ELECTRICAL GRID INFRASTRUCTURE TO SUPORT THE MOGOBE BATTERY ENERGY STORAGE FACILITY NEAR KATHU, NORTHERN CAPE

SPECIALIST STUDY:
Aquatic Compliance Assessment

Prepared for:

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ACRONYMS

CEMP	Construction Environmental Management Plan
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation, previously DWA & DWAF.
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Plan
GA	General Authorisation
GIS	Geographical Information Systems
NFEPA	National Freshwater Ecosystems Priority Areas according to Nel *et al*., 2012
NWA	National Water Act
PES	Present Ecological State
PV	Photovoltaic
RDM	Resource Directed Measures
REC	Recommended Ecological Category
SANBI	South African National Biodiversity Institute
SWMP	Storm Water Management Plan
VEGRAI	Riparian Vegetation Response Assessment Index (Kleynhans *et al*., 2007)
WUA	Water Use Authorisation
WULA	Water Use License Application

1. INTRODUCTION

Mogobe EGI (Pty) Ltd ('the Applicant') is proposing the construction of up to 132 kV Electrical Grid Infrastructure (EGI) to support the Mogobe BESS project located on Portion 1 of the Farm Legoko 460, southeast of the town of Kathu within the Gamagara Local Municipality in the Northern Cape Province. The EGI will traverse Portion 1 of the Farm Legoko 460 and Farm Sekgame 461. The site is accessible via the existing farm access from the N14.

This report is a revised version of the original assessment submitted in 2015, by the same report author but addresses / confirms the following:

1. That the powerline is not within the regulated zone of any aquatic feature.
2. Include a RAM for the substation component only (as substations are specifically excluded from the latest regulations).
3. Any mitigation measures for the substation in the regulated zone (transformer tank and retention bunds etc)

2. PROJECT DESCRIPTION

Extracted from the Project Technical Layout Report

- A 132 kV double circuit monopole and/or lattice tower overhead power line, approximately 9.0 km in length and 30 m in height to connect to the Existing Eskom Ferrum Substation located within an approved corridor of approximately 200 m wide. The power line will be constructed within an approximately 31 m wide servitude.
- A service road of approximately 4 m wide below the power line.
- An on-site switching station, with an estimated footprint of 1.0 ha and up to 5 m in height, at the Mogobe BESS facility. This refers specifically to Eskom's section of the on-site substation, planned to be at 132 kV, which will be transferred from the IPP to Eskom. Lightning masts of up to 21 m will be installed within the substation yard, and
- Associated electrical infrastructure at the Eskom Ferrum Substation. This will include but not limited to a new feeder bay which comprises of the extension to the existing platform and busbars of the 132 kV yard inside Eskom Ferrum Substation.

Water supplied for the construction phase will be obtained from the Gamagara Municipality via a Service Level Agreement (SLA) between them and the proponent. The estimated water consumption for the 18-month construction period is 75 000m^3, which will then reduce to 4 500m^3 per annum for the operational phase, however the EGI component will only require a small portion of this.

The project will not employ any on-site treatment or disposal for the sewerage wastewater generated during the project's development phase. The generated quantities will differ significantly between the construction and operational phases of the development.

The Gamagara Municipality has agreed to take responsibility for the treatment of sewerage that will be generated and stored in on-site conservancy tanks and temporary chemical toilets. The wastewater will be treated at the Kathu Wastewater Treatment Works (WWTW). According to the Gamagara Municipality this facility has sufficient capacity to deal with all the expected Wastewater quantities generated by the project based on the assumption that a maximum of 6 750m^3 will be required.

Figure 1 however indicates the grid corridor in which the Electrical Grind Infrastructure will be placed and assessed in this report.

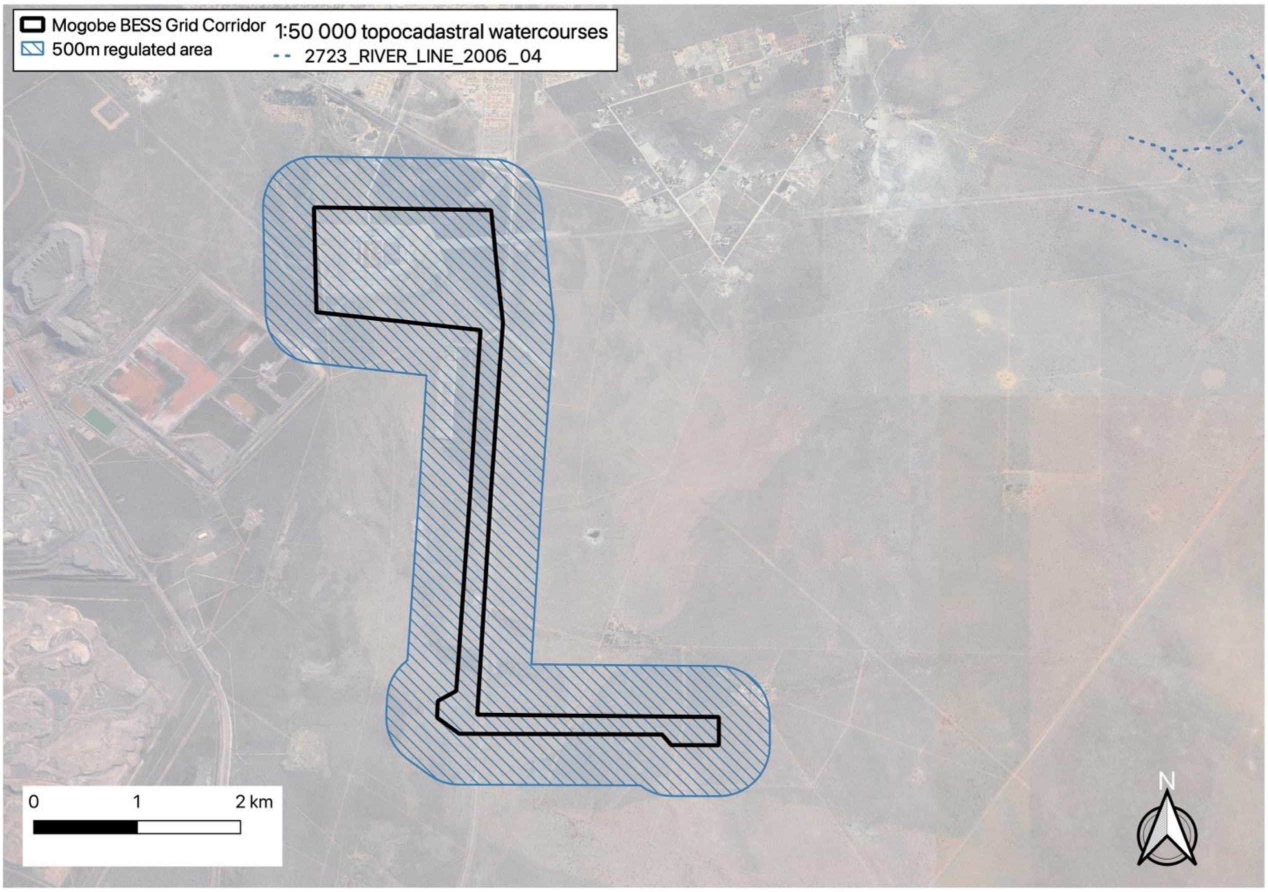

Figure 1: The study area and project components assessed and the 500m assessment (regulated area) to determine the affected aquatic systems

3. SPECIALIST TEAM

Dr. Brian Colloty has a PhD in wetland / aquatic ecology and importance rating and has conducted wetland and riverine / estuarine assessments for projects throughout Africa. Brian has produced more than 185 Renewable Energy project assessments in the last 14 years, part of which includes the production of GIS related sensitivity maps with site-specific Environmental Management Plan (EMP) recommendations with regard construction and operational phases of developments.

4. APPROACH / METHODS

The study areas contain is known as an arid rainfall area consisting of dry riverbeds with little or no flows and clusters of endorheic pans. Thus, the following approach was followed for the aquatic assessment is summarised below, with the specific approach of the methodology shown in Appendix 1:

- A desktop assessment of the study area covering the development footprint in relation to available information related to wetland / riverine ecosystems functioning, river classification, flow regime, water quality, physical, biota, and riparian habitat within the region.
- Mapping to demarcate local drainage and catchments within a 500m radius of the study area (Portion 1 of the Farm Mogobe No. 460) (geo-referenced GIS shape files of the aquatic areas) to demonstrate the connectivity between the site and the surrounding region, i.e. the zone of influence. Maps depicting demarcated waterbodies have been delineated at a scale of 1:10 000 after ground-truthing the study area.
- The determination of the ecological state of any aquatic systems, estimating their biodiversity, conservation, and ecosystem function importance with regard ecosystem services at two sites based on their proximity to PV infrastructure or road crossings. Note that this determination does not include avifaunal, herpetological or invertebrate studies; however, possible habitat for species of special concern has been identified.
- Recommendations made for buffer zones and No-go areas around delineated wetland areas based on the relevant legislation, e.g. Conservation Plan guidelines or best practice.
- Impact assessment, based on the standard assessment methodology.
- Recommendations for mitigation of identified impacts, including engineering services that could negatively affect demarcated aquatic areas.
- Recommendations for Environmental Management / Monitoring Plans.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT: REGIONAL, LOCAL AND SITE-SPECIFIC CONTEXT

5.1. The Regional Study Area

The study area is located within the D41J Subquaternary Catchment of the Ga-Mogara River (Figure 2) a tributary of the Kuruman River, located within the Molopo River Catchment. The study area however showed no evidence of any water courses or drainage lines that occurred within the site. However, the National Wetland Inventory (ver 5.2) (SANBI, 2018 & van Deventer *et al.,* 2020) does indicate several endorheic pans within the study area and some located within 500m of the proposed corridor (Figure 3).

The landscape is characterised by large plains covered by bushveld. The surrounding land use and consequent state of the surrounding vegetation is largely determined by the agricultural practices within the study area, which is dominated by cattle production.

The pans are typical of this flat landscape where runoff accumulates in these depressions (Plate 1). The depressions have formed through the dissolution of the underlying limestone creating these endorheic systems (i.e. inflow but no visible surface outflow) and are thus karst (lime) related systems (Plate 2). This was confirmed by the soil specialist that indicated that large areas within the study area were covered by hard pan carbonates, when an assessment was conducted for the associated PV project.

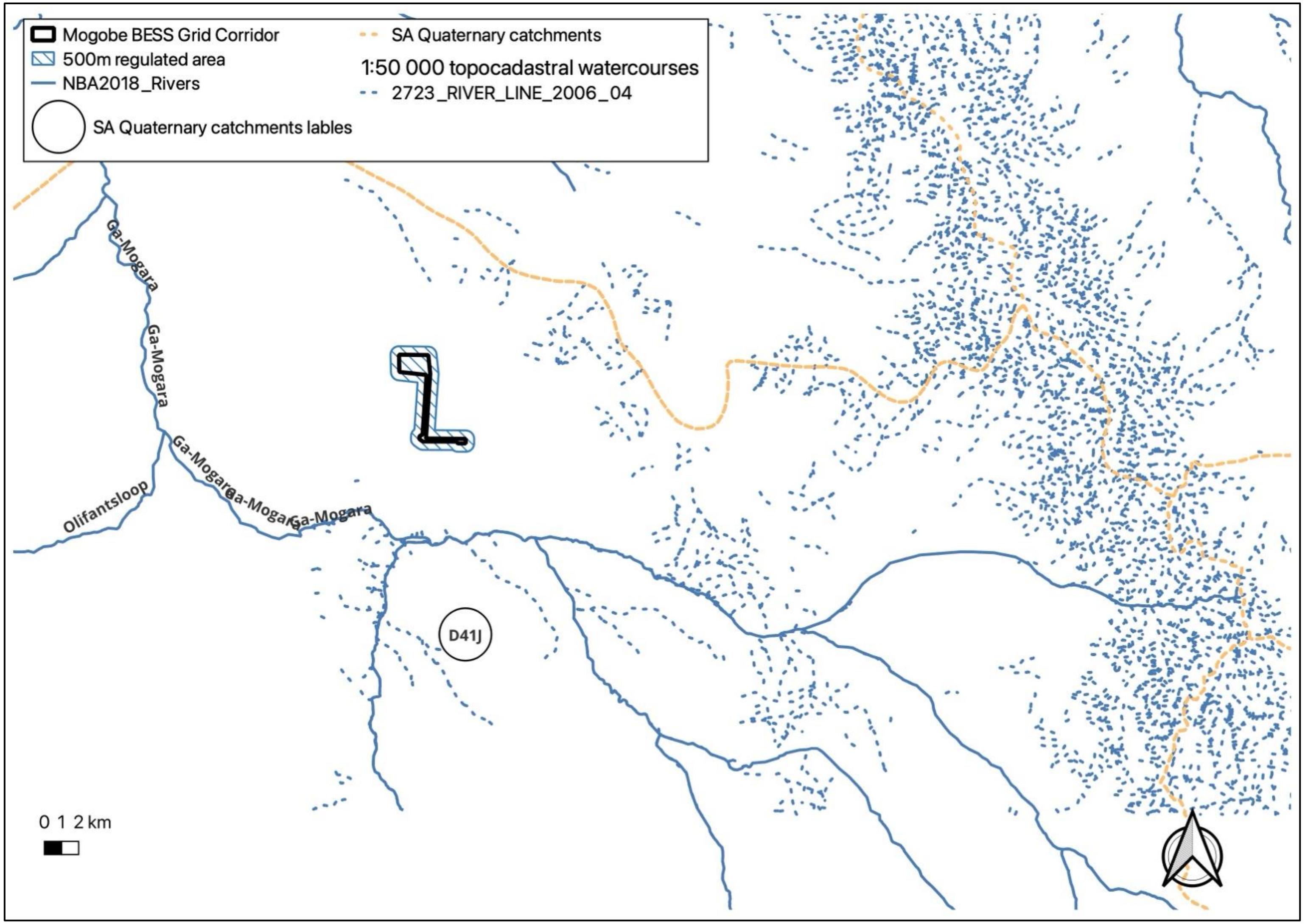

Figure 2: The study area in relation with the Quaternary Catchments and the main stem rivers (Source: DWS & NFEPA)

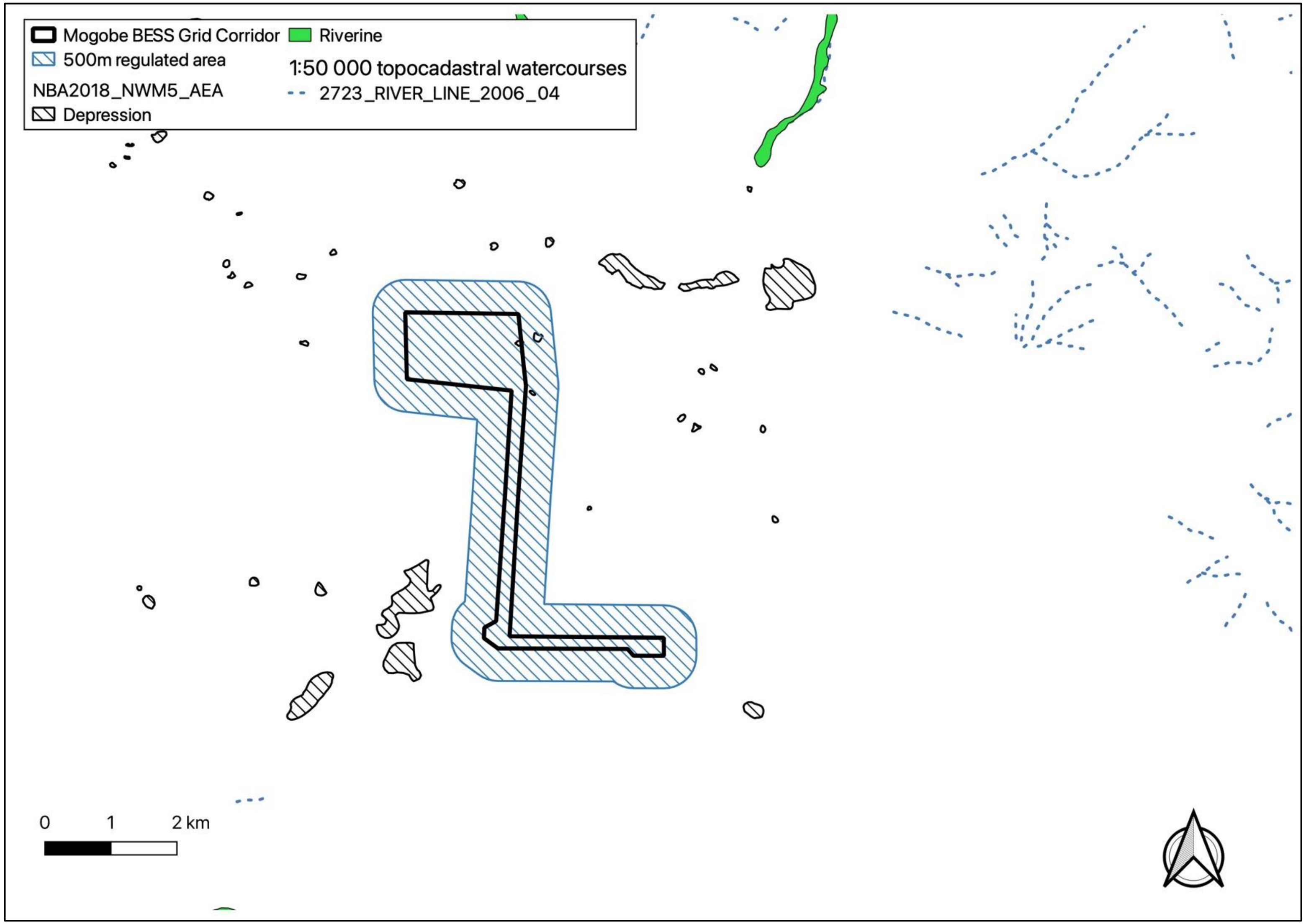

Figure 3: The study area and project components in relation to wetlands and water courses described in National Spatial Databases (SANBI)

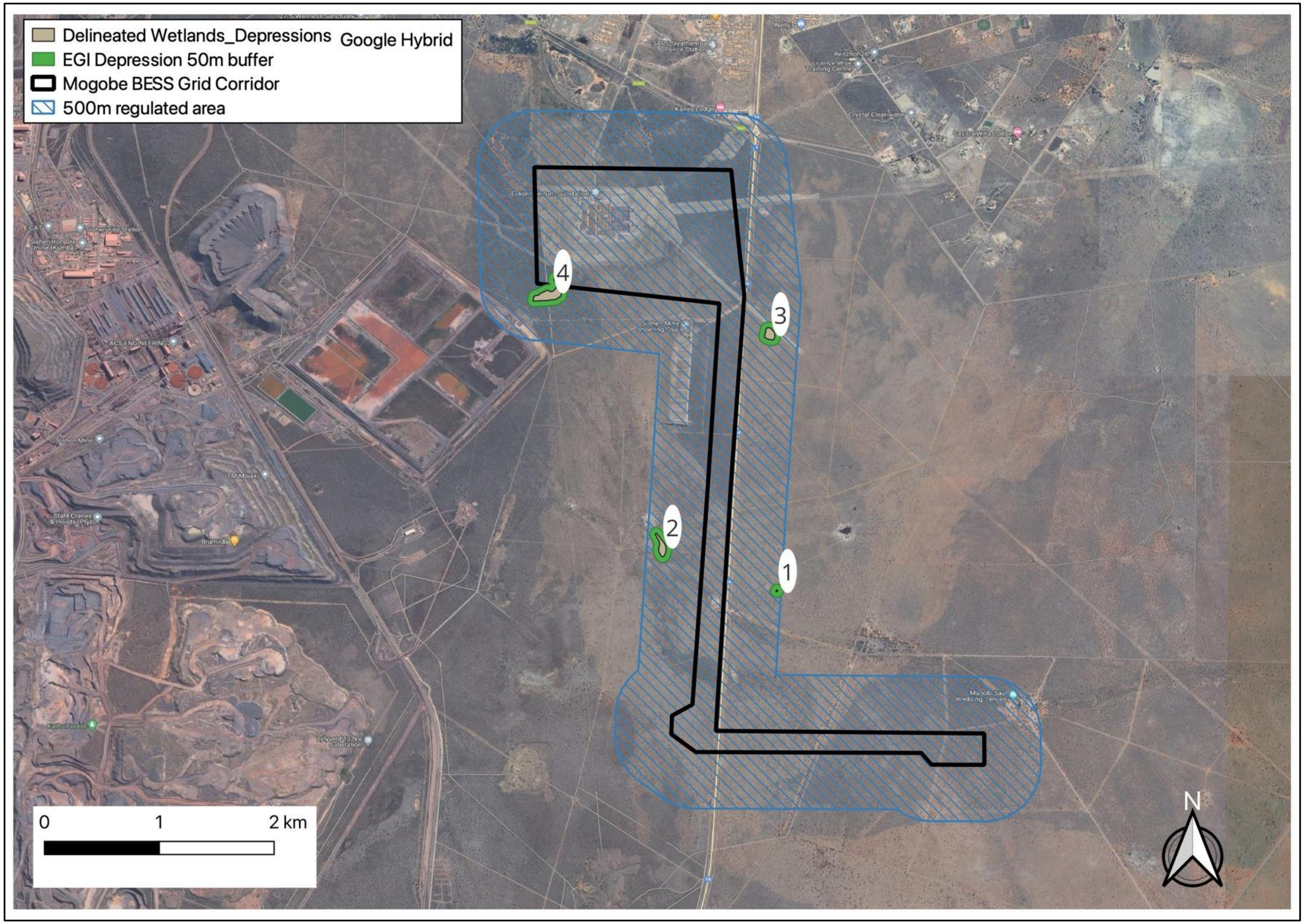

Figure 4: The observed and delineated wetlands observed within the study area

5.3. On-site data

5.3.1. Endorheic Pans

No flow or surface water was observed during the surveys, particularly within any water courses or drainage lines as none of these features were found present outside of the study area. This assessment is therefore based on a broad evaluation of the natural vegetation found within the region and at the site in relation to the wetlands observed and delineated (Figure 4). The pans a form of wetland, are ephemeral for long periods even years at a time. Surface runoff will thus accumulate for short periods after heavy rainfalls, and then either evaporate or percolate into the surrounding ground water systems. No instream or aquatic vegetation was observed in these systems and species were similar to those observed in the surrounding systems.

Only one of these pans, barely functional, is located within the proposed grid corridor, but is small enough (incl of the 50m buffer) to be spanned (Figure 4), and thus could be avoided by the strategic placement of pylons / towers if needed. Once the final layout of the pylons/towers for the line has been developed, then these need to be assessed to determine which are located in the 500m regulated area of the 4 depressions observed. Therefore, the new feeder bay at Ferrum Substation is located within 500m of Pan #4, while the proposed on-site switching station is outside of any regulated areas. Dependent on the fina placement of the pylons/towers portions of the grid line may also be within the 500m regulated zone.

6. PRESENT ECOLOGICAL STATE, ECOLOGICAL IMPORTANCE AND SENSITIVITY

In the compilation of this report, a number of sensitive areas within and adjacent to the study area were identified. From an aquatic systems point of view most of these were associated with the endorheic pans (Figure 4), noting that two of these within the 500 zone have been transformed when converted into farm dams or transformed.

However, two sites representative of these systems within the study area were identified and rated to assess the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the affected systems. Although the PES / EIS was assessed using the VEGRAI 3 models, this was only based on the riparian vegetation component as no instream biota, flows or water quality could be used in the Index for Habitat Integrity due to the extreme ephemeral nature of these systems. The description and scores for each of the sites is presented below, while the overall sensitivity of the systems based on the representative sites assessed below is shown in Figure 5. The only systems that received a Low sensitivity assessment were the two pans that had been transformed (Figure 5):

PES Site 1 -27.763973,23.072967 (DD.dddd WGS84)

Plate 1: A small pan located in the northern portion of the study area. Note the encroaching vegetation in the foreground

The PES assessment was conducted although no instream vegetation was observed, with the pan colonised by typical grass and shrub species from the region. In the Level 3 Riparian Vegetation Response Assessment Index (VEGRAI, Kleynhans *et al*. 2007), PES scoring system (see table below), the non-marginal woody vegetation thus dominated the overall PES score (B/C = Near Natural / Moderately Modified). The score was lowered due to the presence of grazing, trampling and encroachment by the surrounding shrubs.

The EIS of this system, which is representative of all the pans found throughout the site, was rated as Moderate (importance), however due to type and uniqueness within these systems the **Sensitivity would be rated as High** (= Red areas in Figure 5). The likelihood and significance of this impact is assessed in detail in the impact assessment of this report. The EIS score could have been higher but due to the lack of aquatic habitat, grazing and the presence encroaching vegetation the score was reduced.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	100,0	66,7	3,0	2,0	2,0
NON MARGINAL	73,3	24,4	3,0	1,0	1,0
	2,0				3,0
LEVEL 3 VEGRAI (%)				76.5	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				3,0	

PES Site 2 -27.760111,23.062722 (DD.dddd WGS84)

Plate 2: One of the larger pans showing located to the east of the study area

PES Site 2 was situated within a larger pan. No marginal or instream vegetation or other associated aquatic biota have been observed in this system due to its ephemeral nature. The PES score (See Level 3 VEGRAI assessment results below) was B = Near Natural, but this was due to additional impacts such as existing tracks, livestock tracks and grazing that have affected this system.

The EIS of this system, which is representative of all the pans found throughout the site was rated as Moderate (importance), however due to type and uniqueness within these systems the **Sensitivity would be rated as High** (= Red areas in Figure 5). The likelihood and significance of this impact is assessed in detail in the impact assessment of this report. The EIS score could have been higher but due to the lack of aquatic habitat, grazing, and the presence encroaching vegetation, the score was reduced.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	100,0	66,7	3.5	1,0	1,0
NON MARGINAL	60,0	20,0	3.5	2,0	2,0
	2,0				3,0
LEVEL 3 VEGRAI (%)				85.8	
VEGRAI EC				**B**	
AVERAGE CONFIDENCE				2,8	

Figure 5: Overall sensitivity rating for the various aquatic systems. Note the 50m no-go buffer is also indicated.

7. IMPACT ASSESSMENT

During the impact assessment study a number of potential key issues / impacts were identified. Note the loss of wetlands (pans) was not assessed as the systems should be avoided and thus no direct impact on these systems or their catchments is anticipated. Also, no structures would be placed within the 50m buffer proposed for the pans (Figure 4).

However, the proposed project could affect these systems through changes in the hydrological environment by the introduction of hard surfaces. Therefore, the following impacts were assessed:

- Impact 1: Impact on pans through the possible increase in surface water runoff on form and function, although due to the small catchments and the type of development this is unlikely.
- Impact 2: Increase in sedimentation and erosion from the proposed access track.
- Impact 3: Physical disturbance by the supporting infrastructure (e.g. roads) on hydrological environment
- Impact 4: Potential impacts on localised water quality during the construction and or maintenance.

Nature: Impact 1 - Impact on pan systems due to hydrological changes. The physical removal or the clearing of natural vegetation could alter the hydrological nature of the area, by increasing the surface run-off velocities, while reducing the potential for any run-off to infiltrate the soils. This impact would however be localised (mainly the access road), as a large portion of the remaining farm and the catchment would remain intact and the observed pans can be avoided.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium (45)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site must be handled in a suitable manner with no discharge being allowed near or into any of the observed systems		
Cumulative impacts: The increase in surface run-off velocities and the reduction in the potential for groundwater infiltration is likely to occur, however considering that the site is not near any drainage channels and the annual rainfall is low, this impact is not anticipated. It is however assumed, together with the low mean annual run-off that with suitable stormwater management the impacts could		

however be mitigated, coupled to the fact that a low percentage of projects actually move into the construction phase.
Residual impacts: Diversion of run-off away from downstream systems is unlikely to occur as the annual rainfall figures are low and no natural drainage features or water courses are located within the study area.

Nature: Impact 2 - Increase in sedimentation and erosion within the development footprint		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (1)	Low (1)
Probability	Definite (5)	Probable (3)
Significance	**Medium (30)**	**Low (18)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site must be handled in a suitable manner to capture large volumes of run-off, trap sediments and reduce flow velocities.		
Cumulative impacts: Additional downstream erosion and sedimentation of systems lower in the catchment although unlikely due to lack of any water courses and or wetlands.		
Residual impacts: Additional downstream erosion and sedimentation of systems lower in the catchment although unlikely due to lack of any water courses.		

Nature: Impact 4 – Potential water quality impacts During construction earthworks will expose and mobilise earth materials, and a number of materials as well as chemicals will be imported and used on site and may end up in the surface water, including soaps, oils, grease and fuels, human wastes, cementitious wastes, paints and solvents, etc. Any spills during transport or while works area conducted in proximity to a aquatic system has the potential to affect the surrounding biota, however due to the site locality and lack of aquatic systems / system connectivity this is unlikely.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (3)
Probability	Definite (5)	Probable (3)
Significance	**Medium (55)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium

Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	

Mitigation: The proposed layout has been developed to avoid any wetlands. • All liquid chemicals including fuels and oil, must be stored in with secondary containment (bunds or containers or berms) that can contain a leak or spill. Such facilities must be inspected routinely and must have the suitable PPE and spill kits needed to contain likely worst-case scenario leak or spill in that facility, safely. • Washing and cleaning of equipment must be done in designated wash bays, where rinse water is contained in evaporation/sedimentation ponds (to capture oils, grease cement and sediment). • Mechanical plant and bowsers must not be refuelled or serviced within 100m of a river channel. • All construction camps, lay down areas, wash bays, batching plants or areas and any stores should be more than 50 m from any demarcated water courses.. • Littering and contamination associated with construction activity must be avoided through effective construction camp management; • No stockpiling should take place within or near a water course • All stockpiles must be protected and located in flat areas where run-off will be minimised and sediment recoverable;
Cumulative impacts: Additional downstream erosion and sedimentation of systems lower in the catchment although unlikely due to lack of any water courses.
Residual impacts: Additional downstream erosion and sedimentation of systems lower in the catchment although unlikely due to lack of any water courses.

8. ENVIRONMENTAL MANAGEMENT PLAN MEASURES

Project component/s	Site selection with regard minimising the overall impact on the functioning of the aquatic environment
Potential impact	Loss of important habitat
Activity risk source	Placement of hard engineered surfaces (unlikely)
Mitigation: Target / Objective	Select a favourable site, having the least impact or within an area that is least sensitive, i.e. not within wetlands and their buffers.
Mitigation: Action/control	Minimise the loss of aquatic habitat – physical removal and replacement by hard surfaces by avoiding as many of the sensitive (High) pans as possible as is shown in Figure 5
Responsibility	Developer
Timeframe	Planning and design phase
Performance indicator	N/A
Monitoring	N/A

Project component/s	Alteration of sandy substrata into hard surfaces impacting on the local hydrological regime
Potential impact	Poor stormwater management and the alteration hydrological regime
Activity risk source	Placement of hard engineered surfaces
Mitigation: Target / Objective	Any stormwater within the site will be handled in a suitable manner, i.e. clean and dirty water streams around the plant and install stilling basins to capture large volumes of run-off, trapping sediments and reduce flow velocities.
Mitigation: Action/control	Reduce the potential increase in surface flow velocities and the impact on aquatic systems
Responsibility	Developer / Operator
Timeframe	Planning, design and operation phase
Performance indicator	Water quality and quantity management - "Water Use Licence Conditions"
Monitoring	Surface water monitoring plan that ensures no erosion takes place

Project component/s	The use of chemicals and hazardous substances during construction and operation
Potential impact	These pollutants could be harmful to aquatic biota, particularly during low flows when dilution is reduced. Lime-containing (high pH) construction materials such as concrete, cement, grouts, etc., deserve a special mention, as they are highly toxic to fish and other aquatic biota. If dry cement powder or wet uncured concrete comes into contact with surface run-off or river water, these compounds can elevate the pH to lethal levels. Thus extreme care should be taken when these hazardous compounds are used near water. For fish, pH levels of over 10 are considered toxic.
Activity risk source	Accidental spillage of harmful materials and/ or hydrocarbons used during the construction process.
Mitigation: Target / Objective	Management actions that are applicable to all the construction sites include: • Strict use and management of all hazardous materials used on site. Considering the extremely low likelihood of surface flows, it is advised that construction activities are suspended until such contaminants are removed from the site if surface flows are observed at or adjacent to the selected site area. • Strict management of potential sources of pollution (hydrocarbons from vehicles and machinery, cement during construction, etc.). • Strict control over the behaviour of construction workers. • All areas adjacent to the hard-engineered erosion-control structures provided for this project, which are (accidently) disturbed during the construction activities, should to be rehabilitated using appropriate indigenous vegetation.
Mitigation: Action/control	Minimise the potential impact of pollutants entering the pans
Responsibility	Developer / Operator
Timeframe	Planning, design and operation phase
Performance indicator	Water quality and quantity management - "Water Use Licence Conditions"
Monitoring	Surface water monitoring plan

9. CONCLUDING COMMENTS/IMPACT STATEMENT

With suitable mitigation and avoidance of the pans (incl of the 50m no-go buffer), the development should have no direct impact on the overall status of the aquatic systems and within the study area.

No protected or species of special concern (aquatic flora) were observed within the aquatic areas during the site visit thus the development poses no risk to any such species. Therefore, based on the site visits the significance of the impacts on the aquatic environment within the study area would be **LOW**.

A Water Use Authorisation in terms of Section 21 c and i of the National Water Act will be required should any construction take place within any these areas i.e., any development within 500m of a wetland boundary, that is not included in the Appendix D1 notice for exclusion, i.e. only the feeder bay for this project scope, the remainder of the substations are located outside of the 500m zone, while some of the towers/pylons could be dependent on their final placement

When considering any other potential projects within the adjacent / nearby farms the potential for changes to the surrounding aquatic habitat would not be significant especially during the operational phases (hard surfaces and stormwater management). It is however assumed that any such changes would be detrimental to the various projects owners, i.e. erode areas around infrastructure. This, coupled with the low mean annual run-off and with suitable stormwater management, the impacts could however be mitigated. The likelihood of any cumulative impacts listed in this report is especially low when considering that only a low percentage of projects will actually move into the construction phase.

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Appendix 1: Detailed aquatic assessment methodology

This study followed the approaches of several national guidelines with regards to wetland assessment. These have been modified by the author, to provide a relevant mechanism of assessing the present state of the study area aquatic systems, applicable to the specific environment and, in a clear and objective manner, identify and assess the potential impacts associated with the proposed development site based on information collected within the relevant farm portions.

Current water resource classification systems make use of the Hydrogeomorphic (HGM) approach, and for this reason, the National Wetland Classification System (NWCS) approach will be used in this study. It is also important to understand the legal definition of a wetland, the means of assessing wetland conservation and importance and the relevant legislation aimed at protecting wetlands. These aspects will be discussed in greater depth in this section of the report, as they form the basis of the study approach to assessing wetland impacts.

For reference the following definitions are as follows:

- **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 thus contains 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 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).
- **Water course**: 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

Waterbody classification systems

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.

Coupled to this was the inclusion of other criteria within the classification systems to differentiate between river, riparian and wetland systems, as well as natural versus artificial waterbodies.

The South African National Biodiversity Institute (SANBI) in collaboration with several specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS) (Ollis *et al*., 2013). 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 (Ollis *et al*., 2013).

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 the wetland classifications as the HGM approach has been adopted throughout the water resources management realm with regards to the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All 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 and Sanitation (DWS). The Ecological Reserve of a wetland or river is used by DWS to assess the water resource allocations when assessing WULAs

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 or any other activity that qualifies as a water use.

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 (NWCS) (Ollis *et al*., 2013) is used to classify wetland types it is still necessary to understand the definition of a wetland. 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 as the 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 (Ollis *et al*., 2013):

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 latter as a watercourse (Ollis *et al*., 2013). Table 1 below provides a comparison of the various wetlands included within the main sources of wetland definitions 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 NWA, 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 (Ollis *et al.*, 2013).

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 50 cm 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 and rivers.

Table 2: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the NWA and ecosystems 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 described 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	YES[3]
Riparian [3] 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 and would be considered riparian wetlands, as 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.

National Wetland Classification System method

Due to the nature of the wetlands and watercourses observed, it was determined that the newly accepted NWCS should be adopted. This classification approach has integrated aspects of the HGM approach used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (Ollis *et al*., 2013) 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 (Ollis *et al.,* 2013).

The classification system used in this study is thus based on Ollis *et al*. (2013) and is summarised below:

The NWCS has a six-tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 2). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular system 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:

- Landform – shape and localised setting of wetland
- Hydrological characteristics – nature of water movement into, through and out of the wetland
- 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 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 six descriptors to characterise the wetland types based on 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:

- Geology;
- Natural vs. Artificial;
- Vegetation cover type;
- Substratum;
- Salinity; and
- Acidity or Alkalinity

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

The HGM unit (Level 4) is the focal point of the NWCS, with the upper levels (Figure 3 Figure – 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.

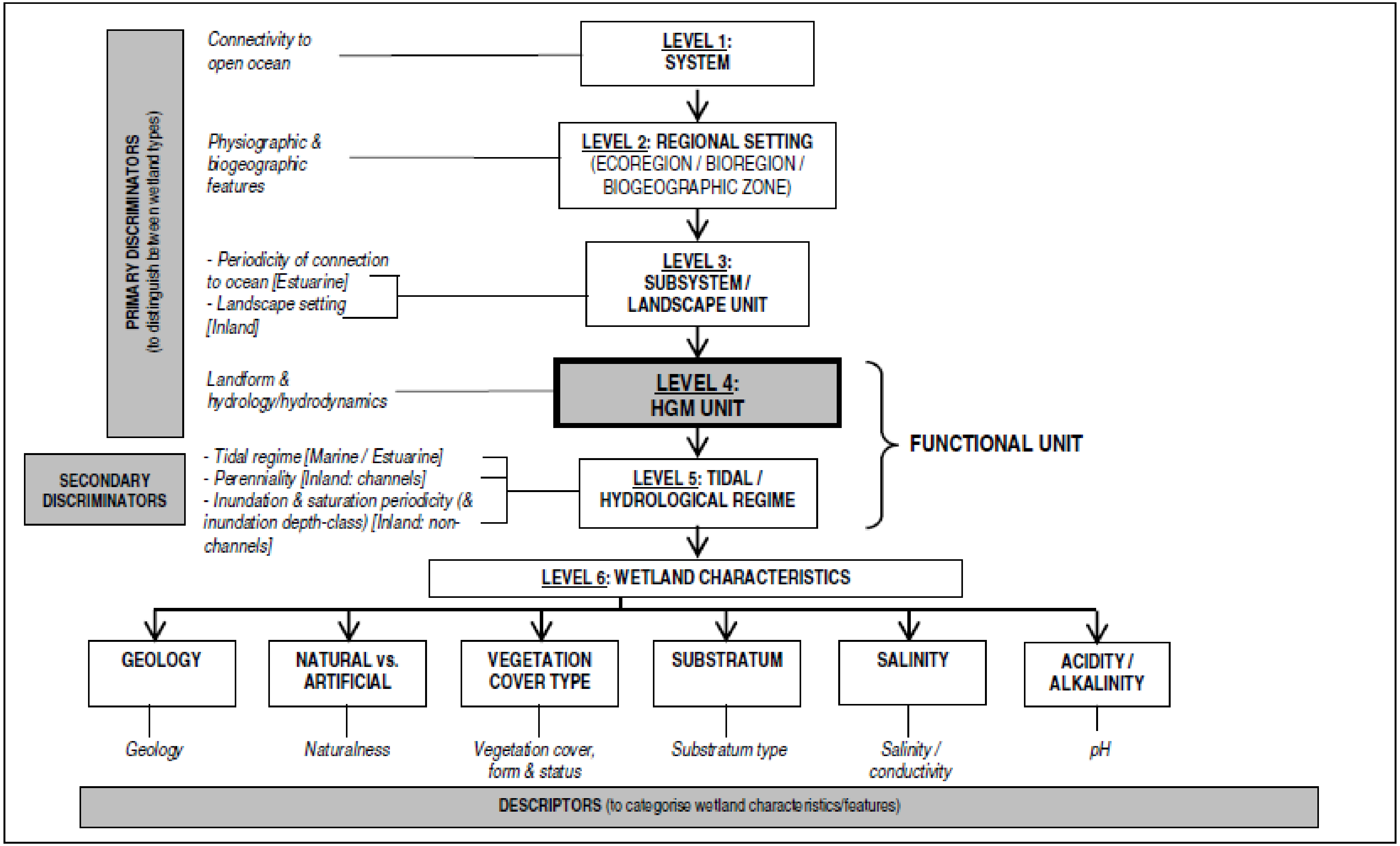

Figure 2: Basic structure of the NWCS, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the tidal/hydrological regime, and 'descriptors' applied

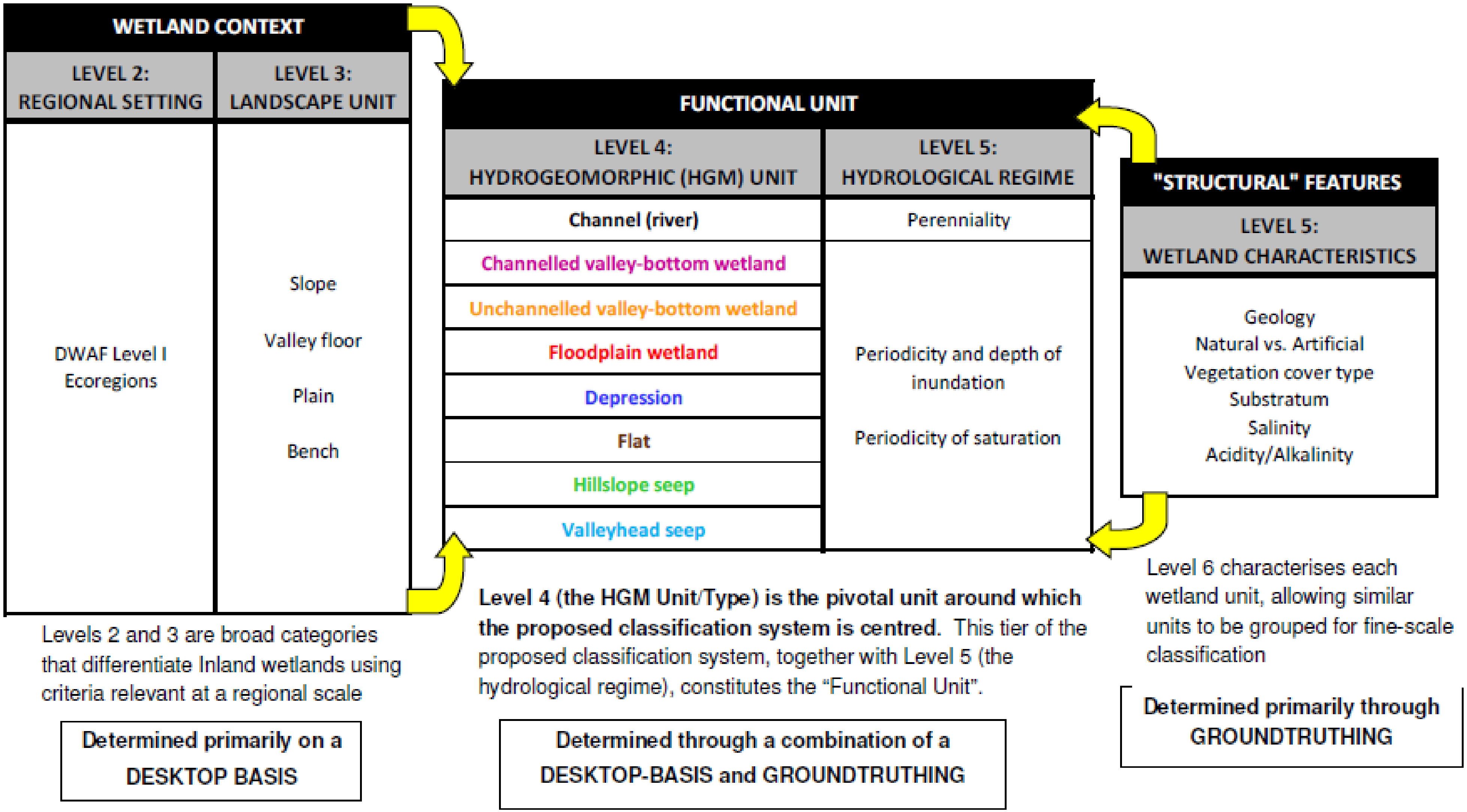

Figure 3: Illustration of the conceptual relationship of HGM Units (at Level 4) with higher and lower levels (relative sizes of the boxes show the increasing spatial resolution and level of detail from the higher to the lower levels) for Inland Systems (from Ollis *et al*., 2013)

Waterbody condition

To assess the 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) and provide a score of the PES 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 with the degraded state of the wetlands in the study area, indicated that 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 3: 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 may have taken place but the ecosystem functions are essentially unchanged.	Some human-related disturbance, but mostly of low impact potential
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 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 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 DWA’s River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Aquatic ecosystem 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 terms of this study, the wetlands provide ecological (environmental) value to the area acting as refugia for various wetland associated plants, butterflies and birds.

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 below 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="15">Ecosystem services supplied by wetlands</td><td rowspan="9">Indirect benefits</td><td rowspan="8">Hydro-geochemical benefits</td><td colspan="2">Flood attenuation</td></tr>
<tr><td colspan="2">Stream flow regulation</td></tr>
<tr><td rowspan="5">Water quality enhancement benefits</td><td>Sediment trapping</td></tr>
<tr><td>Phosphate assimilation</td></tr>
<tr><td>Nitrate assimilation</td></tr>
<tr><td>Toxicant assimilation</td></tr>
<tr><td>Erosion control</td></tr>
<tr><td colspan="2">Carbon storage</td></tr>
<tr><td colspan="3">Biodiversity maintenance</td></tr>
<tr><td rowspan="6">Direct benefits</td><td colspan="3">Provision of water for human use</td></tr>
<tr><td colspan="3">Provision of harvestable resources[2]</td></tr>
<tr><td colspan="3">Provision of cultivated foods</td></tr>
<tr><td colspan="3">Cultural significance</td></tr>
<tr><td colspan="3">Tourism and recreation</td></tr>
<tr><td colspan="3">Education and research</td></tr>
</table>

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

- Habitat uniqueness;
- Species of conservation concern;
- Habitat fragmentation or rather, continuity or intactness with regards to ecological corridors; and
- 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 (SCC) was observed, in which case it would receive a HIGH rating. Any system that was highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating. Wetlands with HIGH and MEDIUM ratings should thus be excluded from development with incorporation into a suitable open space system, with the maximum possible buffer being applied. Natural wetlands or Wetlands that resemble some form of the past landscape but receive a LOW conservation importance rating could be included into stormwater management features and should not be developed to retain the function of any ecological corridors