Rehabilitation of the Ritespruit Dam Wall in Ventersdorp, North West Province – Wetland Delineation Report

Department of Water and Sanitation

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Glossary of Terms

Alluvial Material / deposits	Sedimentary deposits resulting from the action of rivers, including those deposited within river channels, floodplains, etc.
Anaerobic	The absence of molecular oxygen.
Anthropogenic	Originating in human activity.
Apedal	A term indicating the a degree of aggregation of soil particles within a soil horizon, where the material is well aggregated, but without well-formed peds (individual soil aggregates); in the context of the South African Soil Classification System, apedal soils also include structureless soils (e.g. sands) and somewhat more structured soils than the above description.
Baseflow	The component of river flow that is sustained from groundwater sources rather than from surface water runoff.
Colluvial	Relating to gravitational forces that result in the transport and deposition of soil and / or rock fragments down hillslopes to the base of the slope.
Ephemeral	A watercourse that flows at the surface only periodically.
Facultative	Occurring optionally in response to circumstances rather than by nature; applied to wetland plants in this context – a facultative species is a species usually found in wetlands, but occasionally found in non-wetland areas.
G Horizon	A subsoil horizon that is naturally saturated with water for long periods to form dominant grey, low chroma colours (often with blue or green tints) with or without mottling, with the accumulation of colloidal (clay) matter in the horizon.
Gleying	The process by which a material (soil) has been or is becoming subject to intense reduction as a result of prolonged saturation by water. Gleyed soils are characterised by grey (due to an absence of iron compounds), blue and green colours (due to an absence of ferrous compounds).
Hard Plinthic B Horizon	A subsoil horizon that consists of an indurated (hard) zone of accumulation of iron and manganese oxides which have hardened sufficiently not to be able to be cut with a spade. Known also as **hardpan ferricrete.**
Herb	A small non woody plant in which the aerial parts die back at the end of every growing season.
Hydric / Hydromorphic Soils	Soils formed under conditions of saturation, flooding or ponding for sufficient periods of time for the development of anaerobic conditions and thus favouring the growth of hydrophytic vegetation.

Hydrology	The scientific study of the distribution and properties of water on the earth's surface.
Hydromorphy	A process of gleying and mottling resulting from intermittent or permanent presence of free water in soil. Results in hydromorphic soils.
Hydroperiod	The term hydroperiod describes the different variations in water input and output that form a wetland, characterising its ecology – i.e. the water balance of the wetland.
Hydrophilic	A hydrophyte.
Hydrophyte	A plant that grows in water or in conditions that are at least periodically deficient in oxygen as a result of saturation by water – these are typically wetland plants.
Obligate	A species that almost always occurs in wetlands.
Orthic A Horizon	A topsoil (surface) soil horizon that characterises most topsoil horizons; it is not characterised by a high degree of organic carbon and which does not have the strongly developed structure of the vertic or melanic A horizons.
Perched Water Table / Aquifer	A water table caused by the presence of water above an isolated relatively impermeable underlying layer, some height above the normal aquifer level.
Plinthic	Soils with plinthic characteristics contain an iron-rich, humus-poor mixture of clay with quartz and other highly weathered minerals, with the common occurrence of reddish redox concentrations in a layer that has a polygonal (irregular), platy (lenticular), or reticulate (blocky) pattern, formed by the segregation, transport, and concentration of iron. To qualify as being plinthic, irreversible hardening, or a process of the development of hardening must be present (due to the process of repeated wetting and drying).
Reach	A portion / stretch of a river.
Redoximorphic	Features within soil that are a result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic.
Riparian Zone	The physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.
Signs of Wetness	Signs of wetness are signs of hydromorphism in soil, consisting of grey low chroma colours with or without sesquioxide mottles.
Soft Plinthic B Horizon	A subsoil horizon created by a fluctuating water table characterised by grey colours (caused by gleying) and distinct reddish-brown, yellowish-brown and /or black mottles with or without hardening to form sesquioxide concretions. The horizon is non-indurated and can be cut with a spade when wet.

Acronyms

DWS – Department of Water and Sanitation (formerly Dept. of Water Affairs (DWA) or Dept. of Water Affairs and Forestry (DWAF))

HGM – Hydrogeomorphic

MAP – Mean Annual Precipitation

RHDHV – Royal HaskoningDHV

Specialist Declaration

I, **Paul da Cruz**, declare that I –

- act as a specialist consultant in the field of surface water assessment
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2014; and
- will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

PAUL DA CRUZ

EXECUTIVE SUMMARY

Royal HaskoningDHV has been appointed to undertake the design and construct supervision of the rehabilitation of the Rietspruit Dam near Ventersdorp in the North West Province. As part of the investigations the need to determine whether an area of hydrophilic (wetland) vegetation that is located immediately downstream (west of) a portion of the dam wall is present due to seepage from the dam wall or is part of a naturally occurring wetland was identified. Accordingly an in-field wetland delineation assessment was undertaken to investigate the characteristics of soils in the area of investigation.

The area of investigation is located on the lower footslopes immediately adjacent to the valley floor (valley bottom) of the Rietspruit stream. The predominantly-occurring hydrophyte in the area of investigation is *Imperata cylindrica,* with the presence of *Phragmites australis* and *Typha capensis* (obligate wetland species). The in-field investigation determined that hydromorphic soils (wetland soils) were present in the area in which the hydrophilic vegetation is present. The presence of a wetland soil form as the dominant soil form within the area of investigation, as supported by the presence of typical hydrophytic vegetation and hydrology confirms that the area is a naturally-occurring wetland as opposed to an area in which hydrophytes have become established due to seepage from the dam. The predominant soil form at the wetland sample points was a Westleigh Soil Form (an Orthic A (topsoil) horizon overlying a soft plinthic B subsoil horizon) which is a typical wetland soil form as defined by the DWAF (2005) Guidelines for wetland delineation. The soft plinthic B horizon is indicative of periodic saturation with water, typically as a result of a seasonally rising and falling water table. In this case a shallow groundwater table, possibly associated with groundwater seepage is expected to be present, giving rise to the presence and development of hydromorphic soils.

The characterisation of the area of investigation as a wetland is further supported by the presence of a naturally-occurring spring (area of active groundwater seepage) a short distance downslope of the area of hydrophytes (downslope of the canal) that is characterised by *Phragmites australis* reeds and the presence of G horizon within the soils as part of a Katspruit Soil Form that is indicative of a permanently saturated wetland soils. The area of investigation is thus part of a naturally-occurring seep wetland, part of which is hydrologically connected to the Rietspruit stream, and part of which is (naturally) hydrologically not connected to the drainage network. The upper parts of the wetland have likely been disturbed (with wetland habitat loss likely to have occurred) by the presence of the dam wall and the associated track which is comprised of imported fill material, with a canal emanating from the dam wall also bisecting the wider wetland.

As part of the assessment, the present ecological state, functionality and ecological importance and sensitivity of the wetland have been assessed in order to determine an ecological baseline for the wetland. The wetland unit has been determined to be in a moderately modified overall state, due to partial loss of habitat and hydrological change exerted by the historical development of the dam. The small size of the wetland limits its level of functionality; however the wetland has been assessed to perform a number of ecosystem services to a moderately high degree. The wetland has however been assigned a high degree of ecological importance and sensitivity due primarily to the confirmed presence and suitable roosting and breeding habitat for two owl species (African Grass-Owl (*Tyto capensis*) and Marsh Owl (*Asio capensis*)) which are threatened (endangered) or declining (in the case of the Marsh Owl).

The dam wall upgrading and repair could result in an impact on the wetland, particularly if the construction footprint were to extend into the wetland, thereby causing loss / transformation of wetland habitat and disturbance of owls inhabiting this part of the wetland. The design drawings for the repair works show that the dam wall's footprint would not be extended into the wetland located adjacent to the foot of the dam wall. A number of mitigation measures have been specified to ameliorate the impact of the construction works on the wetland, and to ensure that the works result in no further loss or impacting on wetlands on the site.

1 INTRODUCTION

Royal HaskoningDHV's Water Business Unit has been appointed to undertake the design and construction supervision of the rehabilitation of the Rietspruit Dam near Ventersdorp in the North West Province. As part of the investigations the need to determine the origin of an area of hydrophytic (wetland) vegetation that is located immediately downstream (west of) a portion of the dam wall was identified. The requirement for the wetland screening investigation was to determine whether the wetland vegetation was present due to seepage from the dam wall or is part of a naturally occurring wetland. Accordingly an in-field wetland delineation assessment was undertaken to investigate the characteristics of soils in the area of investigation. Through consultation with the National Department of Environmental Affairs (DEA) it was determined that a Basic Assessment Study would be need to be undertaken, and accordingly the wetland assessment study has been updated to comply with the requirements of the EIA process.

The Rietspruit Dam is located to the south of the town of Ventersdorp in the eastern part of the North West Province. The Riet Spruit is a tributary of the Schoon Spruit, itself a tributary of the Vaal River. The Dam is operated by the Department of Water and Sanitation (formerly the Department of Water Affairs). An area of dense moribund wetland grass (primarily consisting of the wetland grass species *Imperata cylindrica*) occurs immediately adjacent to the southern part of the dam wall.

1.1 Assumptions and Limitations

As discussed in section 1.3 below, a definition of wetlands that is slightly different to that provided by the National Water Act has been provided in this report. The definition used is based primarily on the presence of hydric soils, rather than on the hydroperiod of the surface water body.

The field assessment was undertaken outside of the growing season, making it more difficult to identify grass and sedge species (as part of the wetland assessment) due to the absence of inflorescences. Nonetheless vegetation was able to be assessed as part of the assessment.

No information regarding the groundwater dynamics of the area in order to inform the assessment has been provided. An assessment of groundwater dynamics does not form part of this assessment.

It should be noted that no in-field delineation or assessment of state and functionality of the wetlands along the reach of the Rietspruit immediately downstream of the Rietspruit Dam wall has been undertaken as part of the scope of works of this wetland assessment study.

1.2 Definition of Surface Water Features, Wetlands, Hydric Soils and Riparian Zones

1.2.1 Surface Water Features

In order to set out a framework in which to assess surface water features, it is useful to set out what this report defines as surface water resources. In this context the National Water Act is used as a guideline. The Act includes a number of features under the definition of water resources, i.e. watercourses, surface waters, estuaries and aquifers. The latter two do not apply in the context of this study as estuaries are marine features and this report does not consider groundwater, thus surface waters and water courses are applicable in this context. The Act defines a watercourse as (inter alia):

- a river or spring;
- a natural channel in which water flows regularly or intermittently;
- a wetland, lake or dam into which, or from which, water flows

1.2.2 Wetlands and Aquatic Ecosystems

The National Water Act defines a wetland as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

This definition alludes to a number of physical characteristics of wetlands, including wetland hydrology, vegetation and soil. The reference to saturated soil is very important, as this is the most important factor by which wetlands are defined.

Another widely used definition of wetlands is the one used under the Ramsar Convention; wetlands are defined 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"

However the presence / absence of hydric soils is the primary determining factor used to define a surface water feature as a wetland. This determining factor has been utilised in this assessment. Wetland soils can be termed hydric or hydromorphic soils. Hydric soils are defined by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) as being "soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part". These anaerobic conditions would typically support the growth of hydromorphic vegetation (vegetation adapted to grow in soils that are saturated and starved of oxygen) and are typified by the presence of redoximorphic features. The presence of hydric (wetland) soils on the site of a proposed development is significant, as the alteration or destruction of these areas, or development within a certain radius of these areas would require authorisation in terms of the National Water Act (36 of 1998) and in terms of the Environmental Impact Assessment Regulations promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998).

It should also be noted that wetlands are *aquatic ecosystems.* The recently developed Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al,* 2013) defines an aquatic ecosystem as:

"an ecosystem that is permanently or periodically inundated by flowing or standing water, or which has soils that are permanently or periodically saturated within 0.5 m of the soil surface".

Wetlands are thus a type of aquatic ecosystem. Other surface water features such as streams or watercourses may not qualify as wetlands, but would qualify as aquatic ecosystems.

2 METHODOLOGY FOR ASSESSMENT

2.1 Field Assessment and Wetland Delineation

Typically the presence of wetlands is determined through wetland delineation. The accepted procedure for wetland delineation in South Africa is based upon the DWA(F) guidelines 'A practical field procedure for the identification and delineation of wetlands and riparian areas' (DWAF, 2005), which stipulates that consideration be given to four specific wetland indicators to determine the boundary of the wetland.

The four wetland indicators are:

- **terrain unit** - helps to identify those parts of the landscape where wetlands are more likely to occur
- **soil form** - identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation
- **soil wetness** - identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation
- **vegetation** - identifies hydrophilic vegetation associated with frequently saturated soils

The guidelines do mention hydrology, although it is not listed as being one of the four indicators above. However the guidelines state that the delineation procedure is substantially facilitated by an understanding of the broad hydrological processes that drive the frequency of saturation (DWAF, 2005).

Under most circumstances the most important indicator of the presence of hydric soils is the soil wetness indicator, i.e. examination of redoximorphic features within the soil. The reason for this is that vegetation (the primary factor as defined under the National Water Act) can easily respond to changes in hydrology (e.g. the draining of a wetland), while the soil morphological signatures remain even if the wetland hydrology is altered.

In terms of the soil form indicator, the guidelines list a number of soil forms that are associated with the permanent zone of the wetland or the seasonal / temporary zones.

For an area to be considered a wetland, redoximorphic features must be present within the upper 500 mm of the soil profile (Collins, 2005). Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 500mm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils. Redoximorphic features typically occur in three types (Collins, 2005):

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

Under most circumstances the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil) or non-hydric (non-wetland soil) (Collins, 2005; DWAF, 2005).

Vegetation in an untransformed state is a very useful way to support the delineation of a wetland, due to plant community transition from the middle of the wetland to the adjacent terrestrial area. The guidelines specify that when using vegetation indicators, that focus be placed on the plant communities, rather than individual indicator species. The dominant species in the area being assessed (hydrophytes or not) must be assessed to determine the presence of a wetland. The DWA guidelines make reference to vegetation types typically found within the classical zones of a wetland (permanent, seasonal, temporary), but also makes reference to the classification methodology developed by Kotze and Marneweck (1999) as part of the Resource Directed Measures for Protection of Water Resources for Wetland Ecosystems which is based on the identification of obligate and facultative wetland species, and the relative coverage of these species in terms of whether the area being assessed is likely to display hydric conditions, possible display hydric conditions, or not at all.

Lastly, the hydrological framework for wetlands is covered in an appendix of the guidelines. This is based on the longitudinal classification of river channels into three different zones based on their hydrological activation:

- A Section – baseflow never occurs, and the water table never occurs at the surface (typically headward channels)
- B Section – channels within the zone of a fluctuating water table, only being characterised by baseflow when the saturated zone is in contact with the channel bed
- C Section – channels that are always in contact with the zone of saturation, and thus always experiencing baseflow (i.e. being perennial in nature)

Typically wetland habitat will never occur in the A section due to the insufficient period of saturation, while Section B and C channels will contain wetland habitat due to a sufficient period of saturation. In terms of the classical zonation of a wetland, the permanent wetland zone will typically only be found in the C Section, while the B section is only characterised by the presence of seasonal and temporary zones.

Use was made of a GPS to mark sample positions and to identify important points (e.g. wetland boundaries). These GPS points were converted into a GIS shapefile to allow these points to be mapped and to facilitate the delineation of the surface water feature boundaries.

2.2 Assessment of Wetland Functionality, State & Ecological Importance and Sensitivity

Assessments of Wetland Functionality and State have been undertaken in order to establish an environmental baseline against which to measure the impacts of the proposed works.

2.2.1 Wetland Functionality

Wetland functionality was assessed using the WET-EcoServices methodology (Kotze *et al*, 2009). This methodology has been developed as a tool to identify the different aspects of functionality offered by a wetland. Wetland functionality is multi-faceted and includes a number of different but interlinked aspects such as hydrological functionality, ecological functionality, and socio-cultural functionality. The basis of the methodology is the identification of ecosystem services offered by an individual wetland or wetland unit. Ecosystem services as defined in WET-EcoServices are the direct and indirect benefits that people obtain from ecosystems. These benefits may derive from outputs that can be consumed directly; indirect uses which arise from the functions or attributes occurring within the ecosystem; or possible future direct outputs or indirect uses (Howe et al., 1991). Table 1 below lists the ecosystem services that are assessed through the WET-EcoServices methodology.

Table 1 - Ecosystem services included in WET-EcoServices (Kotze *et al, 2009*)

Ecosystem services supplied by wetlands	Indirect benefits	Hydro-geochemical benefits	Flood attenuation	
			Streamflow regulation	
			Water quality enhancement benefits	Sediment trapping
				Phosphate assimilation
				Nitrate assimilation
				Toxicant assimilation
				Erosion control
			Carbon storage	
		Biodiversity maintenance		
	Direct benefits	*Provision of water for human use*		
		Provision of harvestable resources		
		Provision of cultivated foods		
		Cultural significance		

		Tourism and recreation
		Education and research

In Appendix 4, the output diagram indicating the ecosystem services offered by the reach as produced by the WET-EcoServices assessment is included. WET-EcoServices does not provide an overall assessment of wetland functionality, but the spreadsheet tool developed to assign an EIS value to a wetland also calculates a hydrological / functional importance value associated with the wetland.

2.2.2 Wetland State (PES) Assessment

The WET-Health (MacFarlane *et al,* 2009) tool has been used to assess wetland state. The WET-Health tool has been designed by the Water Research Commission to assess the health or integrity of a wetland. Health of the wetland equates to wetland state as referred to in this study. The WET-Health technique assesses the hydrological, geomorphological and vegetative state of a wetland. It assigns wetland units assessed into an Ecological Category (EC) that reflects its state of degradation. Table 2 below indicates the PES (state) categories as assessed using the WET-Health methodology.

Table 2 - PES Categories assigned by the WET-Health Tool (MacFarlane et al, 2009)

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

It should be noted that the wetlands were assessed using the Level 1 Wet-Health tool.

2.2.3 Assessment of Ecological Importance and Sensitivity

Protection of freshwater ecosystems and biodiversity are a critical part of the purpose of the National Water Act. In this context and in the context of the need to protect water resources as espoused by the Act it is thus important to determine the ecological importance and sensitivity of a potentially affected water resource. The ecological importance of a water resource is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) of a surface water feature refers to its ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Rountree *et al,* 2013). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Rountree *et al,* 2013).

A rapid scoring system to evaluate Ecological Importance and Sensitivity of wetlands has been developed as part of the development of a manual for Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Rountree *et al*, 2013). The spreadsheet-based tool evaluates a number of factors to determine importance and sensitivity, including biodiversity value, landscape context and hydrological and water quality-related factors. A score from 0-4 is provided, with a score of 4 reflecting the highest degree of sensitivity to as indicated by Table 3 below.

Table 3 – Ecological Importance and Sensitivity Scores as calculated by the wetland EIS Tool (Rountree *et al*, 2013)

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

3 FINDINGS OF ASSESSMENT

3.1 Results of Delineation Assessment

3.1.1 Soils

Soils were sampled at different points within, and surrounding the area of hydrophytic vegetation immediately adjacent to the southern part of the dam wall, as well as within the neighbouring area in which wetland vegetation also occurs on the northern side of an irrigation canal that commences at the dam wall.

At points sampled in the area covered by *Imperata cylindrica* (see section 3.1.2 below) the soils were largely uniform in their characteristics and characterised by the presence of a soft plinthic B horizon as the second or third horizon within the soil sequence encountered. The presence of a soft plinthic B horizon is important as this diagnostic horizon is always associated with hydric (wetland) soils. The soft plinthic horizon is indicative of a zone of periodic fluctuation with water, typically as a result of a rising and falling water table. The soft plinthic B horizon forms with the iron and manganese oxides and hydroxides to form mottles and concretions through redoximorphic processes gives rise to this horizon.

The predominant soil form encountered within the area of hydrophytic vegetation was the Westleigh Soil Form (Orthic A →Soft Plinthic B), with an Avalon Soil form (Orthic A→Yellow-brown Apedal B→Soft Plinthic B) encountered on the margins of the area of hydrophytic vegetation at one of the sample points. Both of these soil forms are classified as wetland soil forms (DWAF, 2005). Soils sampled within the area of hydrophytic vegetation downstream of the spring located to the north of the canal (i.e. located further downslope towards the Rietspruit valley bottom) also displayed soft plinthic characteristics, with the occurrence of Westleigh Soil Forms at the two sample locations investigated north of the canal. Certain of the soil samples in the area of hydrophytic vegetation to the south of the canal indicated that the soft plinthic B horizon was underlain by a hard plinthic B horizon, with the presence of an indurated plinthic layer at depth here appearing to correspond to the outcropping of the hard plinthic layer to the north (downslope) as discussed below. In the soil samples to the north of the canal in which a Westleigh Soil form was encountered, the soft plinthic layer morphed into non-diagnostic gleyed material (dark grey gleyed clays) that typically occurs with soft plinthic B horizons. The presence of these two soil forms (and predominance of sot plinthic B horizons) is confirmation that the area to the north and south of the canal is a wetland with the occurrence of hydromorphic soils that formed under natural conditions.

Away from the area of hydrophytic vegetation where the sward changed to a short grassland predominated by non-wetland grass species the soft plinthic horizons were no longer present and a Clovelly Soil Form (a non-wetland soil form – Orthic A→Yellow-brown Apedal B→unspecified) was encountered. In the area to the north of the canal (surrounding the spring and associated wetland) shallow soils characterised by a shallow Orthic A horizon overlying hard plinthic material (a Dresden Soil Form), or alternatively areas of hard plinthic outcropping at the surface were encountered.

Figure 1 – Example of Soils from a Soft Plinthic B Horizon

Figure 2 Example of Soils from a Soft Plinthic B Horizon to the north of the canal

The soils were also sampled in a localised area of *Typha capensis* rushes in which groundwater discharge was occurring (i.e. a spring – refer to Figure 9) located to the north of (downslope of) the canal; these soils displayed different characteristics to the rest of the soil samples on the site. A Katspruit Soil Form (Orthic A→G) was encountered at the spring. This soil form is also a wetland soil form and is typically found in wetland areas typified by permanent saturation levels. The G horizon forms in conditions of extended or permanent saturation, resulting in the gleying of soils and the net accumulation of colloidal matter. The presence of the Katspruit soil form in the spring is very strongly indicative that this is a naturally-occurring spring which caused by the discharge of groundwater, being unrelated to any seepage from the dam (refer to section 3.1.3) below.

Figure 3 – Soils from a G Horizon at the spring located to the north of the canal

3.1.2 Vegetation

It is important to note that the field investigation was undertaken in May, outside of the growing season, and inflorescences on grass species were typically absent. This made it more difficult to identify grass, sedge and herb species.

The predominant species within the area of hydrophytic vegetation to the south of the canal is the grass species *Imperata cylindrica.* This species is a facultative hydrophyte (i.e. it occurs both within and outside of wetlands – Kotze and Marneweck, 1999), however that designation is likely to apply more to the mesic eastern seaboard of South Africa which experiences high levels of mean annual precipitation. In the context of the drier western interior of South Africa in which the study site is located (the general area has a MAP of 580mm – Mucina and Rutherford, 2006), this species is more likely to be an obligate hydrophyte, only occurring within wetlands. This species formed dense, tall stands, with the area in which the hydrophytes are located to the south of the canal not appearing to be grazed by livestock.

Other species encountered in this area were scattered *Phragmites australis* and *Typha capensis,* both of which are obligate wetland species. The margins of the area of hydrophytes (*Imperata*) was characterised by the presence of scattered *Asparagus laricinus* shrubs as well as some *Gomphocarpus fruticosus* shrubs. A transition to a short grassland dominated by *Themeda triandra* and *Cymbopogon excavatus* was noted.

Figure 4 – Tall, dense stand of *Imperata cylindrica* to the south of the canal

To the north of the canal, other areas of hydrophytic vegetation were sampled. The area of active groundwater seepage (natural spring) was characterised by the presence of a dense stand of *Typha capensis,* an obligate wetland species. This species was also found along the artificial channel emanating from the canal artificial (see section 3.1.3 below) and within the saturated area into which this channel and the natural spring feed. In the vicinity of the spring and downstream of the spring other typical hydrophytes were encountered including the grass species *Andropogon eucomis,* sedge species such as *Juncus exsertus, Schoenoplectus corymbosus* and other hydrophytic herbs such as *Ranunculus multifidus, Berula erecta* and *Marsilea macrocarpa*, The predominance of these hydrophytes is a strong confirmatory factor of the presence of wetland habitat on the site. Although hydrophytes can colonise an area of artificial saturation, this vegetative assemblage along with the presence of hydric soils is confirmatory of the presence of natural wetland habitat.

Figure 5 – The wetland downstream of the spring feeding down into the valley bottom of the Riet Spruit

3.1.3 Hydrology and Terrain Setting Context

Hydrology is a key consideration of this assessment of wetland occurrence, as the possibility that the hydrophytes are fed by seepage from the dam wall has been raised as a reason to explain their presence. No active seepage was noted from any point on the dam wall adjacent to the area of investigation.

In a terrain setting context, the area of hydrophyte occurrence is located on the footslopes to the south of the Rietspruit valley floor (bottom). It is important to note that wetlands and surface water features can be found all across a landscape, and are not limited to valley floors in which depositional wetland features typically occur. Wetlands can occur on other terrain units including sloping ground and wetlands occurring on these different terrain units typically differ in terms of their formative processes and hydrological inputs. Wetlands occurring in sloping terrain settings are characterised by colluvial processes and the input of sub-surface water inputs.

The classification of wetland form has been based upon the most updated wetland classification system for South Africa – the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*, 2013). The system uses a six-tiered approach for classifying inland aquatic systems, including wetlands. Levels 4 and 5 (hydrogeomorphic (HGM) unit and hydrological regime respectively) are the focal points of the classification system – i.e. these describe the functional unit (Ollis *et al,* 2013).

According to the classification system the wetland on the site qualifies a seep wetland. Under the Ollis *et al* (2013) classification system, a seep is defined as:

"A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope"

In seep wetlands water inputs are primarily via subsurface flows from the upslope catchment of the wetland. Water movement through the seep is mainly in the form of interflow, with diffuse overland flow (known as sheetwash) often being significant during and after rainfall events (Ollis *et al,* 2013). The slope on the site, although gentle is sufficient for the presence of colluvial processes that are associated with seep wetlands. Movement of water down the slope, rather than the deposition of water within the wetland, is the predominant hydrological driver.

Seeps are often associated with lithologies that cause groundwater to discharge to the surface, or are located in topographic positions that either cause groundwater to discharge to the land surface or rain-derived water to 'seep' down-slope as subsurface interflow (Ollis *et al,* 2013).

The dominant presence of soft plinthic strata in the wetland is strongly indicative of the presence of a naturally-occurring shallow groundwater table. The groundwater may be a perched aquifer or hydrologically connected to deeper groundwater. The presence of a G Horizon within the spring located to the north of the canal is also strongly suggestive of the presence of groundwater seepage at this point. The spring is surrounded by hard plinthic material (ferricrete) and the general predominance of plinthic material in the soils (ranging from younger soft plinthic material to hard plinthic material in a more advanced state of induration) suggests that over the wider area on the southern footslopes of this reach of the Riet Spruit immediately downstream of the dam the primary hydrological driver is the presence of naturally-occurring shallow groundwater, which discharges to the surface at the spring (refer to Figure 7).

It is important to note that certain of the hydrological inputs to the wetland area to the north of the canal are artificial. As mentioned above an artificial channel is located to the west of the spring. Analysis on the site revealed that this channel which is lined with *Typha capensis* rushes is directly linked to a sluice gate in the canal. Although the sluice gate was closed, small volumes of water were visibly draining from the canal into the channel. This artificial source of water is feeding the downstream wetland and from the site analysis has effectively widened the area of wetland that would naturally be present due to outflow from the spring to the east, as the artificial channel feeds into that wetland.

Figure 6 – The natural spring located to the north of the canal

It is possible that seepage from the dam could be feeding into sub-surface flow paths that are feeding the spring, however it is important to note that the overall soft plinthic characteristics of the wider area suggest that naturally occurring shallow water tables are present.

Under the Ollis *et al* (2013) categorisation, the sub-categorisation of seeps relates to the nature of the outflow, with seeps either having channelled or without channelled outflow. It is hypothesised that *both sub-categories of seep wetlands naturally* occur on the site. The upper part of the seep wetland (i.e. the portion to the south of the canal) is likely to have naturally had no channelled outflow. The sub-surface hydrological inputs in this upper part of the wetland appear to be naturally related to the presence of a rising and falling groundwater table (possibly due to a perched aquifer), with no natural outflow or discharge of water present (in spite of the transformative presence of the canal). The presence of the natural spring and associated downstream wetland which feeds into the valley bottom wetland / stream falls into the second sub-category of seep. Although no distinct channel exists, this lower part of the seep wetland is hydrologically connected to the wider drainage network via the wetland that feeds into the Riet Spruit downstream of the dam wall.

Figure 7 – The seep wetland with no channelled outflow to the south of the canal

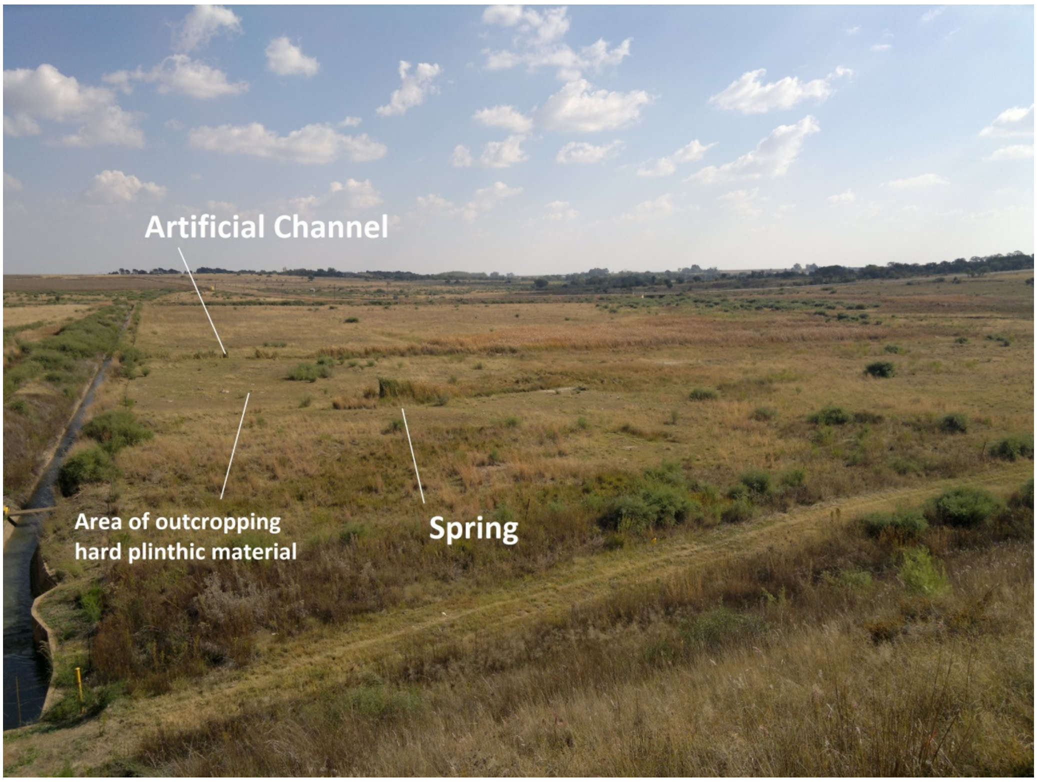


Figure 8 – The seep wetland with channelled outflow to the north of the canal

3.1.4 Wetland Boundaries

The current boundaries of the wetland are indicated in Figure 9 below. The boundaries on the eastern side of the wetland stop at the edge of the access track located immediately adjacent to the toe end of the dam wall. This access track although grassed consists of fill material (imported crushed rock). It is thus highly that part of the eastern part of the wetland has been transformed by the presence of the track as well as by the dam wall.

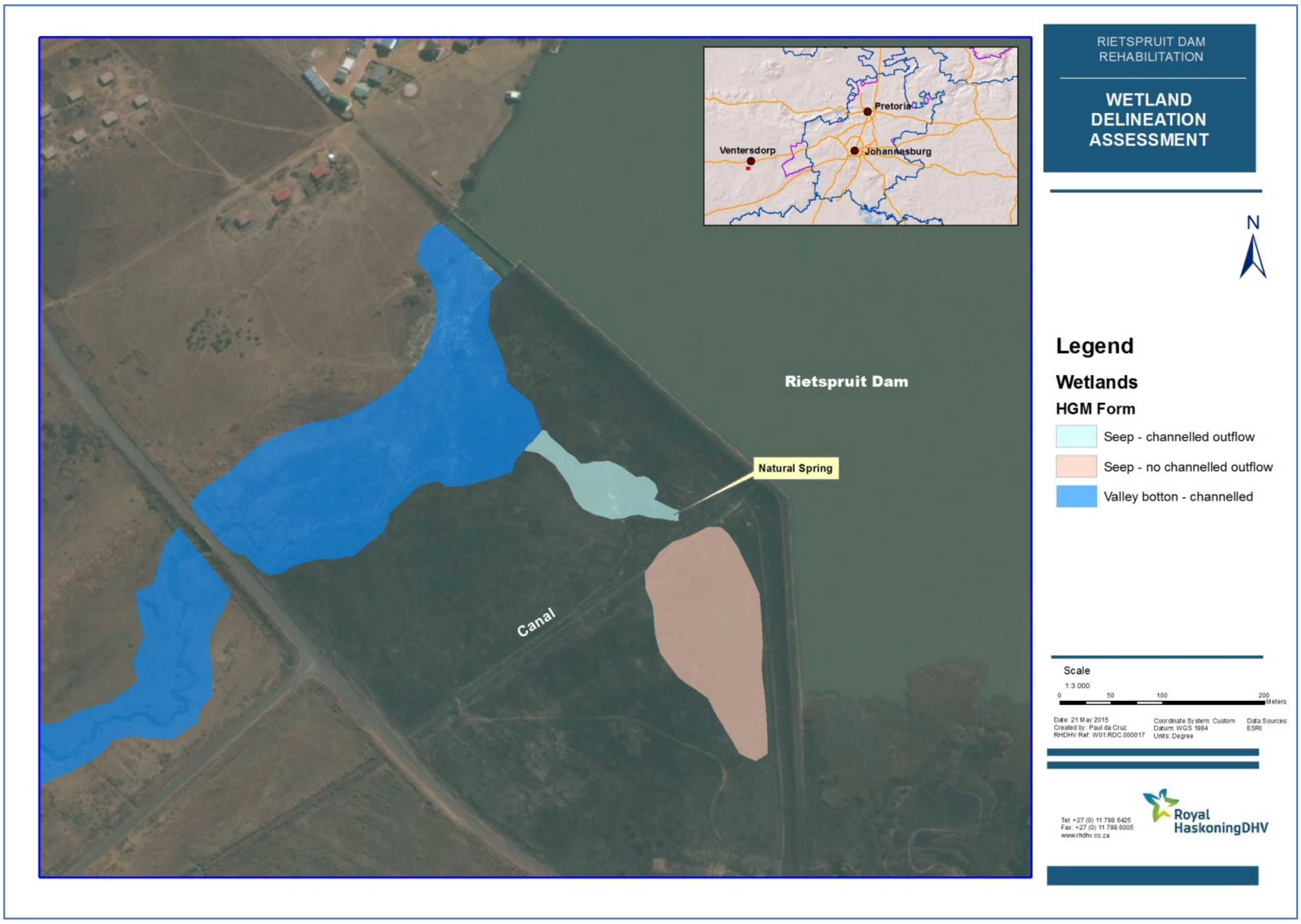


Figure 9 – Location of Wetlands downstream of the Rietspruit Dam Wall

3.2 Assessment of Wetland State

The following scores have been allocated to the wetland unit by the Wet-Health Tool:

Wetland State

PES Geomorphology	PES Hydrology	PES Vegetation
A	C	C

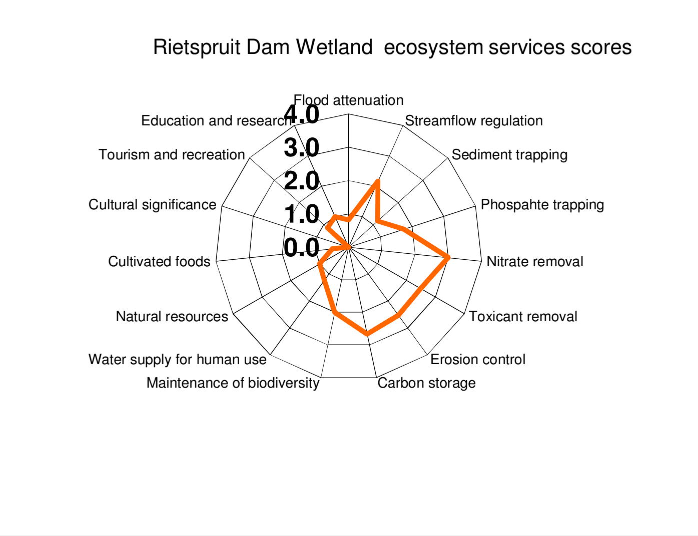
The highest score allocated is for geomorphology, reflecting a natural or unaltered state. This reflects the highly stable nature of soils in the wetland, with no erosion noted. Due to the combination of the sloping terrain setting and the presence of water at the surface, erosion can adversely affect hillslope seepage wetlands, and can negatively impact the geomorphological state of the wetland. The high degree of plant cover (in spite of livestock grazing in the lower part of the reach) assists in the protection of soils in the wetland.

Scores reflecting a moderately modified state have been assigned to the hydrology and vegetative state of the wetland. The presence of the Rietspruit Dam and associated dam wall and access track at the foot of the wall that is believed to have transformed the uppermost parts of the seep wetland is responsible for the partial loss (transformation) of wetland habitat, thus degrading vegetative state. The presence of the dam has altered the natural hydrology of the wetland in two ways; firstly the dam has transformed a large part of the catchment of the wetland, thus altering catchment runoff from a natural state by reducing flows. This is counteracted however by possible increased seepage from the dam wall into the wetland, and by 'leakage' from the canal that leads from the dam and which bisects the wetland. A sluice gate in the canal that although closed, is leaking water towards the downstream part of the wetland unit, creating a narrow artificial flow path which has been colonised by *Typha capensis* rushes. The presence of these reeds suggests that the inflow from the canal leakage occurs on a permanent basis, and is likely to have resulted in a net input of water into the lower part of the wetland unit.

Overall the wetland is likely to be in a moderately modified state, still displaying areas of intact wetland habitat which are important from an ecological perspective as discussed below.

3.3 Assessment of Wetland Functionality

The graph below indicates the outcomes of the wetland functionality assessment.



No ecosystem services were assessed to be performed to a high degree. The following ecosystem services were however assessed to be performed to a moderately degree:

- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage

Nitrate and toxicant removal are typically ecosystem services performed to a high degree by hillslope seepage wetlands. Nitrogen and specifically nitrate removal occurs as the groundwater emerges through low redox potential zones within the wetland soils, with the wetland plants contributing to the necessary supply of organic carbon (Kotze *et al,* 2009). Hillslope seepage wetlands can similarly act to remove toxicants. The small size of the wetland and hydrological connectivity (to the wider drainage system) of only a part of the wetland are likely to limit this aspect of the wetland's functionality, however.

Erosion control and carbon storage functions are a direct product of the high degree of vegetation cover in the wetland. As detailed in section 3.2 above no erosion was noted in the wetland in spite of a relatively high livestock grazing presence within the wetland that is often associated with the exposure and disturbance of soils and vegetation through trampling. The relatively low levels of disturbance in the wetland and moribund plant cover in many parts of the wetland unit contribute to its carbon storage function.

3.4 Assessment of Ecological Importance and Sensitivity

An **ecological importance and sensitivity score of 3.3 (**out of 4) has been assigned to the wetland immediately adjacent to the southern portion of the Rietspruit Dam wall. This reflects a score of *high* ecological importance and sensitivity. Although all wetlands are ecologically important, and in spite of the small size of the wetland, the wetland displays a high ecological importance and sensitivity rating due primarily to the confirmed presence of a threatened bird species in the wetland – the African Grass-owl (*Tyto capensis*) **which is nationally red-listed as being vulnerable.** The wetland habitat within the upper part of the wetland unit (the hydrologically isolated seep compartment) provides suitable breeding and roosting habitat for this species. The species prefers rank grass and marshes and the tall moribund grass of the wetland provides excellent habitat.

In addition another owl species, the Marsh Owl (*Asio capensis*), which although not threatened is vulnerable to continued degradation of its preferred wetland habitat[1] was located in the wetland. Both species were confirmed from the site visit and the wetland area to the south of the canal is thus used a roost site and possibly even as a breeding site.

The Biodiversity Support Aspect of Ecological Importance and Sensitivity of any wetland is based on a number of factors including the presence of threatened species, the presence of populations of unique species and the presence of migration / breeding / feeding sites (Rountree *et al, 2013*). This seep wetland scores very highly under two of these categories (the presence of a nationally threatened bird species and providing habitat for feeding, roosting and possibly breeding of this species).

This wetland is thus highly sensitive and ecologically important from a biodiversity protection viewpoint in spite of its small size. The activities associated with the rehabilitation of the dam must accordingly create as little physical impact and disturbance on this wetland as possible and it is strongly recommended that the footprint of any construction works not extend into the current boundary of the wetland.

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[1] The range change map for the African Grass-Owl on the SABAP2 website that compares differences in reporting rates and reporting areas between the older SABAP1 and current SABAP2 (bird Atlassing) projects shows a drop in reporting rates and contraction of range for this species between the two projects.
(http://sabap2.adu.org.za/species_info.php?spp=361&section=3#menu_left)

4 ASSESSMENT OF THE IMPACTS OF THE DAM WALL UPGRADING ON THE WETLAND

Technical information regarding the works has been provided by the engineers on the project, as detailed in the figures below.

The most important aspect of the repair works that could potentially impact the wetland located just downstream of the dam wall is the footprint of the works, and whether the works area and footprint of the repaired dam wall will extend into the wetland. If this were to occur, this would result in physical alteration of wetland habitat that would be permanent if the dam wall's footprint were to be extended into the wetland. Should this occur, this would impact on the wetland state and functionality, as an area of currently intact wetland habitat would be transformed. More importantly the part of the wetland that is located immediately adjacent to the dam wall to the south of the canal provides very important habitat for two owl species, one of which is threatened (refer to section 3.4 above). Due to the relatively small spatial extent of this part of the wetland, loss of this habitat would be likely to have a very important adverse impact on the owls and their continued presence at the site and in the area around the dam.

Figures 10 and 11 indicate that the footprint of the dam wall would not be extended into the wetland – the cross section of the dam wall as illustrated in Figure 10 indicates that a stabilisation berm would be constructed at the foot of the dam wall on its downstream side, as well as a toe drain. However these would not extend beyond the existing fenceline which comprises the current boundary of the wetland (as fill material has been placed over the former wetland area on the dam wall side of the wetland). The permanent footprint of the repaired dam wall will thus not extend into the current wetland area, and if the plans are followed, no wetland habitat loss will occur as part of the dam repair.

The construction activities associated with the dam wall repair, could however still exert an impact on the wetland and adversely affect the wetland habitat, if the construction footprint were to extend into the wetland area. The cross section of the works (Figure 10) indicates that there is a relatively narrow area between the current edge of the wetland and the newly proposed infrastructure that includes the stabilisation berm and the toe drain. Machinery required for the works would need to move in this area, and the possibility exists that construction equipment and material could enter the wetland, thus causing damage to wetland habitat.

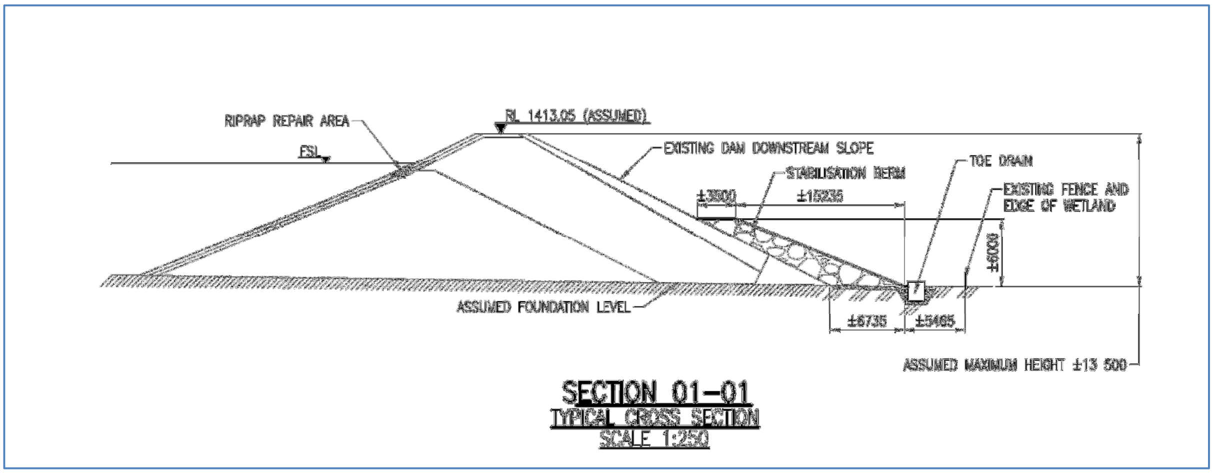

Figure 10 – Typical Cross Section of the Dam Repair Works as proposed

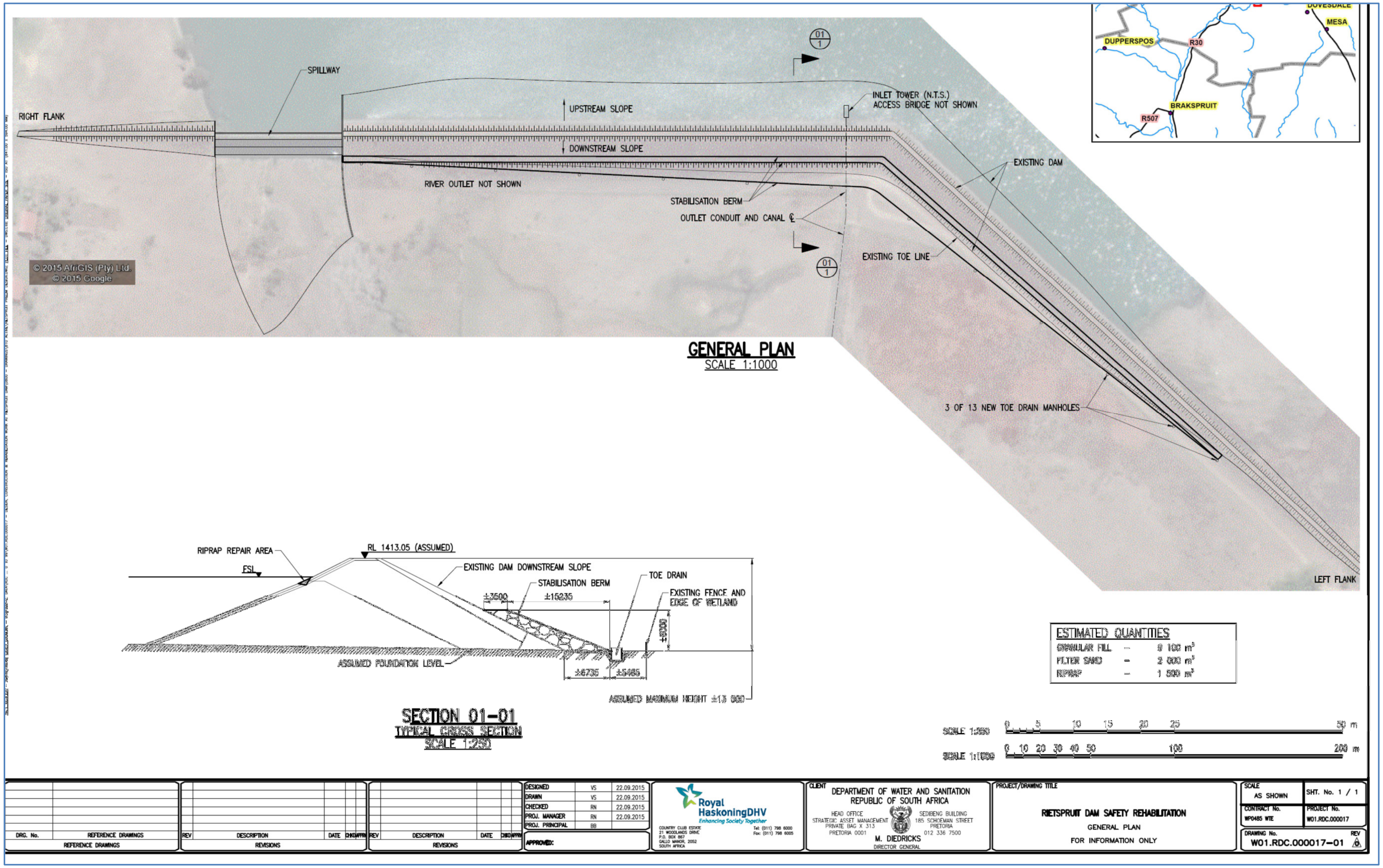

Figure 11 - General plan of the proposed repair works

It is accordingly very important that the construction activities do not extend into the wetland area. It is strongly recommended that the fence be retained in order to prevent access of machinery and construction workers into the wetland. This measure and a number of other construction-related mitigation measures are specified in Section 4.1.1 below. It is recognised that construction activities are inherently noisy, but an attempt should be made to lessen the potential disturbance factor for owls. Apart from not being able to traverse the wetland, it is recommended that construction activities occur in the summer months when the owls would not be breeding. If construction activities occur in the winter months, there would be a greater risk of owl species that are breeding being disturbed and abandoning nests.

4.1 Mitigation Measures

4.1.1 Construction-related Mitigation Measures

- The construction footprint must in no way physically extend into the boundary of the wetland, as delineated (refer to Figure 9 above). This applies to wetland areas on either side of the canal. *The fence that marks the current boundary of the wetland must be retained intact in order to avoid movement of people and machinery into the wetland.*
- The wetland must clearly be designated and signed as a sensitive no-go area.
- No cement batching or any other similar activities that could result in pollutants entering the wetland must be conducted within 50m of the wetland boundary, as delineated.
- No stockpiling of any material must be undertaken within the works area adjacent to the wetland. Stockpiling of excavated or other material must occur no closer than 50m to the boundary of the wetland.
- All portable machinery (such as moveable pumps) that could leak oil into the wetland must operate on drip trays to avoid the spillage of oil into the wetland.
- Spill kits must be retained on site in the event of a fuel spillage.
- Machinery must be inspected on a daily basis to check for oil leaks.
- No water or any other silt from dewatering activities that may need to be undertaken must be discharged into the wetland, as this water is likely to contain silt in suspension or other potential pollutants. If such water is to be discharged into the environment it must first be passed through a silt trap and discharged outside of the wetland area.
- Under no circumstances must the wetland or surrounding veld (pastureland) be burnt, and no open fires must be allowed on the construction site.
- All mitigation measures relating to the presence of the African Grass-Owl (*Tyto capensis*) on the site as specified in the faunal specialist study must be strictly adhered to.
- Although it is recognised that construction activities are inherently noisy, an attempt to reduce the noise disturbance factor must be made.
- Stormwater management must be practiced on the construction site. It is recommended that a low earthen berm or silt fence be erected along the edge of the wetland boundary where it is located adjacent to the works area to prevent stormwater from the construction area from entering the wetland.

4.1.2 Operational-related Mitigation Measures

The operational phase of the dam wall is unlikely to be associated with any impacts of the wetland, however should any maintenance activities need to be undertaken that require any physical works, the construction phase mitigation measures must be applied.

It is very important that the fenceline between the dam wall and the wetland be maintained to prevent any operational-phase incursion of people or vehicles into the wetland.

4.2 Impact Rating Table

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
Construction	• Construction practices could lead to the degradation / transformation of wetland habitat, particularly in the portion of the wetland that is located directly adjacent to the dam wall works area, if people or machinery enter the wetland area. The unnecessary expansion of the footprint of the construction servitude could exert an impact on adjacent wetland/ riparian habitat • This factor and construction activities could disturb sensitive avifauna inhabiting the wetland, which would be particularly important in the affected (owl) species were breeding at the time of the works • Construction practices could lead to the pollution of surface water features through oil leaks, leakage or cement, or through discharge of polluted stormwater or dewatering discharge into the wetland.	**Extent:** Site (-1) **Duration:** Medium-term (-2) **Intensity:** High (-3) **Probability:** Possible (-3) **Significance: Medium (-9)**	• Construction to be guided by the EMPr and the mitigation measures stipulated in this report • Construction to be monitored by an ECO according to the stipulations of the EMPr • The Construction footprint must in no way physically extend into the boundary of the wetland. • The wetland must clearly be designated and signed as a sensitive no-go area. • No cement batching or any other similar activities that could result in pollutants entering the wetland must be conducted within 50m of the wetland boundary, as delineated. • No stockpiling of any material must be undertaken within the works area adjacent to the wetland. Stockpiling of excavated or other material must occur no closer than 50m to the boundary of the wetland. • All portable machinery (such as moveable pumps) that could leak oil into the wetland must operate on drip trays to avoid the spillage of oil into the wetland. • Machinery must be inspected on a daily basis to check for oil leaks. • No water or any other silt from dewatering activities must be discharged into the wetland. If such water is to be discharged into the environment it must first be passed through a silt trap and discharged outside of the wetland area. • Under no circumstances must the wetland or surrounding veld (pastureland) be burnt, and no open fires must be allowed on the construction site. • Construction activities should be undertaken in the summer months to avoid the disturbance of owls that may be breeding.	**Extent:** Site (-1) **Duration:** Medium-term (-2) **Intensity:** Moderate (-2) **Probability:** Possible (-2) **Significance: Medium (-7)**

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
			• Stormwater management must be practiced on the construction site. It is recommended that a low earthen berm or silt fence be erected along the edge of the wetland boundary where it is located adjacent to the works arear	
Operations	• Operational maintenance activities that require physical works could exert a similar impact to construction works (see above). • Any incursion of people or machinery into the wetland area could damage wetland habitat and disturb fauna within the wetland.	**Extent:** Site (-1) **Duration:** Long term (-3) **Intensity:** Moderate (-2) **Probability: Possible** (-2) **Significance: Medium (-8)**	• Should any maintenance activities need to be undertaken that require any physical works, the construction phase mitigation measures must be applied. • It is very important that the fenceline between the dam wall and the wetland be maintained to prevent any operational-phase incursion of people or vehicles into the wetland	**Extent:** Site (-1) **Duration:** Long term (-3) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Medium (-7)**
Cumulative	• Any loss of wetland habitat in the seep wetlands would constitute a cumulative impact as this would add to wetland loss associated with the (historical) development of the dam. This could result in an overall lowering of the Present Ecological State Class of the wetland.		• The construction drawings show that the footprint of the repaired dam wall will not cause further wetland loss. Construction mitigation measures will ensure that the construction footprint does not impinge on the wetland area.	

5 CONCLUSIONS

An investigation has been undertaken to determine the origin / cause of areas of hydrophytic (wetland) vegetation downstream of a portion of the Rietspruit Dam wall. The investigation of soil wetness indicators and soil forms, and supported by an analysis of vegetation, terrain and hydrology has led to the conclusion that the vegetation is part of a naturally-occurring seep wetland on the footslopes above the valley bottom of the Riet Spruit. It is possible that some form of sub-surface seepage from the dam is feeding into the wetland via sub-surface flow pathways, but the soil signature on the site has confirmed that the wetland vegetation is due to naturally-occurring hydromorphic soils on the site.

As part of the assessment, the present ecological state, functionality and ecological importance and sensitivity of the wetland have been assessed in order to determine an ecological baseline for the wetland. The wetland unit has been determined to be in a moderately modified overall state, due to partial loss of habitat and hydrological change exerted by the historical development of the dam. The small size of the wetland limits its level of functionality; however the wetland has been assessed to perform a number of ecosystem services to a moderately high degree. The wetland has however been assigned a high degree of ecological importance and sensitivity due primarily to the confirmed presence and suitable roosting and breeding habitat for two owl species (African Grass-Owl (*Tyto capensis*) and Marsh Owl (*Asio capensis*)) which are threatened (endangered) or declining (in the case of the Marsh Owl).

The dam wall upgrading and repair could result in an impact on the wetland, particularly if the construction footprint were to extend into the wetland, thereby causing loss / transformation of wetland habitat and disturbance of owls inhabiting this part of the wetland. A number of mitigation measures have been specified to ameliorate the impact of the construction works on the wetland, and to ensure that the works result in no further loss or impacting on wetlands on the site.

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