HENDRINA GREEN HYDROGEN AND AMMONIA PROJECT

Wetland and Aquatic Ecology Impact Assessment

Prepared for:

ENERTRAG South Africa (Pty) Ltd

Report Compiler:

Stephen Burton

Date:

February 2023

DETAILS AND DECLARATION OF THE SPECIALIST

Contact person: Stephen Burton

Tel: 083 795 2804

E-mail: Stephenburtonza@gmail.com

Full name:	Stephen Burton
Title/ Position:	Principal Ecologist
Qualification(s):	M.Sc.
Experience (years):	15
Registration(s):	SACNASP: 117474

I, Stephen Burton, declare that: –

- I act as an independent specialist in this application;
- I will perform the work relating to the application objectively, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken concerning the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offense and is punishable by law.

______________ *February 2023*

Signature of the Specialist *Date*

EXECUTIVE SUMMARY

ENERTRAG South Africa (Pty) Ltd (ENERTRAG), a subsidiary of ENERTRAG AG requested Stephen Burton Ecological to compile a wetland and aquatic assessment for the proposed Hendrina Green Hydrogen and Ammonia (GH&A) project. The GH&A project is part of a suite of projects that are collectively known as the Hendrina Renewable Energy Complex. The other facets of the complex are subject to separate assessment and environmental authorization processes.

The Wetland and Aquatic Impact Assessment aimed to comply with the Protocol for Environmental Impacts on Aquatic Biodiversity (terms of GNR 320 in GG 43110 dated 20 March 2020).

The Project Area consisted of a total of 1722.32 ha of wetland areas. Thirty-six (36) HGM units were identified and categorized based on terrain units. These included Hillslope Seep Wetlands (Seeps), Unchanneled Valley Bottom wetlands (UVBs), and Channelled Valley Bottom wetlands (CVBs). The wetlands were grouped into seven groups for ease of the assessment. These included:

- CVBs;
- CVBs (fragmented);
- UVBs;
- UVBs (fragmented);
- Hillslope Seep (Agriculture);
- Hillslope Seep (Fragmented); and
- Hillslope Seep (Unimpacted).

The health and integrity of each of the HGM units varied from **'Moderately Modified'** to **'Largely Modified' (Present Ecological State (PES) C** to **D)**. The entire catchment has been impacted by mining and agricultural activities and infrastructure development. The CVBs have mainly been impacted by agropastoral activities, including cattle grazing, dams, and cultivation. In addition, some of the CVBs have been fragmented by linear infrastructure, including roads, powerlines, and fence lines. Fragmentation of wetlands impacts the natural habitat, functionality, and health of a wetland. The UVBs within the Project Area was dominantly used for cattle grazing. There were no clear signs of channeling, erosion, or extensive cattle trampling.

The vegetation was stable with few changes to water inputs to the systems. Regardless of some of the UVBs being moderately impacted, some of the systems were fragmented by agropastoral, and linear infrastructure. Dams were also indicated in some of the systems. Most of the Hillslope Seep wetlands were used for agropastoral activities, including commercial cultivation and cattle grazing. Unimpacted Hillslope Seep wetlands were recorded within the Project Area. These wetlands were mainly used for cattle grazing, however, this was well regulated and little erosion and few impacts on the vegetation and geomorphology were noted.

In terms of Wetland Ecosystem Service (ES) Provision, sediment trapping, phosphate assimilation, nitrate assimilation, and toxicant assimilation are the dominant ecological services provided by the

HGM units. The unimpacted Hillslope Seeps and CVBs are providing biodiversity maintenance and the CVBs are important for water supply.

The UVBs Fragmented, Hillslope Seep Agriculture, and Hillslope Seep Fragmented HGM units Ecological Importance and Sensitivity (EIS) were regarded as **'Moderate (C)'**. Whereas the CVBs, CVBs Fragmented, UVBs, and HS Unimpacted were considered **'High (B)'**. This suggests that these systems are of ecological importance and are sensitive. The biodiversity of the systems is sensitive to modifications to the habitat and low flows. These systems play an important role in moderating the quality and quantity of water in larger systems.

The proposed GH&A facility will have **Low** impacts on the wetland environment when the proposed mitigation and management plans are considered. In addition, the upgrading of existing roads and wetland crossing potentially also pose a **Low** risk of impacts to the aquatic systems onsite. The installation of electrical cables and water pipelines will potentially have **low** impacts to the freshwater resources within the study boundary, The Department of Water and Sanitation should be approached with regards to the applicability of a Water Use Authorisation. Solitary sections of the wetlands will be impacted due to infrastructure access roads, underground cables, pipelines, electrical powerline infrastructure, and buildings, which can be mitigated and planned.

In terms of alternatives, the preferred site option from a wetland and aquatic biodiversity perspective is site 1, with the least preferred being site option 3. From a powerline connection perspective, connection option 3 for site option 1 is the shortest and is preferred from a wetland and aquatic biodiversity perspective.

Based on the impact assessment significance ratings, it is the opinion of the specialist that this Project is feasible and should be considered.

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LIST OF ACRONYMS, ABBREVIATIONS AND DEFINITION

CBA	Critical Biodiversity Area
CMA	Catchment Management Agency
CVB	Channelled Valley Bottom
DFFE	Department of Forestry, Fisheries and Environment
DWA	Department of Water Affairs
DWAF	Department of Water and Forestry
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMPr	Environmental Management Programme
ES	Ecological Services
ESA	Ecological Support Area
F	Facultative species
FD	Facultative dry-land species
FW	Facultative Wetland species
Ha	Hectares
HGM	Hydrogeomorphic
IWRM	Integrated Water Resource Management
IWUL	Integrated Water Use License
m	Meters
m.a.m.s.l	Meters Above Mean Sea Level
MAP	Mean Annual Precipitation
MBSP	Mpumalanga Biodiversity Sector Plan
mm	Millimetres

MTPA	Mpumalanga Tourism and Parks Agency
NBF	National Biodiversity Framework
NEM: BA	National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act, 1998 (Act No. 36 of 1998)
OW	Obligate Wetland Species
PA	Protected Areas
PES	Present Ecological State
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SFI	Soil Form Indicator
SWI	Soil Wetness Indicator
UVB	Unchanneled Valley Bottom
WET-Ecoservices	Wetland Ecological Services
WET-Health	Wetland Ecological Health Assessment
WMA	Water Management Area
WRC	Water Resource Commission

LEGAL REQUIREMENTS

Legal Requirement		**Section in Report**
2.7	The findings of the specialist assessment must be written up in an Aquatic Biodiversity Specialist Assessment Report that contains, as a minimum, the following information	
2.7.1	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae	Section 6 & Appendix C
2.7.2	a signed statement of independence by the specialist	Pages iii & iv
2.7.3	statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 9
2.7.4	the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 7 & Appendix A
2.7.5	a description of the assumptions made, any uncertainties or gaps in knowledge or data;	Section 5

Legal Requirement		Section in Report
2.7.6	the location of areas not suitable for development, which are to be avoided during construction and operation, where relevant;	Section 9
2.7.7	additional environmental impacts expected from the proposed development;	Section 10
2.7.8	any direct, indirect and cumulative impacts of the proposed development on site;	Section 10
2.7.9	the degree to which impacts and risks can be mitigated;	Section 10
2.7.10	the degree to which the impacts and risks can be reversed;	Section 10
2.7.11	the degree to which the impacts and risks can cause loss of irreplaceable resources;	Section 10
2.7.12	suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies;	Section 9
2.7.13	proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr);	Section 11
2.7.14	motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a “low” aquatic biodiversity sensitivity and that were not considered appropriate;	None
2.7.15	a substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not; and	Section 12
2.7.16	any conditions to which this statement is subjected.	Section 11 & 12

1. Introduction

ENERTRAG South Africa (Pty) Ltd (ENERTRAG), a subsidiary of ENERTRAG AG requested Stephen Burton Ecological to compile a wetland and aquatic assessment for the proposed Hendrina Green Hydrogen and Ammonia (GH&A) facility (the 'Project').

This Report has been compiled to fulfil the requirements of the Specialist Aquatic Biodiversity Impact Assessment undertaken as part of the Environmental Impact Assessment (EIA) and Integrated Water Use License Application (IWULA) processes. This report should be read in collaboration with the Environmental Management Programme (EMPr) and IWULA as well as the other specialist reports (specifically Agricultural Agro-Ecosystems Assessment, Terrestrial Biodiversity Assessment, and Surface Water Assessment).

1.1. Terms of Reference

The proposed construction of the Project and introduction of ancillary infrastructure triggers Listed Activities in terms of the EIA Regulations, 2014 (as amended) as promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), requiring that an EIA Process be undertaken to apply for Environmental Authorisation. Furthermore, a Water Use Authorisation in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) is required to lawfully undertake the proposed construction and operation of the Project.

1.2. Study Areas

For the purpose of this report, the following applies:

- Project Area defines farm portions directly associated with the various Project Components of the greater Hendrina Renewable Energy Complex (red outlined areas on maps); and
- Study Area defines the zone of influence in terms of potential impact the Project will have on the wetlands. This includes the Project Area together with a 500 m Zone of Regulation. The Zone of Regulation is the 500m area surrounding a wetland in which activities must be authorised in terms of the NWA.

1.3. Project Locality

The GH&A facility will be approximately 25 hectares (ha) in size and located in the Mpumalanga Province, approximately 17 km west of the town of Hendrina. The Project Area falls within the Nkangala District Municipality.

The proposed GH&A facility is situated within the Olifants River Catchment (Primary Catchment B), within the B11A and B11B quaternary catchment (Figure 1-1).

The proposed Hendrina GH&A facility alternatives are situated on the following farms:

Site Alternative 1 is located on Portion 3 of the Farm Dunbar 189IS, at the site of an old abandoned farmyard and has three powerline options from the associated Hendrina North and South Wind Energy Facilities ("WEF") as follows:

- Powerline option 1 is up to 2km in length, to the Hendrina North WEF substation Option 1 on Portion 1 of the Farm Dunbar 189IS;
- Powerline option 2 is up to 7km in length, to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 1.5km in length, to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS.

water supply to the Site:

- constructing a new pipeline (up to 16km) from the Komati Power Station

Site Alternative 2 is located on Portion 3 of the Farm Dunbar 189IS and Portion 18 of the Farm Weltevreden 193IS, adjacent to the proposed Hendrina South WEF substation and has three powerline options from the associated wind farms as follows:

- Powerline option 1 is up to 3km in length to the Hendrina North WEF Option 1 substation on Portion 1 of the Farm Dunbar 189IS;
- Powerline option 2 is up to 8km in length to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 0.5km in length to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS.

water supply to the Site:

- constructing a new pipeline (up to 16km) from the Komati Power Station

Site Alternative 3 is located on Portions 14 and 15 of the Farm Weltevreden 193IS and has three powerline options from the associated wind farms as follows:

- Powerline option 1 is up to 5km in length to the Hendrina North WEF Option 1 substation on Portion 1 of the Farm Dunbar 189IS;
- Powerline option 2 is up to 5km in length to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 7km in length to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS.

water supply to the Site:

- constructing a new pipeline (up to 16km) from the Komati Power Station

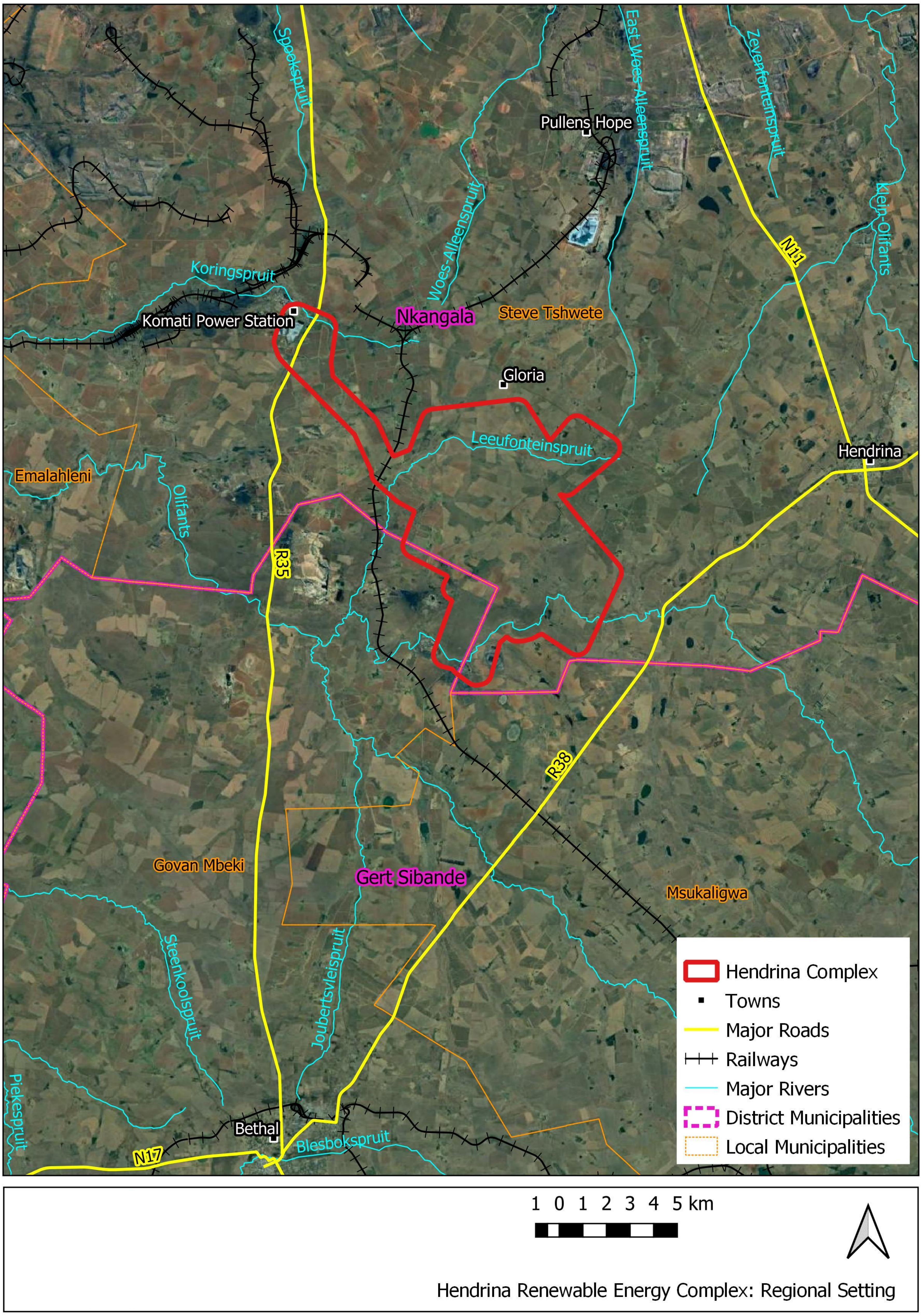


Figure 1-1: Regional Setting

1.4. Proposed Infrastructure and Activities

Below is a synopsis of the proposed infrastructure that will be required for the GH&A facility:

- Water Reservoir of 2 ha;
- Water Treatment Unit 1.5 ha;
- Electrolyser Unit 1 ha;
- Air Separation Unit 0.5 ha;
- Ammonia Processing Unit 2 ha;
- Liquid Air Storage System 1 ha;
- Liquid Ammonia Storage Tank 2 ha
- Oxygen and Hydrogen Storage Tank Farm 12 ha; and
- Ancillary Infrastructure 3 ha.

Water and powerline infrastructure:

- New Water Pipeline up to 16 km in length; and
- Powerline connection options of up to 8km and servitude of 500m wide.

Table 1-1: Project Phases and Associated Activities

Project Phase	Project Activity
Construction Phase	• Site/vegetation clearance for site establishment; • Foundation excavation and pouring; • Construction of GH&A infrastructure; • Construction of power lines water pipelines; and • Construction of other associated infrastructure.
Operational Phase	• Operation and maintenance of GH&A facility; • Operation and maintenance of water reticulation; and • Use of roads.
Decommissioning Phase	• Demolition and removal of infrastructure; • Demolition and removal of power lines and pipelines; • Rehabilitation – rehabilitation mainly consists of spreading and landscaping, profiling of the land, and re-vegetation; and • Monitoring and further rehabilitation.

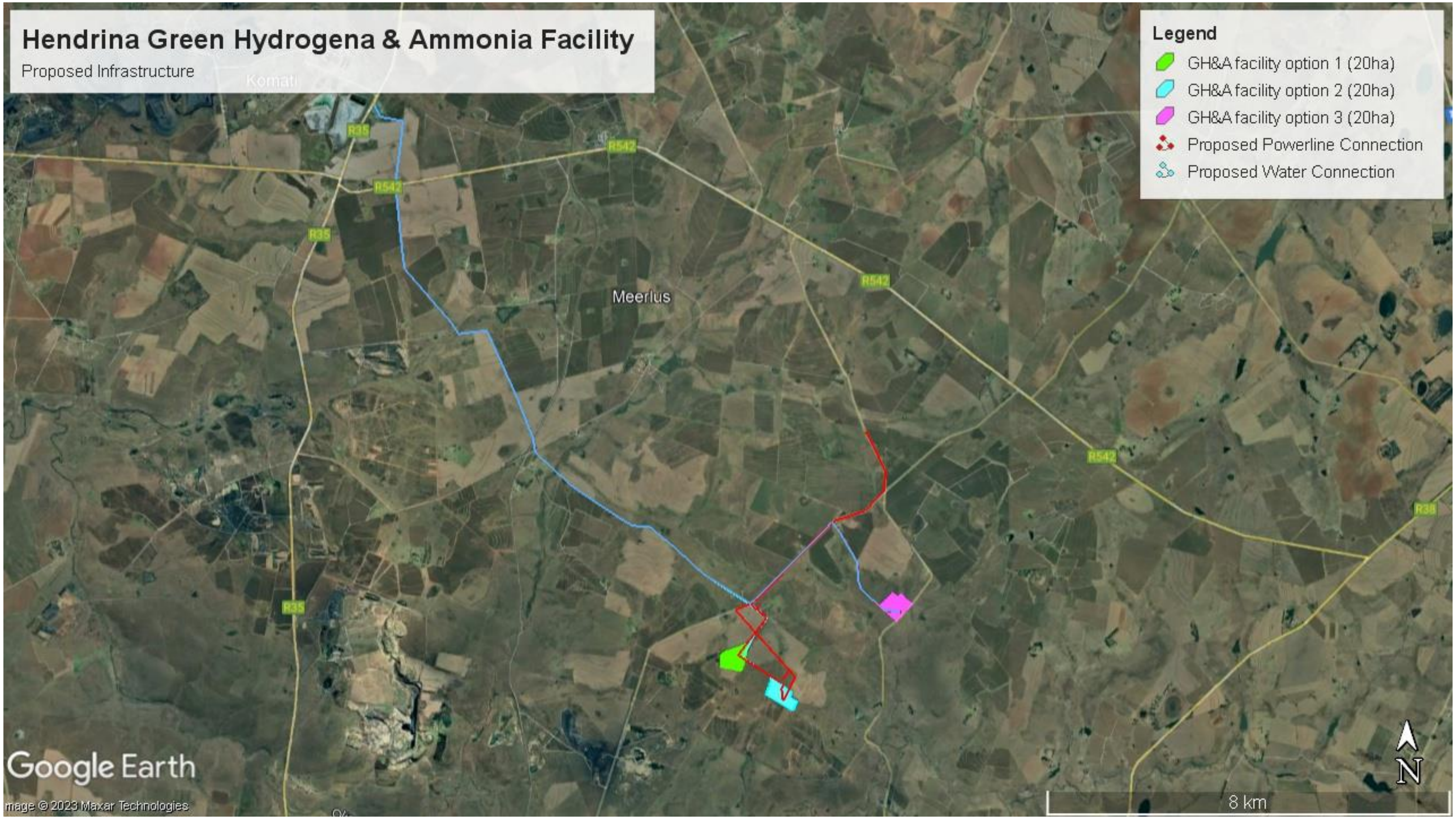


Figure 1-2: Proposed Infrastructure Areas

2. Alternatives Considered

Alternatives to consider ensuring minimal impacts to the Wetlands include:

- Alternative GH&A facility locations have been considered;
- Multiple alternative powerline connection options for each GH&A option above; and
- Alternative water pipeline routings have been proposed.

For a full description of all alternatives please see the EIA report.

3. Scope of Work

The field assessment for the wetland and aquatic ecology associated with the proposed Hendrina Complex was carried out in November 2019 and August 2021. The Scope of Work for the Wetland and Aquatic Impact Assessment comprised of the following:

- Desktop investigation of the catchments, regional context, and potential freshwater resources within the Project Area;
- Wetland Delineations, identification and characterisation of wetlands within the Project Area;
- Wetland Health Assessment including assessment of the Present Ecological State (PES), wetland service provision (ES), and Ecological Importance and Sensitivity (EIS); and
- Sensitivity mapping and the recommendation of buffer zones according to the guidelines set out in WRC Report No. TT610/14, 2014 (Macfarlane, D.D., et al, 2014).

4. Relevant Legislation, Standards, and Guidelines

The Project is required to comply with all the obligations in terms of the provisions of the National legislations, regulations, guidelines, and by-laws. The guidelines directing the Wetland and Aquatic Environmental Impact Assessment are detailed in Table 4-1.

Table 4-1: Applicable Legislation, Regulations, Guidelines, and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). NEMA (as amended) was set in place under Section 24 of the Constitution. Certain environmental principles under NEMA must be adhered to, to inform decision making for issues affecting the environment. • Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity (GN R. 320 of 2020).	• The Wetland and Aquatic Assessment process was undertaken to identify wetlands, potential impacts to the wetlands and freshwater aquatic systems, threatened species, protected species and areas dominated by Alien Invasive Plants (AIPs). • Specific reference is made to the requirements of the protocol for the specialist assessment and reporting requirements of aquatic biodiversity.
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA) The NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act also regulates the protection of species and ecosystems that require national protection and also takes into account the management of alien and invasive species. The following regulations which have been promulgated in terms of the NEM:BA are also of relevance: • Alien and Invasive Species Lists, 2020 (terms of GNR 1003 in GG 43726 dated 18 September 2020 – effective from 18 October 2020); and • National list of Ecosystems Threatened and in need of protection under Section 52(1) (a) of the Biodiversity Act (GG 34809, GNR 1002, 9 December 2011).	• The Wetland and Aquatic Assessment process was undertaken to identify wetlands, potential impacts to the wetlands and freshwater aquatic systems, threatened species, protected species and areas dominated by Alien Invasive Plants (AIPs). • As part of the Wetland and Aquatic Assessment, applicable mitigation measures, monitoring plans and/or remediation have been recommended to ensure that any potential impacts are managed to acceptable levels to support the conservation goals, and protect threatened ecosystems, as per the mandate of NEM:BA.
Department of Water and Forestry (DWAF) Guidelines for the Delineation of Wetlands (2005) To delineate any wetland the following criteria are used in line with the Department of Water Affairs and Forestry (DWAF): A practical field procedure for identification and delineation of wetlands and riparian areas (2005). These	• This guideline is a tool for wetland practitioners, at all levels, to improve procedures for mapping wetlands using a set of standards for data collection and storage, so that data feeds into national-level databases such as

Legislation, Regulation, Guideline or By-Law	Applicability
criteria are: • Topographical location of the wetland in the landscape; • Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation (such as grey horizons, mottling streaks, hardpans, organic matter depositions, iron and manganese concretion resulting from prolonged saturation); • A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50 centimetre (cm) of the soil; and • The presence, at least occasionally, of water-loving (hydrophilic) plants (i.e. hydrophytes).	the National Wetland Inventory, and that informs national policy tools such as National Freshwater Ecosystem Priority Areas (NFEPA); and • It also includes tips on recognising, digitising, and classifying wetlands and human impacts on wetlands from desktop imagery and in the field.
Wetland Management Series (published by Water Research Commission (WRC, 2007) The WET-Management Series is a set of integrated tools that can be used to guide well-informed and effective wetland management and rehabilitation. The WET-Management tools are designed to be used at different spatial and institutional levels as needed, from national and provincial to the level of specific wetland sites involving individual landowners, to meet a range of wetland management and rehabilitation needs.	• Provides background information about wetlands and natural resource management as well as tools that can be used to guide decisions around wetland management.
National Freshwater Ecosystems Priority Areas (NFEPA, (Nel, et al., 2011)**)** The NFEPA project was 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 and Sanitation (DWS) formerly known as the Department of Water Affairs and Forestry (DWAF)), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The NFEPA project aimed 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 NFEPA study responded to the high levels of threat prevalent in a river, wetland, and estuary ecosystems of South Africa. It provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources. These	• Will help greatly to ensure that healthy freshwater ecosystems continue to form the cornerstone of the implementation of our water resource classification system and the development of catchment management strategies throughout the country. They also inform planning and decisions about land use and the expansion of the protected area network. By highlighting which ecosystems should remain in a healthy and well-functioning state, the maps provide a tool to guide our choices for the strategic development of water resources and to support sustainable development.

Legislation, Regulation, Guideline or By-Law	Applicability
strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or 'FEPAs'.	
SANBI, in collaboration with the DWS report on "Wetland offsets: a Best-Practice Guideline for South Africa" (SANBI and DWS, 2016) This guideline serves as a practical tool to aid in the consistent application of wetland offsets in South Africa. The guideline is primarily aimed at wetland offsets required as part of water use authorisation processes (e.g. in an application for a Water Use Licence under the National Water Act) where compensatory actions are required to achieve water resources management and biodiversity conservation objectives. The guideline is equally relevant for use in EIA processes (e.g. as part of the environmental authorisation process in terms of the NEMA). Wetland offsets are enduring measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse impacts on wetlands. They are implemented to address any anticipated significant residual impacts arising from development projects after appropriate avoidance, minimisation, and rehabilitation measures have been considered. The goals of wetland offsets are to achieve 'No Net Loss' and preferably a net gain concerning the full spectrum of functions and values provided by wetlands. These include: • Water resource and ecosystem service value, especially concerning regulating and supporting functions pertinent to water resource management and disaster risk reduction, such as flood control and water quality enhancement, but also including direct services such as food and water provisioning and cultural services such as spiritual, recreational, and cultural benefits that sustain communities; • Ecosystem conservation, especially in terms of meeting national, provincial and local objectives for habitat protection and avoiding a deterioration in ecosystem threat status; and • Species of conservation concern, to ensure that the status of threatened, rare or keystone wetland dependant species is maintained or improved.	• The guideline provides practical guidance for determining the size and characteristics of a wetland offset and determining the requirements for its implementation, once a decision on the need for a wetland offset has been taken through the water use authorisation process by the DWS.

5. Assumptions, Limitations, and Exclusions

The following limitations were encountered during this study:

- Findings and data analysis are based on the wetland assessment site visit completed in 2019, and again in 2021. The site visits were adequate to address the objectives of the study;
- Wetlands situated within the 500 m zone of regulation were assessed on a desktop level with very limited ground-truthing and some discrepancies within this zone may occur.
- This wetland and aquatic study forms part of a larger EIA and should be read in conjunction with the EIA and other related specialist studies; and
- Findings, recommendations, and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author and/or a relevant reference to the report by the inclusion of an appropriately detailed citation. Any recommendations, statements, or conclusions drawn from or based on this report must cite or reference this report. Whenever such recommendations, statements or conclusions form part of the main report relating to the current investigation, this report must be included in its entirety.

6. Details of the Specialists

- **Stephen Burton** is the Principal Ecologist at Stephen Burton Ecological. He is an ecologist with fields of interest in wetlands, fauna, and flora. In his 15-year career he has undertaken numerous wetland delineations and functional assessments, faunal assessments, wetland offset and rehabilitation assessments and audits, as well as project management of various environmental impact assessment and water use license projects. He has also worked extensively with wetland rehabilitation implementation projects for large scale developments.

7. Methodology

A detailed methodology used in the compilation of the Wetland and Aquatic Impact Assessment is described in Appendix A and is summarized in Figure 7-1 below.

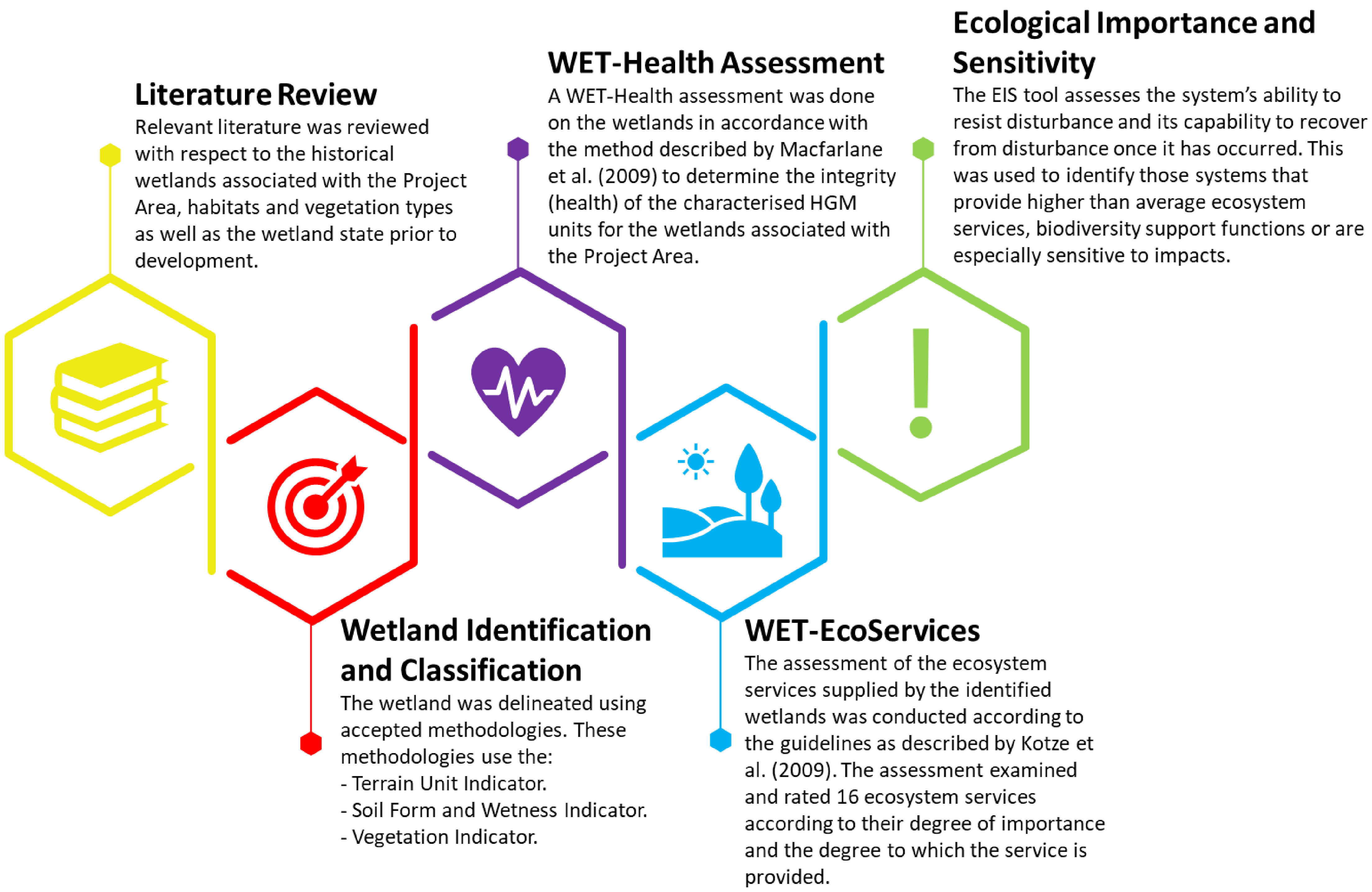


Figure 7-1: Methodology

8. Baseline Assessment

A desktop baseline environmental assessment was conducted and are discussed in Table 8-1 below.

Table 8-1: Baseline Assessment

Bioregional Context (Darwell, Smith, Tweddle, & Skelton, 2009)		**Characteristics of the Highveld Ecoregion** (Kleynhans, Thirion, & Moolman, 2005)		**Plant Species Characteristic of the Eastern Highveld Grasslands** (Mucina & Rutherford, 2012) **(**Figure 8-1**)**	
Political Region	Mpumalanga	Terrain Morphology	Plains; Low Relief; Plains; Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief.	Graminoid Species	*Aristida aequiglumis, A. congesta, A. junciformis subsp. galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. capensis, E. curvula, E. gummiflua, E. patentissima, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata* subsp*. eckloniana, Andropogon appendiculatus, A. schirensis, Bewsia biflora, Ctenium concinnum, Diheteropogon amplectens, Harpochloa falx, Panicum natalense, Rendlia altera, Schizachyrium sanguineum, Setaria nigrirostris, Urelytrum agropyroides.*
Level 1 Ecoregion	Highveld	Vegetation Types	Mixed Bushveld (limited); Rocky Highveld Grassland; Dry Sandy Highveld Grassland; Dry Clay Highveld Grassland; Moist Cool Highveld Grassland; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited).	Herb Species	*Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes, Pentanisia prunelloides* subsp. *latifolia, Selago densiflora, Senecio coronatus, Vernonia oligocephala, Wahlenbergia undulata.*
Climate	The climate is characterised by a temperate climate with hot summers and cold, dry winters. During the summer months (December, January and February), the average daily temperature is 27°C. In winter (June, July and August), the daily average temperature is 4°C. Most (65%) of the rainfall in the area occurs during the summer, largely as thunderstorms. The rainfall averages between 700 and 750 mm per annum.			Geophytic Herb Species	*Gladiolus crassifolius, Haemanthus humilis subsp. hirsutus, Hypoxis rigidula* var. *pilosissima, Ledebouria ovatifolia.*
Freshwater Ecoregion	Southern Temperate Highveld	Altitude (m.a.m.s.l.) (modifying)	1 100-2 100, 2 100-2 300 (very limited)		
Geomorphic Province	Mpumalanga Highlands	Mean Annual Precipitation (MAP) (mm) (Secondary)	400 to 1 000	Succulent Herb Species	*Aloe ecklonis.*
Vegetation Type	Eastern Highveld Grassland	Coefficient of Variation (% MAP)	<20 to 35	Low Shrub Species	*Anthospermum rigidum* subsp. *pumilum, Seriphium plumosum.*

<table>
<tr><td>WMA</td><td>Olifants</td><td>Rainfall Seasonality</td><td>Early to late summer</td><td>Status</td><td>Vulnerable.</td></tr>
<tr><td>Sub-WMA</td><td>Upper Olifants</td><td>Mean Annual Temp. (°C)</td><td>12 to 20</td><td colspan="2">MBSP Category (MTPA, 2014) (Figure 8-2)</td></tr>
<tr><td>Secondary Catchment</td><td>B1</td><td>Mean Daily Summer Temp. (°C): February</td><td>10 to 32</td><td colspan="2" rowspan="2">• CBA irreplaceable;
• CBA optimal;
• ESA local corridor;
• Other natural areas;
• Moderately modified and old lands; and
• Heavily modified areas.</td></tr>
<tr><td>Quaternary Catchment (Figure 8-4)</td><td>B11A and B11D</td><td>Mean Daily Winter Temp. (°C): July</td><td>-2 to 22</td></tr>
<tr><td>Watercourse</td><td>Olifants Watershed</td><td>Median Annual Simulated Runoff (mm)</td><td>5 to >250</td><td colspan="2">NFEPA Wetland Classification (Nel, et al., 2011) (Figure 8-3)</td></tr>
<tr><td>NFEPA Wetlands</td><td colspan="5">Channelled valley bottoms, Unchanneled valley bottoms, floodplains and seeps.</td></tr>
<tr><td>River FEPA</td><td colspan="5">Not a FEPA catchment, classified as a Sub-quaternary catchment.</td></tr>
<tr><td>Topography</td><td colspan="3">The topography is that of undulating plains and gentle slopes. It is located on the Highveld plateau and the Project Area lies between 1515m and 1660m above sea level. Drainage occurs predominantly in a southern direction of the Project Area. Valley slopes are generally flat with gradients between 1:20 and 1:40. Slopes steeper than this gradient are found near rivers in the Project Area.</td><td>Geology</td><td>The Project Area is situated in the Witbank coalfield within the Karoo Supergroup. The Karoo Supergroup within the Project Area comprises the Ecca Group as well as the Vryheid Formation. The Ecca Group is where rich coal deposits are found.
The lithology can be stratigraphically classified, and includes sandstone, shale and coal.</td></tr>
</table>

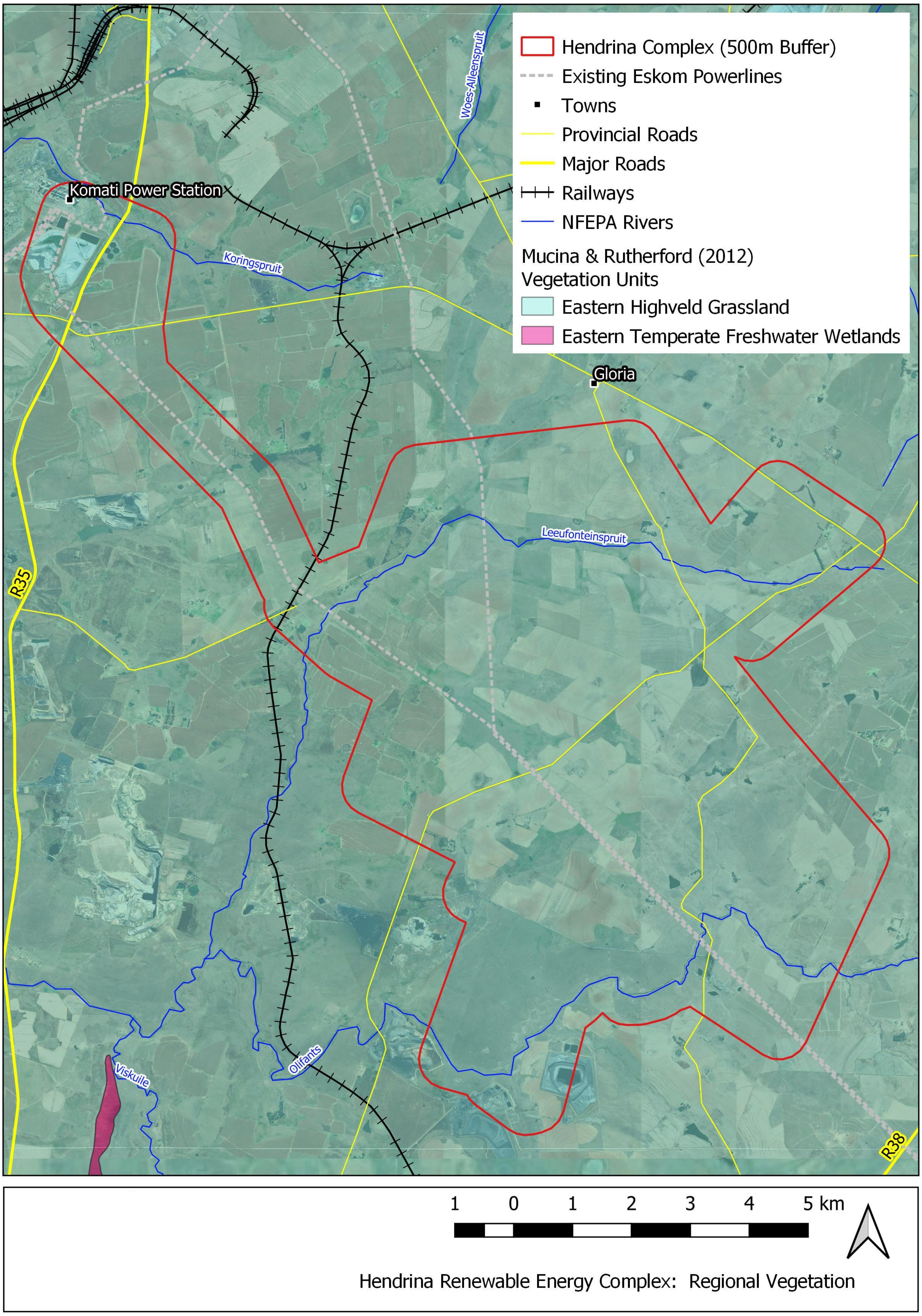


Figure 8-1: Regional Vegetation

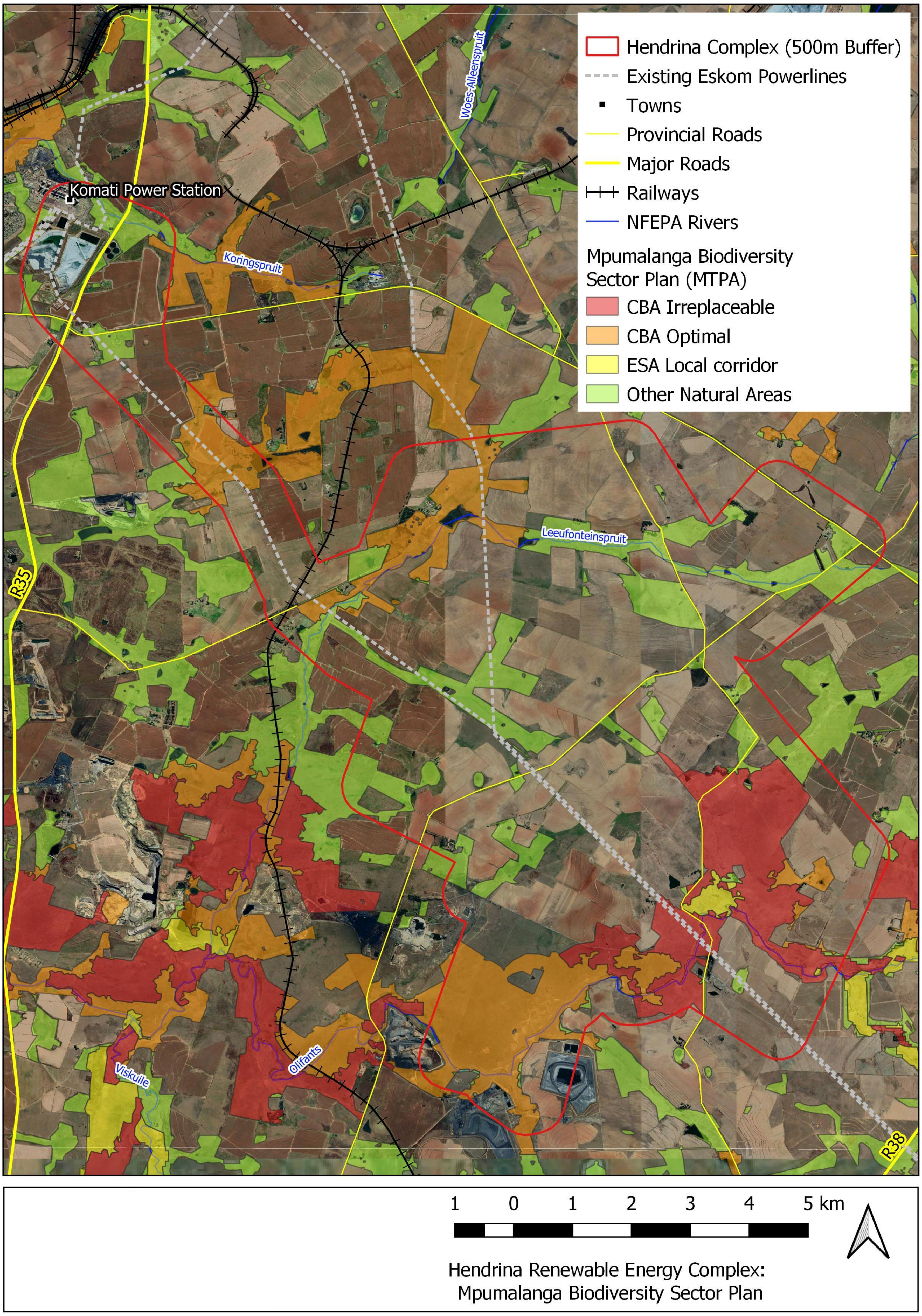


Figure 8-2: Mpumalanga Biodiversity Sector Plan

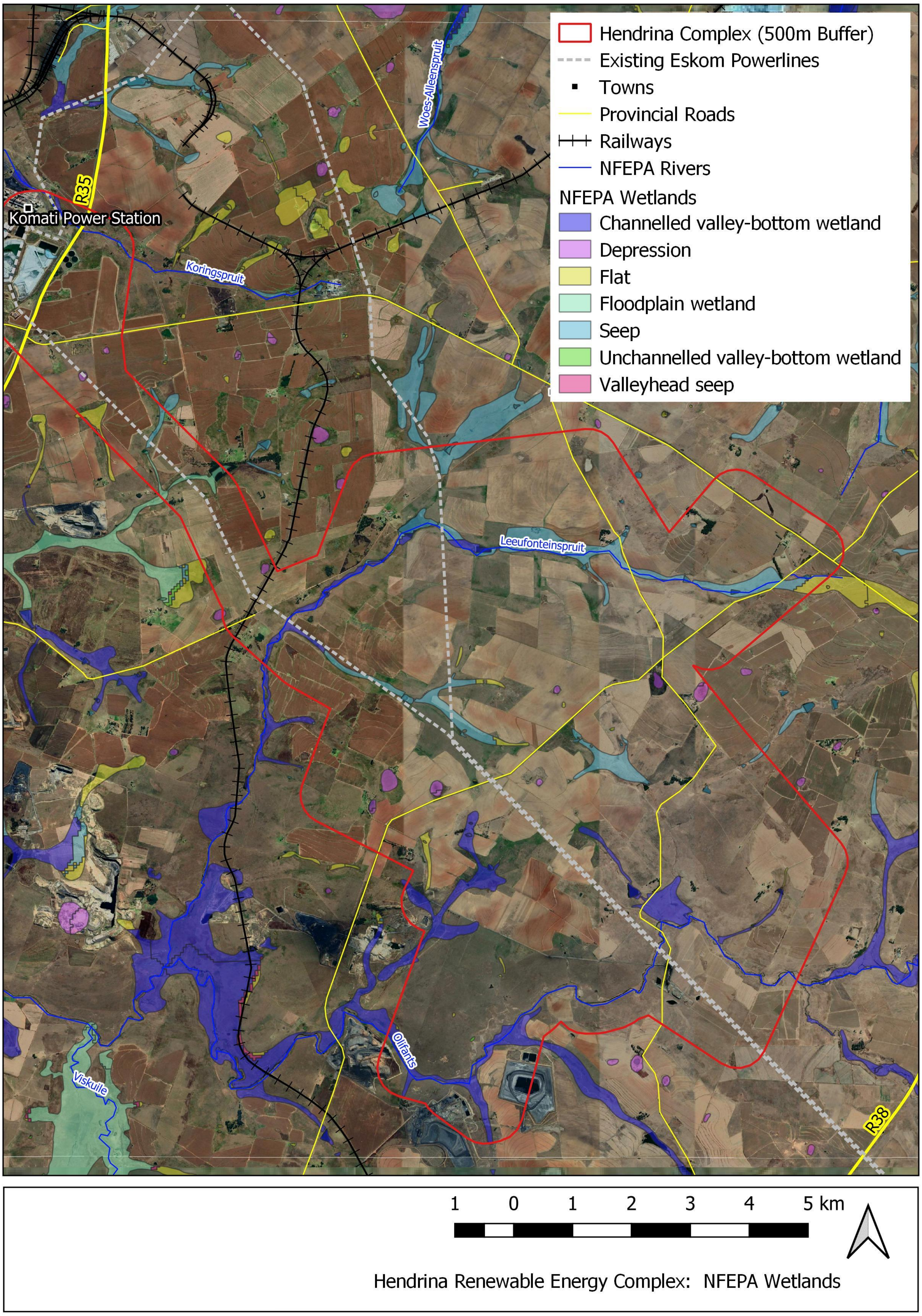


Figure 8-3: NFEPA Wetlands

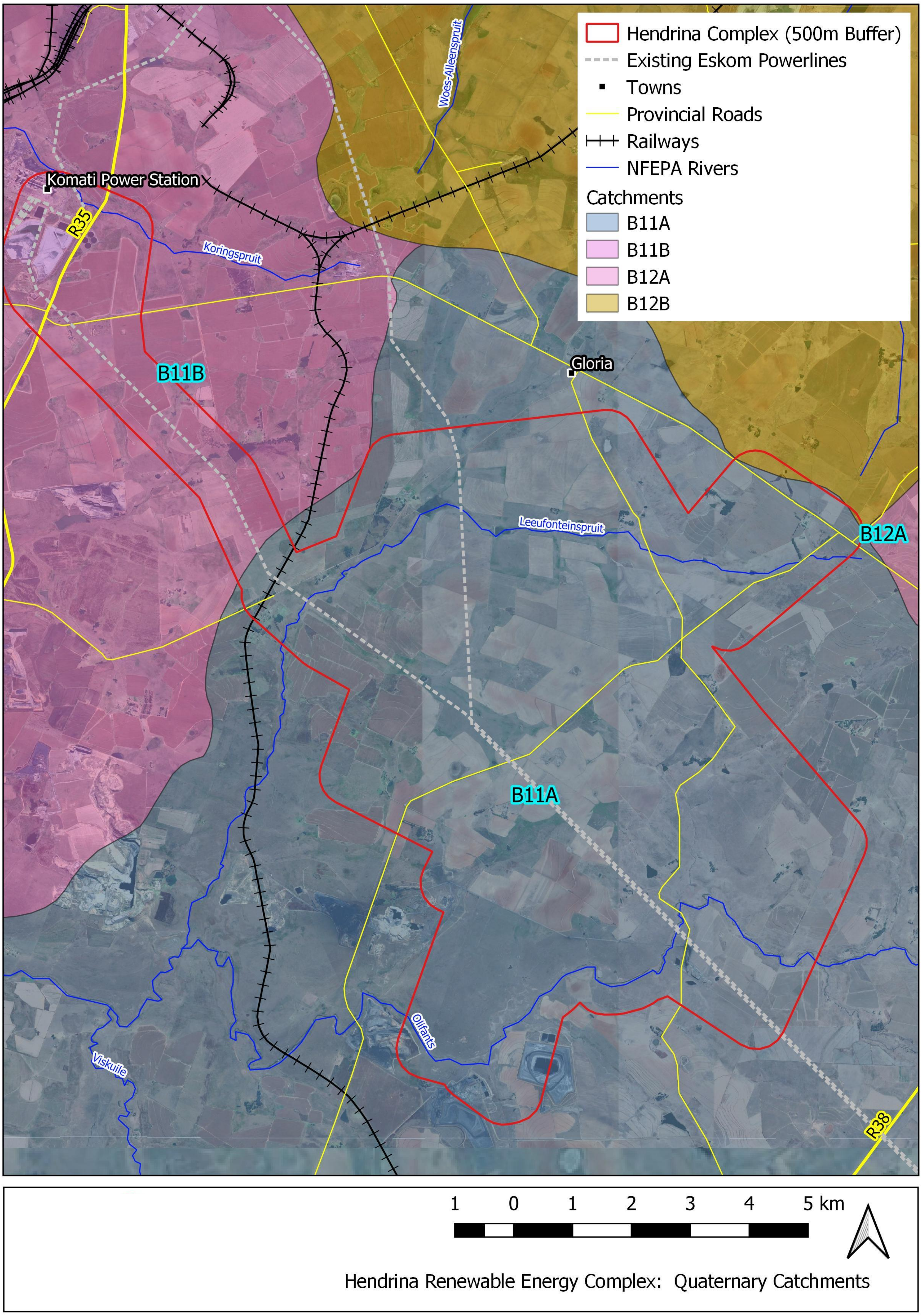


Figure 8-4: Quaternary Catchments

9. Results and Discussion

Site visits were conducted in November 2019 (summer season) and August 2021 (winter season) to assess the ecological integrity, delineate the wetlands, and determine their PES, ES and EIS state. The timing of the site visits is considered adequate to determine the above parameters, and no additional site visits are necessary. This report is based on these findings and available information, to identify the potential impacts the proposed Complex will have on the wetlands associated with the Project Area.

9.1. Wetland Delineation and Hydrogeomorphic Unit Identification

During the desktop and field assessment, 1722.32 ha of wetlands were identified and delineated within the Project Area using the approved methodology by the Department of Water Affairs and Forestry (2005). Surface infrastructure has been finalised (but may still be slightly shifted during the detail design phase based on the findings of various specialists and their pre-construction walk-throughs) and as such the impact of the proposed layouts for all infrastructure are assessed in this report. Thirty-six (36) HGM units were identified and categorized based on terrain units. These include hillslope seep wetlands (Seeps), unchanneled valley bottom wetlands (UVBs), and channelled valley bottom wetlands (CVBs). Land use activities and in-field studies have shown that some of the systems are similar from a catchment management perspective as they would be subject to similar overall land uses impacts. Therefore, it was considered practical to group the HGM units by systems that have similar land use and impacts to calculate more accurate PES and EIS scores. Seven HGM units were identified and assessed. The extent of the combined HGM units are indicated below (Table 9-1).

Table 9-1: Combined HGM Units

No.	Name	Acronym	Area (Ha)
1	Channelled Valley Bottoms	CVBs	168.87
2	Channelled Valley Bottoms (fragmented)	CVBs Fragmented	107.71
3	Unchanneled Valley Bottoms	UVBs	635.99
4	Unchanneled Valley Bottoms (fragmented)	UVBs Fragmented	352.70
5	Hillslope Seep (Agriculture)	HS Agriculture	324.93
6	Hillslope Seep (Fragmented)	HS Fragmented	45.98
7	Hillslope Seep (Unimpacted)	HS Unimpacted	86.14
Total wetlands			**1722.32**

* Artificial wetlands, dams and borrow pits are not regarded as HGM units

Figure 9-1: Wetland Delineations

9.2. Terrain Indicator

The terrain unit indicator was used extensively in the identification of wetlands and their various HGM units. Use was made of topographical maps and five-meter contours in the preliminary identification of wetland areas. Further to this, the underlying geology and geohydrology of the area were investigated to gain a greater understanding of the potential movement of subsurface water and potential areas of daylighting.

Wetlands in the crest and mid-slope were typically characterized as Seeps and UVBs. Wetlands in the middle slope, foot-slope, and bottomland typically identified as CVBs and UVB's. Scattered dams and a large dam within the main CVB on the east of the Project Area were identified. These dams are typically used for non-commercial irrigation, cattle watering, and domestic use.

Some of the wetlands were unimpacted by agricultural activities, whereas some wetlands were fragmented, or cultivated.

Figure 9-2: Terrain Indicators

9.3. Vegetation Indicator

Vegetation structures of the various wetlands and their respective HGM units were relatively variable. Large portions of the natural vegetation structures had been historically altered due to the predominant surrounding land use activities. These included areas of land cleared for crops and the use of the land for grazing and pastures.

Wetland plant species used in the identification and delineation of the various HGM units observed included the species listed in Table 9-2.

Table 9-2: Vegetation Indicators

Obligate wetland species	OWS	*Agrostis lachnantha*, *Leersia hexandra, Phragmites australis, Paspalum distichum*
Facultative wetland species	FWS	*Andropogon eucomis, Hemarrthria altissima, Hyparrhenia tamba, Paspalum urvillei*
Seasonal wetland species	SWS	*Setaria sphacelata; Aristida junciformis, Themeda triandra, Eragrostis gummiflua*
Temporary wetland species	TWS	*Imperata cylindrica; Paspalum dilatatum*
Mostly wetland dependant species	MWS	*Typha capensis, Juncus* sp., *Cyperus* sp., *Persecaria* sp.

Stands of *Euca*lyptus *grandis* and *Pinus patula* were identified within the Project Area. Isolated areas of *Acacia mearnsii* were also observed. It is regarded as likely that these areas may have resulted in serious modifications to historically wet or moist grasslands, VBs, and seeps, thus influencing the wetland delineation at these points.

Figure 9-3: Vegetation Indicators

9.4. Soil Indicator

Soil indicators including soil forms and soil wetness, such as mottling and gleying of soils, were used extensively throughout the Project Area to identify and confirm wetlands.

The wetlands are used for cattle grazing and perennial grasslands. These soils are somewhat limited for cultivation and highly mobile (high erosion probability).

Hydromorphic soils are significant to the overall site sensitivity analysis. The low angled topographic slopes and resulting wide expansive drainage lines coupled with the presence of restrictive sedimentary layers (sandstone predominantly) have resulted in proportionately much larger areas of transition zone moist grasslands and wet based soils that meet the wetland classification both pedologically as well as ecologically.

Figure 9-4: Soil Indicators

9.5. Wetland Ecological Health Assessment

The PES of the seven HGM units were rated to have an ecological state of **'Moderately Modified'** to **'Largely Modified'**. According to the integrity (health) method described by Kotze et al. (2007):

- A **category C** wetland has **Moderate** changes to its ecosystem processes, and loss of natural habitat has taken place; however, the natural habitat remains predominantly intact; and
- A **category D** wetland has **Large** modifications to the natural ecosystem processes and loss of natural habitat and biota.

Each HGM unit, PES score, and its health; hydrological, vegetation, and geomorphological health are tabulated below (Table 9-3) whereas the validations for the PES values are discussed below.

Table 9-3: Present Ecological State Scores

Number	HGM Unit Group	Hydrology	Geomorphology	Vegetation	Combined PES	PES Category
1	CVBs	7.0	1.4	5.9	5.1	**D**
2	CVBs Fragmented	4.0	4.0	5.4	4.4	**D**
3	UVBs	2.0	0.5	6.2	2.8	**C**
4	UVBs Fragmented	3.0	0.3	7.8	3.6	**C**
5	HS Agriculture	2.0	0.6	9.0	3.6	**C**
6	HS Fragmented	4.0	1.2	7.5	4.2	**D**
7	HS Unimpacted	1.0	0.2	7.0	2.5	**C**

9.6. Validation (2019 and 2021)

Channeled Valley Bottoms (D) – The CVBs have mainly been impacted by agropastoral activities, including cattle grazing, dams, and cultivation. Large dams exist within the CVB, together with evidence of cattle trampling, erosion, and compaction. This impacted the natural hydrology, ground cover, and changes to the natural vegetation.

Channeled Valley Bottoms (fragmented) (D) – In addition to the aforementioned, some of the CVBs have been fragmented by linear infrastructure, including roads, conveyors, powerlines, and fence lines. Some systems have been also been fragmented by agropastoral activities. Fragmentation of wetlands impacts the natural habitat, functionality, and health of a wetland. Linear infrastructure within wetlands is prone to creating erosion, channeling, drying out of wetlands, and increased AIPs.

Unchanneled Valley Bottoms (C) – The UVBs within the Project Area were dominantly used for cattle grazing. There were no clear signs of channeling, erosion, or extensive cattle trampling. The vegetation was stable with little changes to water inputs to the systems. The systems were in a stable condition, well-functioning, and creating habitat for various fauna and flora species.

Unchanneled Valley Bottoms (fragmented) (C) – Regardless of some of the UVBs being moderately impacted, some of the systems were fragmented by agropastoral and linear infrastructure. Dams were also indicated in some of the systems. The fragmentation of the UVBs changes the natural habitat and health of the systems.

Hillslope Seep (Agriculture) (C) – The majority of the Hillslope Seep wetlands were used for agropastoral activities, including commercial cultivation and cattle grazing. The soils within Hillslope Seep wetlands (Hutton, Clovelly) are typically used for cultivation due do the decent water-holding-capacity, fertility, and soil depth. However, cultivation changes the natural vegetation, hydrological functioning as well as the geomorphology by ploughing, ripping, and tillage.

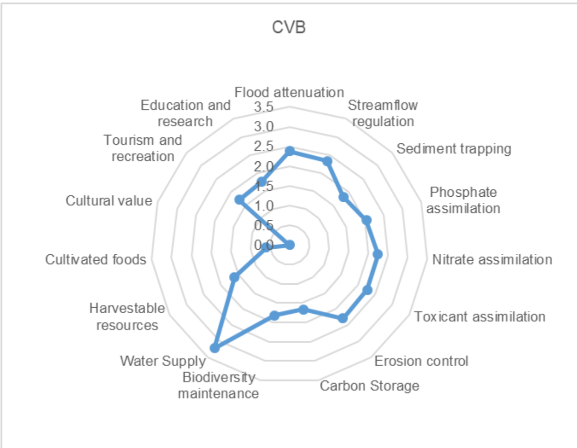
Hillslope Seep (Fragmented) (D) – Regardless of some Hillslope Seeps being impacted by agropastoral activities, some of the seeps have been impacted by linear infrastructure, including roads, dams, and powerlines. Some sections of the seeps have almost completely been removed by these activities or completely separated and cut off from the rest of the system.

Hillslope Seep (Unimpacted) (C) – Unimpacted Hillslope Seep wetlands were recorded within the Project Area. These wetlands were mainly used for cattle grazing, however, was well regulated and little erosion and impacts on the vegetation and geomorphology were noted.

9.7. Wetland Ecological Services

The general ES and natural features of the wetlands were assessed in terms of functioning and the overall importance of each HGM unit was determined at a landscape level. Figure 9-5 represents radial plots showing the relative importance of each ecosystem service and lists the summary of the scores obtained.

As indicated in Table 9-4 and Figure 9-5, sediment trapping, phosphate assimilation, nitrate assimilation, and toxicant assimilation are the dominant ecological services provided by the HGM units. The unimpacted Hillslope Seeps and CVBs are providing biodiversity maintenance due to the fauna and flora importance. The CVBs are important for water supply, supplying all agropastoral activities in the area (dams, cattle, irrigation, domestic use).

<table>
<tr><th>Channeled Valley Bottoms</th><th>Channeled Valley Bottoms (fragmented)</th></tr>
<tr><td>


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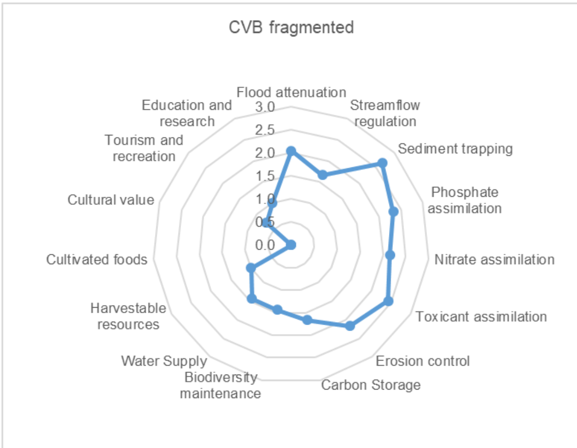
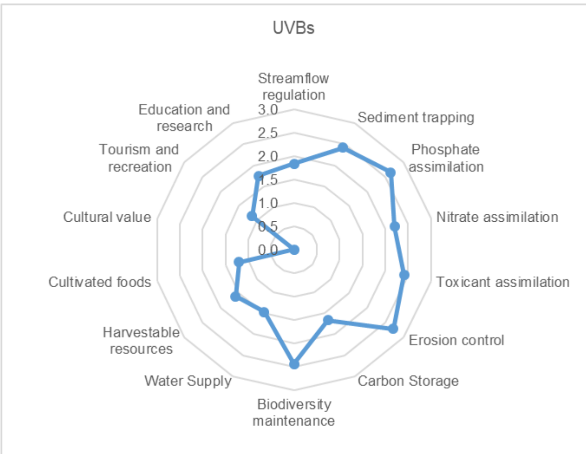


</td></tr>
<tr><th>Unchanneled Valley Bottoms</th><th>Unchanneled Valley Bottoms (fragmented)</th></tr>
<tr><td>


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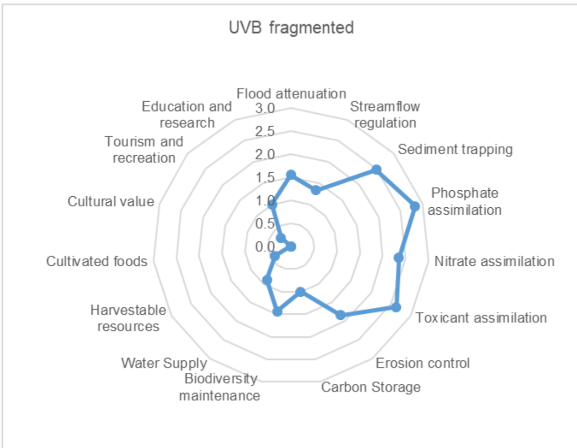


</td></tr>
</table>

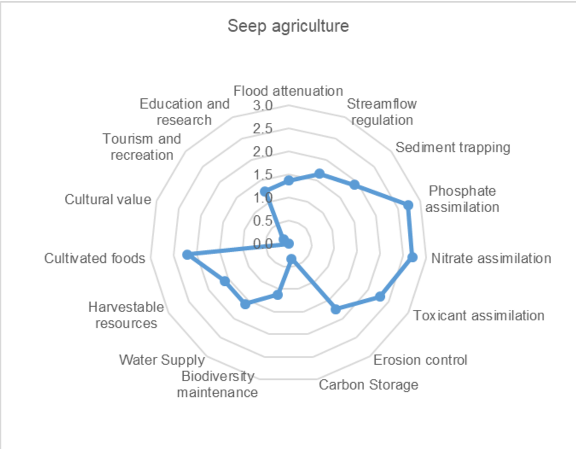
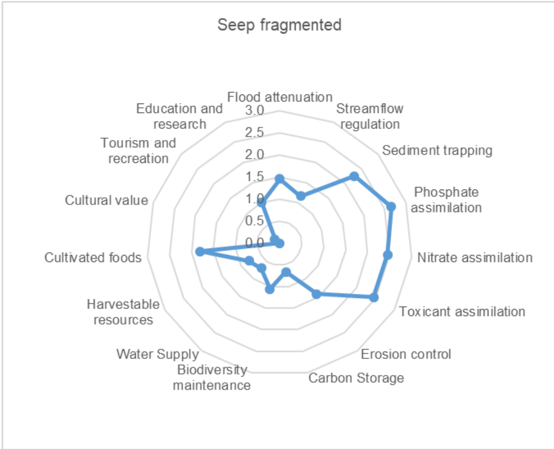
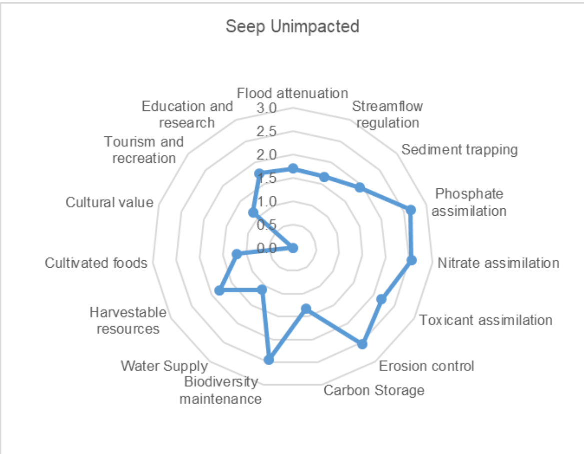
Hillslope Seep (Agriculture)	Hillslope Seep (Fragmented)
	
Hillslope Seep (Unimpacted)	
	

Figure 9-5: Ecoservices Radial Plots

Table 9-4: Ecological Services Scores

Ecosystem service	1	2	3	4	5	6	7
	HS fragmented	UVB fragmented	CVB fragmented	HS agriculture	HS unimpacted	UVBs	CVB
Flood attenuation	1.5	1.6	2.1	1.4	1.7	1.9	2.4
Streamflow regulation	1.2	1.3	1.7	1.7	1.7	1.8	2.3
Sediment trapping	2.3	2.5	2.7	1.9	1.9	2.4	1.8
Phosphate assimilation	2.7	2.8	2.3	2.7	2.7	2.6	2.0
Nitrate assimilation	2.5	2.4	2.2	2.7	2.6	2.2	2.3
Toxicant assimilation	2.5	2.6	2.4	2.3	2.2	2.4	2.3
Erosion control	1.4	1.8	2.2	1.8	2.5	2.7	2.3
Carbon Storage	0.7	1.0	1.7	0.3	1.3	1.7	1.7
Biodiversity maintenance	1.1	1.4	1.4	1.1	2.4	2.4	1.8
Water Supply	0.7	0.9	1.4	1.6	1.1	1.5	3.2
Harvestable resources	0.8	0.4	1.0	1.6	1.8	1.6	1.6
Cultivated foods	1.8	0.0	0.0	2.2	1.2	1.2	0.6
Cultural value	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tourism and recreation	0.1	0.3	0.7	0.1	1.1	1.1	1.7
Education and research	1.0	1.0	1.0	1.3	1.8	1.8	1.8
SUM	**20.0**	**20.0**	**22.7**	**22.7**	**26.0**	**27.4**	**27.8**
Average score	**1.3**	**1.3**	**1.5**	**1.5**	**1.7**	**1.8**	**1.9**
	Intermediate	**Intermediate**	**Intermediate**	**Intermediate**	**Intermediate**	**Intermediate**	**Intermediate**

9.8. Ecological Importance and Sensitivity

The EIS of a wetland is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity refers to the wetland's ability to resist disturbance and is the capability to recover from disturbance that has occurred (DWAF, 1999). Table 9-5 indicates each HGM unit group and EIS Category.

The following was derived from the data:

- The UVBs Fragmented, HS Agriculture, and HS Fragmented were regarded as **'Moderate (C)'**. This specifies that the wetlands are ecologically important, however sensitive on a provincial and local scale. The integrity and biodiversity of these wetlands are sensitive to low flow and habitat modifications as a result of decades of mining, agriculture, and the introduction of AIPs. These wetlands play a small role in moderating the quantity and quality of water; and
- The CVBs, CVBs Fragmented, UVBs, and HS Unimpacted were considered **'High (B)'**. This suggests that these systems are of ecological importance and are sensitive. The biodiversity of the systems is sensitive to modifications to the habitat and low flows. These systems play an important role in moderating the quality and quantity of water in larger systems.

The HGM units assessed play an important role in moderating the quantity and quality of water of major rivers and tributaries. However, the river system has been modified by anthropological activities, specifically mining and agropastoral activities. The outcomes are changes in the water input volumes and pattern as well as water distribution and retention patterns of water passing through the wetlands. Additionally, linear infrastructure, such as roads, conveyor, power lines, and fences change runoff and stormwater as well as causing fragmentation of the natural habitat. Agricultural deposits in a form of phosphates and nitrates using fertilisers or pesticides decrease the quality of water in the wetlands. Roads that have been built within the wetlands increases run-off from these hardened surfaces.

Table 9-5: Ecological Importance and Sensitivity Scores

HGM Number	HGM Unit	Ecological Importance & Sensitivity	Hydrological/ Functional Importance	Direct Human Benefits	Final EIS	EIS Category
1	CVBs	1.8	2.1	1.5	2.1	High (B)
2	CVBs Fragmented	1.7	2.1	0.7	2.1	High (B)
3	UVBs	2.3	2.2	1.2	2.3	High (B)
4	UVBs Fragmented	2.0	2.0	0.3	2.0	Moderate (C)
5	HS Agriculture	1.3	1.8	1.1	1.8	Moderate (C)

HGM Number	HGM Unit	Ecological Importance & Sensitivity	Hydrological/ Functional Importance	Direct Human Benefits	Final EIS	EIS Category
6	HS Fragmented	1.7	1.8	0.7	1.8	Moderate (C)
7	HS Unimpacted	2.3	2.1	1.2	2.3	High (B)

9.9. Sensitivity Mapping

The NEMA (Act 107 of 1998) and the NWA (Act 36 of 1998) stipulates that no activity can take place within the regulated zone of a wetland without the relevant authorisation and no diversion, alteration of banks or impeding of flow in watercourses (including wetlands) may occur without a Water Use Authorisation (WUA). A WUA is required if any development or a water use (according to Section 21 (c) and (i)) takes place within 500 m of a watercourse.

The 100 m buffer and 500 m zone of regulation in terms of GN R.1199 were assessed to indicate sensitive areas that will require an authorisation in terms of the NWA if any proposed infrastructure falls within these areas. Figure 9-6 indicates the wetlands onsite with the proposed infrastructure areas.

Based on the PES, ES and EIS analysis of the wetlands, the following was derived.

Table 9-6: Sensitive Area

HGM Unit Number	HGM Unit	PES	ES	EIS	Sensitivity
1	CVBs	D	1.3	2.1	Medium
2	CVBs Fragmented	D	1.3	2.1	Medium
3	UVBs	C	1.5	2.3	High
4	UVBs Fragmented	C	1.5	2.0	High
5	HS Agriculture	C	1.7	1.8	Medium
6	HS Fragmented	D	1.8	1.8	Low
7	HS Unimpacted	C	1.9	2.3	Medium

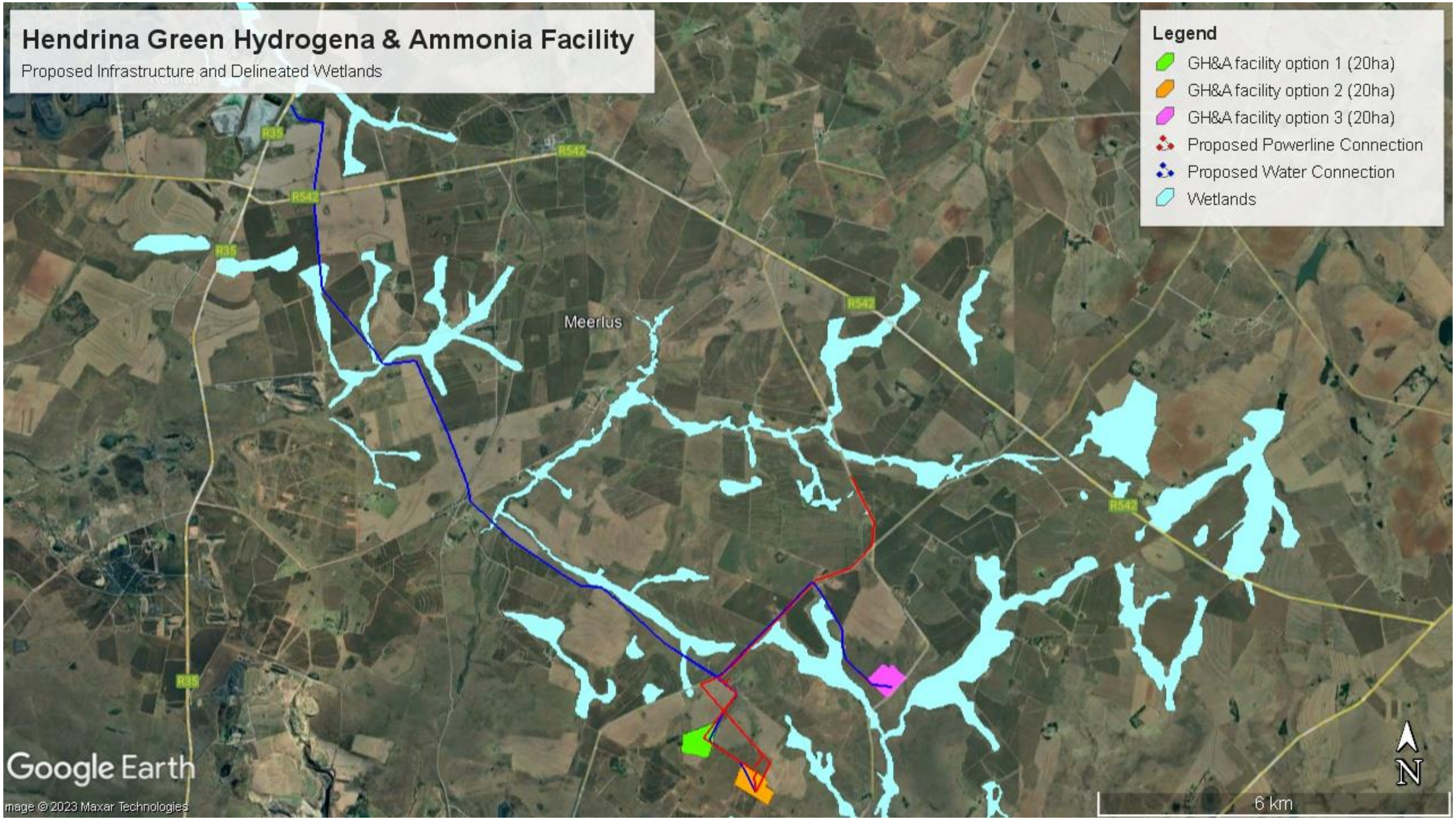


Figure 9-6: Wetlands Delineated and Proposed Infrastructure

10. Impact Assessment

This section aims to rate the significance of the identified potential impacts of pre-mitigation and post-mitigation. The potential impacts identified in this section are a result of both the environment in which the proposed project activities take place, as well as the actual activities. The potential impacts are discussed per aspect and per phase of the project including the Construction, Operational, and Decommissioning Phases.

The most likely construction related impacts are the loss of wetland habitat through the clearing of wetland for construction of roads, electrical cables, water pipelines and electrical powerlines. In addition, the potential exists for hydrocarbon and concrete spills from construction activities to occur within wetland areas that could potentially lead to soil, water and wetland contamination.

During the operational phase of the project, the most likely impacts will be with regards to the possible hydrocarbon spills from maintenance activities and siltation of wetlands by runoff from roads and other infrastructure. These could potentially lead to soil, water and wetland contamination, as well as sedimentation of wetlands.

During the decommissioning phase, the most likely impacts will again be related to the loss of wetland habitat during the removal of infrastructure, and the possible spillage of hydrocarbons into wetland areas and the sedimentation of wetlands from erosion related to infrastructure removal.

The full impact assessment table is available in Appendix B.

The construction of the Hendrina Green Hydrogen and Ammonia facility will require the crossing of several wetland systems by roads, cables, water supply pipelines, and the construction of foundations for the facility infrastructure (these have been designed to fall outside of delineated wetland areas). A summary of potential impacts, and the associated scores in contained in Table 10-1 below, while the impact / risk description and mitigation / management actions are contained in Table 10-2 below.

Table 10-1: Hendrina Green Hydrogen and Ammonia Facility Impact Scores

Phase	Activity	Impact Rating before Mitigation	Impact Rating after Mitigation
Construction	Wetland destruction	Moderate (48)	Low (27)
	Hydrocarbon & Waste Spills	Moderate (33)	Low (18)
Operational	Use of existing haul roads and vehicle movement	Moderate (36)	Low (18)
	Hydrocarbon & Waste Spills	Moderate (33)	Low (18)
Decommissioning	Rehabilitation – rehabilitation mainly consists of spreading and landscaping of the land, and re-vegetation.	Moderate (39)	Low (18)
	Post-closure monitoring and rehabilitation.	Low (27)	Low (16)

Table 10-2: Hendrina Green Hydrogen and Ammonia Impact Description and Mitigation

Phase	Activity	Impact / Risk Description	Management Actions
Construction	Wetland destruction	• Destruction of wetland for the construction of roads, pipelines and power cables in preparation for construction activity will definitely occur on at least the development footprint, where protected ecosystems are present. This will result in the permanent loss of the affected portions of the system if not mitigated, and may lead to the following: Head cut erosion and channel forming from the roads (culverts); Increased erosion and consequently sedimentation potential into wetlands; and Loss of vegetation and habitat.	• Where the destruction of wetlands is unavoidable (i.e. at road crossings), disturbance must be minimised and suitably rehabilitated; • At areas where new road crossings have been designed, these roads should cross wetland or river features at the narrowest point and a 90-degree angle with suitable drainage designed into the relevant bridge/culvert crossing; • Environmental Compliance Officer (ECO) to be present during vegetation clearing to prevent unnecessary clearing of extensive areas not part of the direct footprint area; • Bare land surfaces must be vegetated to limit erosion from surface runoff associated with infrastructure areas. Revegetate disturbed areas immediately after construction; • Stockpiles should be monitored to ensure no runoff, erosion and sedimentation into the adjacent areas, especially the wetlands and freshwater systems; and • A Storm Water Management Plan (SWMP) should be designed and implemented during the construction phase. This should consider wetlands associated with the new developments/infrastructure which should divert stormwater and runoff away from the surface infrastructure and back into natural watercourses to maintain catchment yield as far as possible.
	Hydrocarbon & Waste Spills	• Contamination from Hydrocarbon waste (lubricants, oils, explosives, and fuels); Contamination from sewage and wastewater; and Changes to wetland health and biodiversity.	• All vehicle maintenance must occur within designated areas; • All vehicles must be regularly inspected for leaks; • All spills must be cleaned up immediately to prevent contaminants to enter the wetlands; • Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions and health and safety requirements;

Phase	Activity	Impact / Risk Description	Management Actions
			• Re-fuelling and maintenance must take place on a sealed surface area away from wetlands to prevent the ingress of hydrocarbons into topsoil; and • The edge of the wetland and a 100m buffer or 1:100 flood line buffer should be demarcated in the field with wooden stakes painted white as no-go zones that will last for the duration of the construction phase.
Operational	Use of existing roads and vehicle movement	• Head cut erosion and channel forming from the roads (culverts); and Increased erosion and consequently sedimentation potential into wetlands; Loss of vegetation and habitat; and Wetland fragmentation.	• Quarterly (four times a year) inspections by the site environmental officer to ensure no unnecessary impact to the freshwater resources present, and if so that a remedy is put in place as soon as possible; • All stormwater infrastructure must be maintained .
	Hydrocarbon & Waste Spills	• Contamination from Hydrocarbon waste (lubricants, oils explosives, and fuels); and Changes to wetland health and biodiversity.	• All vehicle maintenance must occur within designated areas; • All vehicles must be regularly inspected for leaks; • All spills must be cleaned up immediately to prevent contaminants to enter the wetlands; • Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions; and • Re-fuelling and maintenance must take place on a sealed surface area away from wetlands to prevent the ingress of hydrocarbons into topsoil.
Decommissioning	Rehabilitation – rehabilitation mainly consists of profiling and landscaping of the land, and re-vegetation.	• Uneven surfaces and topographies, causing water ponding and changes to the hydrogeomorphology of the wetlands; The proliferation of AIPs; Exposure of soils and subsequent compaction, erosion, and sedimentation into the wetlands; Deterioration of water quality; and Potential spillage of hydrocarbons such as oils, fuels, and grease, thus contamination of wetlands.	• Decommissioning should occur in the dry season where possible to avoid high rainfall events that could lead to increased runoff, erosion, contamination and sedimentation of the wetlands; • Stormwater must be diverted from decommissioning activities; All areas of increased ecological sensitivity outside of the project footprint should be designated as "No-Go" areas and be off-limits to all unauthorised vehicles and personnel; • Actively landscape and re-vegetate disturbed areas as soon as possible to avoid loss of soil, organic material, and sedimentation into wetland areas; and • Implement and maintain a Wetland and AIPs Plan for the duration of the decommissioning phase
	Wetland degradation	• Failure to implement monitoring and management resulting in wetland degradation.	• No vehicles or heavy machinery should be allowed to drive indiscriminately within any wetland areas or their buffer areas. All vehicles must remain on demarcated roads; and • Wetland monitoring (See Section 11) must be carried out after the decommissioning phase to ensure the success of wetland rehabilitation.

11. Wetland Monitoring Programme

As the proposed Project Area includes large areas of wetland habitat, it is recommended that WET-health and WET-Ecoservices tools be used to re-evaluate PES, ES, and EIS as follows:

- A suitably qualified wetland specialist should assess the health of the wetlands at the end of the Construction Phase;
- Annually (one-yearly) upon closure and decommissioning for at least three years to ensure no emerging impacts are identified, which may need to be addressed.

Table 11-1: Wetland Monitoring Programme

Monitoring Element **Wetlands**	**Comment**	**Requirements**	**Frequency**	**Responsibility**
• Wetland Extent; • Wetland integrity; • Wetland functionality; • Soil disturbances; • Linear infrastructure; • Discharge points; • Erosion status; • Surface water quality and quantity; • Vegetation basal cover; • Vegetation species diversity.	• A basic level 1 health assessment is necessary to detect changes to the health of vegetation (including alien invasion), hydrology, and geomorphology of the wetlands associated with the site. This allows for the determination of the Present Ecological State (PES); and • The EIS of the wetlands should be determined to detect any alteration to functionality.	• The transportation of soils or other substrates infested with AIPs should be strictly controlled; • Continuous erosion monitoring of rehabilitated areas should be undertaken and zones with excessive erosion should be identified. Erosion can either be quantified or the occurrence there-of simply recorded for the specific location. Immediate rectification of erosion points and ongoing prevention of future erosion must be prioritised; and • The functionality of the surface water drainage systems should be assessed at the end of construction, and again at the end of the rehabilitation phase. This should preferably be done after the first major rains of the season and then after any major storm. An assessment of the wetlands will ensure that the drainage on the recreated profile matches the rehabilitation plan as well as to detect if a system is not functioning at preconstruction levels.	• Erosion monitoring to be undertaken monthly during the construction and decommissioning phases. • Wetland functionality to be undertaken at the end of the Construction Phase; and • Wetland functionality to be undertaken upon completion of the decommissioning phase.	• A wetland specialist must conduct the wetland monitoring at the end of construction and upon completion of the rehabilitation phase and provide a short memo to the Project Proponent (PP) and the Environmental Control Officer (ECO); • The PP and the ECO should ensure erosion monitoring on-site; • ECO to give training to sub-contractors and all workers on the operational procedures and mitigation measures; and • The PP and the ECO should be responsible to determine the effectiveness of erosion control structures.

12. Reasoned Specialist Opinion

The proposed GH&A facility will have **Low** impacts on the wetland environment when the proposed mitigation and management plans are considered. In addition, the upgrading of existing roads and wetland crossing potentially also pose a **Low** risk of impacts to the aquatic systems onsite. The installation of electrical cables and water pipelines will potentially have **low** impacts to the freshwater resources within the study boundary, The Department of Water and Sanitation should be approached with regards to the applicability of a Water Use Authorisation. Solitary sections of the wetlands will be impacted due to infrastructure access roads, underground cables, pipelines, electrical powerline infrastructure, and buildings, which can be mitigated and planned.

In terms of alternatives, the preferred site option from a wetland and aquatic biodiversity perspective is site 1, with the least preferred being site option 3. From a powerline connection perspective, connection option 3 for site option 1 is the shortest and is preferred from a wetland and aquatic biodiversity perspective.

It is highly recommended that concurrent rehabilitation, management, and mitigation measures are correctly implemented to minimise potential impacts on the wetlands and associated catchments to maintain the wetland health and functionality. Wetland monitoring requirements should form part of the conditions for environmental authorisation. It is highly recommended that wetland areas and dams that are not to be impacted by construction are delineated and considered no-go zones (except where the project infrastructure has to cross over these areas). Wetlands and natural water resources are a valuable natural asset, especially within the Highveld area.

Based on the impact assessment significance ratings, it is the opinion of the specialist that this Project is feasible and should be considered.

Wetland management measures and monitoring requirements as set out in this report should form part of the conditions of environmental authorisation and be included in the EMPr.

13. Conclusion

The greater Project Area consisted of a total of 1722.32 ha of wetland areas. Thirty-six (36) HGM units were identified and categorized based on terrain units. These included seeps, UVBs, and CVBs. The wetlands were grouped into seven groups for ease of the assessment.

The health and integrity of each of the HGM units varied from **'Moderately Modified'** to **'Largely Modified' (PES C** to **D)**. The entire catchment has been impacted by mining and agricultural activities and infrastructure development. The CVBs have mainly been impacted by agropastoral activities, including cattle grazing, dams, and cultivation. In addition, some of the CVBs have been fragmented by linear infrastructure, including roads, powerlines, and fence lines. Fragmentation of wetlands impacts the natural habitat, functionality, and health of a wetland. The UVBs within the Project Area was dominantly used for cattle grazing. There were no clear signs of channeling, erosion, or extensive cattle trampling.

The vegetation was stable with few changes to water inputs to the systems. Regardless of some of the UVBs being moderately impacted, some of the systems were fragmented by agropastoral, and linear infrastructure. Dams were also indicated in some of the systems. Most of the Hillslope Seep wetlands were used for agropastoral activities, including commercial cultivation and cattle grazing. Unimpacted Hillslope Seep wetlands were recorded within the Project Area. These wetlands were mainly used for cattle grazing, however, this was well regulated and little erosion and few impacts on the vegetation and geomorphology were noted.

In terms of ES sediment trapping, phosphate assimilation, nitrate assimilation, and toxicant assimilation are the dominant ecological services provided by the HGM units. The unimpacted Hillslope Seeps and CVBs are providing biodiversity maintenance and the CVBs are important for water supply.

The UVBs Fragmented, HS Agriculture, and HS Fragmented HGM units EIS were regarded as **'Moderate (C)'**. Whereas the CVBs, CVBs Fragmented, UVBs, and HS Unimpacted were considered **'High (B)'**. This suggests that these systems are of ecological importance and are sensitive. The biodiversity of the systems is sensitive to modifications to the habitat and low flows. These systems play an important role in moderating the quality and quantity of water in larger systems.

Based on the impact assessment significance ratings, it is the opinion of the specialist that this Project is feasible and should be considered for approval.

14. References

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Appendix A: Methodology

Literature Review

Relevant literature was reviewed concerning the historical wetlands associated with the Project Area. Habitats and vegetation types as well as the wetland state before development was assessed. This was done to obtain relevant information on the wetland ecology of the Project Area and its vicinity to acquire enough information to compile a Baseline Wetland Assessment Report.

Biodiversity within inland water ecosystems in South Africa is both highly diverse and of great regional importance to local livelihoods and economies, as these valuable natural resources (including any associated biota) provide a broad array of goods and services e.g. a source of water for domestic, industrial and agricultural purposes, as well as integral roles in the power generation and waste disposal industries (Darwall, Smith, Tweddle, & Skelton, 2009; Dudgeon et al., 2006). However, the fact that these freshwater systems may well be the most endangered ecosystems in the world threatens any of the 126,000 described species that depend upon freshwater habitats for any critical part of their life cycle, as well as any associated provisioning and/or regulatory ecosystem services (Dudgeon *et al.,* 2006).

Major global threats identified within these species-rich systems include ecosystem destruction, habitat alteration, changes in water chemistry, and direct additions and/or losses of aquatic biota (Malmqvist & Rundle, 2002). The magnitude of the threat to, and loss of, biodiversity in these vulnerable ecosystems is an indicator of the extent to which current practices are unsustainable. Hence, the importance of implementing conservation and management strategies that protect all elements of freshwater biodiversity, which in turn, also helps to guarantee water availability in the future (Dudgeon *et al.,* 2006).

The fact that South Africa is a water-scarce country makes these aquatic ecosystems even more susceptible to anthropogenic activities and their associated impacts. Consequently, the state (quality and quantity) of the county's water resources is fully dependant on good land management practices within catchments. Therefore, to achieve ecological and socio-economic sustainability, our natural water resources rely upon an integrated ecosystem-based approach to natural resource management (i.e., Integrated Water Resource Management, IWRM).

For this assessment, wetland areas were identified, and preliminary wetland boundaries were delineated at the desktop level using detailed aerial imagery and wetland signatures, along with 5m contours. Baseline and background information was researched and used to understand the area on a desktop level before fieldwork confirmation. This includes but is not limited to the following:

Literature Review

<table>
<tr>
<td>National Freshwater Ecological Priority Areas (NFEPA; Nel et al., 2011)
<table>
<tr><th>Criteria</th><th>Rank</th></tr>
<tr><td>Wetlands that intersect with a RAMSAR site.</td><td>1</td></tr>
<tr><td>▪ Wetlands within 500 m of an IUCN threatened frog point locality;
▪ Wetlands within 500 m of a threatened water-bird point locality;
▪ Wetlands (excluding dams) with most of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes;
▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and
▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.</td><td>2</td></tr>
<tr><td>Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.</td><td>3</td></tr>
<tr><td>Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).</td><td>4</td></tr>
<tr><td>Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.</td><td>5</td></tr>
<tr><td>Any other wetland (excluding dams).</td><td>6</td></tr>
</table>
</td>
<td>The NFEPA project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now DWS), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks).

The NFEPA data provides a collated, nationally consistent information source of wetland and river ecosystems for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes (Nel et al., 2011). The spatial layers (FEPAs) include the nationally delineated wetland areas that are classified into Hydro-geomorphic (HGM) units and ranked in terms of their biodiversity importance. These layers were assessed to evaluate the importance of the wetlands.</td>
</tr>
<tr>
<td>Mpumalanga Biodiversity Sector Plan (MTPA, 2014)
<table>
<tr><th>Map category</th><th>Definition</th><th>Desired Management Objectives</th></tr>
<tr><td>PA</td><td>Those areas that are proclaimed as protected areas under national or provincial legislation, including gazette protected environments.</td><td>Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.</td></tr>
<tr><td>CBAs</td><td>Areas that are required to meet biodiversity targets, for species, ecosystems or ecological processes.
CBA Wetlands are those that have been identified as FEPA wetlands that are important for meeting biodiversity targets for freshwater ecosystems.</td><td>Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.</td></tr>
<tr><td>ESAs</td><td>Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services.
ESAs Wetlands are those that are non-FEPA and ESA Wetland Clusters are clusters of wetlands embedded within a largely natural landscape that function as a unit and allow for the migration of species such as frogs and insects between individual wetlands.</td><td>Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorization process that ensures the underlying biodiversity objectives are not compromised.</td></tr>
<tr><td>ONAs</td><td>Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritized for biodiversity, they are still an important part of the natural ecosystem.</td><td>An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.</td></tr>
</table>
</td>
<td>The MBSP is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land use and development planning, environmental assessment and regulation, and natural resource management.

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs).

Wetlands in Mpumalanga Province have been extensively degraded and, in many cases, irreversibly modified and lost through a combination of inappropriate land-use practices, development, agriculture, and mining.</td>
</tr>
</table>

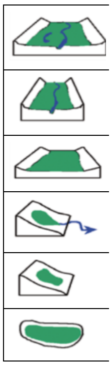
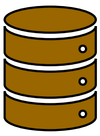
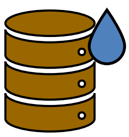
Relevant and available historical studies conducted within, or surrounding the Project Area, the South African National Biodiversity Institute (SANBI), Water Management Areas (WMA) and Quaternary Catchments, the National Spatial Biodiversity Assessment, Governmental reports such as the Mpumalanga State of the Environment Report, (2003), Vegetation types of South Africa (Mucina and Rutherford, 2012); and Fauna distribution and identification books of South Africa (Friedman and Daily, 2004; Skinner, and Chimimba, 2005) were some of the platforms used to identify and create a background study of the area.

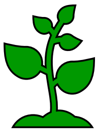
Wetland Identification and Classification

Following the guidelines provided by the DWS wetlands are identified and classified into various hydrogeomorphic (HGM) units based on their characteristics. The HGM unit system of classification focuses on the hydro-geomorphic setting of wetlands which incorporates geomorphology; water movement into, through and out of the wetland; and landscape / topographic setting.

The wetland delineations were verified according to the accepted methodology from the Department of Water and Sanitation ‘A practical field procedure for identification and delineation of wetlands and riparian areas’ (Department of Water Affairs and Forestry, 2005) as well as the “Updated manual for identification and delineation of wetlands and riparian areas” (Department of Water Affairs and Forestry, 2008). These methodologies use:

Wetland Identification and Classification

	**Terrain Unit Indicator (TUI)**	Helps to identify those parts of the landscape where wetlands are more likely to occur. TUI areas include depressions and channels where water would be most likely to accumulate. These areas are determined with the aid of topographical maps, contour data, aerial photographs, and engineering and town planning diagrams (DWAF, 2005). Wetlands are identified and classified into various hydrogeomorphic (HGM) units based on their characteristics and setting within the landscape. The HGM unit classification system focuses on the hydro-geomorphic setting/position of wetlands in a landscape which incorporates geomorphology; water movement into, through, and out of the wetland.
	**Soil Form Indicator**	Identifies the soil forms, which are associated with prolonged and frequent saturation. Hydromorphic soils are characterized as soils that have undergone redox reactions due to the fluctuation of water and oxygen levels in the soil, creating precipitation of iron and manganese particles. Soils that are commonly associated with wetlands are Champagne, Rensburg, Arcadia, Katspruit, Kroonstad, Longlands, Fernwood, and Westley soil forms. These soils are associated with high clay content promoting waterlogging and low drainage, therefor waterlogging conditions. These soils are commonly associated with low-laying landscapes such as valley bottoms, foot-slopes, and mid-slopes.
	**Soil Wetness Indicator**	Identifies the morphological “signatures” developed in the soil profile as a result of prolonged and frequent saturation. Soil Wetness Indicator (SWI) is used as the primary indicator. Iron and manganese accumulation in a soil profile, termed mottles are some of the recognized ‘wet-indicators’. Recurrence of the cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Soil that is gleyed (leached) and has mottles within the first 0.5 m of the surface are indicating a zone that is seasonally or temporarily saturated, interpreted, and classified as a wetland (DWAF, 2005).

	**Vegetation Indicator**	Identifies hydrophilic vegetation associated with frequently saturated soils. Plant communities undergo distinct changes in species composition along the wetness gradient from the center of the wetland to the edge, and into adjacent terrestrial areas. Valuable information for determining the wetland boundary and wetness zone is derived from the change in species composition. A supplementary method for employing vegetation as an indicator is to use the broad classification of the wetland plants according to their occurrence in the wetlands and wetness zones (Kotze and Marneweck, 1999; DWAF, 2005). Areas, where soils are a poor indicator (black clay, vertic soils), vegetation, and species classification (as well as topographical setting), is relied on to a greater extent.

Wetland Ecological Health Assessment (WET-Health)

According to Macfarlane, Kotze, & Ellery (2009), the health of a wetland can be defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. A level 1 WET-Health assessment was done on the wetlands following the method described by (Macfarlane et al., 2009) to determine the integrity (health) of the characterised HGM units for the study area. Level 1 was selected due to the large size of the study area. A Present Ecological State (PES) analysis was conducted to establish baseline integrity (health) for the associated wetlands. The health assessment attempts to evaluate the hydrological, geomorphological, and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions.

The overall approach is to quantify the impacts of human activity or visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial extent of the impact of individual activities and then separately assessing the intensity of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores and PES categories are provided in table below (Macfarlane et al., 2009).

Impact Scores and Present Ecological State Categories used by WET-Health

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

Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The purpose of assessing the importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions, or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term. The methodology outlined in Rountree, Malan, & Weston (2013) and (Rountree et al., 2013) was used for this study. In this method, there are three suites of important criteria.

Interpretation of overall Ecological Importance and Sensitivity (EIS) Scores for biotic and habitat determinants

Criteria	EIS Category	Score
Ecological Importance and Sensitivity Incorporating the criteria used in the EIS assessments Hydro-functional Importance Considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland or freshwater resource may provide Importance in terms of Basic Human Benefits Considers the resources use and cultural benefits of the wetland or freshwater system	Very High (A)	>3 and <=4
	Wetlands are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers.	
	High (B)	>2 and <=3
	Wetlands that are ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water in major rivers.	
	Moderate (C)	>1 and <=2
	Wetlands are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers.	
	Low/Marginal (D)	>0 and <=1
	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers.	

Wetland Ecological Services (WET-Ecoservices)

The importance of a water resource in ecological, social, or economic terms, acts as a modifying or motivating determinant in the selection of the management class' (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines described by Kotze et al. (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided.

The characteristics were used to quantitatively determine the value and, by extension, the sensitivity of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Classes for Determining the Extent of a Benefit Supplied

Score	Rating
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

National Freshwater Ecosystem Priority Areas

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

- Identify Freshwater Ecosystem Priority Areas (FEPAs) to meet national biodiversity goals for freshwater ecosystems. Using systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity within the context of equitable social and economic development.
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers. This comprised of two separate components: the (i) national component aimed to align DWS and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems, while the (ii) sub-national component aims to use three case studies to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes. The project further aimed to maximize synergies and alignment with other national-level initiatives, including the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation (Driver *et al.,* 2011).

The table below indicates the criteria that were considered for the ranking of each wetland. Whilst being an invaluable tool, it is important to note that the NFEPA's are delineated and studied at a desktop and low-resolution level. Therefore, wetlands delineation via the ground-truthing work may vary from the NFEPA layers. The NFEPA assessment does, however, hold significance from a national perspective.

NFEPA Wetland Classification Ranking Criteria

NFEPA Wetland Criteria	NFEPA Rank
• Wetlands that intersect with a RAMSAR site.	1
• Wetlands within 500 m of an IUCN threatened frog point locality; • Wetlands within 500 m of a threatened waterbird point locality; • Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes; • Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and • Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.	2
• Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.	3
• Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and • Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).	4
• Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.	5
• Any other wetland (excluding dams).	6

Mpumalanga Biodiversity Sector Plan

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land-use and development planning, environmental assessment and regulation, and natural resource management. Strategically the MBSP enables the province to:

- Implement the NEMBA, 2004 provincially, and comply with requirements of the National Biodiversity Framework, 2009 (NBF) and certain international conventions;

- Identify those areas of highest biodiversity that need to be considered in provincial planning initiatives, and
- Address the threat of climate change (ecosystem-based adaptation).

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs). The management objectives of these areas are summarised below.

Mpumalanga Biodiversity Sector Plan Categories

Map Category	Definition	Desired Management Objectives
PAs	Those areas that are proclaimed as protected areas under national or provincial legislation, including gazetted protected environments.	Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.
CBAs	Areas that are required to meet biodiversity targets, for species, ecosystems, or ecological processes. CBA Wetlands are those that have been identified as FEPA wetlands that are important for meeting biodiversity targets for freshwater ecosystems.	Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.
ESAs	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services. ESAs Wetlands are those that are non-FEPA and ESA Wetland Clusters are clusters of wetlands embedded within a largely natural landscape that function as a unit and allow for the migration of species such as frogs and insects between individual wetlands.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorisation process that ensures the underlying biodiversity objectives are not compromised.

Map Category	Definition	Desired Management Objectives
ONAs	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritised for biodiversity, they are still an important part of the natural ecosystem.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.
Heavily or Moderately Modified Areas	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritised for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximise ecological functionality, and authorisation is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilised and restored where possible, especially for soil carbon and water-related functionality.

Appendix B: Detailed Impact Assessment

Hendrina Green Hydrogen and Ammonia Facility Detailed Aquatic Biodiversity Impact Assessment

Hendrina Green Hydrogen & Ammonia

Impact Assessment

CONSTRUCTION

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Aquatic Biodiversity	Destruction of wetland for the construction of roads, pipelines and power cables in preparation for construction activity will definitely occur on at least the development footprint, where protected ecosystems are present. This will result in the permanent loss of the affected portions of the system if not mitigated, and may lead to the following: Head cut erosion and channel forming from the roads (culverts); Increased erosion and consequently sedimentation potential into wetlands; and Loss of vegetation and habitat.	Construction	Negative	If the destruction of wetlands is unavoidable, disturbance must be minimised and suitably rehabilitated; At areas where new road crossings have been designed, these roads should cross wetland or river features at the narrowest point and a 90-degree angle with suitable drainage designed into the relevant bridge/culvert crossing; Environmental Compliance Officer (ECO) to be present during vegetation clearing to prevent unnecessary clearing of extensive areas not part of the direct footprint area; Bare land surfaces must be vegetated to limit erosion from surface runoff associated with infrastructure areas. Revegetate disturbed areas immediately after construction; and Stockpiles should be monitored to ensure no runoff, erosion and sedimentation into the adjacent areas, especially the wetlands and freshwater systems.	3	2	3	4	4	48	N3	2	1	3	3	3	27	N2
					Significance	N3 - Moderate							N2 - Low						
Impact 2:	Aquatic Biodiversity	Contamination from Hydrocarbon waste (lubricants, oils explosives, and fuels); Contamination from sewage and wastewater; and Changes to wetland health and biodiversity.	Construction	Negative	All vehicle maintenance must occur within designated areas; All vehicles must be regularly inspected for leaks; All spills must be cleaned up immediately to prevent contaminants to enter the wetlands; Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions and health and safety requirements; Re-fuelling and maintenance must take place on a sealed surface area away from wetlands to prevent the ingress of hydrocarbons into topsoil; and The edge of the wetland and a 100m buffer or 1:100 flood line buffer should be demarcated in the field with wooden stakes painted white as no-go zones that will last for the duration of the construction phase.	4	2	3	2	3	33	N3	3	1	3	2	2	18	N2
					Significance	N3 - Moderate							N2 - Low						

OPERATIONAL

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Aquatic Biodiversity	Head cut erosion and channel forming from the roads (culverts); and Increased erosion and consequently sedimentation potential into wetlands; Loss of vegetation and habitat; and Wetland fragmentation.	Operational	Negative	Quarterly (four times a year) inspections by the site environmental officer to ensure no unnecessary impact to the freshwater resources present, and if so that a remedy is put in place as soon as possible; If it is unavoidable that any of the wetland areas present will be affected, the disturbance must be minimised and suitably rehabilitated; A Storm Water Management Plan (SWMP) should already be implemented. This should consider wetlands associated with the new developments/infrastructure which should divert stormwater and runoff away from the surface infrastructure and back into natural watercourses to maintain catchment yield as far as possible.	3	2	3	4	3	36	N3	2	1	3	3	2	18	N2
					Significance	N3 - Moderate							N2 - Low						
Impact 2:	Aquatic Biodiversity	Contamination from Hydrocarbon waste (lubricants, oils explosives, and fuels); Contamination from sewage and wastewater; and Changes to wetland health and biodiversity.	Operational	Negative	All vehicle maintenance must occur within designated areas; All vehicles must be regularly inspected for leaks; All spills must be cleaned up immediately to prevent contaminants to enter the wetlands; Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions; and Re-fuelling and maintenance must take place on a sealed surface area away from wetlands to prevent the ingress of hydrocarbons into topsoil.	4	2	3	2	3	33	N3	3	1	3	2	2	18	N2
					Significance	N3 - Moderate							N2 - Low						

DECOMISSIONING

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Aquatic Biodiversity	Uneven surfaces and topographies, causing water ponding and changes to the hydrogeomorphology of the wetlands; The proliferation of AIPs; Exposure of soils and subsequent compaction, erosion, and sedimentation into the wetlands; Deterioration of water quality; and Potential spillage of hydrocarbons such as oils, fuels, and grease, thus contamination of wetlands.	Decommissioning	Negative	Decommissioning should occur in the dry season where possible to avoid high rainfall events that could lead to increased runoff, erosion, contamination and sedimentation of the wetlands; Stormwater must be diverted from decommissioning activities; All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off-limits to all unauthorised vehicles and personnel; Actively landscape and re-vegetate disturbed areas as soon as possible to avoid loss of soil, organic material, and sedimentation into wetland areas; and Implement and maintain a Wetland and AIPs Plan for the duration of the decommissioning phase	3	2	3	5	3	39	N3	2	1	3	3	2	18	N2
					Significance	N3 - Moderate							N2 - Low						
Impact 2:	Aquatic Biodiversity	Minimal negative impacts on the environment; and Wetland and AIPs Monitoring Plan.	Decommissioning	Negative	No vehicles or heavy machinery should be allowed to drive indiscriminately within any wetland areas or their buffer areas. All vehicles must remain on demarcated roads; Wetland monitoring must be carried out after the decommissioning phase to ensure the success of wetland rehabilitation.	3	1	3	2	3	27	N2	2	1	3	2	2	16	N2
					Significance	N2 - Low							N2 - Low						

Appendix C: Specialist CV

Name	Stephen Burton
Profession	Ecologist
Education	MSc. Zoology (University of KwaZulu-Natal) BSc Hons. Zoology BSc Zoology & Entomology
Registrations / Affiliations	SACNSAP (Pr. Sci. Nat. 117474/17) International Association for Impact Assessment (IAIA)

Overview

Specialisation	Faunal and Wetland Ecologist
Expertise	Stephen is an ecologist with fields of interest in wetlands, fauna, and flora. In his 15-year career he has undertaken numerous wetland delineations and functional assessments, faunal assessments, wetland offset and rehabilitation assessments and audits, as well as project management of various environmental impact assessment and water use license projects. He has also worked extensively with wetland rehabilitation implementation projects for large scale developments.
Employment	March 2021 – May 2022 : Digby Wells Environmental – Divisional Manager: Ecology and Atmospheric Sciences March 2014 – February 2021 : SiVEST SA (Pty) Ltd: Environmental Division – Senior Environmental Scientist April 2008 – July 2014 : SiVEST SA (Pty) Ltd: Environmental Division - Environmental Scientist May 2007 – March 2008: UDIDI Project Development Company: Environmental Planner
Languages	English, isiZulu (Basic) and Afrikaans

Project Experience

Client	Barrick Gold
Location	Zambia
Name of Project	Lumwana Terrestrial Biodiversity Assessment
Year Completed	2021
Project Description	Terrestrial Biodiversity Assessment for the Residual Impact Assessment of the Lumwana Mining Rights Area

Client	Universal Coal Development
Location	South Africa
Name of Project	New Clydesdale Colliery Wetland Offset Plan
Year Completed	2022
Project Description	Creation of a Wetland Offset and Rehabilitation Plan for the integrated water use license application for the New Clydesdale Mine

Client	Ixia Coal
Location	South Africa
Name of Project	Imvula Mine Wetland Offset Plan
Year Completed	2021
Project Description	Creation of a Wetland Offset and Rehabilitation Plan for the integrated water use license application for the Imvula Mine.

Client	Anglo American
Location	South Africa
Name of Project	Mogalakwena Platinum Mine Biodiversity Baseline
Year Completed	2022
Project Description	Compilation of the Significant Biodiversity Features and Priority Ecosystem Services Baseline Report

Client	Harmony
Location	South Africa
Name of Project	Kalgold Prospecting rights Expansion: Ecological walkdown
Year Completed	2021
Project Description	Compilation of an Ecological Walkdown Assessment for the expansion of prospecting rights for the Kalahari Goldridge Mining Company