# HARTENBOS HEUWELS RESIDENTIAL DEVELOPMENT
# Wetland Assessment

**SEF Reference No: 504632**

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# Declaration of Independence

I, **Willem Lubbe,** in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Have and will not have 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 has 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 National Environmental Management Act, 1998 (Act 107 of 1998);
- 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;
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member;
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement; and
- Undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

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3 December 2014
**Date**

## EXECUTIVE SUMMARY


Strategic Environmental Focus (Pty) Ltd (SEF), as independent environmental consultants and ecological specialists, was appointed by Afrikaanse Taal en Kultuurvereniging (ATKV) to undertake a wetland assessment of the proposed Residential Development on Erf 3122, Hartenbos Heuwels, Mossel Bay. The terms of reference for the current study were as follow:

- Identify and delineate wetland areas associated with the proposed site according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas"
- Determine the Present Ecological State (PES) of identified wetlands using the WET-Health approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWA;
- Identify possible impacts of unauthorised activities associated with wetlands within the study area and provide mitigation measures.

Two hydro-geomorphic units (HGM), comprising one HGM type, namely a hillslope seepage wetland connected to a watercourse were delineated and classified within the study area. In addition to the wetland areas, numerous riparian areas were also delineated throughout the study area.

The ecosystem services performed by the identified wetlands were assessed through applying a Level 2 Wet-EcoServices assessment. Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits therefore contribute directly or indirectly to increased biodiversity within the study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes. The wetlands' ability to contribute to ecosystem services within the study area is further dependent on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. A Wet-Health Level 2 assessment of the wetlands within the study area assigned a Present Ecological State score for each of the particular hydro-geomorphic units. Combined area weighted Wet-Health results considered the identified wetlands to be moderately modified.

The Ecological Importance and Sensitivity assessment was undertaken to rank wetlands in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- Biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Both HGM units attained moderate scores for their Ecological Importance and Sensitivity analysis as at least one species of conservation concern was confirmed within wetland habitat. The temporary nature of the wetland habitat on site reduced

the hydrological potential and functioning of the hillslope seepages. Direct human benefit associated with the wetlands within the study area include some potential subsistence hunting as well as recreational opportunities that can be developed further. Current impacts on the habitat integrity of the riparian habitat included alien vegetation infestation and erosion processes that was evident in the majority of the drainage lines.

The impact assessment identified the destruction of wetland habitat, surface water pollution (including sedimentation) as well as increased erosion as the major potential impacts associated with the proposed development. Potential sources of the above mentioned impacts include reshaping and construction activities for residential development, roads and stormwater infrastructure as well as increased surface runoff from the development footprint. Several mitigation measures are proposed to prevent negative impacts on wetland and riparian areas, including attenuation and diffuse release infrastructure as well as a rehabilitation program within riparian habitat which include design and placement of rehabilitation infrastructure as well as alien vegetation control measures. It is cardinal that the rehabilitation plan be approved by the competent authority and completed before the advent of construction activities. The sensitive stormwater management plan must be designed in conjunction with a wetland specialist in order to ensure that no concentrated run-off reaches wetland, riparian or buffer zones.

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# 1. INTRODUCTION

With South Africa being a contracting party to the Ramsar Convention on Wetlands, the South African government has taken a keen interest in the conservation, sustainable utilisation and rehabilitation of wetlands in South Africa. This aspect is also reflected in various pieces of legislation controlling development in and around wetlands and other water resources, of which the most prominent may be the National Water Act, Act 36 of 1998. As South Africa is an arid country, with a mean annual rainfall of only 450mm in relation to the world average of 860mm (DWAF, 2003), water resources and the protection thereof becomes critical to ensure their sustainable utilisation. Many wetlands perform various important functions related to water quality, flood attenuation, stream flow augmentation, erosion control, biodiversity, harvesting of natural resources, and others, highlighting their importance as an irreplaceable habitat type. Determining the location and extend of existing wetlands, as well as evaluating the full scope of their ecosystem services, form an essential part in striving towards sustainable development and protection of water resources.

## *1.1 Project Description*

Strategic Environmental Focus (Pty) Ltd (SEF), as independent environmental consultants and ecological specialists, was appointed by Afrikaanse Taal en Kultuurvereniging (ATKV) to undertake a wetland assessment of the proposed Residential Development on Erf 3122, Hartenbos Heuwels, Mossel Bay. The current vacant land will be converted into a residential township with a proposed footprint area of approximately 50 ha that will include the following:

- 445 single residential plots;
- 4 group housing plots;
- 5 public open areas;
- Business park;
- Sport grounds; and
- Associated infrastructure such as roads, sewerage, water and electricity.

The preliminary proposed development lay-out is indicated in Figure 1.

## *1.2 Terms of Reference*

The terms of reference for the current study were as follows:

- Identify and delineate wetland areas associated with the proposed site according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas"
- Determine the functionality using Wet-EcoServices, as well as the Present Ecological State (PES) of identified wetlands using the WET-Health approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWA;
- Identify possible impacts of proposed activities that could affect wetlands within the study area and propose mitigation measures.

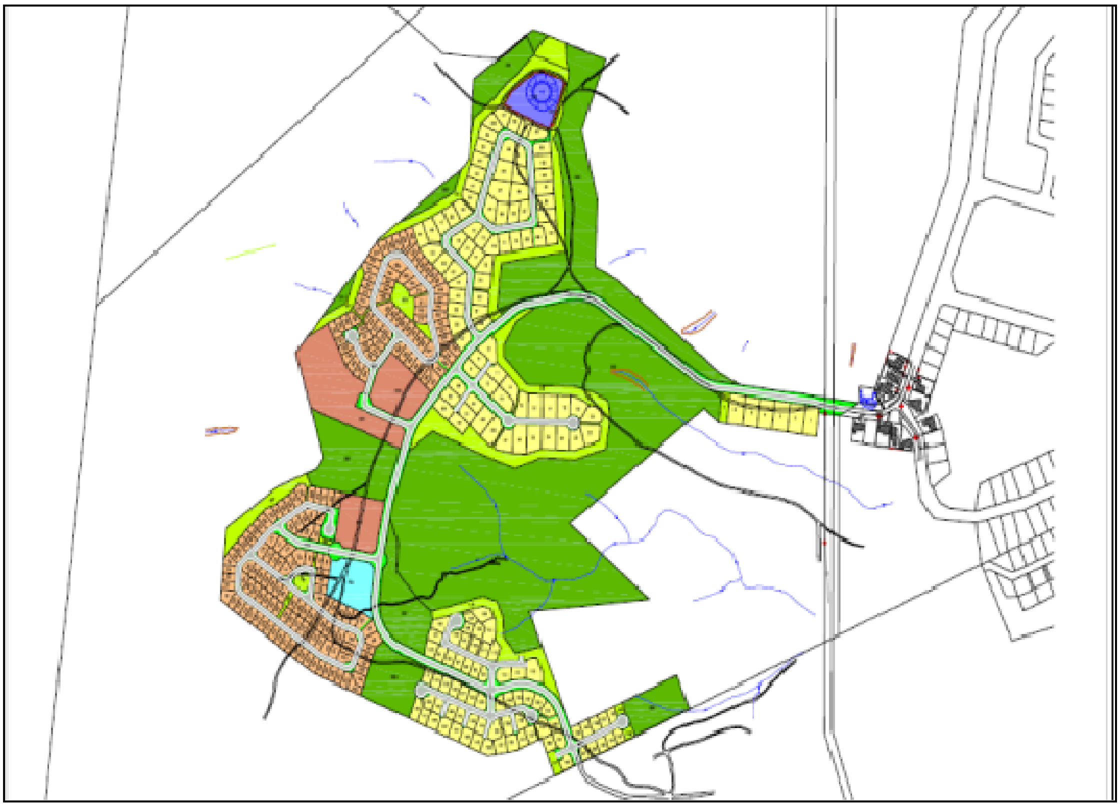


**Figure 1: Preliminary proposed lay-out of the residential development (including business park and sports field)**

### *1.3 Assumptions and Limitations*

In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years. The current study relied on information gained during a three day field survey conducted during a single season, desktop information for the area as well as professional judgement and experience, which were deemed sufficient for the purposes of the study. In addition, soil form classification was made by a wetland ecologist and not a specialised soil scientist which could potentially result in different interpretations of diagnostic horizons in some instances. Delineations of wetland and riparian areas were dependent on the extrapolation of data obtained during field surveys and from interpretation of orthophotos and other imagery. It should also be noted that wetlands and riparian habitat delineated extend further beyond the indicated study boundary.

### *1.4 Methodology*

Field surveys were undertaken from the 7$^{th}$ to the 9$^{th}$ of October 2014. The wetland delineation was based on the legislatively required methodology as described by DWAF (2005). In order to determine the functionality of wetlands, a Level 2 Wet-EcoServices (Kotze *et al.*, 2005) assessment was performed. A Level 2 Wet-Health assessment (Macfarlane *et al*., 2008) was applied in order to determine the Present Ecological Status (PES) of wetlands within the study area through assigning PES categories to wetlands. The Ecological Importance and Sensitivity (EIS) was determined by utilising methodology described by Rountree (2013). For a more comprehensive study approach and specific methodologies employed during the current study, see Appendix A.

# 2. BACKGROUND INFORMATION

## *2.1 Locality*

The study area is located on Erf 3122, Hartenbos Heuwels in Mosselbay, Western Cape and is located approximately 1.5km north east of the centre of Hartenbos town. The study area falls within Quarter Degree Grid Cell (QDGC) 3422AA between 34°07'00.6" – 34°08'16.5" south and 22°05'31.4" – 22°04'30.6" east (Figure 2).

## *2.2 Climate*

The study area receives an annual rainfall between 350mm in the west to 750mm in the east with approximately 50% falling in summer between October and March and 50% in winter between April and September. The mean daily temperatures are 26ºC for February and 7ºC in July (Mucina and Rutherford, 2006).

## *2.3 Geology and soils*

According to Bergwind (2006), Hartenbos Heuwels lies on sediments of the Uitenhage Group of the Enon Formation. This formation of sediments consists of silty mudstones interspersed with rounded cobbles of quartz and gravels that were deposited by rivers into the marine environment on the coastline during the Cretaceous period. (Norman & Whitfield 2006). The geology over the whole of the study area is fairly uniform and erosion through the gravely conglomerates has resulted in the present day topography (Bergwind, 2006).

## *2.4 Regional Vegetation*

The study area is located in the Fynbos Biome which occupies most of the Cape Fold Belt as well as the adjacent lowlands between the mountains and the Atlantic Ocean. The Fynbos Biome is also a member of the global Mediterranean Biome which is located on the western shores of the continents of the world (Mucina and Rutherford, 2006). Furthermore, there are three major vegetation complexes within the Fynbos Biome namely Fynbos, Renosterveld and Strandveld.

According to Mucina and Rutherford (2006), the study area is located within the Western Strandveld vegetation complex which consists of nine vegetation types, with one vegetation type, Groot Brak Dune Strandveld represented within the study area. The Groot Brak Dune Strandveld vegetation type is located on the coastal stretches between the mouth of the Gouritz River to the Victoria Bay near the Wilderness. According to, this vegetation type is currently listed as Endangered with no areas conserved and more than half of the area already transformed by cultivation, roads and infrastructure (Mucina and Rutherford, 2006).

However, according to Helme (2012), the original natural vegetation on the site is best classified as Mossel Bay Shale Renosterveld in terms of the South Africa Vegetation map categories (Mucina & Rutherford 2006). Helme (2012) further states that the South Africa Vegetation map is very inaccurate in this particular area and the actual map indicates that Great Brak Dune Strandveld is the vegetation type on site (Mucina and Rutherford 2006), which is clearly incorrect, as this is a

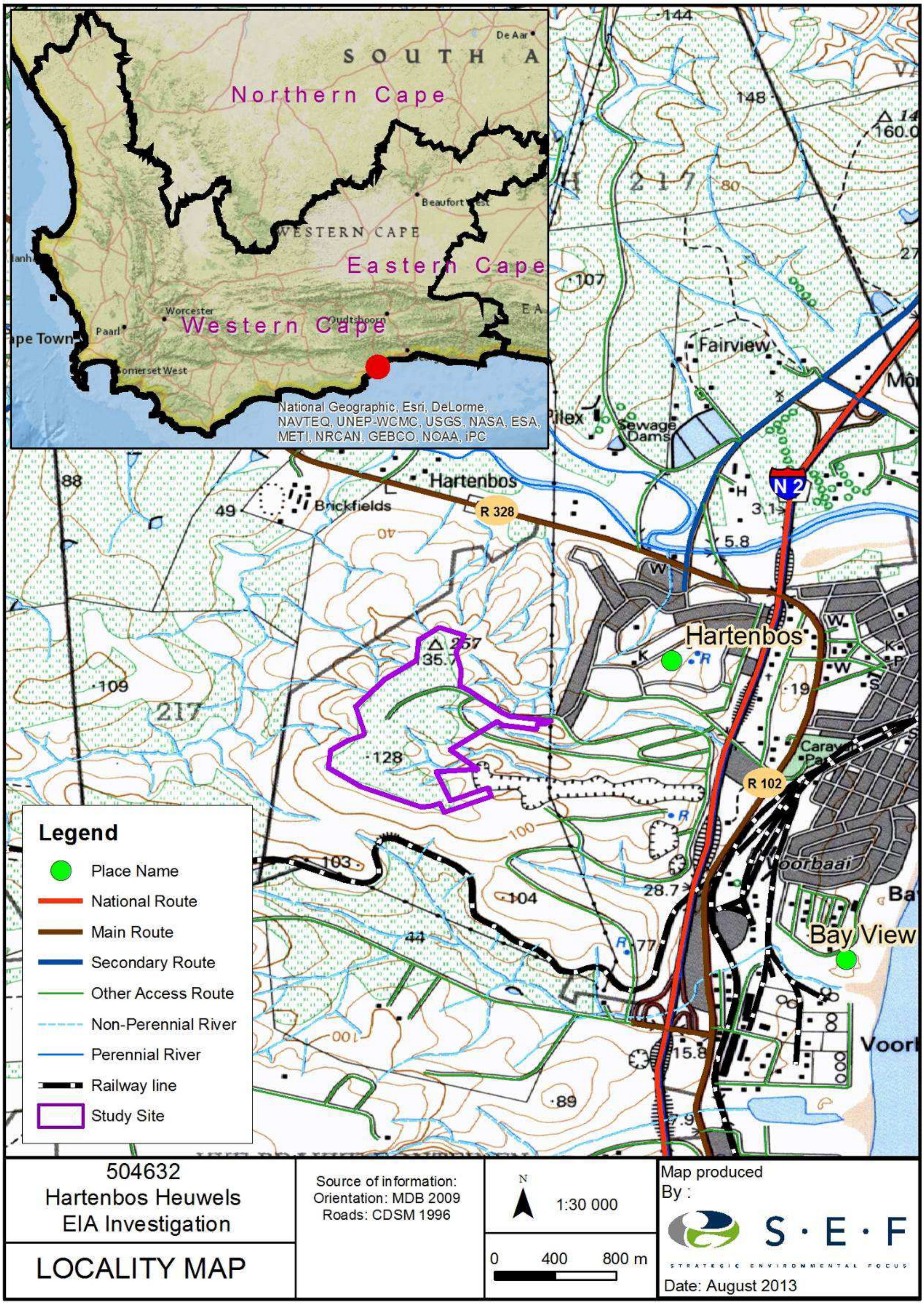



**Figure 2: Locality map of the study area**

thicket vegetation type restricted to coastal sands which are not present in the study area. According to Helm (2012), Mossel Bay Shale Renosterveld is listed as Endangered in terms of the national list of Threatened Terrestrial Ecosystems (DEA, 2011), as only 49% of its original extent remains and the unit has a national conservation target of 36% of its original extent, with 0% formally protected (Rouget *et al.,* 2004). The vegetation type is thus very poorly conserved and is often vulnerable to further loss, usually to agriculture, quarrying, and residential development (Rouget *et al*., 2004).

### *2.5 Wetland Vegetation Group*

According to the National Biodiversity Assessment's Freshwater Component (Nel and Driver, 2012), the study area falls within the South Strandveld Western Strandveld wetland vegetation group. According to the Wetland's Vegetation Group's Ecosystem Threat Status, South Strandveld Western Strandveld is regarded as Endangered (Nel and Driver, 2012). However, it is likely that the South Strandveld Western Strandveld wetland vegetation group is not applicable to the study area as a result of the terrestrial vegetation being incorrectly classified (Helme, 2012). The closest Rhenosterveld wetland vegetation group to the study area is East Coast Shale Rhenosterveld which is regarded as Critically Endangered (Nel and Driver, 2012).

### *2.6 Associated Watercourses*

The study area is located in the Cape Fold freshwater ecoregion within Quaternary Catchments K10B of the Coastal Gouritz sub-management area of the Gouritz water management area 16 (Driver *et al*., 2011; FEOW, 2014;). According to Kleynhans (2007), the study area is located within the . Southern Coastal belt Level 1Ecoregion and more specifically within Level 2 Ecoregion 22.02. Water draining west and north from the study area from non-perennial watercourses drains into the Hartenbos River and estuary. Water draining east and south from the study area drain into an unknown tributary through culverts which drains into a unamend (Driver *et al*., 2011).

### *2.7 National Freshwater Ecosystem Priority Areas*

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

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

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development. The second aim comprises a national and sub-national component: The national component aims to align DWA and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level. The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation (Driver *et al*., 2011).

Based on current outputs of the NFEPA project, two FEPA wetlands were identified within the study area (Figure 3). Both wetlands' FEPA status was likely derived as a result of their endangered Wetland's Vegetation Group's Ecosystem Threat Status within a natural setting and also form part of a wetland cluster. Wetland clusters were derived where significant clusters of wetlands are embedded in a relatively natural landscape matrix through which dispersal between wetlands can occur (e.g. frogs and invertebrates). This allows for important ecological processes such as migration of frogs and insects between wetlands. In many areas of the country, wetland clusters no longer exist because the surrounding land has become too fragmented by human impacts. A goal of NFEPA is to ensure that at least 20% of the wetland cluster area identified for each wetland vegetation group is managed in a way that supports dispersal between wetlands within the cluster, ideally a natural or near-natural condition.

Water from the study area drains into the Hartenbos River and estuary which is considered a phase 2 FEPA as well as into an unnamed FEPA estuary below Bayview.

### *2.8 Mossel Bay Municipality Critical Biodiversity Areas*

The Mossel Bay Critical Biodiversity Areas (CBA) map aims to guide sustainable development by providing a synthesis of biodiversity information to decision makers. It serves as the common reference for all multi-sectoral planning procedures, advising which areas can be developed, and which areas of critical biodiversity value and their support zones should be protected against impacts. The broad objective is to ensure appropriate land use and planning for the best possible long-term benefits and to promote integrated management of natural resources. The main CBA Map categories are Critical Biodiversity Areas (Terrestrial and Aquatic), Ecological Support Areas (Critical and Other), Other Natural Remaining Areas and No Natural Remaining Areas (BGIS, 2014). Several aquatic critical biodiversity features are indicated within the study area including Critical Biodiversity Areas polygons 508, 509, 510, 511 and 513 (of which 511 and 513 was identified as FEPA wetlands) (Figure 4). Several Ecological Support Area Buffers are also indicated along drainage lines.

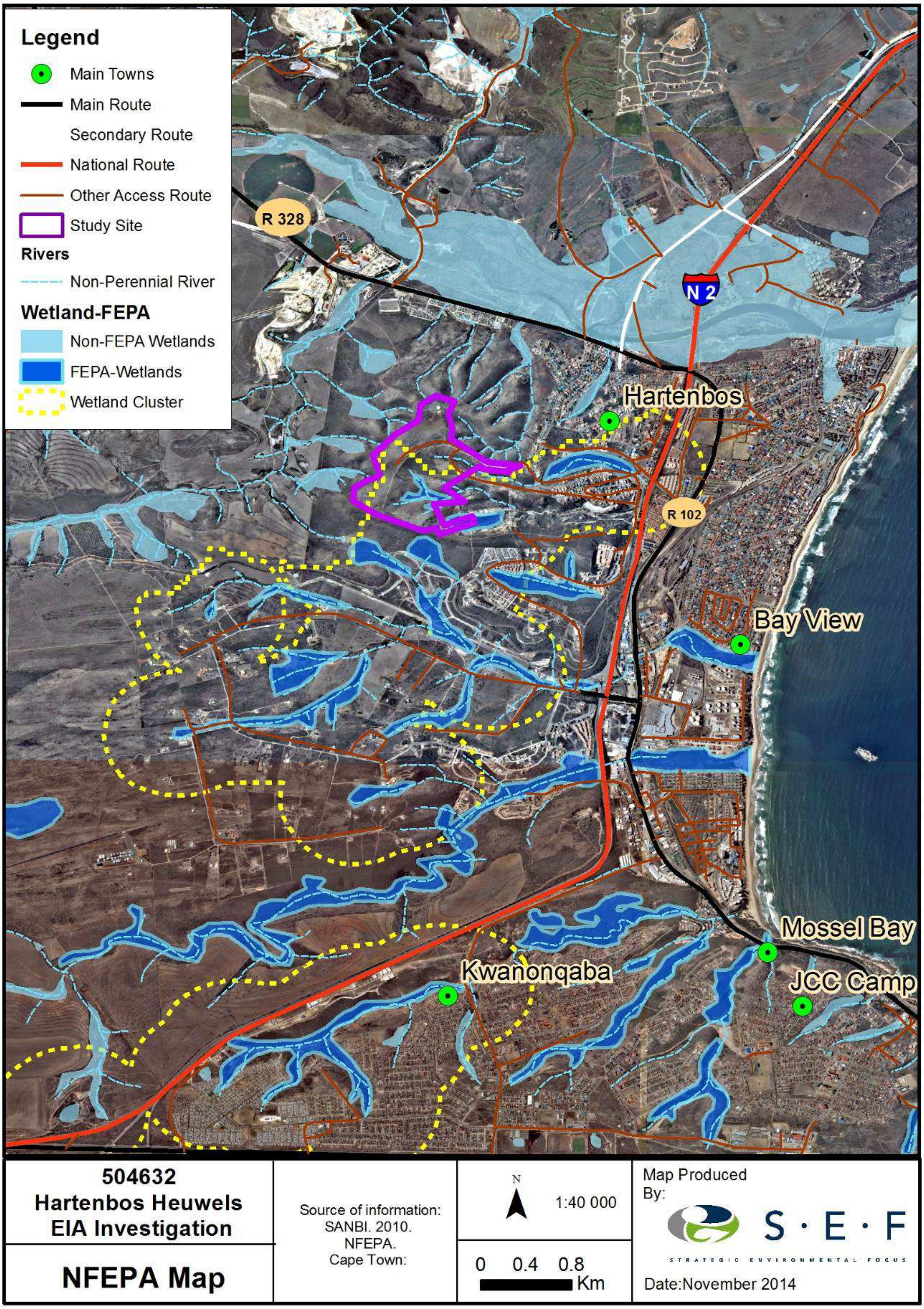



**Figure 3: National Freshwater Ecosystem Priority Areas map**

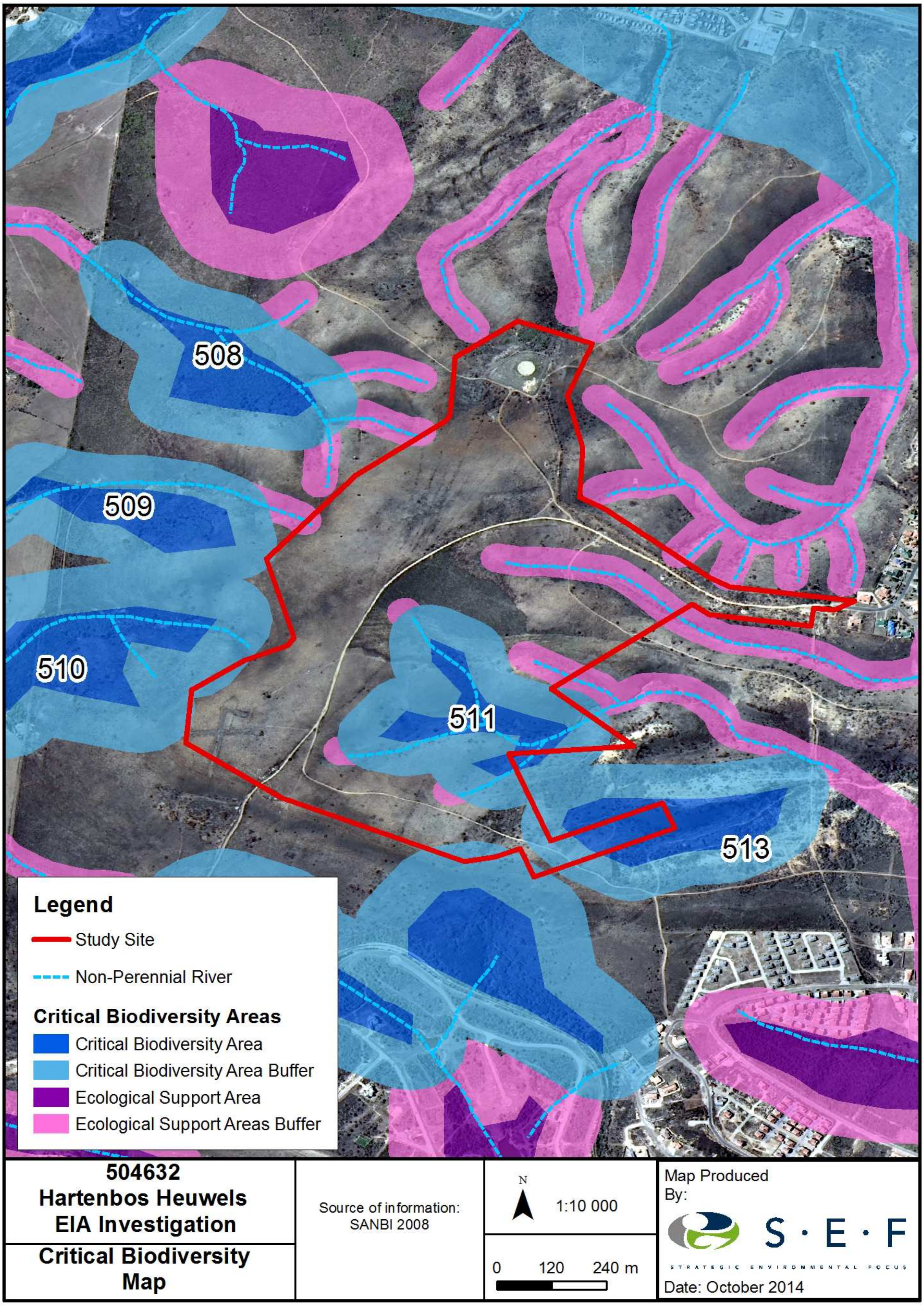



**Figure 4: Mossel Bay Municipality Critical Biodiversity Area map for the study area**

# 3. RESULTS

The study area has a central plateau that is fairly flat and has an average elevation of 120 meters above main sea level (m.a.m.s.l.). Topographic maps indicate that the land use for the plateau area is agriculture. To the south, the plateau drops away as uniform slopes with a moderate gradient to the southern boundary near the railway line. On the southeast to northeast side the landscape is dissected by some valleys that are not very deep but do have slopes with distinctly north- and south-facing aspects. These valleys drain east into canals and pipes which are likely to daylight south of Bayview and north of the Oil depot site into an unnamed FEPA estuary. The elevation in the valleys is around 60 m.a.m.s.l. with the difference in altitude between the deepest valley floor and the central plateau being approximately 60 m. The Hartenbos water reservoir is situated at the highest point on the property at 139.6 m.a.m.s.l. The slopes north of the reservoir, with a northerly aspect, are moderately steep, dropping evenly to the north with valleys draining into the Hartenbos River. The western slopes drop away from the central plateau also with a moderate gradient and also have a series of valleys that drain to the west into a stream which eventually flows into the Hartenbos River. There were no water flow within any of the watercourses at the time of the survey, accept for one section that was fed artificially by a leaking municipal water main.

## *3.1 Soils*

In general, the soils in the study area consisted of shallow sandy loams with an underlying conglomerate formation consisting of numerous rounded pebbles and stones, supported in a matrix of silt, clay and loamy sand. The vast majority of soil samples augered within the study area consisted of terrestrial Clovelly and Mispah soil forms with a few red apedal B horizon-containing Hutton soils towards the highest topography surrounding the water reservoir (Figure 5). Soil profiles on the plateau area indicated soil disturbances (mixed orthic A and apel B horizons) which confirms historic cultivation as soil scarification marks are clearly visible on Google earth imagery of 2010 (Figure 6)

According to DWAF (2005), the permanent zone of a wetland will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991). The seasonal and temporary zones of the wetlands will have one or more of the following soil forms present (signs of wetness incorporated at the form level): Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu. Alternatively, the seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the family level): Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee (DWAF, 2005). The only hydric soil form sampled within the study area were a few shallow Pinedene's in the south of the study. No permanent or seasonal soil forms were sampled within the study area.

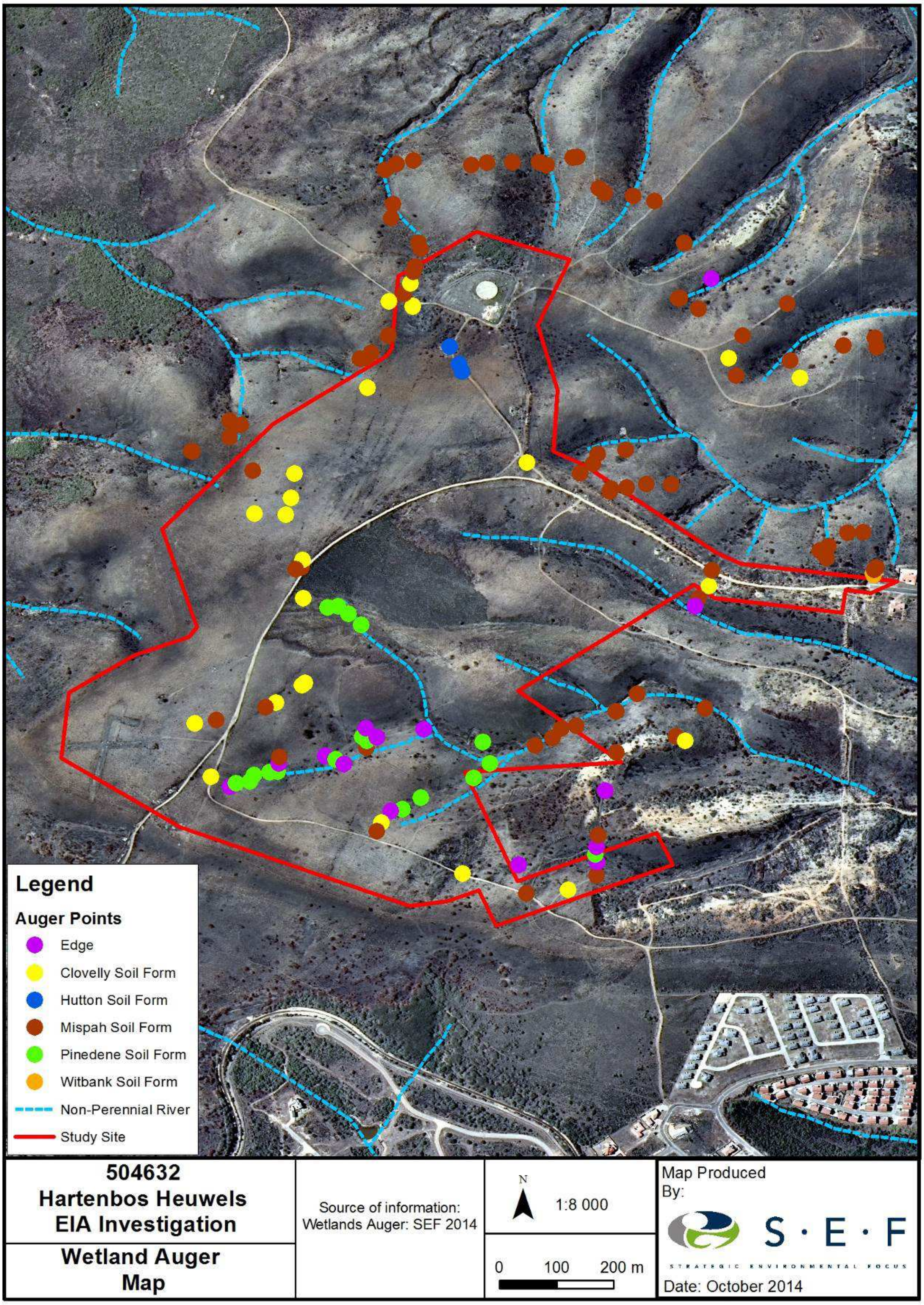



**Figure 5: Auger points with identified soil forms**


**Figure 6: Parallel soil scarification marks on the plateau and some higher lying drainage lines (Google Earth, 2010)**

Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of iron and manganese oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. 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; and,
    - 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 recognised as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

Redoximorphic features were present within soil profiles of the wetland areas including orange and red mottles as well as rhizospheres (Photograph 1; Photograph 2). All of the areas that exhibited redoximorphic features were found on slopes of less than 5%. It was deduced that once a slope becomes steeper than 5%, water is not retained within the landscape for long enough periods to develop redoximorphic features, instead expressing as surface runoff.

**Photograph 1: Red mottles observed within soil matrix of delineated wetland area**

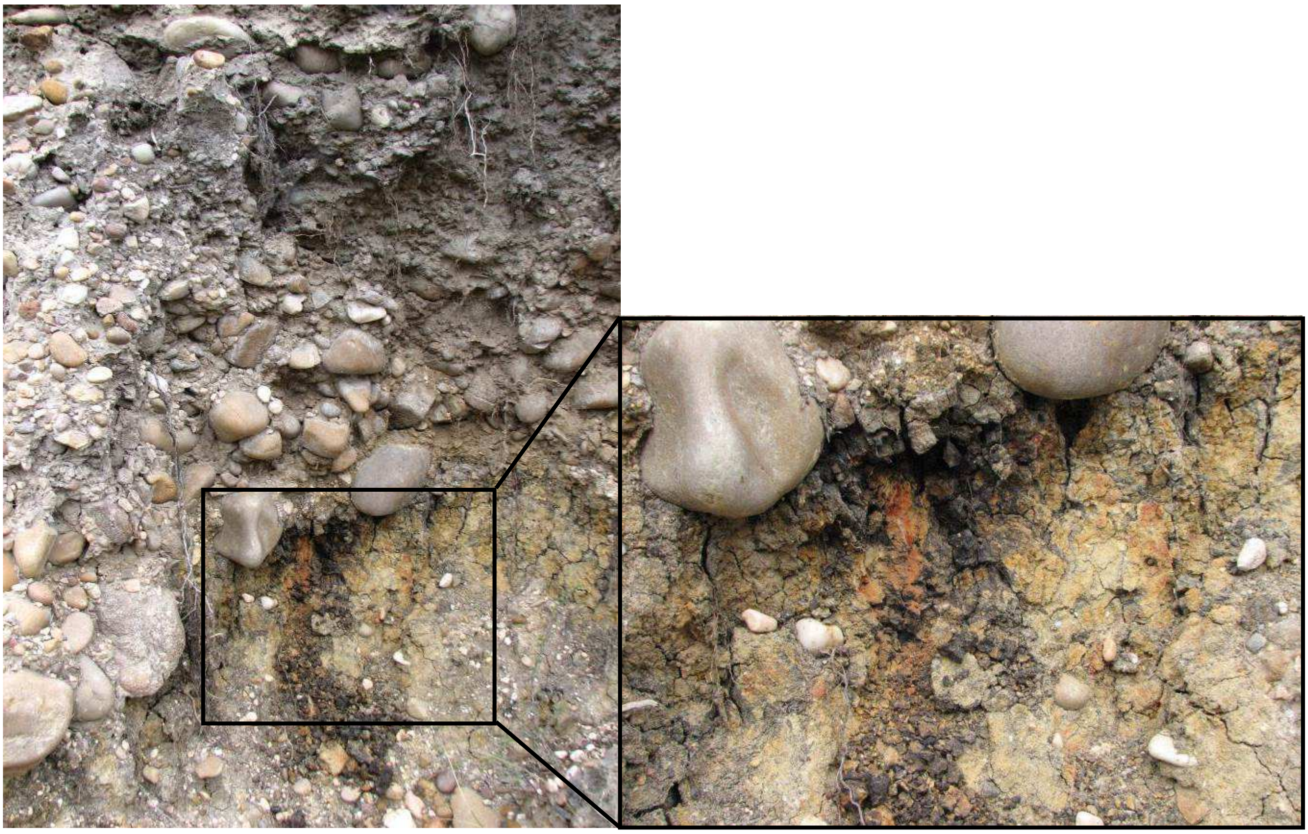
**Photograph 2: Orange mottles observed within soil matrix of delineated wetland area**

According to the DWAF (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators (redoximorphic features) remain in wetland soils, even if they are degraded or desiccated. It is important to note that 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).

Only soils indicating temporary zonation were sampled within the study area, of which most samples indicates borderline temporary zonation close to terrestrial soil colours. Munsell values for 10YR had Values of 5 and Chroma of 2.5 (Photograph 3). The Munsell values differed very little from the majority of terrestrial soils (excluding a small area containing the Hutton soil form), which could possibly be a result of the palaeogeological formation processes of the conglomerates (fluvial materials deposited in marine environment). Several samples taken within wetland habitat had almost no noticeable redoximorphic features which emphasised the very temporary nature of the wetland habitat on site. It is therefore hypothesised that the water source supporting the wetlands is rainfall and that the slope of the topography was not such that allowed for the retention of water within the landscape for a period of time that would have allowed for the formation of seasonal or permanent zonation. During high-intensity rainfall events, the primary water source feeding downstream watercourses would likely be surface water. The contribution of sub-surface water during no rainfall or low intensity rainfall events is not certain as the hydraulic conductivity of the conglomerate matrix is not known. However, signs of subsurface water movement was evident within eroded riparian channels (situated lower down within valleys), which would suggest that subsurface water does play at least some role in supporting the wetland. The temporary nature of the wetlands however suggests that the contribution of subsurface water was likely to be small.


**Photograph 3: Soils derived from HGM 2 in a semi-dry state sampled for evaluation of Munsell values**

Eroded and exposed soil profiles along riparian drainage lines exhibited the importance of riparian habitat for water accumulation and flow in several areas. The development of well-structured horizons (through seasonal wetting and desiccation) with clear redoximorphic signs are indicative of the lateral flow of water through the landscape along the hillslope (interflow or hillslope water) as well as return flow of water that intercepts the soil/landscape surface at the drainage line (riparian habitat) (Photograph 4).



**Photograph 4: Gully erosion exposed deeper section of soil profile where a well-structured layer with redoximorphic features representing lateral return flows from the hillslope**

### *3.2 Wetland and Riparian Vegetation*

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. Using vegetation as a primary wetland indicator however, requires undisturbed conditions (DWAF, 2005). A cautionary approach must be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterized by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (DWAF, 2003). This typical wetland gradient was not observed within the study area, most likely as a result of the very temporary zonation (no seasonal or permanent zones identified) of the identified wetlands combined with historic disturbances through grazing and cultivation. Vegetation species identified within wetland habitat were therefore similar as found within terrestrial areas and included graminoids such as *Aristida junciformi, Themeda triandra, Eragrostis capensis, E. curvula, Hyparrhenia hirta* as well as shrubs and herbaceous components such as *Elytropappus rhinocerotis, Helichrysum teretifolium, Senecio burchellii, Lobelia spp.* and

*Chrysanthemoides monilifera* (Photograph 5). The slightly deeper soils could likely provide suitable habitat for geophytes (including species of conservation concern) within wetland habitat.

**Photograph 5: Temporary wetland habitat in the south of the study area dominated by graminoids and herbs such as *Helichrysum teretifolium*.**

Riparian habitat within the study area was structurally dominated by shrub and tree species such as *Olea capensis* and *Croton* cf. *gratissimus*. Anthropogenic impacts on the riparian habitat were evident as species composition was dominated by declared invasive species such as *Acacia mearnsii*, *Hakea sericea* and *Acacia saligna* (Photograph 6).

**Photograph 6: Riparian habitat in the north eastern section of the study area that is typically invaded by species such as Acacia saligna**

### *3.3 Delineated Wetland and Riparian Areas*

According to the National Water Act (Act no 36 of 1998) a wetland is 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 typically adapted to life in saturated soil*." Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is often represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Terrain unit which is another indicator of wetland areas refers to the land unit in which the wetland is found. Wetlands can occur across all terrain units from the crest to valley bottom. Many wetlands occur within valley bottoms, but wetlands are not exclusively found within depressions.

In practice all indicators should be used in any wetland assessment / delineation exercise, the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to the DWAF delineation guidelines, the more wetland indicators that are present, the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present.

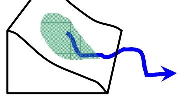
Wetland boundaries determined within the study area focused on identifying soil forms and especially soil hydric features such as the presence of mottling, where these features were clearly identifiable.

Two hydro-geomorphic units (HGM), comprising one HGM type, namely a hillslope seepage wetland connected to a watercourse, were delineated and classified within the study area. The HGM units identified within the study area are presented in Figure 7. HGM units encompass three key elements (Kotze *et al*, 2005):

(1) Geomorphic setting. This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
(2) Water source. There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
(3) Hydrodynamics, which refers to how water moves through the wetland.

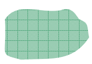
Table 1 describes some of the characteristics that form the basis for the classification of the HGM units within and surrounding the study area. It should be noted that the table describes typical hillslope seeps that are often groundwater fed which is not the situation within the study area.

**Table 1: Wetland hydro-geomorphic type typically supporting inland wetlands in South Africa and also present within the study area (adapted from Kotze et al., 2005)**

| **Hydro-geomorphic types** | **Description** | **Source of water maintaining the wetland[1]** | |
|---|---|---|---|
| | | **Surface** | **Sub-surface** |
| ***Hillslope seepage feeding a watercourse***  | Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse. | * | *** |

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

| | | |
|---|---|---|
| Water source: | * | Contribution usually small |
| | *** | Contribution usually large |
| | */ *** | Contribution may be small or important depending on the local circumstances |



Wetland

Several riparian areas were also delineated throughout the study area. The National Water Act (Act 36 of 1998), defines a riparian habitat as follows: "*Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.*" Due to water availability and rich alluvial soils, riparian areas are usually more productive than the surrounding landscape. For the purpose of the present study, alluvial soils, species composition and vigorous growth form were utilised as indicators of riparian habitat. In general, alluvial soils were only sampled within more relaxed gradients of valley bottoms (where a decrease in hydraulic energy would allow deposition). Vigorous growth form was used as the main riparian indicator.

One artificial wetland was also identified within the study area (Photograph 7). The artificial wetland developed as a result of historic construction activities within the study area which left a small borrow pit cut area without appropriate drainage. The artificial wetland which is dissected by a dirt road is shallow, less than 5cm deep, is rain dependent and does not constitute a watercourse.

**Photograph 7: Artificial wetland within study area with dirt road transecting**

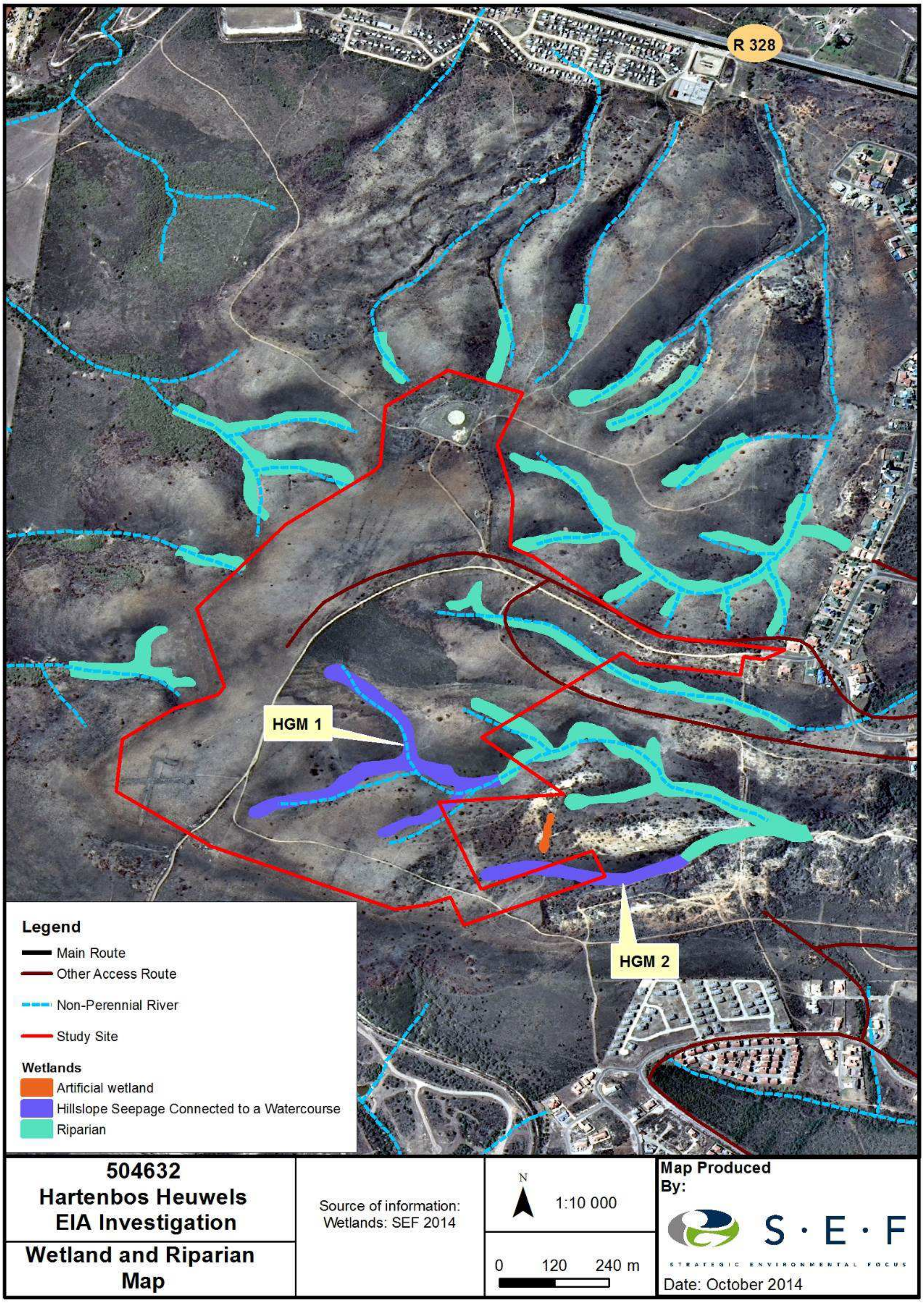



**Figure 7: Wetland and Riparian delineation map**

## 4. FUNCTIONAL AND PRESENT ECOLOGICAL STATE ASSESSMENT

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits therefore contribute directly or indirectly to increased biodiversity within the study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (Table 2).

**Table 2: Potential wetland services and functions in study area**

| Function | Aspect |
|---|---|
| Water balance | Streamflow regulation |
| | Flood attenuation |
| | Groundwater recharge |
| Water purification | Nitrogen removal |
| | Phosphate removal |
| | Toxicant removal |
| | Water quality |
| Sediment trapping | Particle assimilation |
| Harvesting of natural resources | Reeds, Hunting, etc. |
| Foraging | Water for animals |
| | Grazing for animals |

Hydro-geomorphic units are inherently associated with hydrological characteristics related to their form, structure and particularly their position in the landscape. This, together with the biotic and abiotic character (or biophysical environment) of wetlands, means that certain wetland types are able to contribute better to some ecosystem services than to others (Kotze *et al.* 2005) (Table 3).

**Table 3: Preliminary rating of the hydrological benefits potentially provided by a wetland given its particular hydro-geomorphic type (Kotze et al., 2005)**

| WETLAND HYDRO-GEOMORPHIC TYPE | HYDROLOGICAL BENEFITS POTENTIALLY PROVIDED BY THE WETLAND | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flood attenuation | | Stream flow regulation | Erosion control | Enhancement of water quality | | | |
| | | | | | Sediment trapping | Phos-phates | Nitrates | Toxicants[2] |
| Hillslope seepage feeding a stream channel | + | 0 | + | ++ | 0 | 0 | ++ | ++ |

[2]Toxicants are taken to include heavy metals and biocides

Rating:
- 0 Benefit unlikely to be provided to any significant extent
- \+ Benefit likely to be present at least to some degree
- ++ Benefit very likely to be present (and often supplied to a high level)

Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were determined for various wetlands within the study area using Wet-Health Level 2 assessment. Through the use of a scoring system, the perceived departure of elements of each particular system from the "natural-state" was determined. The following elements were considered in the assessment:

- Hydrologic: Flow modification (has the flow, rates, volume of run-off or the periodicity changed);
- Geomorphic (Canalisation, impounding, topographic alteration and modification of key drivers);
- Biota (Changes in species composition and richness, Invasive plant encroachment, over utilization of biota and land-use modification)

The ecosystem services and PES of the delineated wetlands are discussed in more detail below. HGM 1 and HGM 2 were assessed together as no discernible differences were noticed between the soils, wetland vegetation condition, slope or ratio of wetland size to catchment size.

HGM 1 and HGM 2

Both HGM units consisted of hillslope seepages draining the southern portion of the plateau. From a functional perspective the hillslope seepages attained relatively low scores as a result of the temporary nature of the wetlands (Figure 8). Functions receiving the highest scores from the Wet-EcoServices assessment include flood attenuation, streamflow regulation, nitrate removal, sediment trapping, toxicant removal, erosion control and the maintenance of biodiversity. It should however be emphasised that ecosystem services attained very low values, indicating the limited services that are provided.  The relatively low gradient and relatively high basal cover associated with these particular hillslope seepages increased the erosion control service provided. According to Kotze *et al*, (2005), the accumulation of organic matter and fine sediments in the wetland soils results in the wetland slowing down the sub-surface movement of water down the slope.  This “plugging effect” increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the stream system during low flow periods. For some hillslope seepage wetlands this contribution may continue into the dry season, but it is unlikely the case for HGM 1 and HGM 2 as a result of their temporary nature. Seepage wetlands are commonly considered to supply a number of water quality enhancement benefits, for example, removing excess nutrients and inorganic pollutants produced by agriculture (Kotze *et al*, 2005).  Hillslope seepages generally would be expected to have a relatively high nitrogen removal potential.  Nitrogen and specifically nitrate removal could be expected 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. Particularly effective removal has been recorded of nitrates from diffuse sub-surface flow, as characterizes hillslope seepages (Muscutt et al., 1993).

From a biodiversity perspective, these seepage wetlands likely provide habitat for faunal and floral species of conservation concern including several geophytes. One individual *Circus maurus* (Black Harrier) was recorded within one of the wetland areas. *C. maurus* is globally listed as Vulnerable and Near Threatened in South Africa, and is also listed on Appendix II of the Convention of Migratory Species.  It is endemic to South Africa where it prefers Fynbos areas, especially Strandveld and mountain Fynbos where it relies on remnant patches of natural vegetation (SEF, 2014). It is acknowledge that the presence of  *C. maurus* within wetland habitat could have been coincidental, although they are known to breed close to coastal and upland marshes, damp sites, near vleis or streams with tall shrubs or reeds (Rust, 2014)

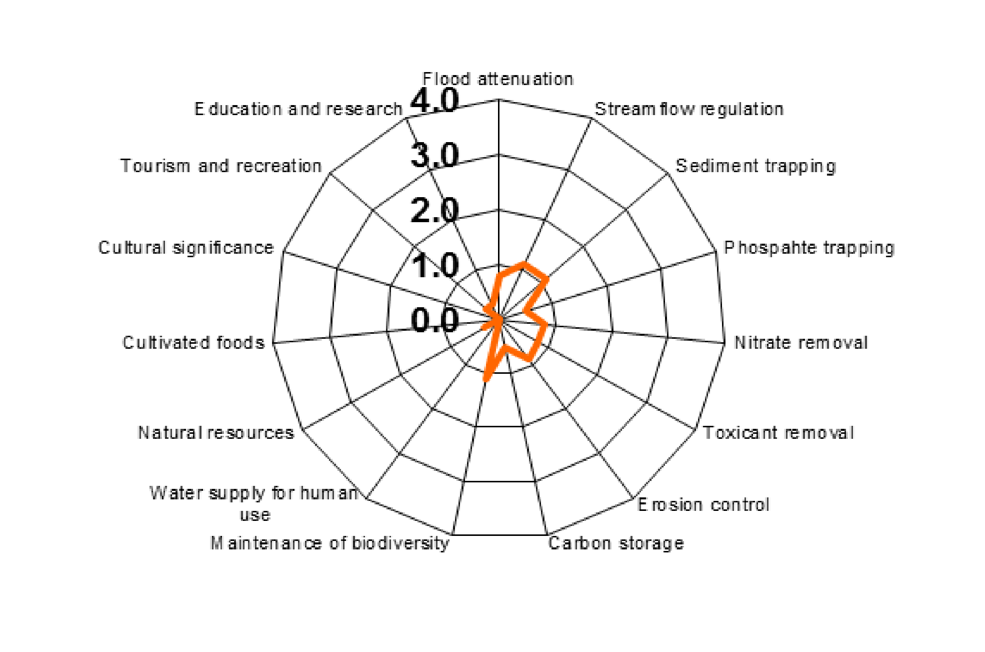



**Figure 8: Spiderweb diagram depicting results for Wet-EcoServices assessment for HGM 1 and HGM 2**

Both HGM units were determined to be moderately modified with some loss of natural habitats (PES Category C; Table 4). Modifications to these systems included changes to their hydrology and geomorphology as a result of historic cultivation through large sections of the wetlands as well as in the majority of the wetlands catchment. Repeated cultivation has led to some soil compaction which would have had a considerable effect on the infiltration rate of water to the soils. Passive restoration has taken place over several decades but it is likely that a large amount of soil was lost as a result of cultivation practices. Head cut erosion processes was likely initiated during years of cultivation as a result of reduced basal cover and reduced surface roughness as well as inadequate contouring techniques. Although cultivation has ceased for some time, the initiated gully erosion processes is threatening the wetlands present as it is advancing slowly upslope (Photograph 8). Although the original primary vegetation has likely been lost, adequate basal cover by indigenous species has been achieved through several decades of passive restoration. Some invaders such as *Acacia saligna* was found in several areas but was not dominating yet.

The anticipated trajectory of change is dependent on several land management factors such as burning regimes, active control of alien vegetation as well as erosion control. If no erosion control is implemented to halt gully erosion processes advancing towards the wetlands, the wetlands could potentially deteriorate dramatically within the next five years (due to the close proximity of gully erosion to the wetlands).

**Table 4: Wet-Health scores for HGM 1 and HGM 2**

| Hydrology | Geomorphology | Vegetation | PES Category |
|---|---|---|---|
| 3.1 | 3.4 | 2.8 | C (3.1) |

**Photograph 8: Gully erosion advancing through conglomerate bedrock towards HGM 1**

## 5. ECOLOGICAL IMPORTANCE AND SENSITIVITY

All wetlands, rivers, their flood zones and their riparian areas are protected by law and no development is allowed to negatively impact on these. The vegetation in and around wetlands, rivers and drainage lines play an important role in water catchments, assimilation of phosphates, nitrates and toxins as well as flood attenuation. Quality, quantity and sustainability of water resources are fully dependent on good land management practices within the catchment. All flood lines, riparian zones and wetlands must be designated as sensitive.

According to SEF (2014), watercourses and wetlands are often areas of high faunal diversity as the riparian environment and dense vegetation provides abundant cover, feeding and breeding habitat for many species of invertebrates, birds, mammals, reptiles and amphibians. When it is available, surface water provides drinking water for many faunal species while the soft substrate of alluvial soils provides perfect burrowing environments for fossorial animals (Deeper soils within the study area were provided within wetland habitat). The increase in prey and vegetation attracts a high diversity of birds as well as terrestrial mammals and reptiles (including predators).

Watercourses, the associated riparian vegetation and wetland areas also tend to be corridors of movement through the landscape for fauna and flora. They are especially important in transformed landscapes where most of the natural terrestrial habitat has been destroyed or transformed. The preservation of such remnant ecological networks is imperative for the conservation of biodiversity and provision of ecosystem services (Samways *et al*., 2009).

The Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank wetlands in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree, 2013). Ecological Importance and Sensitivity results for HGM 1 and HGM 2 are listed in Table 5.

**Table 5: Ecological Importance and Sensitivity scores for wetland**

| Wetland Complex | Parameter | Rating (0 - 4) | Confidence (1 – 5) |
|---|---|---|---|
| **HGM 1 and HGM 2** | **Ecological Importance & Sensitivity** | Moderate (2.2) | 3.4 |
| | **Hydrological / Functional Importance** | Low (1.3) | 3.5 |
| | **Direct Human Benefits** | Low (1.0) | 1.5 |

Both HGM units attained moderate scores for their Ecological Importance and Sensitivity analysis as at least one species of conservation concern was confirmed within wetland habitat, although this species is not regarded as being dependent on wetlands themeselves. The temporary nature of the wetland habitat on site reduced the hydrological potential and functioning of hillslope seepages. Direct human benefit associated with the wetlands within the study area included some potential subsistence hunting as well as recreational opportunities that are utilised by limited Hartenbos residents

Current impacts on the habitat integrity of the riparian habitat included alien vegetation infestation and erosion processes that were evident in the majority of the drainage lines. In general, riparian habitat was likely to provide several functions, which according to Anon (2002) include:

- sediment trapping;
- nutrient trapping;
- bank stabilization and bank maintenance;
- contributes to water storage;
- possible aquifer recharge;
- flow energy dissipation;
- maintenance of biotic diversity; and
- primary production.

Considering the moderate intactness of the structure and function as well as the high degree of landscape connectivity that the riparian habitat provide within the greater study area, all of the riparian habitat present was considered to be sensitive.

# 6. IMPACT ASSESSMENT AND MITIGATION

Any developmental activities in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed development and to provide a description of potential mitigation required so as to limit the perceived impacts on the natural environment.

## *6.1 Impact Assessment Methodology*

The environmental impacts are assessed with mitigation measures (WMM) and without mitigation measures (WOMM) and the results presented in impact tables which summarise the assessment. Mitigation and management actions are also recommended with the aim of enhancing positive impacts and minimising negative impacts. In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operational phase. The criteria against which these activities were assessed are discussed below.

*Nature of the Impact*
This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

*Extent of the Impact*
A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.

*Duration of the Impact*
This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.

*Intensity*
This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.

*Probability of Occurrence*
This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

*Degree of Confidence*

This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

The following risk assessment was used to determine the significance of impacts:

**Significance = (Magnitude + Duration + Scale) x Probability**

The maximum potential value for significance of an impact is 100 points. Environmental impacts can thus be rated as high, medium or low significance on the following basis:

- High environmental significance 60 – 100 points
- Medium environmental significance 30 – 59 points
- Low environmental significance 0 – 29 points

Table 6 illustrates the scale used to determine the overall ranking.

**Table 6: Scale used to determine significance ranking**

| Magnitude (M) | | Duration (D) | |
|---|---|---|---|
| **Description** | **Numerical value** | **Description** | **Numerical value** |
| Very high | 10 | Permanent | 5 |
| High | 8 | Long-term (ceases at end of operation) | 4 |
| Moderate | 6 | Medium-term | 5-15 years |
| Low | 4 | Short-term | 0 – 5 years |
| Minor | 2 | Immediate | 1 |
| **Scale (S)** | | **Probability (P)** | |
| **Description** | **Numerical value** | **Description** | **Numerical value** |
| International | 5 | Definite (or unknown) | 5 |
| National | 4 | High | 4 |
| Regional | 3 | Medium | 3 |
| Local | 2 | Low | 2 |
| Site | 1 | Improbable | 1 |
| None | 0 | None | 0 |

### *6.2 Impact Assessment*

Possible impacts and their sources that the proposed residential development is likely to have on wetlands and riparian habitat are provided in Table 7 (construction phase) and Table 8 (operational phase). The proposed development lay out and wetland and riparian sensitivities are indicated in Figure 9.

**Table 7: Possible impacts arising during the construction phase**

| Possible impact | Source of impact |
|---|---|
| Destruction of wetland and riparian habitat | Reshaping and construction activities of roads, bridges and stormwater infrastructure within wetland or riparian habitat |

| | |
|---|---|
| Surface water pollution including sedimentation | Soil disturbances. Flooding of construction area; construction vehicles; construction camp within wetland/riaprian habitat or associated catchments |

**Table 8: Possible impacts arising during operation phase**

| Possible impact | Source of impact |
|---|---|
| Increased erosion and loss of wetland characteristics due to prevention of infiltration | Increased surface runoff and changes to existing hydrological pathways |

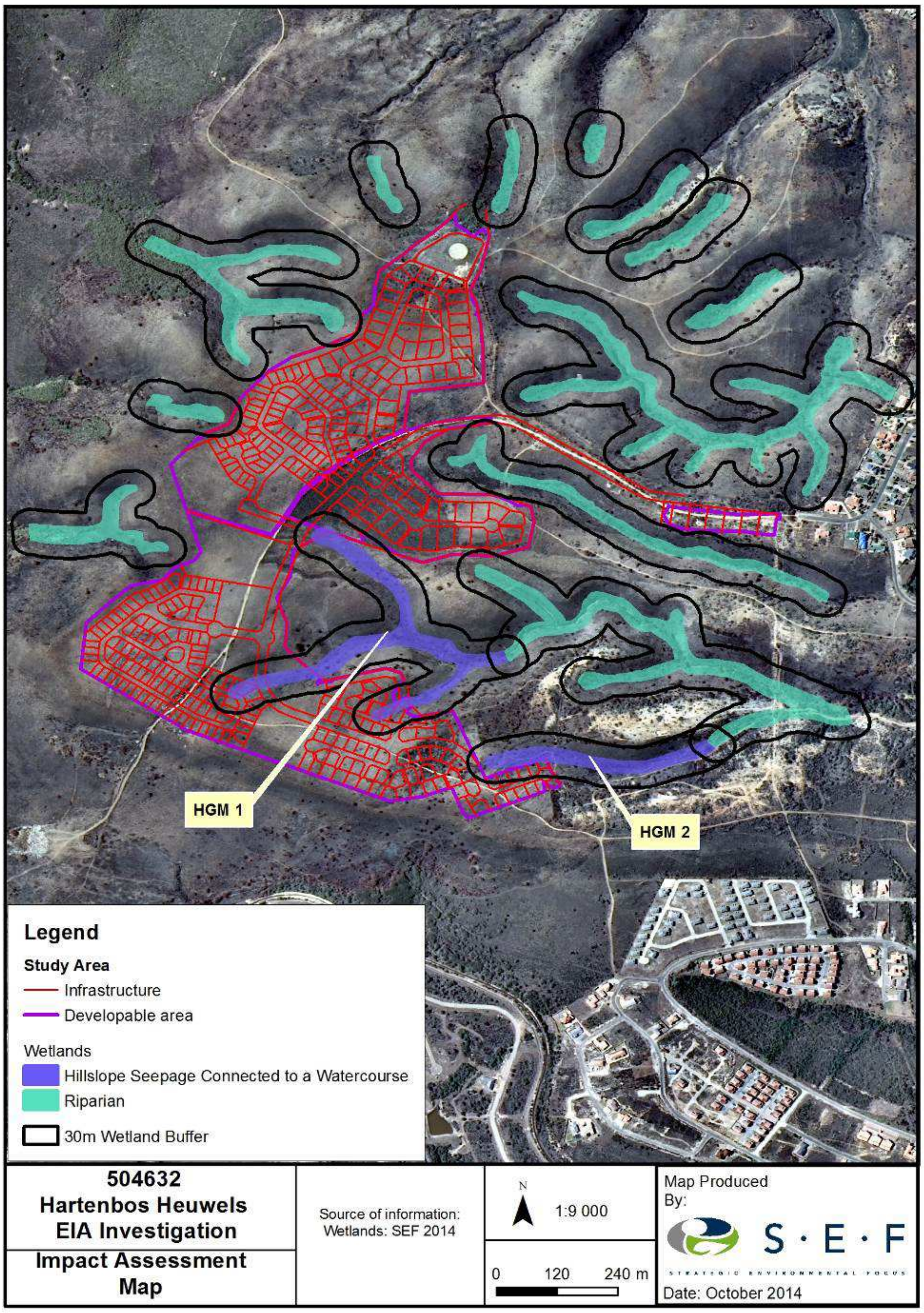



**Figure 9: Impact assessment map indicating preliminary proposed development lay out over wetland and riparian sensitivities**

### 6.2.1 Construction Phase

*Destruction of wetland and riparian habitat through reshaping and construction activities of roads, bridges and stormwater infrastructure within or within the direct vicinity of wetland or riparian habitat*

| | Scale | Duration | Magnitude | Probability of occurrence | Significance | Confidence |
|---|---|---|---|---|---|---|
| Without mitigation measures | Local (2) | Long term (4) | Moderate (6) | High (4) | Medium (48) | Medium |
| With mitigation measures | Site (1) | Short-term (2) | Low (4) | Medium (3) | Low (21) | Medium |

Description of Impact

Footprint of houses, new roads or stormwater infrastructure could infringe or destroy wetland or riparian habitat and associated biota through removal of hydrophytic vegetation and or hydric soils if the development lay-out is not adjusted or uncontrolled construction processes are allowed.

Specific Mitigation Measures

- As a point of departure for construction activities, the key stormwater infrastructure facilities must be built and completed before other construction activities are allowed to commence, including attenuation, retention and diffuse release infrastructure (as discussed in more detail under the operational phase).
- No construction activities are allowed within wetland habitat, riparian habitat or a 30m buffer zone from the edge of a wetland and riparian habitat. The preliminary proposed lay-out should therefore be revised to include the no-go areas within the design (Figure 10);
- In order to avoid negative impacts on the 30m buffer (which should remain natural), an initial 40m to 50m buffer should be demarcated (depending on available space)
- The design of stormwater drainage systems must ensure there is no contamination, eutrophication or increased erosion of wetland or riparian habitat. Drainage systems should be maintained regularly. The construction of surface stormwater drainage systems during the construction phase must be done in a manner that would protect the quality and quantity of the downstream system. For example, the use of swales which could then be grassed for the operational phase.
- Stormwater outflows should not enter directly into a wetland, drainage line or 30m buffer zone. The velocity of water that may reach the buffer zone should be slowed before it is intercepted by virgin soils using a siltation and erosion control structure such as attenuation swales and be released in a diffused manner.
- Re-vegetation of disturbed areas must be undertaken with site indigenous species and in accordance with the instructions issued by the ECO. Areas where soil compaction or ruts developed should be rehabilitated.
- A wetland monitoring program must be designed and implemented that ensure that all wetland protection infrastructure and storm-water systems are properly installed and that all affected wetland areas are adequately rehabilitated. The wetland monitoring program needs

to focus on measurable components that will allow the extent of impact mitigation to be tracked. It must include recommendations for reactive responses, as monitoring on its own will not "ensure" wetland protection. A baseline for the monitoring program should also be established prior to the start of construction.

- Avoid construction activities in wetlands, riparian areas and the associated 30m buffer zone at all cost through proper demarcation and appropriate environmental awareness training. The Contractor has a responsibility to inform all staff of the need to be vigilant against any practice that will have a harmful effect on wetlands and riparian habitat. This information shall form part of the Environmental Education Programme to be effected by the Contractor, including the following:
    - No construction shall take place in areas of high sensitivity such as wetlands or 30m buffer zone i.e. "NO-GO Areas". All no-go areas must be demarcated with red tape / fencing under guidance of the ECO.
    - Any proclaimed weed or alien species that germinates during the contract period shall be cleared by hand before flowering.
    - Infilling, excavation, drainage, dumping of building material and hardened surfaces (including buildings and asphalt) should not occur in any of the wetland, riparian or within the 30m buffer zone as a minimum, but should preferably be done as far away as practically possible from these areas.
    - Imported fill material should be monitored during and after construction for the presence of any alien species. Any such species should be removed immediately.
    - Emergency plans must be in place in case of pollutant spillages.
    - All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds. It should also only be stored for the minimum amount of time necessary.
    - Erosion control of all banks must take place so as to reduce erosion and sedimentation into riparian channels or wetland areas.
    - Silt traps and culverts should be regularly maintained and cleared so as to ensure effective drainage.
    - Littering and contamination of water sources during construction must be mitigated by effective construction camp management.
    - All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination. The storage areas should be constructed as far away as practically possible outside of wetlands, riparian and buffer zones.
    - Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase.

### 6.2.1.b Surface water pollution

| | Scale | Duration | Magnitude | Probability of occurrence | Significance | Confidence |
|---|---|---|---|---|---|---|
| Without mitigation measures | Local (2) | Long-term (4) | Moderate (6) | Medium (3) | Medium (48) | Medium |
| With mitigation measures | Site (1) | Short-term (2) | Low (4) | Low (2) | Low (14) | Medium |

Description of Impact

Hydrocarbons-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into wetlands and surface water bodies. Stripping of topsoil will result in increased runoff of sediment from site into watercourses associated with the study area. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by raw sewage. While it is acknowledged that the impacts associated with the proposed activities will be negligible, every effort should still be taken so as to limit contributions, especially taking into consideration of downstream FEPA's including estuaries.

Mitigation Measure

- Make use of existing roads and tracks where feasible, rather than creating new routes through vegetated areas;
- Vegetation and soil must be retained in position for as long as possible, and removed immediately ahead of construction / earthworks in that area (DWAF, 2005);
- Runoff from roads must be managed to avoid erosion and pollution problems. Where excessive loose sediment is created, attenuation swales and / or soils screens should be installed;
- Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc.;
- Sufficient care must be taken when handling these materials to prevent pollution;
- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- Oil residue shall be treated with oil absorbent such as Drizit or similar and this material removed to an approved waste site;
- Concrete and tar shall only be mixed on mixing trays and in areas which have been specially demarcated for this purpose;

- All concrete and tar that is spilled outside these areas shall be promptly removed by the Contractor and taken to an approved dumpsite;
- After all the concrete / tar mixing is complete all waste concrete / tar shall be removed from the batching area and disposed of at an approved dumpsite;
- Storm water shall not be allowed to flow through the batching area. Cement sediment shall be removed from time to time and disposed of in a manner as instructed by the Consulting Engineer;
- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Portable septic toilets are to be located outside of the 1:100 year floodline;
- Under no circumstances may ablutions occur outside of the provided facilities;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs (DWA) must be informed immediately;
- Where construction in close proximity to sewer lines is unavoidable then excavations must be done by hand while at all times ensuring that the soil beneath the sewer lines is not destabilised;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed;
- Conduct ongoing staff awareness programs so as to reinforce the need to avoid littering; and
- Backfill must be compacted to form a stabilised and durable blanket; and
- The current load above the sewer lines must at no time be exceeded.

### *6.2.2 Operational Phase*

*Increased erosion and loss of wetland characteristics due to prevention of infiltration*

| | **Scale** | **Duration** | **Magnitude** | **Probability of occurrence** | **Significance** | **Confidence** |
|---|---|---|---|---|---|---|
| Without mitigation measures | Local (2) | Long term (4) | Moderate (6) | High (4) | Medium (48) | Medium |
| With mitigation measures | Site (1) | Medium term (3) | Low (4) | Medium (3) | Low (24) | Medium |

<u>Description of Impact</u>

Due to infrastructure development such as roads, residents and stormwater infrastructure which increases impermeable surfaces, there is an associated increase in flow velocities and erosion potential for wetland and riparian habitats. Runoff from especially road surfaces and stormwater infrastructure could enter into the associated watercourse, resulting in higher catchment runoff, wetland/riparian scouring and increased flooding and erosion of downstream areas. The existing erosion processes present within the riparian habitat of the study area would therefore likely be accelerated. The supporting hydrological characteristics of the catchment to the wetlands are also likely to change significantly unless predevelopment hydrological pathways to the wetland are mimicked.

Mitigation Measure

- An ecologically-sensitive stormwater management plan should be developed that does not allow concentrated stormwater to enter into a wetland or watercourse directly, but instead makes use of flow diffusers and retention and attenuation areas (such as artificial wetland areas, attenuation swales/ponds, retention areas, baffles and gabion structures). The stormwater plan must include adequate attenuation facilities to ensure that peak flows do not cause negative impacts on wetlands or riparian areas. More specifically as a guideline:
  - Post development flows for frequent, average every afternoon type storm event 6 mm over 2 hours, will not exceed pre development flows.
  - Post development velocities associated with the 1:5 year return event storm will be within 25% of predevelopment velocities.
  - Stormwater release structures must be designed to release diffusely, mimicking seepage wetlands outside of the watercourse.

  Attenuation and stormwater infrastructure must be established outside of the 30m buffer zone or maximal available distance from the buffer zone where possible.
- The attenuation and retention facilities should retain stormwater runoff and then allow the water to diffusely enter the buffer zone at a slower velocity through appropriate infrastructure such as flow diffusers and reno-mattresses. The stormwater infrastructure should therefore be designed to prevent erosion processes from being initiated within wetlands and riparian habitat, allow for sediment deposition within the swales / attenuation / retention facilities, re-distribute water movement evenly within the buffer zone, mimicking pre development runoff received by drainage lines. One way of achieving the above is through designing and implementation of diffuse release channels that are placed on contour outside of the 30m buffer zones (Figure 11). Water from attenuation facilities could be released into the diffuse release contour channels and or the size of the diffuse release contour channels could be increased to serve as combined attenuation and diffuse release infrastructure. It is cardinal that the diffuse release channels are constructed exactly on contour as to spread the water evenly along the whole length of the infiltration channel. The horseshoe-shaped diffuse release channels depicted in Figure 11 does not need to be a continuous channel but could be placed in an intermittent pattern as to compliment biodiversity corridors and access if needed.
- Current erosion processes within riparian habitat should be addressed through the design and implementation of a rehabilitation program. The placement of thirty five gabion mattresses are proposed to halter head cut and gully erosion within riparian areas (Figure

10). However, proposed number of gabions and placement positions are only preliminary, final design and placement of each required gabion basket should be established through a thorough on site assessment and liaison with engineers responsible for the final designs and implementation. It will be necessary to reshape some sections of the watercourse/drainage lines as well as revegetate affected areas by rehabilitation activities. Alien vegetation composition and distribution should also be assessed during the onsite assessment with appropriate recommendation for alien vegetation management to be included in the rehabilitation program.

- A wetland monitoring program should be initiated at the start of the construction phase. The monitoring program should be designed *in situ* with construction and rehabilitation plans by a wetland specialist. The Environmental Control Officer should be briefed by a wetland specialist on specific monitoring issues. Appropriate mitigation needs to be implemented after consultation with relevant specialist if any problems are detected. The detail design phase should also include an ecologist in order to ensure that the final lay-out addresses wetland (including stormwater) as well as terrestrial concerns. Input from an ecologist would also be advantageous to align biodiversity corridors, decide on appropriate land use within specific positions (e.g. aligning open space areas next to buffers to increase the open space functionality) and reduce edge effect impacts associated with the mixed development.

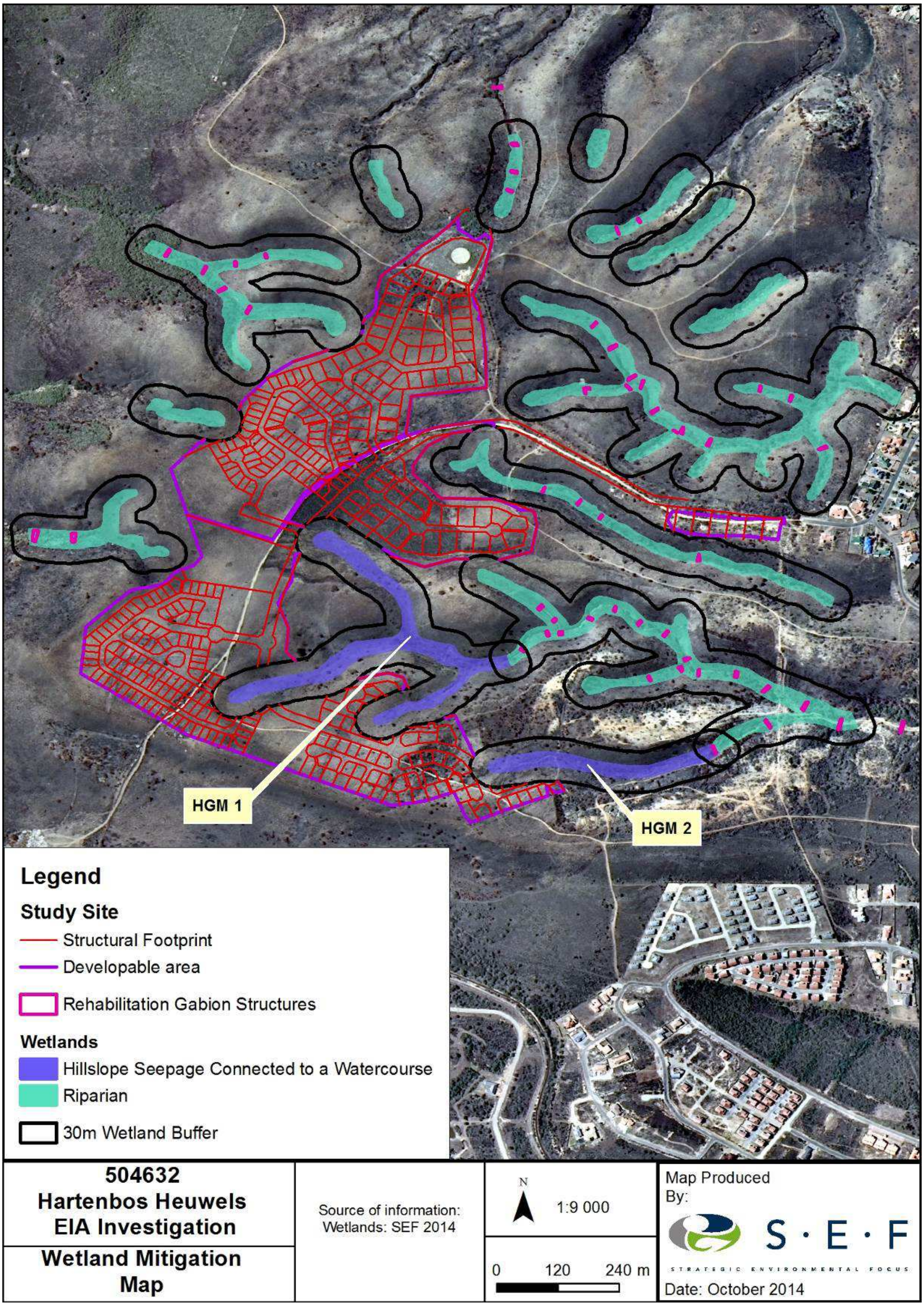



**Figure 10: Wetland mitigation map indicating areas where proposed layout needs amendment as well as preliminary position of gabion rehabilitation structures**


**Figure 11: Example of diffuse release contour channels that can also attenuate water through widening channel size**

# 7. CONCLUSION

Two hydro-geomorphic units (HGM), comprising one HGM type, namely a hillslope seepage wetland connected to a watercourse were delineated and classified within the study area. In addition to the wetland areas, numerous riparian areas were also delineated throughout the study area.

Combined area weighted Wet-Health results considered the identified wetlands to be moderately modified. Both HGM units attained moderate scores for their Ecological Importance and Sensitivity analysis as at least one species of conservation concern was confirmed within wetland habitat. The temporary nature of the wetland habitat on site reduced the hydrological potential and functioning of hillslope seepages.  Direct human benefit associated with the wetlands within the study area include some potential subsistence hunting as well as recreational opportunities that can be developed. Current impacts on the habitat integrity of the riparian habitat included alien vegetation infestation and erosion processes that was evident in the majority of the drainage lines.

The impact assessment identified the destruction of wetland habitat, surface water pollution (including sedimentation) as well as increased erosion as the major potential impacts associated with the proposed development. Potential sources of the above mentioned impacts include reshaping and construction activities for residential development, roads and stormwater infrastructure as well as increased surface runoff from the development footprint. Several mitigation measures are proposed to prevent negative impacts on wetland and riparian areas, including attenuation and diffuse release infrastructure as well as a rehabilitation program within riparian habitat which include design and placement of rehabilitation infrastructure as well as alien vegetation control measures. It is cardinal that the rehabilitation plan be approved by the competent authority and completed before the advent of construction activities. The sensitive stormwater management plan must be designed in conjunction with a wetland specialist in order to ensure that no concentrated run-off reaches wetland, riparian or buffer zones.

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## GLOSSARY

**Alien species** Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity.

**Biodiversity** Biodiversity is the variability among living organisms from all sources including inter alia terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

**Biome** A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.

**Buffer zone** A collar of land that filters edge effects.

**Conservation** The management of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystems function and integrity.

**Critically Endangered** A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

**Ecosystem** Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

**Ecological Corridors** Corridors are roadways of natural habitat providing connectivity of various patches of native habitats along or through which faunal species may travel without any obstructions where other solutions are not feasible.

**Edge effect** Inappropriate influences from surrounding activities, which physically degrade habitat, endanger resident biota and reduce the functional size of remnant fragments including, for example, the effects of invasive plant and animal species, physical damage and soil compaction caused through trampling and harvesting, abiotic habitat alterations and pollution.

**Endangered** A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

**Exotic species** Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity

**Fauna** The animal life of a region.

**Flora** The plant life of a region.

**Forb** A herbaceous plant other than grasses.

| | |
|---|---|
| **Habitat** | Type of environment in which plants and animals live. |
| **Indigenous** | Any species of plant, shrub or tree that occurs naturally in South Africa. |
| **Invasive species** | Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas. |
| **Outlier** | An observation that is numerically distant from the rest of the data |
| **Primary vegetation** | Vegetation state before any disturbances such as cultivation, overgrazing or soil removal |
| **Threatened** | Species that have naturally small populations and species which have been reduced to small (often unsustainable) population by man's activities. |
| **Red data** | A list of species, fauna and flora that require environmental protection. Based on the IUCN definitions. |
| **Species diversity** | A measure of the number and relative abundance of species. |
| **Species richness** | The number of species in an area or habitat. |
| **Vulnerable** | A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future. |

## APPENDIX A

### Wetland delineation methodology

The report incorporated a desktop study, as well as field surveys, with site visits conducted during October 2014. Additional data sources that were incorporated into the investigation for further reliability included:

- Google Earth images;
- 1:50 000 cadastral maps; and
- ortho-rectified aerial photographs.

A pre-survey wetland delineation was performed in order to assist the field survey. Identified wetland areas during the field survey were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). These potential wetland areas were confirmed or dismissed and delineation lines and boundaries were imposed accordingly after the field surveys.

The wetland delineation was based on the legislatively required methodology as described by DWAF (2005). The DWAF delineation guide (DWAF, 2005) uses four field indicators to confirm the presence of wetlands, namely:

- terrain unit indicator (i.e. an area in the landscape where water is likely to collect and a wetland to be present),
- soil form indicator (i.e. the soils of South Africa have been grouped into classes / forms according to characteristic diagnostic soil horizons and soil structure), See Figure 6 for auger sample points
- soil wetness indicator (i.e. characteristics such as gleying or mottles resulting from prolonged saturation), and
- vegetation indicator (i.e. presence of plants adapted to or tolerant of saturated soils).

The Department of Water affairs and Forestry (DWAF) wetland delineation guide makes use of indirect indicators of prolonged saturation by water, namely wetland plants (hydrophytes) and (hydromorphic) soils. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. Hydrophytes were recorded during the site visit and hydromorphic soils in the top 0.5 m of the profile were identified by taking cored soil samples with a bucket soil auger and Dutch clay auger (photographs of the soils were taken). Each auger point was marked with a handheld Global Positioning System (GPS) device. All cored samples were analysed for signs of wetness that indicate wetland associated conditions.

The methodology "*Wet-EcoServices"* (Kotze *et al.,* 2005) was adapted and used to assess the different benefit values of the wetland units. A level two assessment, including a desktop study and a field assessment were preformed to determine the wetland functional benefits between the different hydro-geomorphological types within the study area. Other documents and guidelines used are referenced accordingly. During the field survey, all possible wetlands and drainage lines identified from maps and aerial photos were visited on foot. Where feasible, cross sections were taken to determine the state and boundaries of the wetlands.

Following the field survey, the data was submitted to a GIS program for compilation of the map sets. Subsequently the field survey and desktop survey data were combined within a project report.

In order to gauge the Present Ecological State of various wetlands within the study area, an adapted level 2 Wet-Health assessments were applied in order to assign PES categories to certain wetlands. Wet-Health (Macfarlane *et al., 2*009) is a tool which guides the rapid assessment of a wetland's environmental condition based on a site visit. This involves scoring a number of attributes connected to the geomorphology, hydrology and vegetation, and devising an overall score which gives a rating of environmental condition.

Wet-Health is useful when making decisions regarding wetland rehabilitation, as it identifies whether the wetland is beyond repair, whether rehabilitation would be beneficial, or whether intervention is unnecessary, as the wetland's functionality is still intact. Through this method, the cause of any wetland degradation is also identified, and this facilitates effective remediation of wetland damage. There is wide scope for the application of Wet-Health as it can also be used in assessing the Present Ecological State of wetlands and thereby assist in determining the Ecological Reserve as laid out under the National Water Act. Wet-Health offers two levels of assessment, one more rapid than the other.

For the assessments, an impact and indicator system is used. The wetland is first categorized into the different hydrogeomorphic (HGM) units and their associated catchments, and these are then assessed individually in terms of their hydrological, geomorphologic and vegetation health by examining the extent, intensity and magnitude of impacts, of activities such as grazing or draining. The extent of the impact is measured by estimating the proportion the wetland that is affected. The intensity of the impact is determined by looking at the amount of alteration that occurs in the wetland due to various activities. The magnitude is then calculated as the combination of the intensity and the extent of the impact and is translated into an impact score. This is rated on a scale of 1 to 10, which can be translated into six health classes (A to F – compatible with the Ecostatus categories used by DWAF) (Table 14).

**Table 9: Interpretation of scores for determining Present Ecological State (Kleynhans 1999)**

| Rating of Present Ecological State Category (PES Category) |
|---|
| **CATEGORY A**<br>Score: 0-0.9; Unmodified, or approximates natural condition. |
| **CATEGORY B**<br>Score: 1-1.9; Largely natural with few modifications, but with some loss of natural habitats. |
| **CATEGORY C**<br>Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats. |
| **CATEGORY D**<br>Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred. |
| **OUTSIDE GENERAL ACCEPTABLE RANGE** |
| **CATEGORY E**<br>Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive. |

| CATEGORY F |
|---|
| Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat. |

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean

### *Determination of Ecological Importance and Sensitivity*

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the National Water Act (NWA), the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze *et al.* (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2013). An example of the scoring sheet is attached as Table 15. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 16.

**Table 10: Example of scoring sheet for Ecological Importance and sensitivity**

| **ECOLOGICAL IMPORTANCE AND SENSITIVITY:** | | | |
|---|---|---|---|
| **Ecological Importance** | Score (0-4) | *Confidence (1-5)* | **Motivation** |
| **Biodiversity support** | | | |
| Presence of Red Data species | | | |
| Populations of unique species | | | |
| Migration/breeding/feeding sites | | | |
| **Landscape scale** | | | |
| Protection status of the wetland | | | |
| Protection status of the vegetation type | | | |
| Regional context of the ecological integrity | | | |
| Size and rareity of the wetland type/s present | | | |
| Diversity of habitat types | | | |
| **Sensitivity of the wetland** | | | |
| Sensitivity to changes in floods | | | |
| Sensitivity to changes in low flows/dry season | | | |
| Sensitivity to changes in water quality | | | |
| **ECOLOGICAL IMPORTANCE & SENSITIVITY** | | | |

| | Direct Human Benefits | | Score (0-4) | *Confidence (1-5)* |
|---|---|---|---|---|
| ***Subsistence benefits*** | ***Water for human use*** | *The provision of water extracted directly from the wetland for domestic, agriculture or other purposes* | | |
| | ***Harvestable resources*** | *The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.* | | |
| | ***Cultivated foods*** | *Areas in the wetland used for the cultivation of foods* | | |
| | | | | |
| ***Cultural benefits*** | ***Cultural heritage*** | *Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants* | | |
| | ***Tourism and recreation*** | *Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife* | | |
| | ***Education and research*** | *Sites of value in the wetland for education or research* | | |
| | | ***TOTAL OVERALL SCORE AND CONFIDENCE:*** | | |

**Table 11: Category of score for the Ecological Importance and Sensitivity**

| Rating | Explanation |
|---|---|
| Very low (0-1) | Rarely sensitive to changes in water quality/hydrological regime. |
| Low (1-2) | One or a few elements sensitive to changes in water quality/hydrological regime. |
| Moderate (2-3) | Some elements sensitive to changes in water quality/hydrological regime. |
| High (3-3.5) | Many elements sensitive to changes in water quality/ hydrological regime. |
| Very high (+3.5) | Very many elements sensitive to changes in water quality/ hydrological regime. |