<u>Aquatic Delineation and Impact Statement:</u>

HUMANSRUS SOLAR 4

NORTHERN CAPE PROVINCE

Prepared for:

Humansrus Solar 4 (Pty) Ltd

Prepared by:

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January 2016

SPECIALIST STATEMENT DETAIL

This statement has been prepared with the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant other National and / or Provincial Policies related to biodiversity assessments in mind.

Report prepared by: Dr. Brian Colloty Pr.Sci.Nat. (Ecology) / Certified EAP / Member SAEIES & SASAqS

Expertise / Field of Study: BSc (Hons) Zoology, MSc Botany (Rivers), Ph.D Botany Conservation Importance rating (Estuaries) and interior wetland / riverine assessment consultant from 1996 to present.

I, **Dr. Brian Michael Colloty** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs

Signed:… ……………… Date:…21 January 2016……

1 - Introduction

Scherman Colloty & Associates (SC&A) was appointed by Humansrus Solar 4 (Pty) Ltd to conduct an aquatic assessment for the proposed Humansrus Solar 4 Photovoltaic Energy Facility and any additional supporting infrastructure near Copperton in the Northern Cape. This includes any transmission lines, substations and temporary works areas located within the solar facility.

This study includes verifying any previous desktop delineations conducted by SC&A (2013 & 2014) and was based on additional site specific information collected during a site visit in November 2015, while adhering to the assessment criteria contained in the DWAF 2005 / 2007 delineation manuals and the National Wetland Classification System found in the Appendix 1.

This report thus provides the relevant delineations and Present Ecological State status assessment of the observed waterbodies together with an analysis of the potential impact of the proposed activities on the aquatic environment.

2 - Project description

The proposed solar facility is located on a portion of the Farm 147 Humansrus, near Copperton in the Northern Cape and will be accessed via the R357.

The project comprises of the following components related to the aquatic environment:

- PV Footprint (including PV Panels, Substation, laydown areas).
- Grid connection options
- Proposed access road option (including new roads as well as existing roads that may need some upgrading).
- Water supplied for the construction phase will be obtained from Alkantpan via an agreement between them and the proponent.
- The project will not employ any on-site treatment or disposal for the waste water generated during the project's development phases. The generated quantities will differ significantly between the construction and operational phases of the development. The waste water will be treated at the Siyathemba Local Municipality Waste Water Treatment Works (WWTW). According to the Municipality this facility has sufficient capacity to deal with all the expected Waste Water quantities generated by the project.

3 – Study area description

The study area is characterised by non- perennial watercourses (Plate 1), drainage lines and depressions (Plate 2) associated with the Bastersput River although located within the Carnavonleegte River D54D quaternary catchment (Figure 1).

Several of the national spatial databases such as the National Freshwater Ecosystems Priority Areas (NFEPA) assessment also identified several wetlands within the study area. These were typical pans or depressions (Figure 2) or the riparian[1] systems associated with the larger river systems to the east of the study area. The wetland areas were investigated during the site visit with the majority confirmed to be either farm dams or old borrow-pits.

According to the Present Ecological State Scores (PES) issued by the Department of Water and Sanitation (DWS) in 1999 (Nel *et al*. 2011), the D54 systems were rated with a PES = B, largely natural, with impacts mostly related either to agricultural practices, impoundments or alien vegetation (*Prosopis* spp).

[1] Riparian systems were included in NFEPA database, but are associated with river systems thus not typically considered wetlands, unless these are defined as floodplain wetlands which is not the case for the study area.

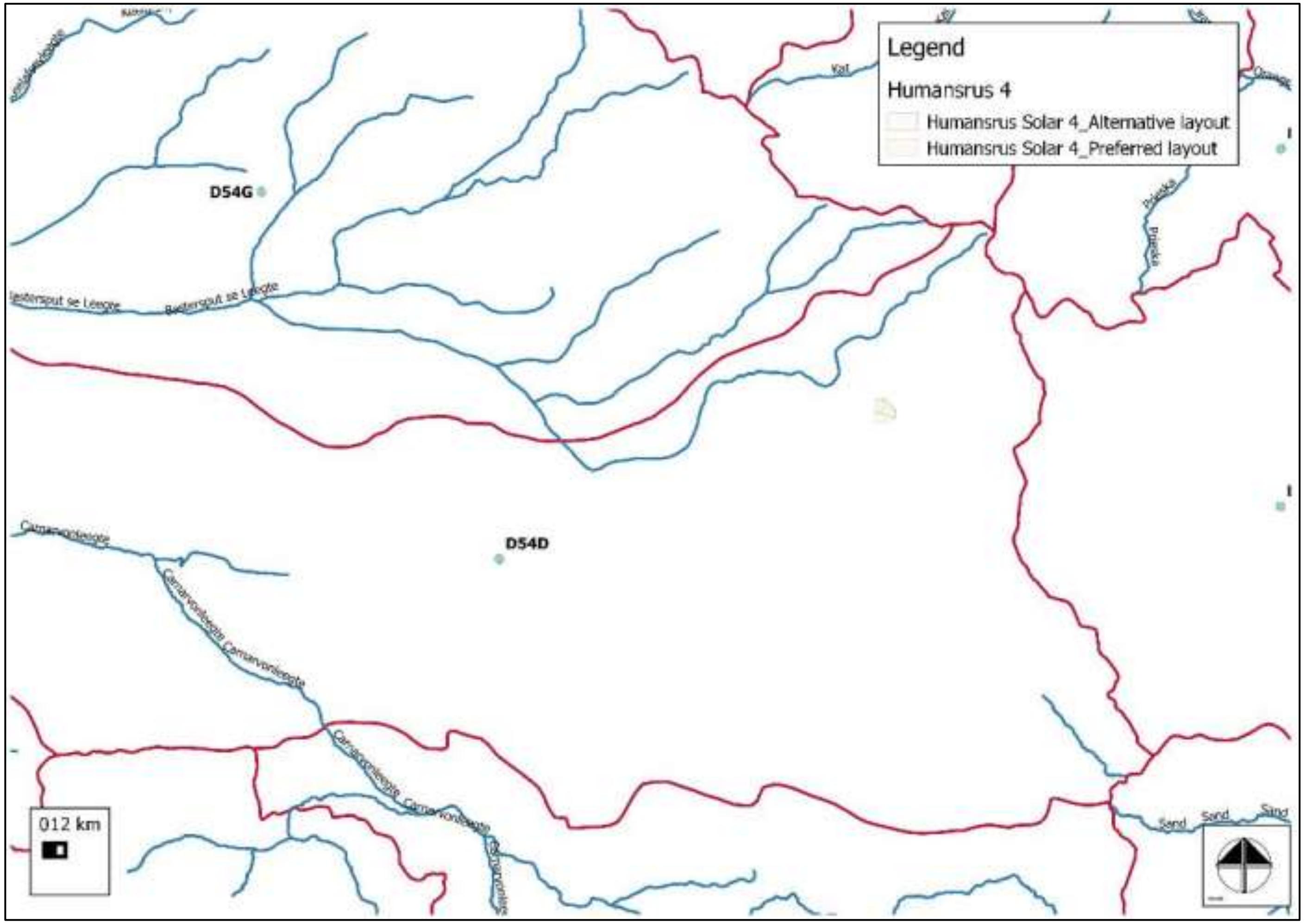

Figure 1: Project locality map indicating various quaternary catchments and main stem rivers within the region (NFEPA & DWS)

4 – Waterbody delineation & classification

The water body delineation and classification was conducted using the standards and guidelines produced by the DWA (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance and Present Ecological State (PES) assessment methods used in this report. Reference is also included with regard to relevant legislation related to the protection of waterbodies and the minimum requirements in terms of prescribed buffers.

For reference, definitions are as follows:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may or may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).
- **Water course**: as per the National Water Act means -

    (a) a river or spring;

    (b) a natural channel in which water flows regularly or intermittently;

    (c) a wetland, lake or dam into which, or from which, water flows; and

    (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

As previously mentioned, the National Freshwater Ecosystems Priority Area (NFEPA) wetland data, indicated that several natural waterbodies could occur within the study area, some being artificial or man-made systems are also shown in Figure 2. This was confirmed during the site visit. However, no natural wetlands were found in close proximity to the site, and only dams and or borrow-pits were observed (Plate 3).

Figure 3 thus indicates that no portions of the project are located within 500 m of a wetland boundary, and only water course crossings will be required.

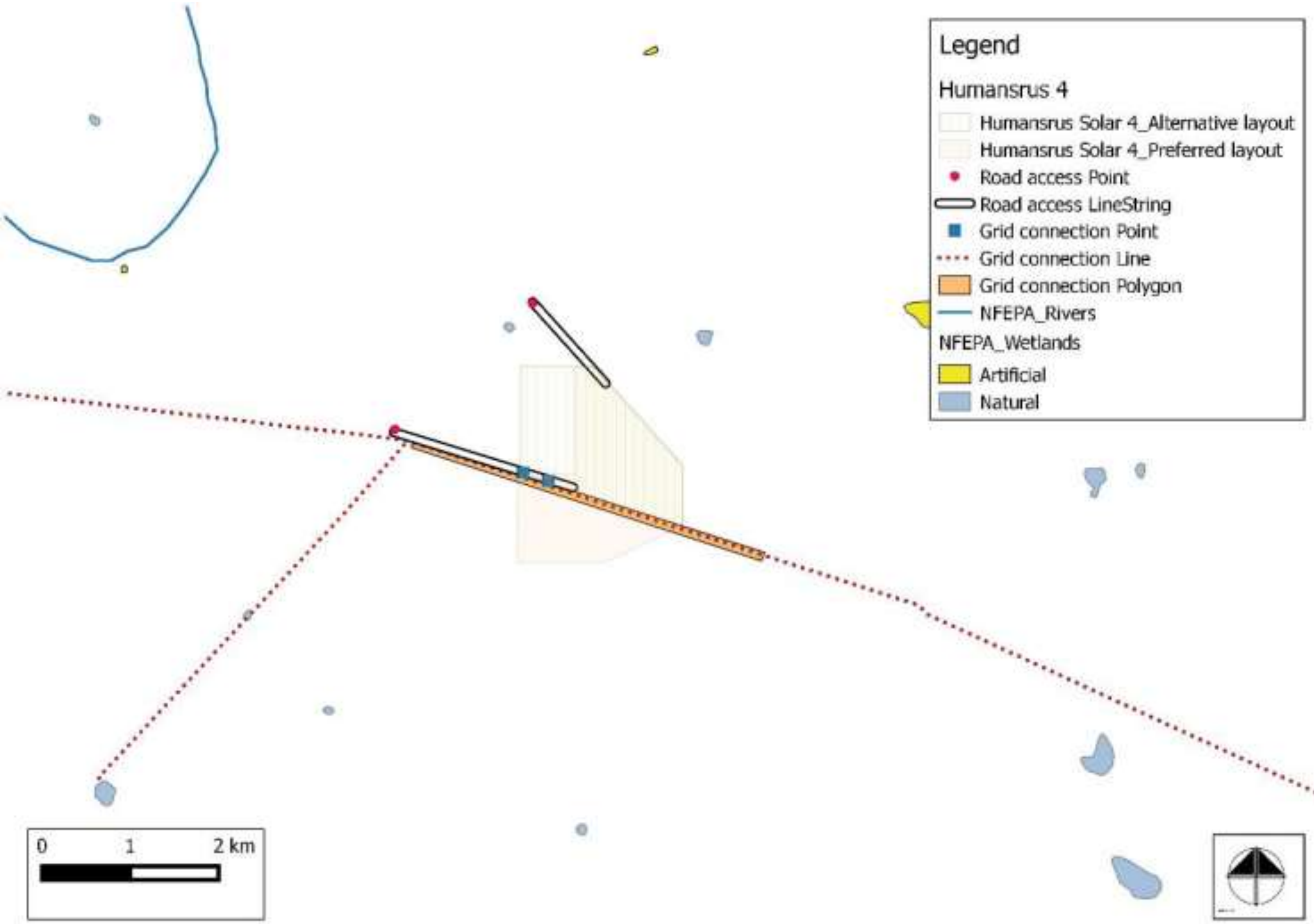

Figure 2: Potential wetlands according to the National Wetland Inventory (Nel *et al.*, 2011) in relation to the proposed layout. None of these in close proximity to the project components were found to be natural.

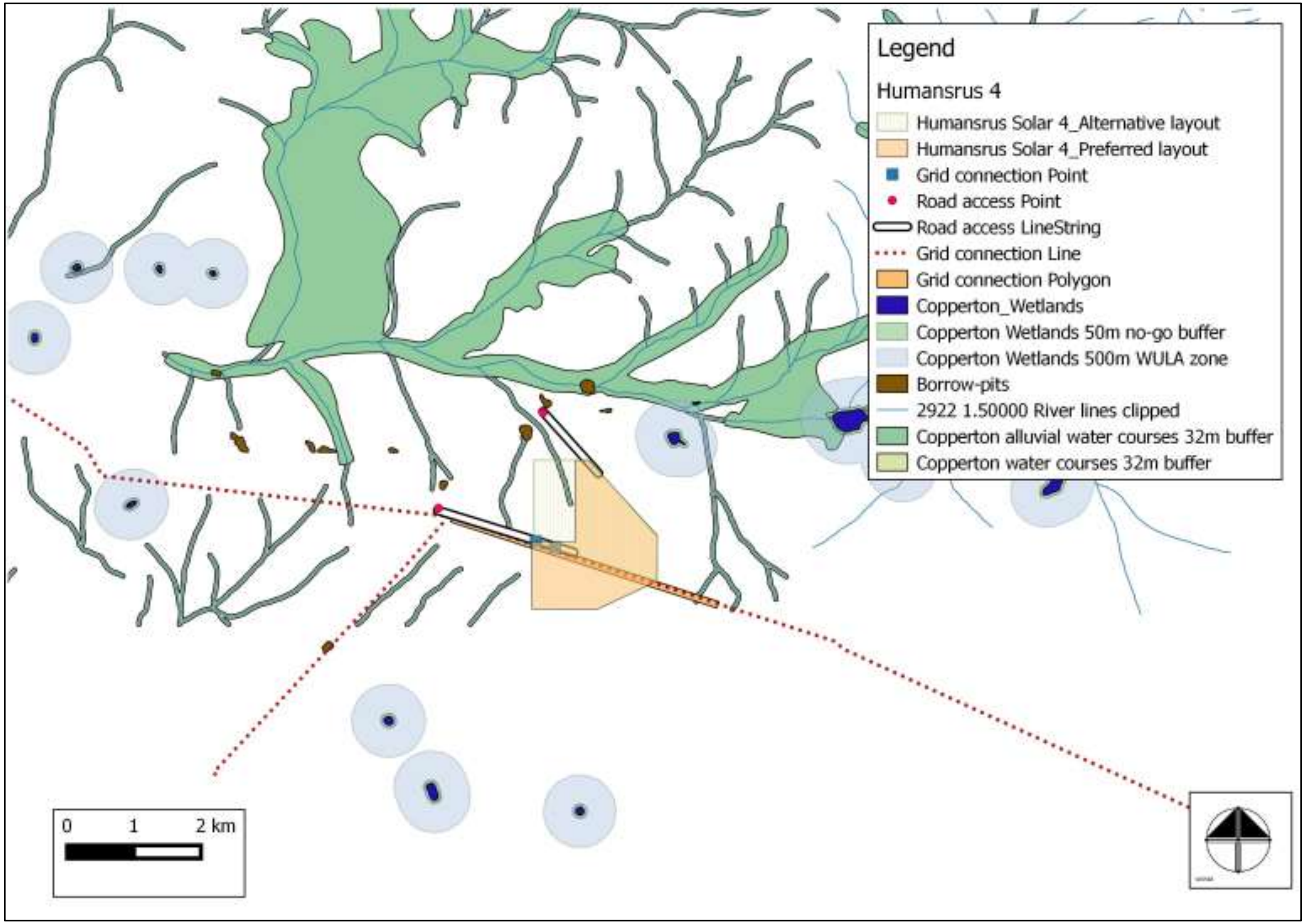

Figure 3: The layout in relation to the main watercourses (incl. of 32 m buffer) delineated wetland and the 500 m Wetland WULA zone.

5 - Present Ecological State and conservation importance

The Present Ecological State (PES)

The Present Ecological State of a waterbody represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habitat and biota, as well as ecosystem functioning (Category E).

The national Present Ecological Score or PES scores have been revised for the country and is based on new models that incorporate aspects of functional importance as well as direct and indirect impacts. The new PES system also incorporates EI (Ecological Importance) and ES (Ecological Sensitivity) separately as opposed to EIS (Ecological Importance and Sensitivity) in the old model. Although the new model is still heavily centered on rating rivers using broad fish, invertebrate, riparian vegetation and water quality indicators. The Recommended Ecological Category (REC) is still contained within the new models, with the default REC being B, when little or no information is available to assess the system or when only one of the above mentioned parameters is assessed or the overall PES is rated between a C or D.

Previously it was stated in this report that the PES scores for the respective catchments (i.e. main stem water courses) as per the 1999 data were B or largely Natural. Based then on the latest model and information collected during the site visit, these remained unchanged and would also apply to all the smaller systems within the study area. This is due to the fact that the impacts are similar to those listed previously and no additional degradation to the landscape has occurred since 1999.

With regard to this study, the wetlands i.e. pans, would also be considered Largely Natural (**PES = B)**.

The EI and ES for these systems will be rated as **Low**. This would apply to both the riverine and remaining wetland area observed in this study. The overall EI and ES scores for all the systems within the site could have been higher, but scores were reduced due to the presence of tracks and grazing.

6 - Recommended buffers

Presently there are no prescribed aquatic buffers for the Northern Cape and for this project, thus best practice guidelines will be applied (Table 1). These are shown below, to make the engineers and contractors aware of these buffers during the planning phase, i.e. construction, associated batch plants, stockpiles, lay down areas and construction camps should avoid these buffer areas. The proposed buffers are indicated in Figure 3.

Table 1: Recommended buffers for rivers, with those applicable to the project highlighted in blue

River criterion used	Buffer width (m)	Rationale
Mountain streams and upper foothills of all 1:500 000 rivers	▪ 50	▪ These longitudinal zones generally have more confined riparian zones than lower foothills and lowland rivers and are generally less threatened by agricultural practices.
▪ Lower foothills and lowland rivers of all 1:500 000 rivers	▪ 100	▪ These longitudinal zones generally have less confined riparian zones than mountain streams and upper foothills and are generally more threatened by development practices.
▪ All remaining 1:50 000 streams	▪ 32	▪ Generally smaller upland streams corresponding to mountain streams and upper foothills, smaller than those designated in the 1:500 000 rivers layer. They are assigned the riparian buffer required under South African environmental legislation.

Plate 1: A typical alluvial water course outside of the study area with no instream or marginal habitat, i.e. dry river bed

Plate 2: The endorheic depression located east of the study area

Plate 3: A borrow-pit located to the west of the site and is thus not considered a wetland as indicated in the national wetland databases

7 – Potential impacts and risk assessment

During the impact assessment study a number of potential key issues / impacts were identified. Two main issues are highlighted and these are listed below, together with related impacts that have the potential to arise should the project go-ahead.

Issue – Biological environment (e.g. vegetation)

- Impact 1: Loss of riparian systems

Issue - Physical environment

- Impact 2: Impact on dry riverbeds and localised drainage systems (road crossings)
- Impact 3: Impact on riparian systems through the possible increase in surface water runoff on riparian form and function (hydrological changes)
- Impact 4: Increase in sedimentation and erosion
- Impact 5: Physical disturbance by the supporting infrastructure (e.g. transmission lines) on the riverine environment

The impacts were assessed as follows, noting that these would be similar for all the alternatives as the proposed footprint areas could avoid all major water courses, while utilising the same or similar main access road and transmission line routes:

<table>
<tr><td colspan="3">Nature: Impact 1 - Loss of riparian systems

The physical removal of the narrow strips of woody riparian zones. This biological impact would however be localised within the dry river beds and small drainage lines within each of the road crossings only while a large portion of the remaining farms and the mainstem systems will remain intact.</td></tr>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>Local (1)</td><td>Local (1)</td></tr>
<tr><td>Duration</td><td>Long-term (4)</td><td>Long-term (4)</td></tr>
<tr><td>Magnitude</td><td>Low (2)</td><td>Low (2)</td></tr>
<tr><td>Probability</td><td>Probable (3)</td><td>Improbable (1)</td></tr>
<tr><td>Significance</td><td>Low (21)</td><td>Low (7)</td></tr>
<tr><td>Status (positive or negative)</td><td>Negative</td><td>Negative</td></tr>
<tr><td>Reversibility</td><td>Medium</td><td>High</td></tr>
<tr><td>Irreplaceable loss of resources</td><td>No</td><td>No</td></tr>
<tr><td>Can impacts be mitigated</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">Mitigation:
The proposed layout should be developed to avoid as many of the smaller drainage lines as possible.</td></tr>
</table>

Where crossings do occur, designs will ensure that flow are not disrupted and that erosion protection is placed appropriately
Cumulative impacts: None
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Nature: Impact 2 - Impact on dry riverbeds and localised drainage systems

The physical removal of narrow strips of woody riparian zones and the clearing of natural vegetation could alter the hydrological nature of the area, by increasing the surface run-off velocities, while reducing the potential for any run-off to infiltrate the soils. This impact would however be localised (road crossings and panel arrays), as a large portion of the remaining farm and the catchment would remain intact. As in Impact 1, only a small number of the narrower drainage lines should be impacted on directly at road crossings and or the development taking place within areas of Low Sensitivity.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium (45)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	

Mitigation:
Any stormwater within the site must be handled in a suitable manner to capture large volumes of run-off, trap sediments and reduce flow velocities.

Cumulative impacts:
The increase in surface run-off velocities and the reduction in the potential for groundwater infiltration is likely to occur, considering that the site is near the main drainage channels and the annual rainfall figures are low. When considering the other potential projects within the adjacent / nearby farms, the potential for changes to the surrounding hydrological habitat could be significant especially during the operational phases (hard surfaces and stormwater management). It is however assumed, together with the low mean annual run-off that with suitable stormwater management the impacts could however be mitigated, coupled to the fact that a low percentage of projects actually move into the construction phase.

Residual impacts:

Diversion of run-off away from downstream systems is unlikely to occur as the annual rainfall figures are low.

Nature: Impact 3 - Impact on riparian systems through the possible increase in surface water runoff on riparian form and function		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (2)	Low (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (35)**	**Low (19)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant, and install stilling basins to capture large volumes of run-off, trap sediments, and reduce flow velocities (e.g. water used when washing the mirrors). The project should also try capture and recycle any form of run-off created by the daily operations. This would minimise the amount of water required by the project, but also serve to limit the downstream impacts on the riparian systems through an increase in run-off, a situation that these systems are currently unaccustomed to.		
Cumulative impacts: Downstream alteration of hydrological regimes due to the increased run-off from the area. When considering the other potential projects within the adjacent / nearby farms within a 10-15 km radius, the potential for changes to the surrounding hydrological habitat could be significant especially during the operational phases (hard surfaces and stormwater management). It is however assumed that any such changes would be detrimental to the various project's owners (erode areas around infrastructure), thus together with the low mean annual run-off and suitable stormwater management, the impacts could be mitigated, coupled to the fact that a low percentage of projects actually move into the construction phase.		
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site but unlikely.		

Nature: Impact 4 - Increase in sedimentation and erosion within the development footprint		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (1)	Low (1)
Probability	Definite (5)	Probable (3)
Significance	**Medium (30)**	**Low (18)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant, and install stilling basins to capture large volumes of run-off, trap sediments and reduce flow velocities (e.g. water used when washing the mirrors).		
Cumulative impacts: Downstream erosion and sedimentation of the downstream systems and farming operations. During flood events, the unstable banks (eroded areas) and sediment bars (sedimentation downstream) already deposited downstream will then be washed into the Bastersput River. When considering the other potential projects within the adjacent / nearby farms the potential for changes to the surrounding hydrological habitat would not be significant especially during the operational phases (hard surfaces and stormwater management).		
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site but unlikely.		

Nature: Impact 5 - Physical disturbance by the supporting infrastructure (roads & transmission lines) on the riparian environment The proposed alignments will have limited to no (Transmission line) impact on the functioning of any riparian systems.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (3)
Probability	Definite (5)	Probable (3)
Significance	**Medium (55)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: The proposed layout has thus been developed to avoid the significant water courses and should avoid as many of the smaller drainage lines as possible. Care should however be taken that if any clearing is done, that this area is monitored for plant re-growth, firstly to prevent alien plant infestations and to ensure no erosion or scour takes place.		
Cumulative impacts: Additional downstream erosion and sedimentation of the downstream watercourses.		
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site but unlikely.		

Measures for inclusion into the Environmental Management Programme

Project component/s	Site selection with regard minimising the overall impact on the functioning of the riparian environment
Potential impact	Loss of important habitat and fragmentation of the riverine systems
Activity risk source	Placement of hard engineered surfaces (PV plants)
Mitigation: Target / Objective	Select a favourable site, having the least impact or within an area that is least sensitive, i.e. not within the mains stem systems.
Mitigation: Action/control	Minimise the loss of riparian habitat – physical removal and replacement by hard surfaces by avoiding as many of the sensitive (High) water courses possible as is shown in Figure 4
Responsibility	Developer
Timeframe	Planning and design phase
Performance indicator	N/A
Monitoring	N/A

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

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

8 – Conclusion and recommendations

The proposed layout for the solar energy facility will have a negligible impact on the aquatic environment. The project has adhered to past specialist recommendations and the infrastructure that would have posed even a slight risk to water resources has been moved outside of any direct wetlands or water course areas.

Furthermore, during the site visit, no aquatic protected or species of special concern (fauna & flora) were observed within the adjacent areas that will be used. Therefore, based on the site visit the significance of the impacts assessed for the aquatic systems after mitigation would be LOW.

Figure 3 further indicates various buffers as required by the legislation, for each type of aquatic feature, which would trigger the need for a Water Use License application, should any construction take place within these areas. The author of this report would thus not object to the authorisation for any of the supporting infrastructure.

This would apply to any of the proposed alternatives as they would present a similar impact on the aquatic environment.

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

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10 – Appendix 1: Wetland assessment methods

Survey methods

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

A one day site visit was then conducted to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts and delineating the wetland areas.

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

- Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database.
- Plant species were further categorised as follows:
    - Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall
    - Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non-wetland) (DWAF, 2005)
    - Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005)
- Assessment of the wetland type based on the NWCS method discussed below and the required buffers
- Mitigation or recommendations required

National Wetland classification System (NWCS 2010)

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

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

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

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

Definition Box

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

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).

Reserve: The quantity and quality of water needed to sustain basic *human needs* and *ecosystems* (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The *Ecological Reserve* pertains specifically to aquatic ecosystems.

Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements).

Ecological Reserve determination study: The study undertaken to determine Ecological Reserve requirements.

Licensing applications: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment.

Ecological Water Requirements: This **is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the Reserve Template**

Water allocation process (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements.

Ecoregions are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans *et al.* 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

Wetland definition

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

The Ramsar Convention definition of a wetland is widely accepted as **"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"** (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

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

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

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are defined as "land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a water course (SANBI, 2009). The DWA is however reconsidering this position with regard the management of estuaries due to the ecological needs of these systems with regard to water allocation. Table 1 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

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

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

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

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

Table 1: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	▪ YES	▪ NO	▪ NO
▪ Estuarine	▪ YES	▪ NO	▪ NO
▪ Waterbodies deeper than 2 m (i.e. limnetic habitats often describes as lakes or dams)	▪ YES	▪ NO	▪ NO
▪ Rivers, channels and canals	▪ YES	▪ NO[2]	▪ NO
▪ Inland aquatic ecosystems that are not river channels and are less than 2 m deep	▪ YES	▪ YES	▪ YES
▪ Riparian[3] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	▪ YES	▪ YES	▪ YES[4]
▪ Riparian[2] areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	▪ NO	▪ NO	▪ YES[3]

Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources

[2] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act

[3] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[4] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

they could provide. Wetland conservation is now driven by the South African National Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

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

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

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

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

Table 2 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze *et al*., 2008). One such example is emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 2: Summary of direct and indirect ecoservices provided by wetlands from Kotze *et al.*, 2008.

Ecosystem services supplied by wetlands	Indirect benefits	Hydro-geochemical benefits		Flood attenuation
				Stream flow 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[2]
				Provision of cultivated foods
				Cultural significance
				Tourism and recreation

		▪ *Education and research*

Relevant wetland legislation and policy

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

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

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

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

Provincial legislation and policy

Various provincial guidelines on buffers have been issued within the province. These are stated below so that the engineers and contractors are aware of these buffers during the planning phase. Associated batch plants, stockpiles, lay down areas and construction camps should avoid these buffer areas.

Until national guidelines for riverine and wetland buffers are established, the guidelines set out in the Eastern Cape Biodiversity Conservation Plan documentation should be applied (Berliner & Desmet, 2007). Table 3 recommends buffers for rivers.

Table 3: Recommended buffers for rivers, with the applicable buffer related to this study shaded in grey

River criterion used	Buffer width (m)	Rationale
Mountain streams and upper foothills of all 1:500 000 rivers	▪ 50	▪ These longitudinal zones generally have more confined riparian zones than lower foothills and lowland rivers and are generally less threatened by agricultural practices.
▪ Lower foothills and lowland rivers of all 1:500 000 rivers	▪ 100	▪ These longitudinal zones generally have less confined riparian zones than mountain streams and upper foothills and are generally more threatened by agricultural practices. These larger buffers are particularly important to lower the amount of crop-spray reaching the river.
▪ All remaining 1:50 000 streams	▪ 32	▪ Generally smaller upland streams corresponding to mountain streams and upper foothills, smaller than those designated in the 1:500 000 rivers layer. They are assigned the riparian buffer required under South African legislation.

Currently there is no accepted priority ranking system for wetlands. Until such a system is developed, it is recommended that a **50m buffer be set for all wetlands**.

Other policies that are relevant include:

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

National Wetland Classification System method

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

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

The classification system used in this study is thus based on SANBI (2009) and is summarised below:

The NWCS has a six tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 4). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). Level 2 then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

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

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

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

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

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

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

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

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

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

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

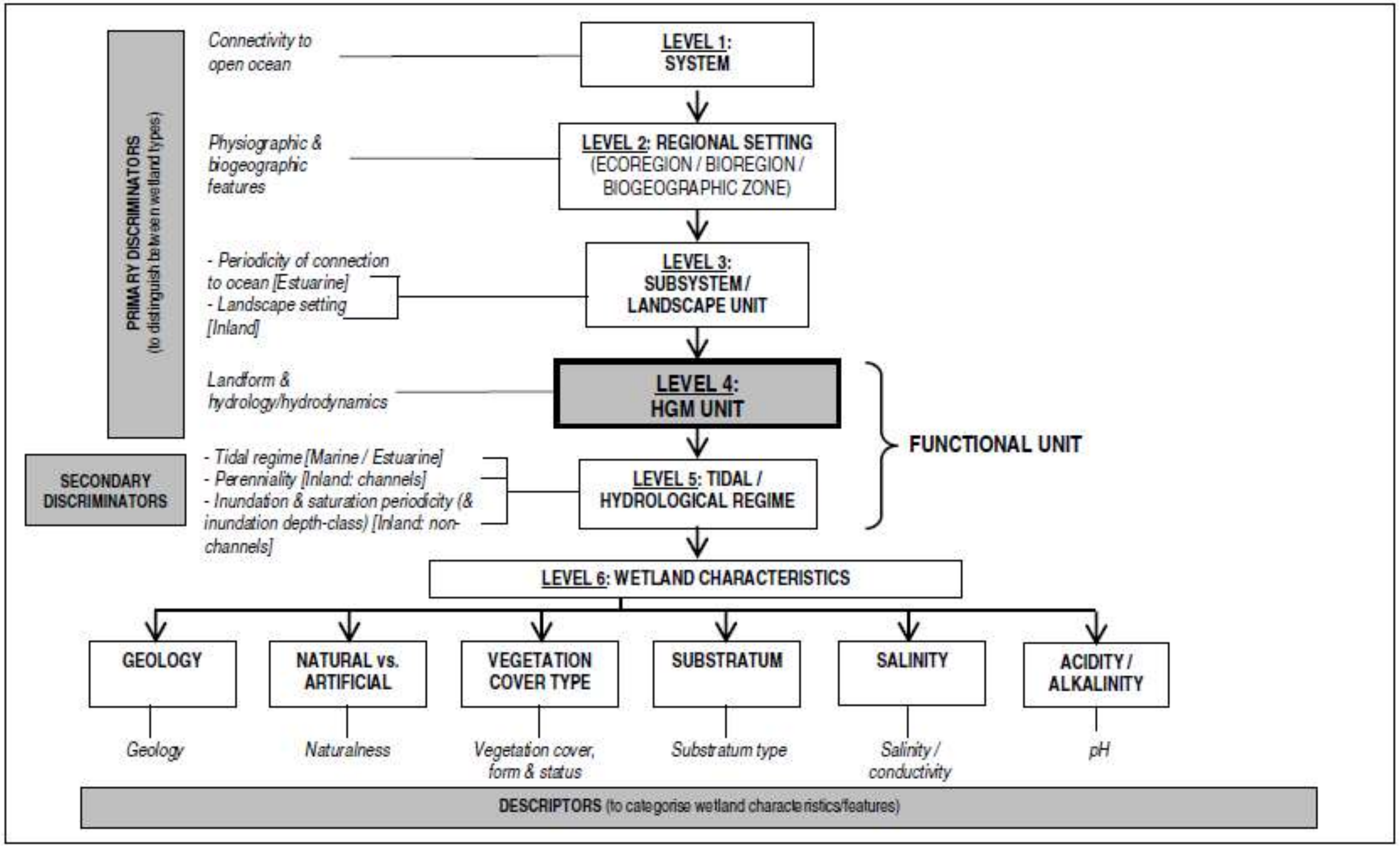

Figure 4: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the tidal/hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

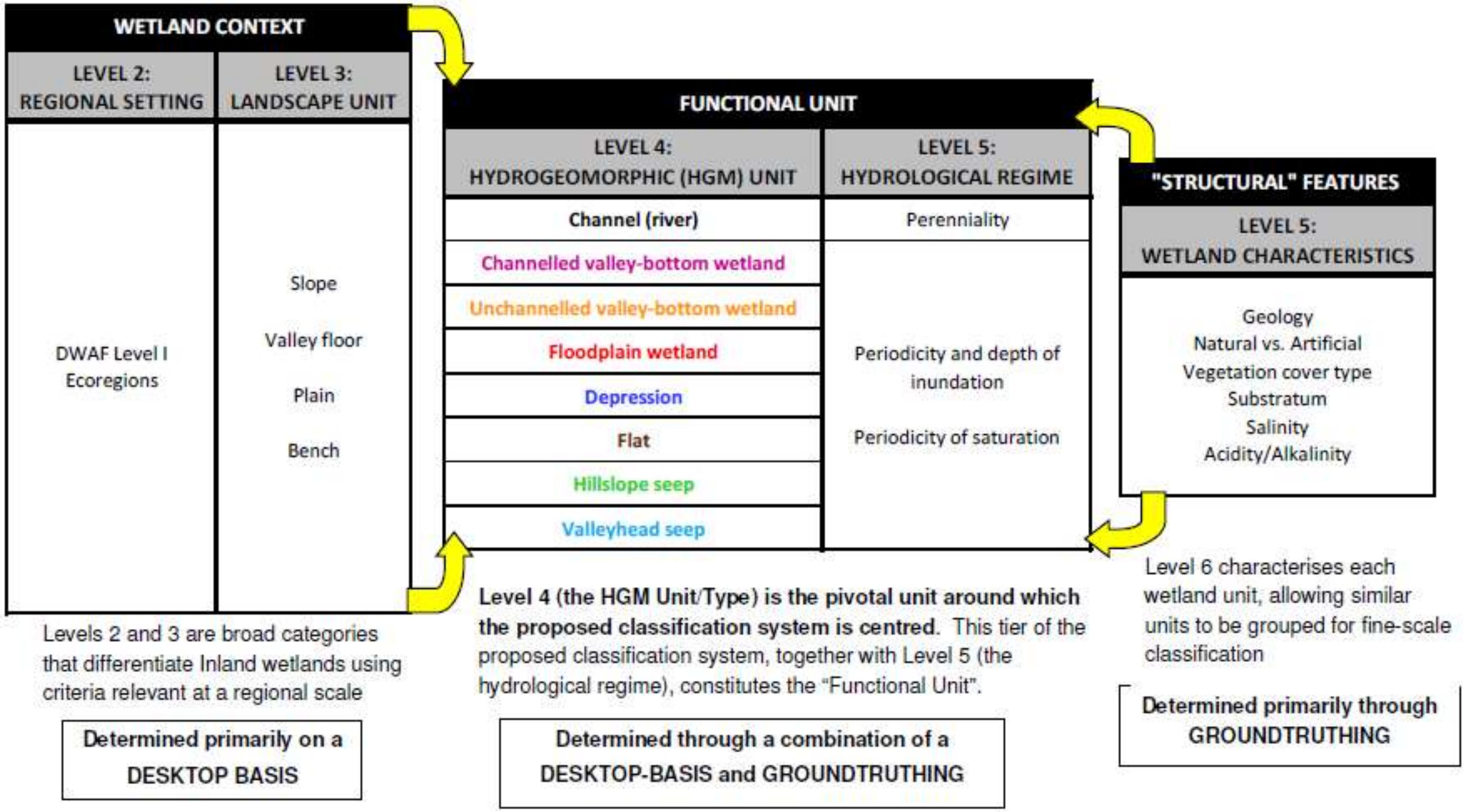

Figure 5 Illustration of the conceptual relationship of HGM Units (at Level 4) with higher and lower levels (relative sizes of the boxes show the increasing spatial resolution and level of detail from the higher to the lower levels) for Inland Systems (from SANBI, 2009).

Wetland condition and conservation importance assessment

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

Table 4: Description of A – F ecological categories based on Kleynhans *et al.*, (2005).

<table>
<tr><th>ECOLOGICAL CATEGORY</th><th>ECOLOGICAL DESCRIPTION</th><th>MANAGEMENT PERSPECTIVE</th></tr>
<tr><td>A</td><td>▪ Unmodified, natural.</td><td>▪ Protected systems; relatively untouched by human hands; no discharges or impoundments allowed</td></tr>
<tr><td>B</td><td>▪ Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.</td><td>▪ Some human-related disturbance, but mostly of low impact potential</td></tr>
<tr><td>C</td><td>▪ Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.</td><td rowspan="2">▪ Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation</td></tr>
<tr><td>D</td><td>▪ Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.</td></tr>
<tr><td>E</td><td>▪ Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.</td><td rowspan="2">▪ Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality</td></tr>
<tr><td>▪ F</td><td>▪ 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.</td></tr>
</table>

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

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

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

- Habitat uniqueness
- Species of conservation concern
- Habitat fragmentation with regard ecological corridors
- Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a Species of conservation concern was observed (HIGH). Any systems that was highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating. Wetlands with HIGH and MEDIUM ratings should thus be excluded from development with incorporation into a suitable open space system, with the maximum possible buffer being applied. Wetlands which receive a LOW conservation importance rating could be included into stormwater management features, but should not be developed so as to retain the function of any ecological corridors.