations aim to mitigate the negative impacts in order to enhance the overall value and functioning of the system:

- Re-vegetation
- Controlling Alien Invasive Plants
- Minimising Human Disturbances
- Storm Water Management
- Pollutant control
- Legislation
- 30 m Buffer

1 Introduction

The term 'wetland' is generally used to describe various habitats where land becomes periodically saturated. Precipitation such as snow or rain, that is not lost to atmospheric processes such as transpiration or evaporation, enters a catchment and travels through until it reaches the sea (Collins, 2005). The formation of a wetland occurs when the topography or geology hinders the movement of the water travelling through the catchment. This is usually where the topography is very gentle sloping or flat, or where groundwater seeps to the surface resulting in the soil layers at the surface to become permanently or seasonally saturated (DWAF, 2004).

Internationally, wetlands are recognised as being valuable, natural ecosystems and are known to carry out important functions (Davies and Day, 1998). Some of these functions include; providing a habitat for certain organisms which are exclusively reliant on wetland environments as areas for feeding, breeding, or as a nursery area for their young (Cowan, 1995). Furthermore wetlands also act as a 'sponge' during periods of flooding (flood attenuation), whereby wetlands are able to retain flood waters in the soil and thereafter gradually release the water. Additionally wetlands act as water purifiers, as wetlands are able to absorb the nutrients and contaminants contained in the surface runoff (Davies and Day, 1998).

As a result of identifying the significance of wetlands, the Ramsar Convention was formed in 1971. The Ramsar Convention is a global treaty that aims to conserve wetland environments (Cowan, 1995). The treaty, of which South Africa was the fifth signatory member, binds its members to a set standard which promotes the conservation of wetland environments (Day and Malan, 2010).

1.1 Project Description

In an aim to meet the import coal demands of ESKOM, Exxaro is required to upgrade their current infrastructure in order to ensure effortless coal supply to Matla Power Station. The current Sublime road was originally constructed as an emergency road resulting from unexpected strike action taking place at the colliery. The road was therefore not designed for the present traffic it is currently accommodating.

Exxaro, on behalf of Matla Coal Mine has therefore proposed the upgrading of the existing Sublime exit road. The road was initially meant for one directional traffic, however ESKOM has suggested upgrading the road to a dual carriage road. In addition to the upgrading of the road, it is understood that as a result of the road upgrade sufficient stormwater upgrades will also be required.

The total length of the road is estimated to be 1711 m with an average width of 6.4 m. The additional lane is estimated to be 4.5 m, including storm water infrastructure. In total, the new road is projected to be 8 m in width with the necessary storm water drainage and a 1 m shoulder or road reserve on either side.

As per Section 21(c) and (i) of the National Water Act (NWA), water uses that require a Water Use Licence Application (WULA) include; “impeding or diverting the flow of water in a water course” and “altering the bed, banks, course or characteristics of a water course.”

The date at which the Sublime road was initially constructed is uncertain. As a result, the initial construction of the road could have preceded the proclamation of the NWA 36 of 1998, therefore there was no legal obligation to apply for a WULA under section 21(c) and (i) of the NWA. However, due to the proposed development encompassing the widening of the existing road, it is considered a new activity and therefore requires a water use licence.

As a result of the WULA process, Exxaro has therefore appointed GIBB to undertake a wetland delineation, functional and ecological sensitivity assessment of all wetlands within a 500 m buffer of the proposed development.

1.2 Terms of Reference

The terms of reference for this study were as follows:

- Map, delineate and classify the wetlands within 500 m of the existing Sublime road.
- Determine the Present Ecological State (PES) of the wetland(s) on site;
- Establish the ecological sensitivity (EIS) of wetlands within the study site.
- Provide suitable and relevant mitigation measures and recommendations, regarding the storm water structures.
- Indicate the watercourses and wetland habitat within the 500 m developmental buffer area around the area of development, as required by the DWS;
- Provide a risk assessment for the upgrade of the access road, as required by the DWS.

1.3 Assumptions and Limitations

In order to gain detailed information regarding the geomorphology, hydrology, vegetation and functioning of particular wetlands, assessments should ideally be carried out over numerous seasons, over a number of years. The current study however, relied on information gained during a two day field survey which was conducted during a single season. Regardless, desktop analysis for the area, professional judgement and experience, were considered to be sufficient for the purposes of the study.

The GPS used for wetland delineations is accurate within approximately five meters. Therefore, the wetland delineation plotted utilising a GPS may be inaccurate by at least five meters on either side.

Additionally, numerous areas could not be verified due to landowner issues. Further delineation of wetland areas were largely dependent on the extrapolation of field indicator data obtained during field surveys, interpretation of 5m contour interval maps and, other imagery. Therefore, inherent ortho-rectification errors associated with data capture and transfer to electronic format are likely to decrease the accuracy of wetland boundaries in multiple instances.

These types of mapping constraints, discussed above are well recognised (Tiner, 1999), and their limitations need to be understood with regards to interpreting map results as well as the overall functional assessment. Nonetheless, the delineations portrayed do provide a high confidence with respect to the identification of the associated wetlands in this study.

2 Site Description

2.1 Locality

Matla Power Station is located in the Mpumalanga province of South Africa (26.28249°S, 29.14072°E). It is situated approximately 20 km west of Kriel, 50 km southwest of Witbank and 30 km south and north of Ogies and Secunda, respectively (Ayanda *et al.*, 2012). See Figure 1. The power station was the first of the giant 3 600 MW coal fired power stations to be commissioned during the 1980's and was fully operational in July 1983 (Okedeyi *et al.*, 2012).

2.2 Climate

The study area is located 1550-1600 m above mean sea level, within the Highveld ecoregion. This region receives moderate to high rainfall of 500-800 mm, which is moderate to high in comparison to the rest of the country which has a mean annual precipitation (MAP) of 490 mm. Most of the rainfall experienced in this area occurs primarily during the early to mid-summer months (Kleynhans et al., 2007; Worldwide Fund for Nature - South Africa, 2016). The average annual temperature within this ecoregion varies from 12 – 18°C, with an average daily maximum temperatures ranging between 22 – 28°C occurring in the summer months and an average daily minimum temperatures ranging between -2 – 1°C in July occurring in the extremely dry winters (Kleynhans et al., 2007).

2.3 Regional Vegetation

Mpumalanga is well renowned for its vast grasslands and multiple wetlands, where the natural predominance of high shrubs and/or trees is significantly restricted by regular occurrences of frost (and other factors) during the winter season, which tufted perennial grasses are better adapted to survive in. Approximately 21% of South Africa's flora exists in the Mpumalanga region. The bulk (64 %) of these plant species constitutes of soft herbs and bulbous plants (geophytes) located in the grassland biome. The majority of these species remain dormant during winter or very dry seasons, and re-sprout during early summer if there has been sufficient rain.

The grassland biome constitutes of an assortment of various vegetation types, which differ pertaining to the existing abiotic conditions. As per the delineation of these vegetation types, mapped for South Africa (in Mucina and Rutherford, 2006 and updated 2012 on BGIS), the study area was previously found to be covered with Eastern Highveld Grassland, whereas the wetlands generally consists of Eastern Temperate Freshwater Wetland Vegetation, in the past (Mucina and Rutherford, 2006).

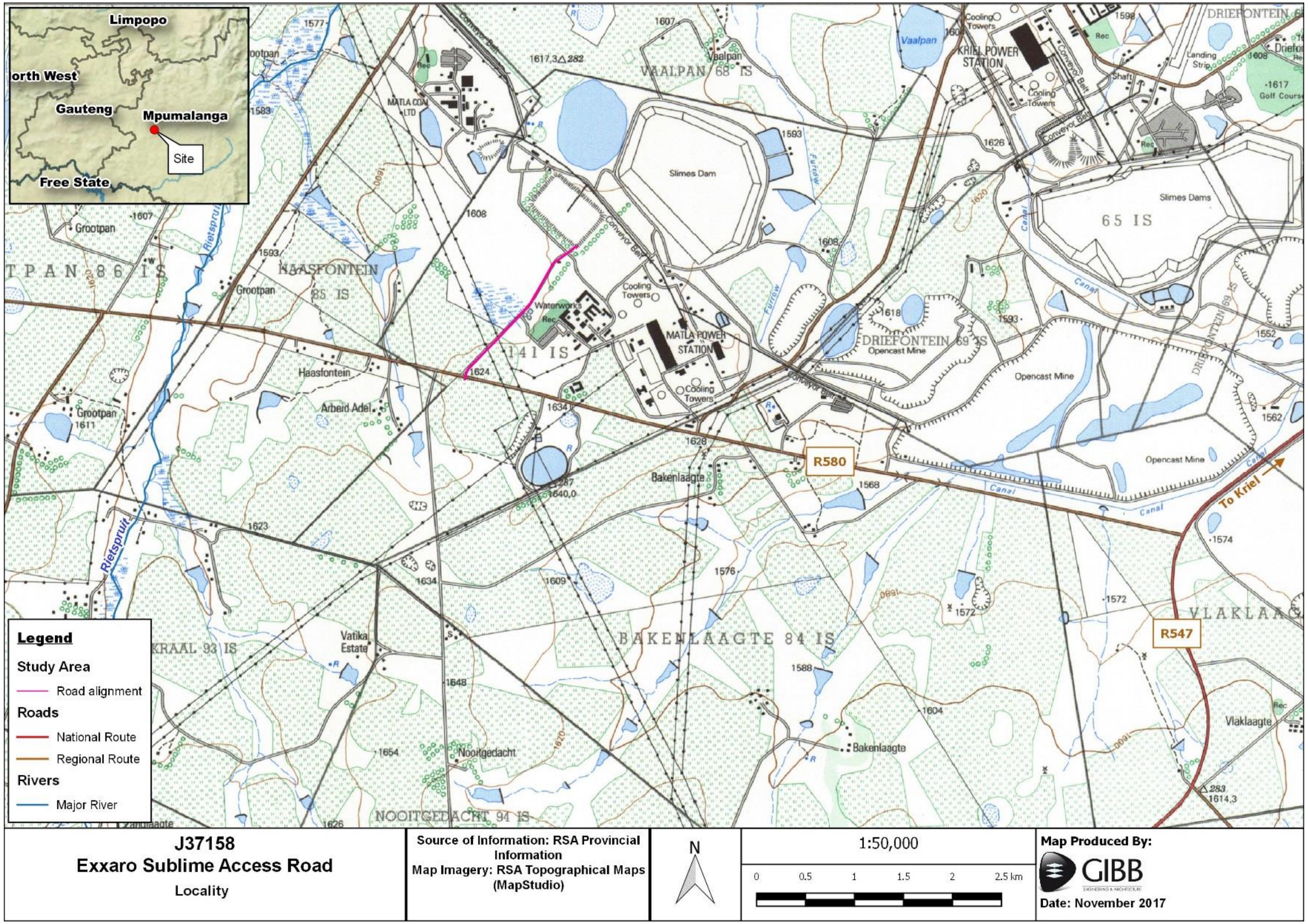


Figure 1: Locality Map of the proposed road upgrade

2.4 Associated Watercourses

The study region is situated within the Olifants Water Management Area (WMA) and in the B11E Upper Olifants sub-catchment, which corresponds to the South African portion (excluding the Letaba River catchment) of the Olifants River Catchment (Department of Water Affairs and Forestry, 2004). Lying beneath this sub-catchment is a vast coal depository and consequently, the predominant industries located within this region are focused around the extraction, processing and utilisation of this ore. As a result, a significant threat to water resources within the region emanates from the power generation industry, as made evident by the moderately high usage (44.15%) of the water which is utilised as cooling water for the multiple surrounding thermal power stations (Department of Water Affairs and Forestry, 2004).

More specifically, the study area is situated between two main national river systems, namely the Steenkoolspruit River which occurs at an estimated 25 km west of the study site, and the Rietspruit River which exists approximately 7 km north of the study site.

2.5 National Freshwater Ecosystem Priority Areas

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

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

The first aim utilises systematic biodiversity planning to recognise priorities areas for conserving South Africa's freshwater ecosystems, taking into consideration equitable social and economic development. The second aim encompasses a national and sub-national constituent: The national component aims to align DWA and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level. The project further aims to maximize collaborations between other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project, it can be established that NFEPA's surround the Rietspruit River, which encompasses the study site, as seen in Figure 2 below.

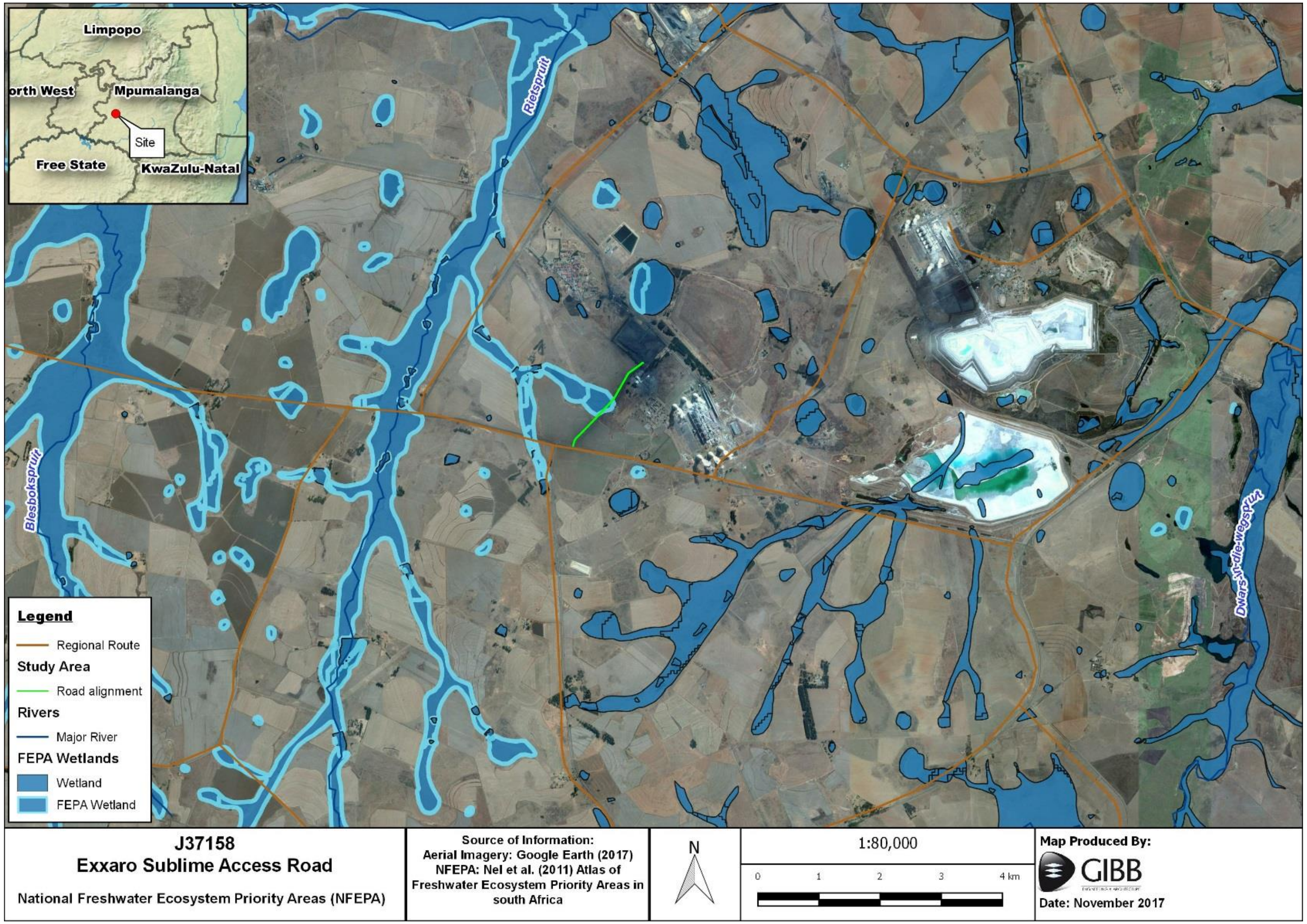


Figure 2: Map of NEFPA's identified

3 Methodology

Field surveys were undertaken on the 25th to the 27th of October 2017. The wetland delineation was based on the required methodology as described by DWAF (2005). A Level 2 WET-Health assessment (Macfarlane *et al.*, 2007) was applied in order to determine the Present Ecological Status (PES) of wetlands within the study area in order to assign PES categories to wetlands. In addition, the Ecological Importance and Sensitivity (EIS) was determined.

3.1 Wetland Delineation

A desktop study was initially completed in order to obtain a broad understanding of the general study site. Once wetland boundaries were delineated at a desktop level, a field survey was conducted to verify whether these areas were correct and to delineate areas that were not identified at a desktop level.

Desktop delineation was conducted on Google Earth®. The polygon tool was used and boundaries were drawn around each HGM unit identified at a desktop level by identification of characteristic vegetation and topography.

Different hydrological zones of wetlands (permanent, seasonal and temporary zones) are generally classified according to the duration to which they are submerged by water. Permanent zones are permanently submerged, whereas seasonal zones are saturated for a minimum of three months per annum, with temporary zones being inundated by water for a period of less than three month per annum. These zones are often separated by different soil and vegetation profiles, which display different characteristics within the different zones.

A field survey was conducted in order to ensure boundaries were accurately delineated at a desktop level. In order to map out the different boundaries of the wetland study site, soil cores were obtained by using a Dutch soil auger up to a depth of approximately 50 cm to 60 cm. The location of each soil core obtained was thereafter logged, recorded by a Global Positioning System, and documented by photographs taken on site.

In order to identify wetland areas within the study site, four specific wetland indicators were used:

- Vegetation
- Topography of the landscape
- Soil wetness
- Soil form

The sediment cores were evaluated on-site for redoximorphic soil features such as gleying, mottling, soil wetness and soil chroma. In addition the soil cores were mapped using Google Earth® for further analysis and processing. All information such as aerial photography, field notes and coordinates of sampling sites were used in combination to identify and delineate the extent of the wetlands.

The verification of the different hydrological zones started at the most outer edge of the temporary zone in order to find the boundary between the aquatic and neighbouring terrestrial area.

3.1.1 Soil Wetness and Soil Form Indicators

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

The delineation of the hydrological zones is further compounded by the characteristics of the soil profiles taken. The presence of mottles, the matrix value and matrix chroma are significant indictors of hydrological zonation. Mottles are contained mostly within the matrix of a soil profile and are recognised as soft structures that are of an irregular shape and bright colours (usually orange, red or yellow). Mottling occurs due to the alternating of wetting and drying of the soil, and appears when the soil is exposed to air during dry periods allowing for the oxidation of metals, such as iron, to take place (Collins, 2005). It can therefore be understood that the permanent zone of a wetland would have little to no mottling as these soils are constantly submerged, therefore oxidation of these metals will not take place. However, due to variations in the water table level, the uppermost layer of the soil may become exposed to the atmosphere thereby developing a few mottles. Conversely, the seasonal zone should have an abundance of mottles present due to a significant variation in the wetting and drying periods, allowing for oxidation of these metals to take place and thus the formation of mottles. Similar to the permanent zone, the temporary zone of a wetland would have little to no mottles present within the soil profile as these soils are very rarely wet long enough for the formation of mottles to occur.

The matrix and chroma values are correlated to the leaching of Fe-Mn oxides in the soil under saturated conditions, giving the soil a 'greyish' appearance. The more often a soil is subjected to saturation, the lower the chroma and matrix values will be, therefore as one moves from the temporary to the seasonal and then to the permanent zone of a wetland, the matrix values and chroma are expected to decrease (Verpraskas, 1995).

3.1.2 Vegetation

The vegetation health of a wetland refers to the compositional and structural state of the vegetation. The compositional and structural state of wetland vegetation serves as a habitat for multiple species and contributes a multitude of benefits. Due to the significant sensitivity of wetland vegetation to hydrology, they are commonly utilised for the delineation of wetland boundaries. In order to use the wetland vegetation for wetland delineation purposes the predominant categories of hydrophilic plant species present must be identified, as it is not a sufficient indicator to identify individual wetland plants for delineation.

3.2 Wetland Classification

Wetland areas may encompass more than one hydrogeomorphic units. HGM units were identified and were classified according to the National Wetland Classification System developed by SANBI (Kotze *et al.*, 2005) as seen in Figure 2. The HGM classification system uses the hydrological and geomorphological features of the delineated wetland unit to determine its classification.

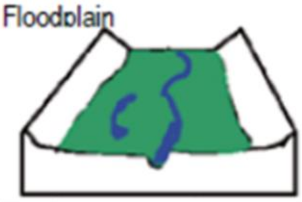
Hydrogeomorphic types	Description
Floodplain 	Valley-bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley-bottom, channelled 	Valley-bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Vallev-bottom. unchannelled 	Valley-bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Hillslope seepage linked to a stream 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a stream channel.
Isolated Hillslope seepage 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network

Figure 3: Classification of Wetland Hydrogeomorphic Units

3.3 Wetland Functional Assessment

Functional assessments were conducted on all HGM units comprising of the study site. The functional assessment tools utilised in this study were: WET-Health Level 2 assessment.

3.3.1 WET- Health

The health of wetlands is defined as its deviation from its natural reference condition. In order to establish the health of a wetland the hydrological, geomorphological and vegetation regime must be evaluated, as these are the three predominant components comprising of a wetland environment.

The WET-Health tool has been developed to monitor wetlands nationally in South Africa which will be used in a range of contexts such as wetland management and rehabilitation. (Macfarlane *et al*., 2007). WET-Health takes into consideration three important components of wetland systems which are geomorphology, hydrology and vegetation. These components are assessed and any deviations from the natural environmental conditions are noted. The overall health of each component is assessed within a three step process (Macfarlane *et al*., 2007).

Step 1: PES Determination for each Hydrological, Geomorphological and Vegetation Components

The first step was based on human and natural impacts in the wetland and catchment areas, and each HGM unit was assessed on "Present Ecological State" so that ultimately the wetland could be scored from 0 (wetland being identical to natural environmental conditions) to 10 (wetland significantly changed) for hydrology, geomorphology and vegetation separately. Due to the score of 0-10 not being entirely easy to work with when doing a wetland assessment, this will be translated into one of six health classes, A-F (Refer to Table 2).

Step 2: Wetland Vulnerability determination

The second step was completed by determining the threat and/or vulnerability, and an evaluation was also completed for each HGM of the likely "Trajectory of Change" within the wetland (Lackey, 2001). This was broken up into five categories of likely alteration depending on the direction and/or degree of probable change. These categories are as follows:

↑↑ = large improvement
↑ = slight improvement
→ = remain the same
↓ = slight decline
↓↓ = rapid decline

Step 3: Determination of the Overall PES

The third and final step was completed by establishing the overall health of each HGM by jointly representing the overall "Present Ecological State" (a combination of the hydrological, geomorphological and vegetation heath) and likely Trajectory of Change (Macfarlane *et al.*, 2007).

Table 1: PES Categories and Functional Health Status of Wetlands

Impact Category	Health Category	Description	Range
None	A	Unmodified/natural	0 – 0.9
Small	B	Mostly Natural with a few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9
Moderate	C	Moderately modified. A moderate change in the ecosystem processes and the loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9
Large	D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4 – 5.9
Serious	E	A very large change in ecosystem processes and loss of natural habitat and biota but some of the remaining natural habitat features are still recognizable.	6 – 7.9
Critical	F	The modification has reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota	8 – 10

3.4 Ecological Importance and Sensitivity

"Ecological importance" of a wetland refers to its importance in maintaining ecological diversity and functioning on local and wider scales. "Ecological sensitivity" makes reference to a system's capacity to resist disturbance and its ability to recuperate from a disturbance once it has occurred. The Ecological Importance and sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

In this particular method, a number of determinants for EIS are evaluated on a scale of 0 to 4, where 0 indicates low/no importance and 4 indicates a very high importance (Table 2). The median of the determinants was thereafter used to assign the appropriate Ecological Management Class (EMC) for a wetland (Kleynhans, 1999).

Table 2: EIS Categories

Impact Category	Health Category	Description	Range
Very high	A	Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High	B	Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate	C	Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/Marginal	D	Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

3.5 Risk Assessment

The Risk Assessment was conducted as required by the Department of Water and Sanitation, using the risk-based approach stipulated in GA Notice 509 of 2016. The Risk Assessment matrix is utilised in order to determine the level of risk to wetland quality. 'Risk' is dependent on the possibility of occurrence and the resulting consequence it has on the properties of a watercourse. 'Likelihood' is an aspect of determining failure, the occurrence of an activity is taking place, legal repercussions of failure and the common occurrence of impacts on the watercourses. 'Consequence' is determined with regards to the severity, duration and spatial scale. The quantity of risk involved will activate resultant measures to be introduced in order to diminish the risk.

Table 3: Risk Management Categories

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

4 Results and Discussion

The following section is a condensation of all the data obtained through desktop analysis and field surveys. Data concerning delineation, functional health, and EIS within the study site have been assessed and are displayed below.

4.1 Wetland Delineation

Four separate HGM Units were identified within the 500 m buffer zone of the proposed road development (Figure 4). Figure 5 below displays the delineation of the identified HGM Units.

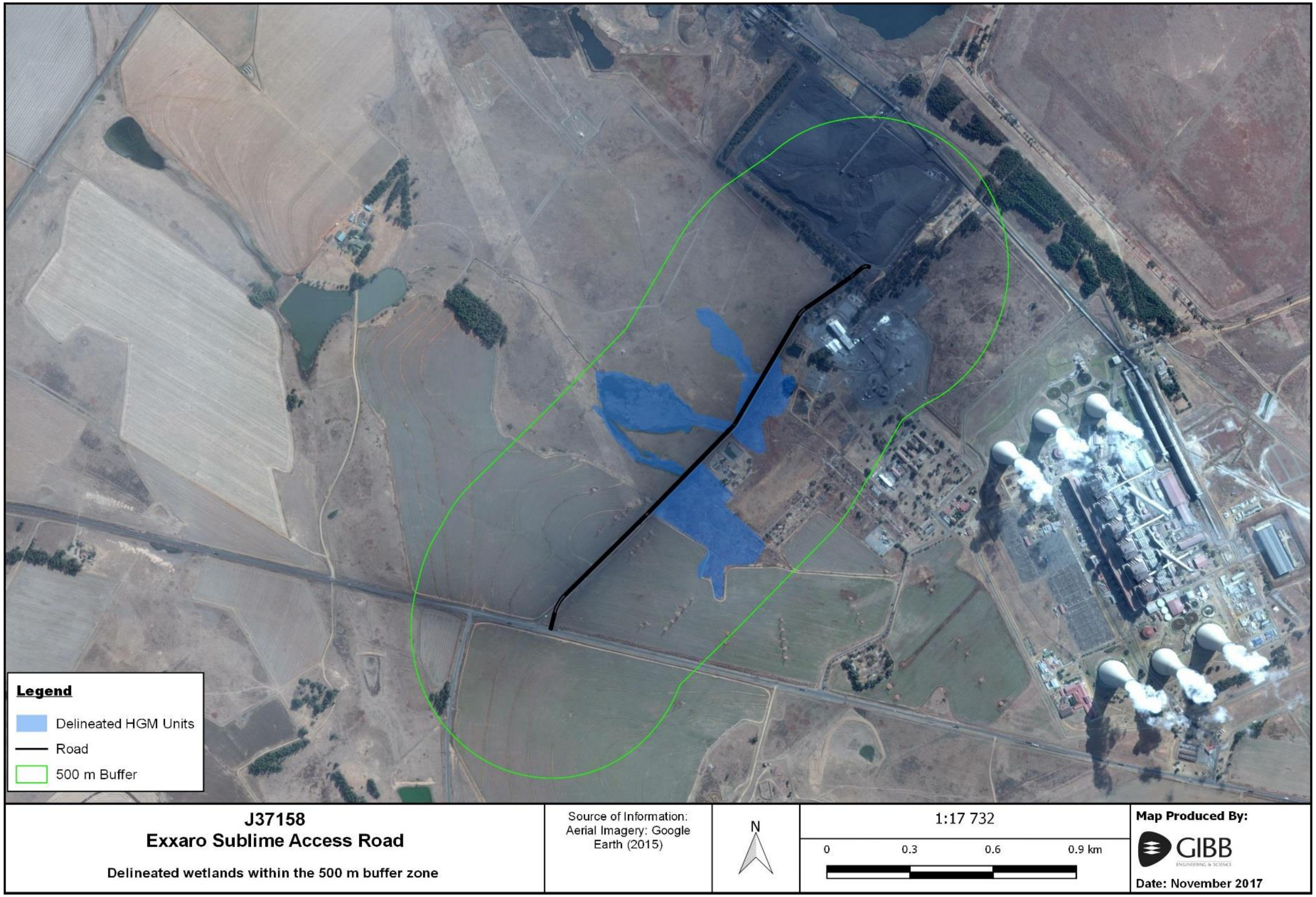


Figure 4: Delineation of HGM units identified within a 500 m buffer of the proposed development

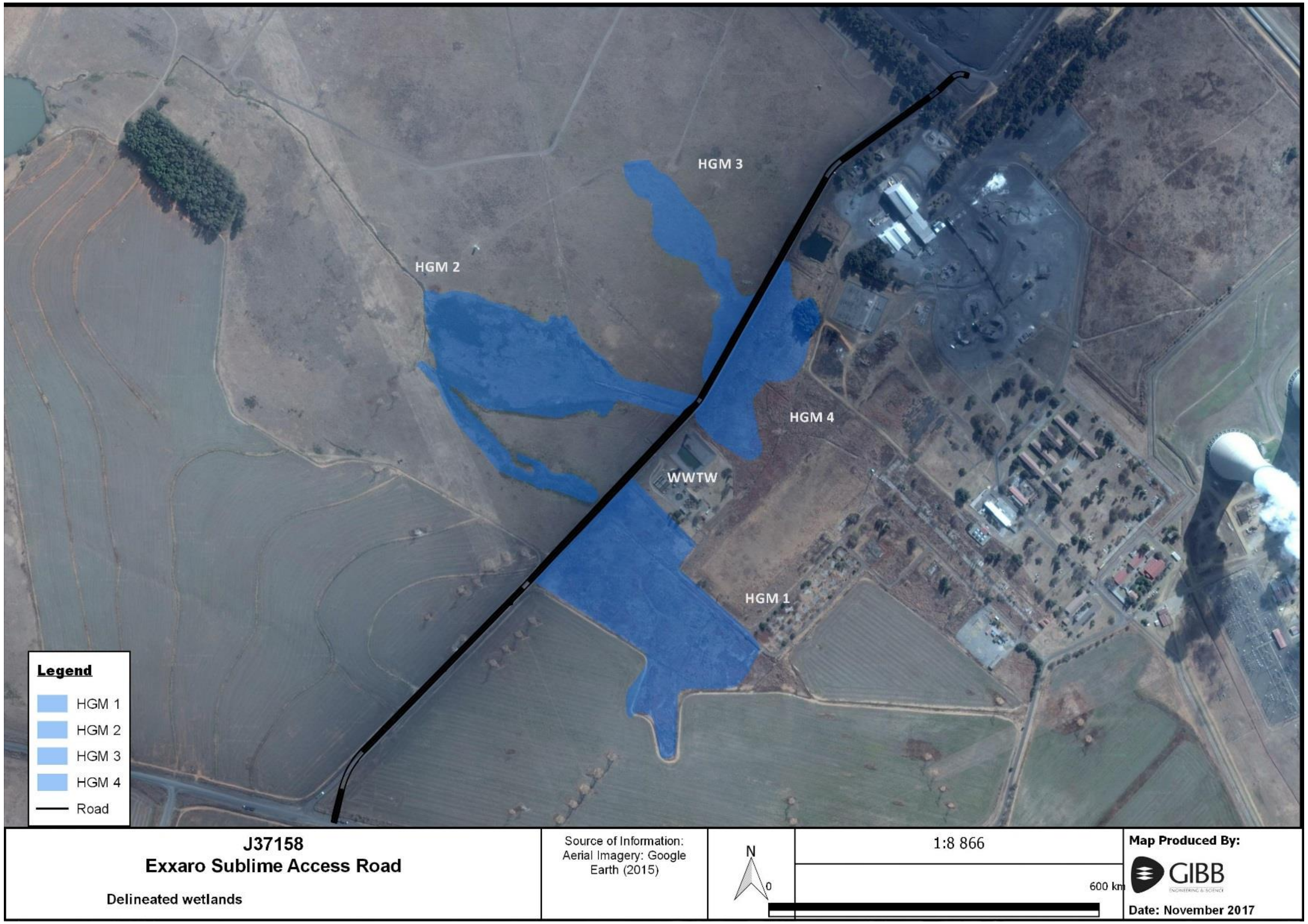


Figure 5: Four (4) HGM Units identified

4.1.1 HGM 1

HGM 1 was classified as an unchannelled valley bottom (UCVB) type wetland. This HGM unit was relatively flat, sloping slightly towards the existing road which it runs parallel to for about 220 m. Additional features surrounding HGM 1 was the Waste Water Treatment Works (WWTW) facility to the right and crop lands to the left. A trench, which was constructed by the farmer for the purpose of draining the wetland for his crop lands, was evident transecting approximately the middle of the HGM unit in the wettest portion channelling the water, which then seeps out creating wet zones on either side.

Auger samples were taken on either boundary of the HGM unit. Sample 1 was taken along the boundary of the WWTW. The matrix of Sample 1 was identified to be brownish grey. Within both the 0-20 cm and 30-50 cm horizons many dark orange and yellow mottles were present (Figure 6). The clay content increased from the upper 0-20 cm layer to the bottom 30-50 cm layer, as the upper layer had a moderate amount of clay with a high sand content, whereas the bottom layer was predominantly clay.

Figure 6: Sample 1 in HGM 1 showing presence of yellow mottles

Sample 2 was taken along the boundary of the crop lands. The sample had a brown matrix with very low OM content. Mottles were completely absent in the 0-20 cm layer, with a few occurring in the 30-50 cm layer. There was a distinct change in horizon, with the soils transitioning from a light brown colour and sandy texture, to a darker brown clayey textured soil (Figure 7). Sample 2 was therefore indicative of the outer temporary zone of the wetland.

Figure 7: Sample 3 in HGM 1

4.1.2 HGM 2

HGM 2 was classified as an unchannelled valley bottom (UCVB) type wetland. This HGM unit was flat throughout, sloping down away from the existing road. The HGM 2 system is made up of a large portion and a smaller 'arm' portion originating at the road and joining the top of the larger system. A trench was dug by the landowner, who is a farmer, which is assumed for the purpose of draining the wetland in order to gain grazing land for his cattle.

Transects were taken through the arm of the system, as well as through the larger portion. Sample 1 was taken along the boundary of the arm of the system. The matrix of Sample 1 was identified to be brown, and consisted of low amount of organic matter. Within the 0-20 cm layer the presence of mottles were non-existent, whereas in the 30-50 cm layer there was an abundance of small clear mottles present (Figure 8). Furthermore, the soil sample taken was found to be high in sand content.

Figure 8: Sample 1 in HGM 2

Sample 2 was taken in the lower middle portion of the arm. The sample had a grey matrix with very high Organic Matter (OM) content. Mottles were completely absent in both the 0-20 cm and 30-50 cm layers (Figure 9). There was a distinct change in horizon, with the soils transitioning from an organic rich, dark brown layer to a gleyed, greyish brown layer. Within both layers the samples were high in clay content. Gleyed soils implies long periods of waterlogging which causes al the colour-forming minerals to go into solution, therefore this was indicative of permanently saturated soils.

Figure 9: Sample 2 in HGM 2

Samples 3 to 5 were taken in the main body of HGM 2. Sample 3 and Sample 5 were found to be very sandy in texture, with the top layers encompassing calcium carbonate from calcrete used on the adjacent road (Figure 10 – sample 3). The matrix of these samples were identified to be greyish brown with very low OM content. Mottles were absent in the 0-20 cm layer, with few feint, small, orange mottles present in the 30-50 cm layer (Figure 10 – sample 5). In addition, Samples 3 and 5 were found to be predominantly sandy in texture. These samples were therefore indicative of the outer most boundaries of HGM unit 2.

Figure 10: Sample 3 (left) and Sample 5 (right) in HGM 2


Figure 11: Sample 4 in HGM 2

Sample 4 was taken in approximately the middle of the system. The soil matrix of Sample 4 was found to be brownish grey with a relatively high OM content. Within both the 0-20 cm and 30-50 cm layers there were many mottles present (Figure 11). The soil within this sample was found to be very high in clay content throughout both layers and was therefore indicative of the seasonal zone.

4.1.3 HGM 3

HGM 3 was classified as an unchannelled valley bottom (UCVB) type wetland. This HGM unit was relatively flat throughout, sloping away from the existing road. HGM 3 and HGM 4 are presumed to be connected through subsoil flow.

Three auger samples were taken throughout the HGM unit. Sample 1 was taken along the boundary closest to the road. The matrix of Sample 1 was identified to be brownish, and consisted of an intermediate amount of organic matter. Within both the 0-20 cm and 30-50 cm layers there was an abundance of yellow and orange mottles (Figure 12). The soil sample also revealed a clear distinction in the soil horizons, as the sample transitioned from a very sandy A-horizon to a more clay rich and greyer than the B-horizon, indicating seasonally saturated soils.

Figure 12: Sample 1 in HGM 3

Samples 2 and 3 were taken on opposite boundaries of the HGM unit. These samples had a brown matrix with very low OM content. Mottles were lacking in the 0-20 cm layer, with a few occurring in the 30-50 cm layer (Figure 13). Samples 2 and 3 were therefore indicative of the boundary of the temporary zone of HGM unit 3.

Figure 13: Sample 2 (left) and 3 (right) in HGM 3

4.1.4 HGM 4

HGM 3 was classified as an unchannelled valley bottom (UCVB) wetland and exists to the right of the WWTW facility. This HGM unit was relatively flat throughout, sloping towards the existing road to which it runs parallel to for an approximate extent of 315 m.

Sample 1 was taken at the closest boundary of the WWTW. The sample was found to have a greyish brown matrix with a high OM content and evidence of gleyed soils were present (Figure 14). In the 0-20 cm there were no mottles present, whereas in the 30-50 cm layers there were a few mottles present (Figure 14). The soils within this sample were saturated and were rich in clay.

Figure 14: Sample 1 in HGM 4

A transect was taken through HGM 4 at the opposite end of the WWTW, at which samples 2-5 were taken. Sample 2 comprised of a grey matrix with a high OM content and was waterlogged. There were no mottles present in the upper 0-20 cm layer, with a few mottles present in the 30-50 cm layer (Figure 15). This sample was clearly indicative of permanently saturated soils.

Figure 15: Sample 2 in HGM 4

The matrix of sample 3 was brownish grey and had an intermediate OM content. Within this sample there was an abundance of mottles present in both the 0-20 cm and 30-50 cm layers (Figure 16). Sample 3 was therefore indicative of soils which are seasonally inundated.

Figure 16: Sample 3 in HGM 4

Sample 4 had a matrix of brown with an intermediate amount of OM. Mottles sparsely occurred in the lower 30-50 cm layers, with no mottles present in the upper 0-20 cm layer. The soil profile was indicative of temporary wet soils (Figure 17).

Figure 17: Sample 4 in HGM 4

Sample 5 displayed a brown matrix, with no mottles present and no indication of wetness. Sample 5 was therefore indicated the terrestrial zone (Figure 18).

Figure 18: Sample 5 in HGM 4

4.2 Vegetation Profile

Vegetation within the wetland systems consisted of hygrophilous vegetation. Larger reed species occurred where there was standing water on the east side of the road, while perennial grasses and sedges were more common on the west side. Common grass species included *Juncus effusus, Cyperus spp., Hyparrhenia sp., Eragrostis chloromelas, Leersia hexandra, Pennisetum clandestinum, Typha capensis, Cynodon dactylon, Imperata cylindrica, Phragmites australis, and Paspalum distichum*. Few herbaceous species were observed. Common species included *Homeria pallida, Limosella major*, and *Arctotis arctotoides*.

Figure 19 Dominant Vegetation type (*Juncus Effusus*) found in HGM 2, 3, 4

4.3 Mpumalanga Biodiversity Sector Plan

Creation of the freshwater CBA map depended on the newly completed National Freshwater Ecosystems Priority Areas (NFEPA) project (Nel *et al.,* 2011). The freshwater CBA map depicts three sub-categories of CBA (CBA Aquatic Species, CBA Rivers and CBA Wetlands) and five sub categories of ESA (Wetlands, Wetland Clusters, Important Sub-catchments, Fish Support Areas and Strategic Water Source Areas).

The following features were identified within the site (Figure 20):

- CBA Wetlands - Wetlands that are important for meeting biodiversity targets for freshwater ecosystems; the ecological condition of these wetlands needs to be maintained or improved, and their loss or deterioration must be avoided. This category includes FEPA wetlands.

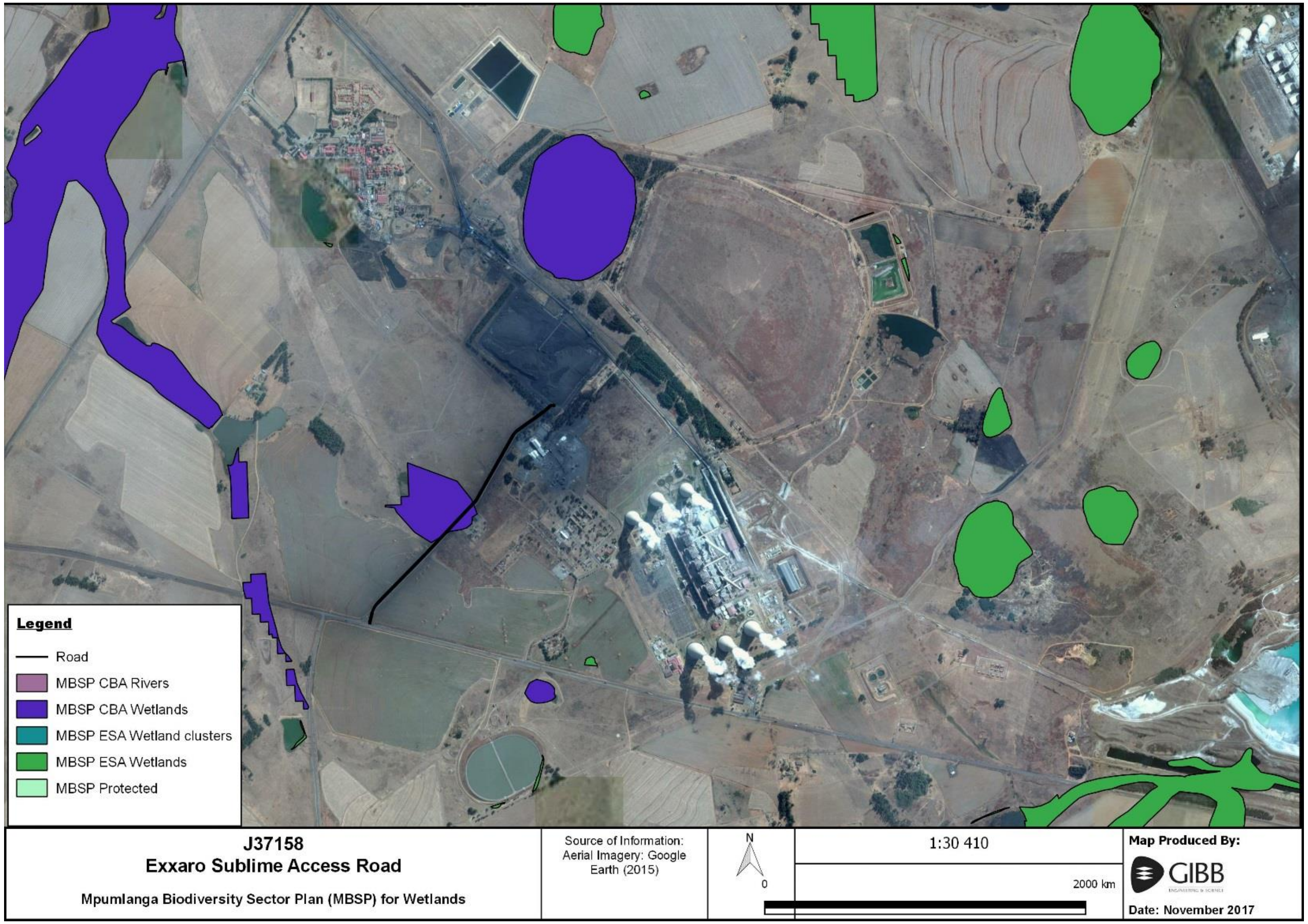


Figure 20 Mpumalanga Biodiversity Sector Plan for Wetlands

4.4 Functional Health (Present Ecological State)

The PES (WET-Health Level 2) was determined for the Unchannelled Valley Bottom wetlands found on site. The three categories (i.e. hydrology, geomorphology and vegetation) as well as the overall health and the vulnerability profile are detailed below.

4.4.1 Hydrology

The hydrological health of a HGM unit refers to alterations in the movement and distribution of water through a wetland and its soils. This occurs due to changes in activities within the catchment, and other modifications occurring in a wetland HGM that may alter the patterns of water distribution and retention within the wetland.

Table 4 below, displays the overall hydrological health of HGM Units 1-4 in terms of PES scores and subsequent categories ranging from A-F.

Table 4: Hydrological Health Status of HGM's 1 - 4

HGM UNIT	AREA (Ha)	PES SCORE	PES CATEGORY	TRAJECTORY OF CHANGE
1	6.9	3.0	C	↓
2	6.9	3.0	C	↓
3	2.4	5.0	D	↓
4	3.2	3.0	C	↓

HGM unit 1, 2 and 4 have a PES category C. A category C unit refers to a unit in which the impact of the modifications on the integrity of the hydrological regime is limited, but still clearly identifiable. HGM unit 3 has a PES category of D which speaks of a system in which the modifications are clearly detrimental to the hydrological integrity where approximately 50% of the hydrological integrity has been lost.

The trajectory of change for all HGM units is a downward trajectory, suggesting the continued slight hydrological degradation of these HGM’s over the next five years.

One of the essential attributes of climate that affects a wetlands vulnerability to a change in the water inputs is the ratio of MAP: PET (mean annual precipitation: potential evapotranspiration). The lower the ratio, the lower the contribution of direct precipitation entering the wetland, thereby causing the hydrology of the wetland to become more dependent on water flows from the catchment upstream, and thus more vulnerable to reduced inflows. The wetlands of this particular study site fall into a catchment zone where the MAP: PET ratio is relatively low, thus making the hydrological regime of the wetland exceptionally vulnerable to a lack of inflows from the upper catchment regions.

Land uses which have an impact on the hydrology of the wetlands within the study area include the presence of alien vegetation. Within the entire assessed HGM units it was confirmed that the presence of alien vegetation was moderate. Alien vegetation has a negative impact on hydrology due to their ability to take up large quantities of water, and thus have a large impact in excessively depleting water sources.

The extent of hardened surfaces additionally has a significant impact on the hydrology of the HGM units. It was established that within the catchment of the HGM units there was a small percentage of hardened surfaces present in the form of roads, other forms of infrastructure. Hardened surfaces increase the flow velocity during rain events, lower the infiltration rate of storm water, and thereby increase the surface runoff and occurrence of flood peaks. The impact of hardened surfaces can create areas of bare soil, which may lead to erosion. If flooding continually occurs for extensive periods of time, this can result in the complete degradation of wetland habitat.

Additionally, the effect of drains have a considerable effect on the hydrology of these HGM units, as it tends to have a significant impact on the retention and distribution of water in a wetland. Artificial drains were found within some of the HGM units, however the most extensive was found to be in HGM 2. The presence of these artificial drains causes a reduction in the hydrological conductivity of sediments in a wetland. Hydrological conductivity refers to the easy facilitation of water through sediments, therefore by reducing the hydraulic conductivity, the distribution of water becomes limited.

4.4.2 Geomorphology

The geomorphic health of a HGM unit refers to the distribution and retention patterns of sediment within a wetland (Table 5). The geomorphic health of a HGM unit is influenced by excessive sediment inputs and/or losses of organic and mineralogical sediment.

Table 5 below, displays the overall geomorphic health of HGM 1 in terms of PES scores and subsequent categories ranging from A-F.

Table 5: Geomorphological Health Status of HGM's 1 - 4

HGM UNIT	AREA (Ha)	PES SCORE	PES CATEGORY	TRAJECTORY OF CHANGE
1	6.9	2.2	C	→
2	6.9	1.7	B	→

3	2.4	2.3	C	→
4	3.2	1.1	B	→

HGM 1 and 3 are in C PES Category which refers to systems which are moderately modified, and a moderate change in geomorphic processes has occurred but the system remains predominantly intact. HGM units 2 and 4 fall within a PES Category of B. A category B refers to a system which has a few modifications, but remains largely natural, a slight change in geomorphic processes is noticed but the unit remains predominantly intact.

Alterations to the runoff characteristics' of a HGM changes the ability of water to transport, lift and deposit sediment, which leads to erosion or deposition in a HGM unit. This is one of the primary factors causing geomorphological damage in a wetland. The runoff characteristics of the wetlands within the study site have been altered due to the construction of the surrounding buildings, roads and other infrastructure within the catchment of the wetland. As a result, this has reduced the surface roughness allowing water to flow into the wetland at increased speeds due to no frictional barrier being present, and at increased volumes due to the infiltration rate being reduced. Both of these factors coupled together further encourage the occurrence of erosional activities and thereby geomorphological degradation.

Another contributing reason to the slight alteration in geomorphology in the catchment could be as a result of artificial filling, which causes changes to water flows and geomorphic activities to a localised portion of a wetland which thereby decreases the frequency, extent, and the rate of erosion or deposition in those areas closer to the channel than would naturally occur. The presence of roads in close proximity to the HGM unit provided evidence of artificial infilling.

4.4.3 Vegetation

The vegetation health of an HGM refers to the composition and structure of the vegetation within a HGM unit and is influenced by the impacts of historic and current transformations and disturbances on site. Table 6 below, displays the overall vegetation health status of the HGM units in terms of PES scores and subsequent categories ranging from A-F.

Table 6: Vegetation Health of HGM's 1 - 4

HGM UNIT	AREA (Ha)	PES SCORE	PES CATEGORY	TRAJECTORY OF CHANGE
1	6.9	2.8	C	→

2	6.9	3.4	C	→
3	2.4	3.2	C	→
4	3.2	3.6	C	→

4.4.4 Overall Health

The below results in Table 7 below, were obtained by using the PES scores of each HGM's hydrological, geomorphological and vegetation health. The following equation was utilised:

$$\frac{(\text{Hydrology PES} \times 3) + (\text{Geomorphology PES} \times 2) + (\text{Vegetation PES} \times 2)}{7}$$

Table 7: Overall Health Status of HGM's 1 - 4

HGM UNIT	AREA (Ha)	OVERALL PES SCORE	PES CATEGORY	HEALTHY WETLAND (Ha)	LOSS OF WETLAND (Ha) (Hectare Equivalence)
1	6.9	2.7	C	5.0	1.9
2	6.9	2.7	C	5.0	1.9
3	2.4	3.7	C	1.5	0.9
4	3.2	2.6	C	2.4	0.8

From the above table it can be seen that all HGM Units fall within a C PES Category, which is typical of a system that has been moderately modified, where there has been a moderate change in ecosystem processes, and a loss of natural habitats has taken place, but the natural habitat remains predominantly intact.

4.5 Ecological Importance and Sensitivity

Table 8, Table 9, Table 10 and Table 11 below displays the ecological importance and sensitivity (EIS), hydro functional importance and the direct human benefits provided by the considered HGM units.

Table 8: EIS of HGM 1

	Score	Recommended Ecological Management Class
Ecological Importance and Sensitivity	2.3	B
Hydro Functional Importance	1.8	C
Direct Human Benefits	0.8	D

Table 9: EIS of HGM 2

	Score	Recommended Ecological Management Class
Ecological Importance and Sensitivity	2.7	B
Hydro Functional Importance	1.8	C
Direct Human Benefits	0.8	D

Table 10: EIS of HGM 3

	Score	Recommended Ecological Management Class
Ecological Importance and Sensitivity	2.3	B
Hydro Functional Importance	1.4	C
Direct Human Benefits	0.3	D

Table 11: EIS of HGM 4

	Score	Recommended Ecological Management Class
Ecological Importance and Sensitivity	2.7	B
Hydro Functional Importance	1.8	C
Direct Human Benefits	0.3	D

The scores of 2.3, 2.7, 2.3 and 2.7 for HGM's 1 – 4 respectively for ecological importance and sensitivity places these units in B recommended ecological management class. Class B is characteristic of wetlands which are considered to be ecologically important and sensitive. The biodiversity of these wetlands are usually very sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water in major rivers.

With regards to hydro functional importance, all HGM units are in a recommended ecological management class of C. Class C refers to a wetland that is considered to have a low ecological importance and sensitivity on a provincial or local scale. The biodiversity of this wetland is usually not sensitive to flow and habitat modifications, and plays a small role in moderating the quantity and quality of water of major rivers.

The provision of direct human benefits scored 0.8, 0.8, 0.3, 0.3 respectively, placing it in a D recommended management class, which refers to a wetland which has a very low ecological importance and sensitivity at any scale. The biodiversity of this wetland is ubiquitous and not sensitive to flow and habitat modifications. Additionally, they play an insignificant role in moderating the quantity and quality of water of major rivers and provide little to no benefits to humans.

4.5.1 Ecological Importance and Sensitivity

The wetland systems were determined to have a high ecological importance and sensitivity. The ability of the wetland to support biodiversity was determined to be high as it was established that there were red data species present (Marsh owls), and a high ability in acting as a migration, breeding or feeding site for wetland species, particularly HGM units 2 and 4.

In terms of the wetland importance on a landscape scale it was determined to have a low importance and sensitivity due to the lack of protection status of the wetland, the diminished regional context of the ecological integrity, their small size. Apart from HGM 2 and 3 which are in close proximity to a classified NFEPA.

Due to the flat terrain of the wetland systems, the sensitivity of the wetland to changes in floods was determined to be moderate as the vegetation cover acts as a barrier to rainfall events occurring.

4.5.2 Hydro Functional Importance

Unchannelled valley bottom type wetlands generally have a gentle slope and are therefore characterised by the deposition of alluvial deposits and subsequently the net accumulation of sediment. Water inputs are mainly derived from the channel entering the wetland, from the adjacent slopes, and potentially groundwater. However, the surrounding infrastructure and trenches within these HGM units has significantly affected the ability of these wetland systems to provide such functions, particularly HGM 1 and 3.

The hydro functional importance of the wetland system was therefore determined to be moderate/low due to its intermediate ability to attenuate floods, regulate stream flows, trap sediment, and assimilate phosphates, nitrates, toxicants and store carbon. However, erosion control was deemed to be a somewhat significant function of the wetland, which is as a result of the gentle slope of the wetlands and dense vegetation cover allowing for high velocity flows to flow down the slopes in a regulated manner. As these flows travel down the slope at a regulated pace it allows for settling time of the water, thereby allowing for water quality enhancement by the wetland via assimilation of nutrients.

4.5.3 Direct Human Benefits

The wetland system was found to have very low importance in terms of direct human benefits (both subsistence and cultural). Water for human use was non-existent. The only use of the wetland was for small scale farming. The provision of harvestable resources from the wetland, such as plants for crafts was determined to be low; even though these plants could be used for certain purposes, it is very unlikely within this site. Furthermore, the site was not deemed a cultural heritage site, and the area was not found to be utilised for tourism and recreation or education and research.

4.6 Risk Assessment

The risk assessment matrix was completed by considering the potential effects of the upgrading of the road. The road already exists therefore the activity of upgrading the road is thought to be relatively low, assuming careful measures are taken in order to prevent further unnecessary degradation of the surrounding HGM units (Table 12).

All of the HGM units identified exist in close proximity to the road which therefore increases their risk, particularly HGM units 2 and 3, which slope down from the road. Therefore during periods of excessive rainfall, any material will directly be deposited into this catchment.

The activity of clearing vegetation is presumed to pose an overall low risk to the associated watercourses as a very small portion of vegetation will be removed, therefore minimally affecting the loss of vegetation, surface runoff, infiltration, soil compaction, and the dispersal of alien invasive species. The actual upgrading of the road is also believed to ultimately pose a low risk as the impacts associated with this activity are assumed to occur at a minimal basis due to the short time span of construction activities taking place.

Additionally, the utilisation and maintaining of the road were deduced to present a low risk to the considered watercourses as impacts such as erosion activities, and littering on-site are understood to be of low risk due to the minimal extent of the development and the small scale of the development.

Table 12: Risk Assessment Matrix

PHASE	ACTIVITY	ASPECT	IMPACT	RISK	Risk with Mitigation
Construction	Clearing of vegetation	Workers removing vegetation and movement of people on site	Vegetation loss.	L	L
			Decrease in surface roughness.	L	L
			Increase in run off.	L	L
			Decrease in infiltration.	L	L
			Soil compaction.	L	L
			Alien invasive dispersal.	L	L
Construction	Upgrading of road	Storage of material, movement of people/ machinery through the site, filling in and clearing of land.	Impeding the flow of water.	L	L
			Siltation of wetland.	L	L
			Erosion of water course.	L	L
			Littering and dumping within the site.	L	L
			Compaction of soil which will influence the soil through-flow of water in the subsoil	L	L
Operational	Utilisation of the road	Delivery of material, gaining access in and out of the power station.	Increase in erosion activities.	L	L
			Contamination of water courses.	L	L
			Increase in littering and pollutants on-site.	L	L
Operational	Maintaining of the road	People moving around the sewer pump station. Interference and consequential malfunctioning of the sewer plant.	Increase in erosion activities.	L	L
			Increase in littering and pollutants on-site.	L	L

5 Mitigating Measures and Recommendations

The following recommendations aim to mitigate the negative impacts in order to enhance the overall value and functioning of the system:

- Re-vegetation

  In cases where natural vegetation were cleared/removed due to the movement of people or stockpiling of building materials, re-vegetation should take place. Prior to re-vegetation efforts taking place in cleared and degraded wetlands, it is imperative that all solid wastes are removed from individual HGM units and their immediate surrounding regions. Post solid waste removal, a mixture of indigenous species should be introduced (Peters *et al.*, 2012). The re-establishment of vegetation will increase these systems' ability to maintain biodiversity, the reduction in velocity and quantity of runoff waters into wetlands, the slowing down of water movement though a wetland thus aiding in trapping sediment and improving the overall quality of water (Mullins, 2012).

- Controlling Alien Invasive Plants

The careful control of the dispersion of alien invasive vegetation within a wetland is imperative due to their degradation causing properties. The key to controlling the dispersion of alien vegetation is through early detection and removal. The removal and management of alien vegetation is essential in maintaining the ecological integrity of a wetland as well as its ability to maintain biodiversity (Richardson *et al*., 2007).

- Minimising Human Disturbances

As a consequence of the proposed development, the wetland system will possibly encounter anthropogenic disturbances. Therefore, in order to manage and mitigate these threats faced by the wetland a suitable buffer should be determined. Therefore, during periods of construction there should be minimal human disturbances by minimising activities that would lead to excessive pollution and run off into the drainage line (Kotze *et al*., 2008). During the construction phase all measures should be taken in order to prevent contamination of wetland areas by vehicles utilised. If any spills of diesel, petrol, oil, or corrosive fluid occur a spill kit should be kept on site to immediately address this. All vehicles and machinery should therefore be kept off site in a bunded, platformed location in order to avoid such contamination in the watercourses.

- Storm Water Management

Storm water management reduces the negative effects of storm water runoff. Management of storm water comprises of controlling flooding, reducing erosion and improving water quality. This can be achieved by implementing measures known as Best Management Practices (BMPs). Such BMPs include the installation of a porous pavement, which are interlocking tiles or bricks that allows storm water runoff to infiltrate the pavement and thereafter enters the soil which removes fine grain pollutants and provides erosion control. In addition there are vegetative BMPs which include a number of landscaping practices. Grassed swales, or ditches, can be placed in residential areas or in highway medians. This BMP helps lessen the peak runoff downstream through processes of infiltration and storage. Filter strips are designed to direct storm water from impervious areas into a stone trench, which evenly distributes the runoff over a grass strip. Particular attention should be given to HGM units 3 and 4 when considering storm water management infrastructure, as these HGM units run in close proximity to the road which could cause an accumulation of water, and consequential flooding of the road if proper storm water management systems are not implemented.

- Pollutant control

During construction periods vehicles should only be allowed to stand overnight and refuelled only on impervious surfaces. Additionally, materials not to be stockpiled within the buffer area; all materials should strictly be kept 30 m away from the watercourses on site. Furthermore, during the operational phase, when maintaining and utilising the road, mitigation measures must be developed and implemented to inhibit further degradation of these wetland systems. In the event of an unexpected damage occurring this should be reported to the relevant authority immediately.

- Legislation

The enforcement of relevant legislation pertaining to wetlands and the adherence to policies is vital for maintaining the health and overall integrity of wetlands.

- 30 m Buffer

Buffer zones are areas around the wetland boundaries, which are requested to protect the wetland from developmental or land use changes. Protection may also extend to peak runoff/flood flows and the buffer zone may also provide feeding/breeding areas for wetland or river fauna and accordingly enhance the corridor function of drainage lines. In terms of the guidelines presented by DWAF (2005), an appropriate buffer strip surrounding the wetland/riparian habitat is required to protect the habitat and the water resource.

The buffer recommended around the HGM units is 30 m (see Figure 19), which will help maintain the integrity of these environments in its current state by preventing any activities occurring and storage of any material within this region.

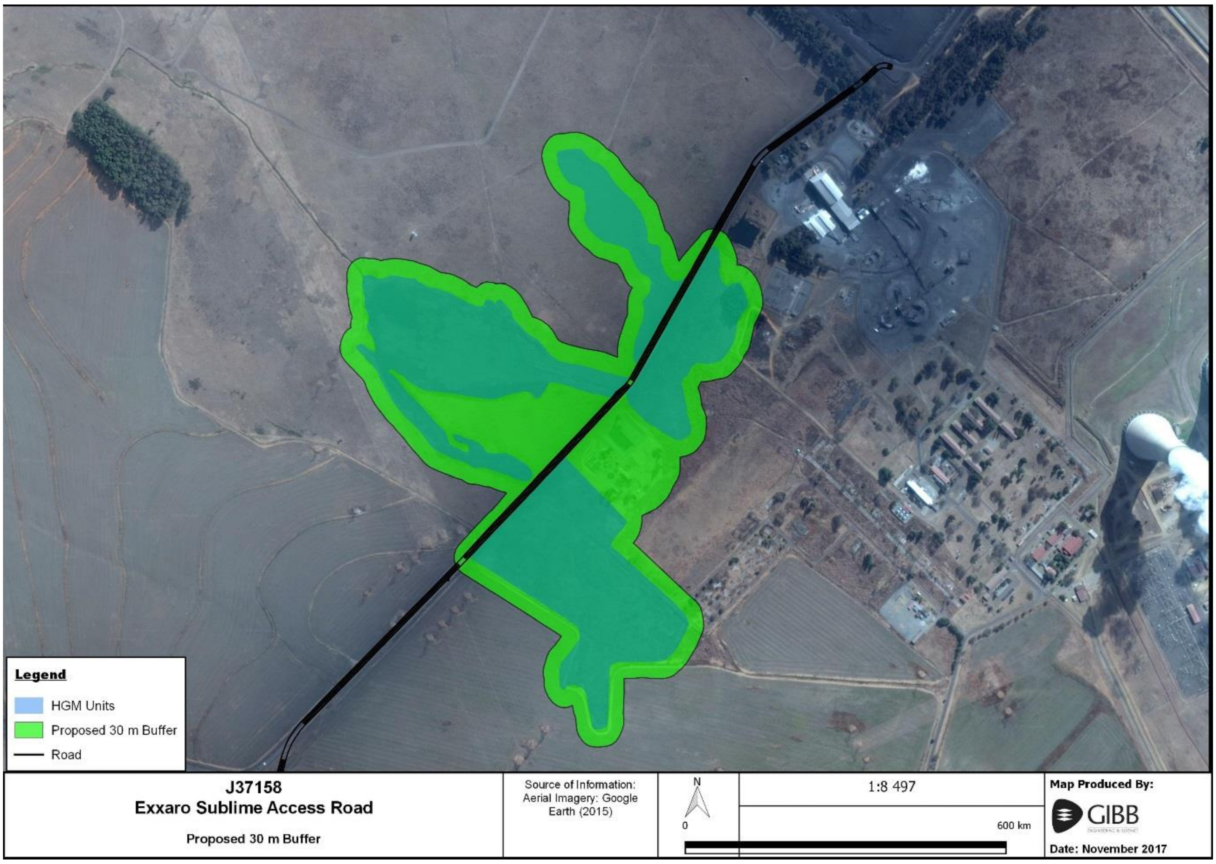


Figure 21: Proposed 30 m Buffer around HGM units

6 Conclusion

From the assessment carried out, it was found that one UCVB/seep wetland system is situated within the site of the proposed development within the Matla Power Station. These were separated into 4 HGM units since the road and historical agricultural practices resulted in four quite different segments of the system.

The wetlands were found to be unchannelled valley bottom systems with areas of 6.9 Ha, 6.9 Ha, 2.4 Ha and 3.2 Ha, respectively. The health status, EIS and risk matrix was determined by using the relevant assessment tools. It was thereby concluded that all the HGM units were currently in a moderately modified state, not sensitive and is of low risk to the proposed development occurring. However, these systems were recognised for their importance in providing a habitat and breeding site for protected species such as Marsh Owls, as well as various other species identified during field visits.

The proposed development was regarded to be a low risk, to these wetland systems, and therefore a GA would be recommended. However severe degradation of these systems could occur if proper mitigation measures are not implemented. In order to ensure that the development has minimal impact on the surrounding HGM units, special attention should be given to storm water management and removal of alien invasive species.

7 References

Ayanda O.S., Fatoki O.S., Adekola F.A., Ximba B.J., 2012. Characterization of Fly Ash Generated from Matla Power Station in Mpumalanga, South Africa. E-Journal of Chemistry. Vol. 4, pp 1788-1795.

Collins N.B., 2005. Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.

Cowan G.I. (ed.), 1995. Wetlands of South Africa. Department of Environmental Affairs and Tourism, Pretoria, South Africa.

Davies B. and Day J., 1998. Vanishing waters. University of Cape Town Press. Rondebosch, Cape Town, South Africa.

Day E. and Malan H., 2010. Tools and Metrics for Assessment of wetland Environmental Condition and Socio-economic Importance. Handbook to the WHI Research Programme. WRC Report No. TT433/09.

DWAF, 2005. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Kleynhans C. F., 1999. The development of a fish index to assess the biological integrity of South African rivers. Water SA. Vol. 25, pp 265-278.

Kotze D.C., Marneweck G.C., Batchelor A.L., Lindley D.S. and Collins N.B., 2008. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria.

Lackey R.T., 2001. Values, policy and ecosystem health. Bioscience. Vol. 51, pp. 437–443.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P., and Goge C., 2007. WET-Health: A technique for rapidly assessing wetland health. Water Research Commission, Pretoria.

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

Mullins G., 2012. Copensation Flats Industrial Park- Wetland Rehabilitation Plan. Available: http://www.rhdhv.co.za/media/201210/CIBE/Addendum%201%20Appendix%20G3%20%20Wetland %20rehabilitation%20Plan.pdf.

Okedeyi O.O., Nindi M.M., Dube S., Awofolu O.R., 2013. Distribution and potential sources of polycyclic aromatic hydrocarbons in soils around coal-fired power plants in South Africa. Environmental Monitoring Assessment. Vol. 185, pp 2073-2082.

Ollis, D.J., Snaddon, C.D., Job, N.M., and Mbona, N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22, South African National Biodiversity Institute, Pretoria.

Peters, M. and Clarkson, B. (Eds), 2012. Wetland Restoration: A Handbook for New Zealand Freshwater Systems, Manaaki Whenua, New Zealand.

Richards, N.P., Botha, G.A., Schoeman, P., Clarke, B.M., Kota, M.W. and Ngcobo, F.N., 2009. Engineering geological mapping in Pietermaritzburg, South Africa: constraints on development. Engineering geology of tomorrow's cities. Geological Society, London, Engineering Geology Special Publication. pp. 22.

Richardson D.M., Holmes P.M., Elser K.J., Galatowitsch S.M., Stromberg J.C., Kirkman S.P., Pysek P., Hobbs R.J., 2007. Riparian vegetation: degradation, alien plant invasions, and restoration prospects. Diversity and Distributions. Vol. 13, pp. 126-139.

Tiner R.W., 1999. Wetland Indicators. A guide to wetland identification, delineation, classification and mapping, Lewis Publishers, New York.

Verpraskas M.J., 1995. Redoximorphic features for identifying Aquic Conditions. North Carolina Agricultural Research Service. North Carolina State University. Technical bulletin 301.

Document Control and Disclaimer

FORM IP180_B

GIBB
ENGINEERING & ARCHITECTURE

CLIENT	:	EXXARO			
PROJECT NAME	:	EXXARO Sublime Road Design	**PROJECT No.**	:	J37158
TITLE OF DOCUMENT	:	Wetland Assessment Of The Sublime Road Upgrade			
ELECTRONIC LOCATION	:	C:\Users\sgounden.GIBB\Desktop\Exxaro Wetland Assessment_V6.docx			

	Approved By	Reviewed By	Prepared By
ORIGINAL	NAME **Robyn Phillips**	NAME **Lulu Van Rooyen**	NAME **Salicia Gounden**
DATE	SIGNATURE	SIGNATURE	SIGNATURE

	Approved By	Reviewed By	Prepared By
REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

GIBB (Pty) Ltd

Postal Address	:	PO Box 1365	Website	:	www.gibb.co.za
			Physical Address	:	1st Norfolk House 54 Norfolk Terrace Westville 3630
Contact Person	:	S. Gounden	Email Address	:	sgounden@gibb.co.za
Telephone No.	:	031 267 8574	Fax No.	:	031 266 3310