FLORAL, FAUNAL, WETLAND AND AQUATIC ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED CONSTRUCTION OF A FERROCHROME SMELTER NEAR NORTHAM, LIMPOPO PROVINCE

Prepared for

SLR Consulting (Africa) (Pty) Ltd.

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SECTION D – Wetland Assessment

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1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, floral, wetland and aquatic ecological assessment as part of the environmental assessment and authorisation process for the proposed construction of a new ferrochrome (FeCr) Smelter located immediately adjacent to the existing Union Section Mine on Portion 3 of the farm Grootkuil 409 KQ, in the Thabazimbi Local Municipality, Limpopo Province. The proposed Siyanda ferrochrome smelter (hereafter referred to as the 'Project Infrastructure Area'), which will in broad terms comprise a railway siding, a raw materials offloading area, two 70 MW DC furnaces, crushing and screening plant, slag dump and baghouse slurry dam, as well as related facilities such as material stockpiles, workshops, stores and various support infrastructure and services, is located within the western portion of Portion 3 of the farm Grootkuil 409 KQ. In addition, an overhead powerline as well as one access road is proposed, with two access road alternatives, namely Access Road Corridor Option 2 and Access Road Option 3, being considered for development. The proposed powerline will originate from the Spitzkop substation to the southeast of Portion 3 of the farm Grootkuil 409 KQ, run north towards the southeastern corner of Portion 3 of the farm Grootkuil 409 KQ and from there extend along the southern boundary of the property towards the Project Infrastructure Area. The proposed Project Infrastructure Area, together with the proposed powerline and the two access road alternatives, of which only one will be developed, are hereafter referred to as the 'project site' (Section A Figures 1 & 2). As part of the ecological assessment, the remainder of Portion 3 of the farm Grootkuil 409 KQ was also assessed, and, together with the project site, is hereafter referred to as the 'study area'.

The Project Infrastructure Area is situated approximately 10km to the west of the R510 regional road and 8km to the northwest of the town of Northam, and approximately 1,5km to the south of the Brits Road. The Swartklip Mine Village (developed as part of the Union Section Mine) is located immediately to the southwest of the Project Infrastructure Area.

2 METHOD OF ASSESSMENT

2.1 Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the wetland and riparian resources, located within the study area, are located.

Wetland specific information resources taken into consideration during the desktop assessment of the study area included the National Freshwater Ecosystem Priority Areas (NFEPAs; 2011):

- NFEPA Water Management Areas (WMAs);
- NFEPA wetlands;
- FEPA (sub)WMA % area;
- Sub water catchment area FEPAs;
- Water management area FEPAs;
- Fish sanctuaries; and
- Wetland ecosystem types.

The results of the desktop assessment are included in Section A.

2.2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland and riparian features encountered within the study area were assessed using the Classification System for Wetlands (hereafter referred to as the 'Classification System') and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013).

A summary of Levels 1 to 4 of the Classification System for Inland Systems are presented in Table 1 and 2 below.

Table 1: Classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	**LEVEL 2: REGIONAL SETTING**	**LEVEL 3: LANDSCAPE UNIT**
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 2: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River (Channel)	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional stream	Active channel
		Riparian zone
	Upper foothill rivers	Active channel
		Riparian zone
	Lower foothill rivers	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothill rivers	Active channel
		Riparian zone
	Upland floodplain rivers	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.2.1 Inland systems

For the purposes of the Classification System, Inland Systems are defined as an aquatic ecosystem that have no existing connection to the ocean[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically.

It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

2.2.2 Level 1: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the Classification System is that of Department of Water Affairs (DWA[2])'s Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (Figure 1). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

2.2.3 Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions – composite spatial terrestrial units defined on the basis of similar biotic and physical features and processes at the regional scale (Mucina & Rutherford, 2006).

To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups, and it is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

[1] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

[2] The Department of Water Affairs (DWA) is currently known as the Department of Water and Sanitation (DWS) and prior to being known as DWA, it was known as the Department of Water Affairs and Forestry (DWAF). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used

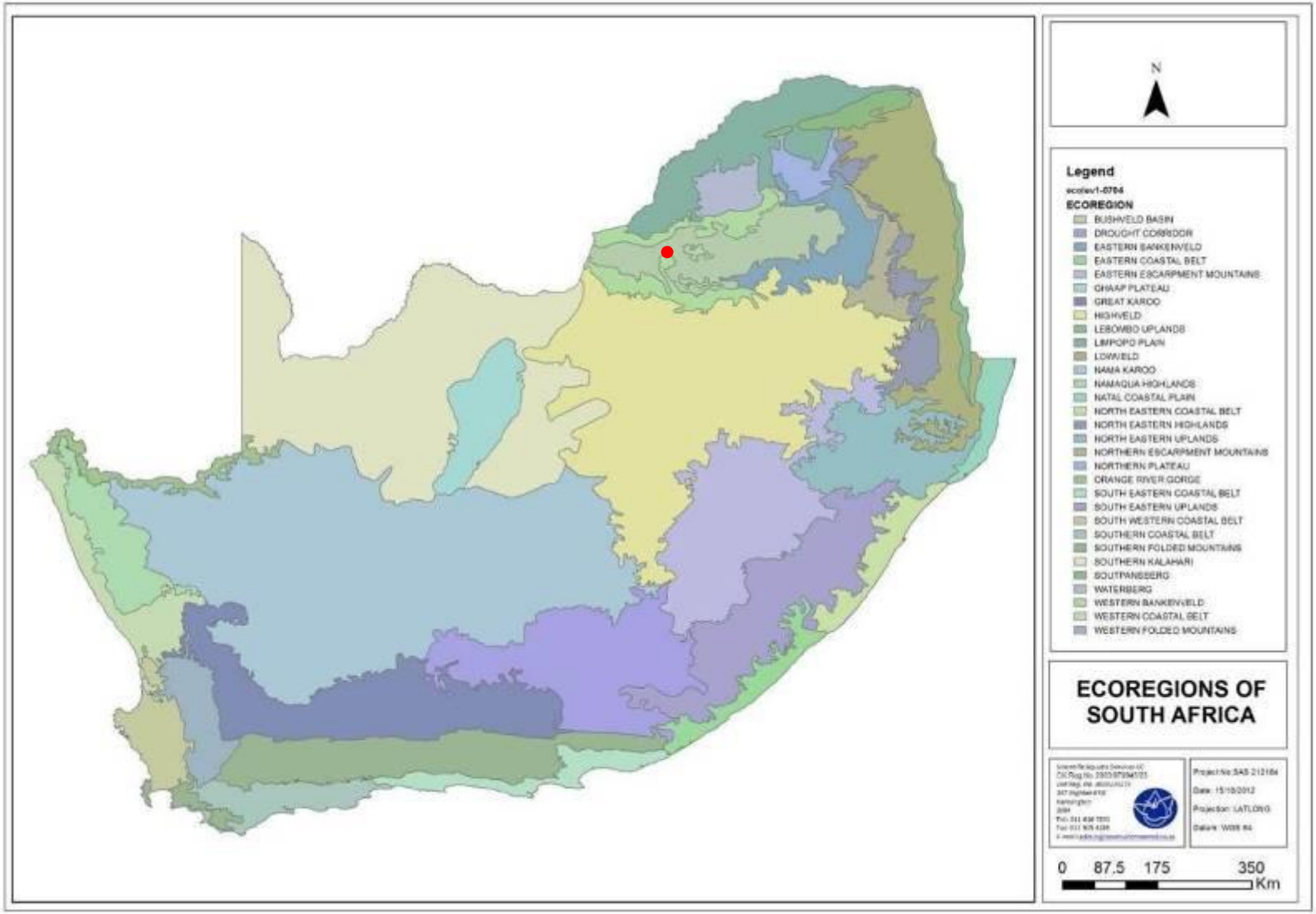

Figure 1: Map of Level 1 Aquatic Ecoregions of South Africa (the approximate location of the study area is indicated in red).

At Level 3 of the Classification System for Inland Systems, a distinction is made between four Landscape Units (Table 1) on the basis of the landscape setting (i.e. topographical position) within which a Hydrogeomorphic (HGM) Unit is situated, as follows (Ollis *et al.,* 2013):

- Slope: an inclined stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- Valley floor: The base of a valley, situated between two distinct valley side-slopes.
- Plain: an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- Bench (hilltop/saddle/shelf): an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.2.4 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table 2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- Channel (River): a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- Channelled valley-bottom wetland: a valley-bottom wetland with a river channel running through it.
- Unchannelled valley-bottom wetland: a valley-bottom wetland without a river channel running through it.
- Floodplain wetland: the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- Depression: a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- Wetland Flat: a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat.

- Seep: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the Classification System to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the tools developed as part of the Wetland Management Series including WET-Health (Macfarlane *et al.,* 2008) and WET-EcoServices (Kotze *et al.,* 2009).

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

At Level 4B of the classification system, certain of the primary HGM Units can further be divided into sub-categories on the basis of longitudinal geomorphological zonation or localised landform, as follows:

- Channels (including their banks) are divided into six primary longitudinal zones and three zones associated with a rejuvenated longitudinal profile, according to the geomorphological zonation scheme of Rowntree & Wadeson (2000). The sub-categories are Mountain Headwater Stream, Mountain Stream, Transitional River, Upper Foothill River, Lower Foothill River, and Lowland River (i.e. the primary zones); and Rejuvenated Bedrock Fall, Rejuvenated Foothill River, and Upland Floodplain River (i.e. the zones associated with a rejuvenated long profile).
- Channelled and unchannelled valley-bottom wetlands are divided into 'valley-bottom flats' and 'valley-bottom depressions'.
- Floodplain wetlands are divided into 'floodplain depressions' and 'floodplain flats'.

2.3 Wetland and Riparian Function Assessment

"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".[3] The assessment of the ecosystem services supplied by the identified wetlands/riparian features was conducted according to the guidelines as described by Kotze *et al.* (2008). 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:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands and riparian features. 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 or riparian feature.

Table 3: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

[3] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

2.4 Index of Habitat Integrity (IHI)

To assess the Present Ecological State (PES) of the various drainage features, the Index of Habitat Integrity (IHI) for South African floodplains, channelled and channelled valley bottom wetland types (DWAF, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A – F ecological categories (Table 4 below), and provide a score of the PES of the habitat integrity of the wetland and riparian system being examined.

Table 4: Descriptions of the A – F ecological categories (after Kleynhans, 1996, 1999).

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

2.5 WET-Health

2.5.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution;
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Due to the limited time spent on site in relation to the extent of features to be assessed, this study was undertaken as a Level 1 assessment.

2.5.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.5.3 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems in Section 2.2.

2.5.4 Quantification of Present State of a Wetland

The overall approach is to quantify the impacts of human activity or clearly 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 impact of individual activities and then separately assessing the intensity of 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 Present State categories are provided in Table 5.

Table 5: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
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
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

2.5.5 Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 6).

Table 6: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

2.5.6 Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the

health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

2.6 Ecological Importance and Sensitivity (EIS)

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health and IHI as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland, riparian feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category as listed in Table 7 below.

Table 7: EIS Category definitions.

Recommended Ecological Management Class	EIS Category	Range of Mean
A	Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4
B	High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3
C	Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2
D	Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1

2.7 Recommended Ecological Category (REC)

“A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure.” [4]

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999

The Recommended Ecological Category (REC) was determined based on the results obtained from the Wet-IHI, WET-Health calculations, reference conditions and Ecological Importance and Sensitivity (EIS) of the resource; followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland or riparian feature may receive the same category for the REC as the Present Ecological State (PES), if the feature is deemed in good condition, and it must therefore remain in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland or riparian feature.

Table 8: Description of REC classes.

Category	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

2.8 Wetland and Riparian Features Delineation

For the purposes of this investigation, wetland habitat and riparian zones are defined in the National Water Act (NWA; Act 36 of 1998) as stated below:

- A wetland is land which is transitional between a terrestrial and aquatic system where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soils; and
- A riparian zone is defined as the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zones and riparian zones delineations took place according to the methods presented in the “Updated manual for the identification and delineation of wetlands and riparian areas” published by DWAF (2008). The foundation of the method used in wetland delineation is based on the fact that wetland zones have several distinguishing characteristics including the following:

- Position in the landscape;
- Type of soil form;

- Presence of wetland vegetation species adapted to saturated soils; and
- Redoxymorphic soil features which appear in soils with prolonged period of saturation.

Wetland zones can be divided into three zones (DWAF, 2008). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

The following characteristic were used to delineate the riparian zone:

- Position in the landscape;
- Alluvial soils and recently deposited materials;
- Topography associated with riparian zones; and
- Vegetation associated with riparian zones.

From the above, main indicators of riparian zones are the vegetation indicators and the topography of the banks of the river of stream.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2008). One of the main objectives of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around wetland and riparian areas.

3 RESULTS

3.1 Wetland and Riparian System Characterisation

During the field assessment, two HGM Units have been identified within the study area that can be defined as wetland habitat or riparian zones in line with the DWA (2008) definitions. These features are located to the west of the Project Infrastructure Area and within the remainder of Portion 3 of the farm Grootkuil where it traverses the proposed powerline alignment. Neither of the two proposed access road alignments are traversed by watercourses and it is not expected that any infrastructure apart from the powerline will be

placed within proximity of a wetland feature. The identified features include one unchannelled valley bottom wetland feature (an unnamed tributary of the Brakspruit River) and two non-perennial drainage features with riparian characteristics, namely the Brakspruit River and its tributaries and the Phufane River. These two units were assessed according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013) outlined in Section 2.2. The results of the wetland system characterisation are illustrated in the table below.

The wetland and riparian features identified within and in the vicinity of the study area were classified at Level 1 of the Classification System as Inland Systems, which is defined as ecosystems that have no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically. The features fall within the Bushveld Basin Aquatic Ecoregion, and within the Central Bushveld Group 2 WetVeg group, which is classified by SANBI (2012) as "Vulnerable".

Table 9: Classification system of wetland features and riparian features within the study area.

Feature	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit
		HGM Type
Brakspruit River	**Valley floor:** The typically gently sloping, lowest surface of a valley.	**River:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
Phufane River	**Valley floor:** The typically gently sloping, lowest surface of a valley.	**River:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
Wetland feature	**Valley floor:** The typically gently sloping, lowest surface of a valley	**Unchannelled valley bottom:** A valley bottom wetland without a river channel running through it.

Both the Brakspruit and Phufane Rivers, classified as rivers, are situated within the centre of the study area. Two unnamed tributaries of the Brakspruit River, although locally having less well-defined channels and riparian vegetation, formed part of the assessment for this feature, while the portion of the Phufane River in the vicinity of the proposed powerline crossing, to the southeast of the study area formed part of the assessment of the Phufane River located within the study area itself. Both the Brakspruit and Phufane Rivers will be traversed by the proposed powerline and potential road upgrades (of existing dirt roads within the study area) in order to access the proposed smelter infrastructure, but are located outside of the proposed smelter infrastructure footprint area.

The unchannelled valley bottom wetland feature is situated within the western portion of the study area and is located in close proximity to agricultural land to the north and west thereof,

with existing mining activity located adjacent to the western upstream portion of the feature. Within the western portion of the wetland feature, a separate drainage line has formed due to changes in surface hydrology and terrestrial encroachment, which has led to modifications to the wetland extent and integrity. Wetland vegetation and terrain units were taken into consideration when assessing and determining the outer boundaries of the features. In addition, both portions/features of the wetland have therefore been assessed as a single wetland feature.

In addition to the abovementioned features, a single ephemeral depression was identified towards the centre of the study area, as well as three off-channel dams located in close proximity to the Phufane River. The ephemeral depression and artificial dams were not defined as true wetland features and were therefore not assessed in detail as part of the wetland assessment.

The location of the wetland and riparian features identified within the study area and along the powerline alignment, are presented in the figure below.

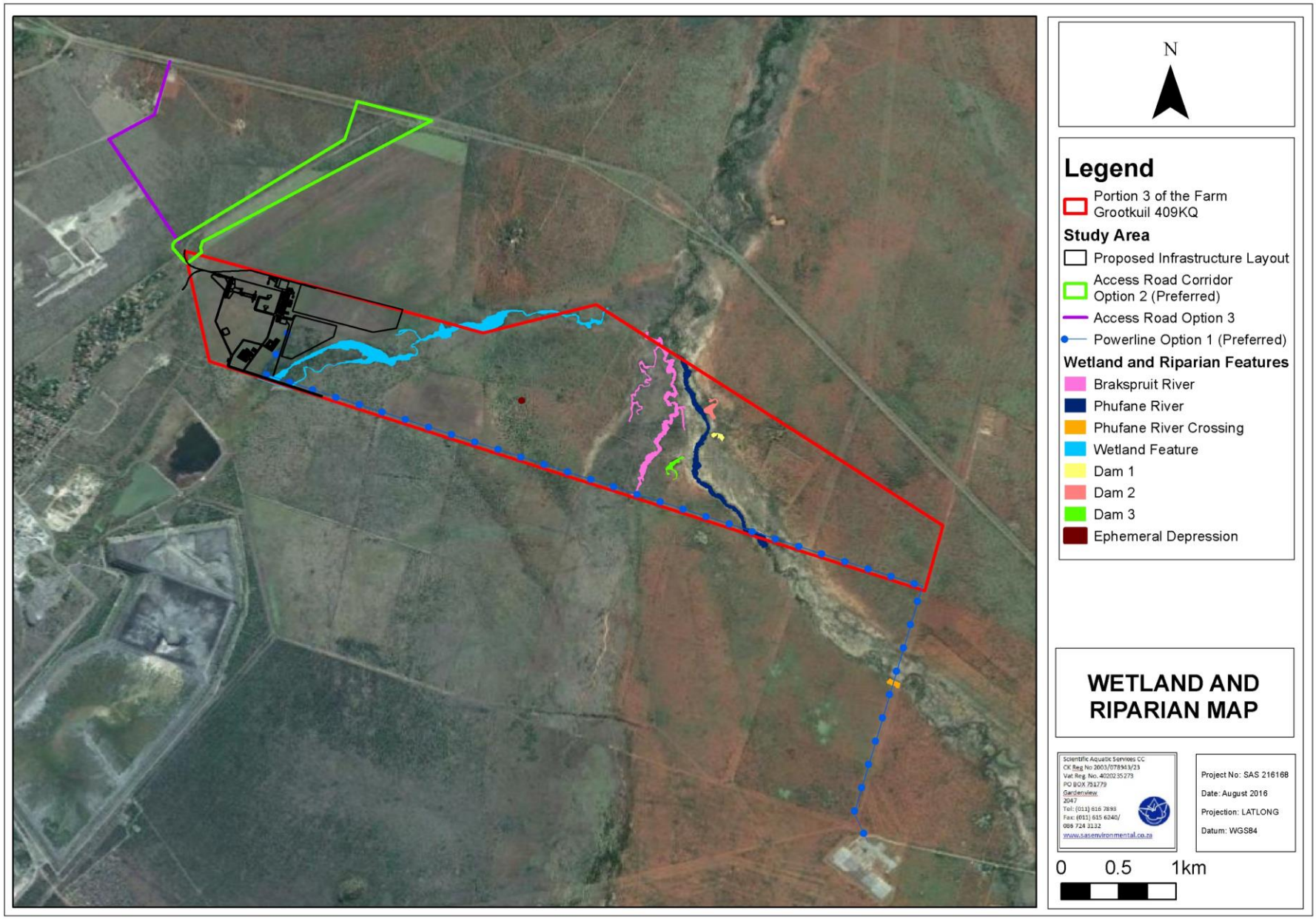

Figure 2: Map of the wetland and riparian features within the study area, including the powerline alignment.

3.2 General Wetland Assessment

3.2.1 Riparian Zones/ Rivers (Brakspruit River and unnamed tributaries and Phufane River including powerline crossings)

Figure 3: Representative photographs of the Brakspruit River.

Figure 4: Representative photographs of the unnamed tributaries of the Brakspruit River.

Figure 5: Representative photographs of the unnamed tributaries of the Phufane River within the study area.

Figure 6: Representative photographs of the Phufane River in the vicinity of the proposed powerline crossing to the southeast of Portion 3 of the farm Grootkuil 409 KQ.

3.2.1.1 Terrain Units

Terrain units and the outer edge of the macro channel banks were used in the identification of channelled water courses in the vicinity of the study area. The terrain units associated with the Brakspruit and Phufane River can be described as open conduits with clearly defined margins (as per definition of rivers provided by the Classification System, 2013).

3.2.1.2 Soil

Loose, unconsolidated alluvial soils, derived from material deposited by flowing water, were observed and the extent of these deposits were used to assist in defining the outer edge of the wetland and riparian features.

3.2.1.3 Vegetation

Vegetation associated with the riparian features is dominated by woody vegetation and was used to define the outer boundary of the riparian zones. This was done, in line with DWA (2008), by identifying the boundary where a distinctive change occurs in species composition relative to the adjacent terrestrial area. This included the presence of facultative riparian tree species such as *Combretum erythrophyllum* and *Searsia lancea* that were only encountered within the riparian zones of the Brakspruit and Phufane Rivers. A change in the physical size and robustness of growth forms of species similar to that of adjacent terrestrial areas was also observed within the riparian zones, with such species including *Grewia flava*, *Senegalia mellifera* subsp. *detinens*, *Gymnosporia senegalensis, G. buxifolia, Vachellia tortilis, V. karroo* and *Ziziphus mucronata.*

3.2.1.4 Surface Water

The field assessments were undertaken during autumn/ late summer and again in late winter. Limited surface water, with the exception of occasional pools containing stagnant water, was present within the Brakspruit and Phufane River channels.

3.2.2 Unchannelled Valley Bottom Wetland (unnamed tributary of the Brakspruit)

Figure 7: Representative photographs of the western portion of the unchannelled valley bottom wetland. *Sorghum versicolor* dominates the grass layer.

Figure 8: Representative photographs of the eastern portion of the unchannelled valley bottom wetland.

3.2.2.1 Terrain Units

Terrain units were not suitable as the main indicator in delineation of the unchannelled valley bottom wetland feature due to the absence of a defined channel. Several artificial impoundments have been constructed within the feature and water is also retained against the central dirt road forming the southern boundary of the study area.

3.2.2.2 Vegetation

Sorghum versicolor, which occurs on river banks and close to vlei areas, was identified as one of the main wetland indicators. This species dominates the vegetation within vicinity of the western portion of the wetland feature and at the confluence of the western and eastern portions of the wetland and is also present within the temporary zone of the wetland.

Other dominant floral species present include woody species such as *Diospyros lycioides*, *V. tortilis* and *V. karroo* within the temporary zone, graminoid species *Hemarthria altissima* and *Cynodon dactylon* within the seasonal wetland zones and *Sporobolus africanus, Fuirena pubescens* and *Diplachne fusca* within both the seasonal and permanent zones.

3.2.2.3 Surface Water

No surface water was present was present at the time of assessment but soils were found to be moist with a high water table likely to be present.

3.2.3 Ephemeral Depression

Figure 9: Representative photographs of the ephemeral depression identified within the study area.

3.2.3.1 Terrain Units

A single circular, inward draining depression, of approximately 30m in diameter, was identified within the central portion of the study area. The terrain units and the location of this

feature within the lowest point of the landscape were used as the primary indicator of the ephemeral depression edge.

3.2.3.2 Soil

Figure 10: No hydromorphic soil types were present within the ephemeral depression.

Unlike soil present within the temporary zones of the wetland feature, soil associated with the ephemeral depression was of a more sandy nature and did not show any signs of mottling or gleying. As such, the feature does not retain water long enough for the formation of hydromorphic soil distinctive of wetlands. Furthermore, the depression, due to its small size and resulting limited catchment size, does not collect sufficient volumes of water to support wetland conditions.

3.2.3.3 Vegetation

Although all depressions may be conducive to the formation of wetland habitat, this feature was characterised by bare soils and the absence of vegetation and due to the lack of hydromorphic soil, is unlikely to support facultative or obligate floral species.

3.2.3.4 Surface Water

No surface water was present during the field assessments.

3.2.4 Off Channel Dams

Figure 11: Representative photographs of Dam 1.

Figure 12: Representative photographs of Dam 2.

Figure 13: Representative photographs of Dam 3.

Three artificial off-channel dams collecting diffuse runoff within the valley bottom landscape associated with the Phufane River are located within the eastern portion of the study area. Both Dams 2 and 3, which are relatively large, have clearly defined dam walls present, while

in the case of Dam 1, surface water from periodic flood events dams up adjacent to the existing dirt road. Other than in the case of artificial dams located within the unchannelled valley bottom wetland, Dams 1, 2 & 3 are located outside of well-defined drainage channels. The historical condition of the dams, in terms of past connections to streams or historical depression landscapes is unknown. At present, these dams do provide habitat for obligate wetland vegetation and although the dams are artificial in nature these features have been present for a long enough period to allow for the establishment of avifaunal and amphibian communities, particularly during the rainy season, which are typically associated with wetland habitats.

Although these features and the surrounding valley bottom area, which do not support hydromorphic soils or wetland vegetation, are not considered to be wetland features or riparian zone as defined by DWA (2008) or the NWA (Act 36 of 1998), these dams do play a role in local ecology and should ideally remain outside of the proposed and future development footprint areas.

3.3 Wetland and Riparian Function Assessment

Wetland and riparian function and service provision were assessed according to the method defined in section 2.3 of this report, taking into consideration the findings of both the desktop and field assessment results. The average scores are presented in the following table as well as the radar plot in the figure that follows the table. When considering the average score for the each drainage feature it is evident that all feature can be considered of moderately low importance in terms of service and function provision. The Brakspruit and the Phufane Rivers, although having the same HGM Unit, have been assessment separately.

Table 10: Wetland functions and service provision for the wetland and riparian features.

Ecosystem service	Brakspruit River	Phufane River	Wetland Feature
Flood attenuation	2.2	2.5	1.6
Streamflow regulation	1.6	1.6	1.2
Sediment trapping	2.2	2.4	3
Phosphate assimilation	2.3	2.3	1.5
Nitrate assimilation	1	1	2.6
Toxicant assimilation	2	2	2.6
Erosion control	1.6	1.3	2.1
Biodiversity maintenance	2	2	2.2
Carbon Storage	1.8	1.5	2
Water Supply	0.6	0.6	0.3
Harvestable resources	0.4	0.2	0.2
Cultivated foods	0	0	0
Cultural significance	0	0	0
Tourism and recreation	0	0	0
Education and research	0	0	0
SUM	**17.7**	**17.4**	**19.3**
Average score	**1.2**	**1.2**	**1.3**

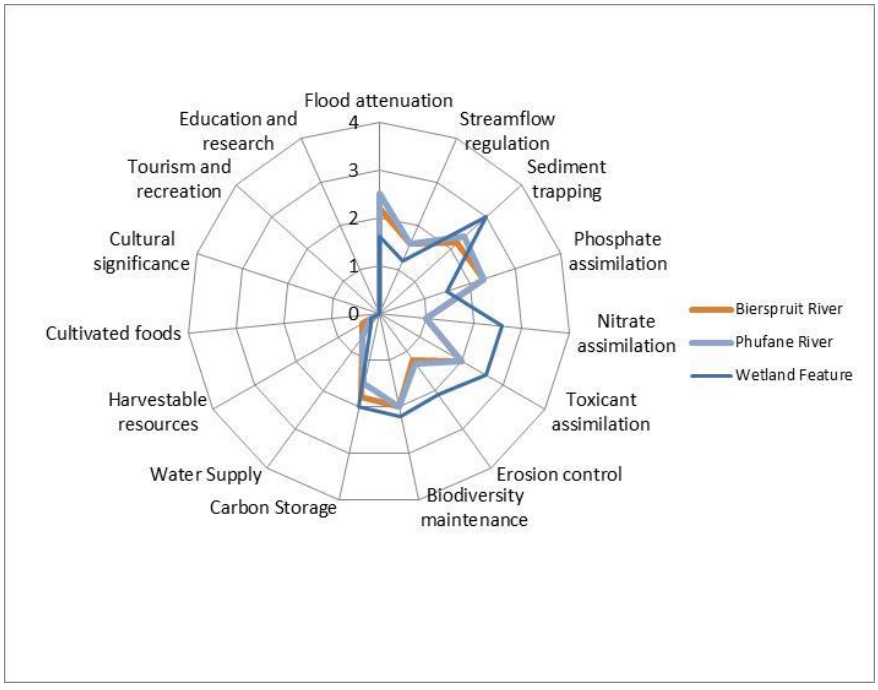

Figure 14: Radar plot of wetland services provided by the wetland and riparian features.

3.3.1 Riparian features

The Brakspruit and Phufane Rivers obtained largely similar scores for the individual ecosystem services, with an average score of 1.2 calculated for both features. This implies

that the features in their current state provide ecological services and functioning at a moderately low level.

The scores achieved for flood attenuation were moderately high, but somewhat lower for streamflow regulation. The sinuosity of the features, particularly the Brakspruit River, also makes it possible for the feature to control water flood velocities during heavy rainfall periods. The location of the features within lower lying topography allows for floods to overtop the stream banks, which will serve to slow down flow velocity and allow for some deposition of particles, including phosphate and toxicants within the valley bottom landscape. The lengths of the streambeds are however almost bare or support low levels of vegetation cover, which may impact on the ability of the wetland to assimilate these substances within the active stream channels.

Both features achieved intermediate scores for erosion control, although some erosion is present within both features, particularly in the vicinity of existing stream crossings. The features provide support for an intermediate level of biodiversity and species not occurring elsewhere within the study area and provide habitat and migratory connectivity for a number of faunal species.

Due to the non-perennial nature of the features, the features are unlikely to significantly contribute to water supply, particularly during the dry season, although water abstraction does occur upstream and off-channel dams are present. Based on the location and inaccessibility of the features to the general public, the features have limited importance in terms of socio-cultural service provision.

3.3.2 Wetland feature

The unchannelled wetland feature obtained an average score of 1.3, placing the feature within an intermediate category in terms of service provision and ecological functioning. The feature plays an intermediate role in flood attenuation and a moderately low role in streamflow regulation. The high level of surface roughness of the feature, good vegetation cover and greater contact of the wetland with runoff waters, in addition to the expected increased level of toxicant and nitrate input from surrounding mining and agricultural activities allow the feature to assimilate nutrient and toxicants. The feature also plays an important role in sediment trapping and erosion control, particularly due to the presence of dams within the feature. As with the riparian features, the wetland feature has limited

importance in terms of socio-cultural service provision due to its location within a fenced property.

3.4 Riparian Zone PES Assessment

The WET-Index of Habitat Integrity (WET-IHI) was applied to Brakspruit River and Phufane River in order to determine the PES of the riparian features as occurring within the study area. The water quality for both features is considered fair, with low dissolved salts in the system, the pH is regarded as largely natural and average dissolved oxygen concentrations were measured upstream of the features. The results of the IHI assessment are presented in the tables below.

3.4.1 Brakspruit River

Table 11: Results of the IHI Assessment of the Brakspruit River.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.0**		
Hydrology	1	100	1.6	*2.8*	**C**
Geomorphology	2	80	2.5	*2.1*	**D**
Water Quality	3	30	1.9	*1.3*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**1.9**	***2.9***	
Vegetation Alteration Score	1	100	1.9	*2.9*	**C**
OVERALL SCORE:			**1.9**		
	PES %		**61.2**	***Confidence Rating***	
	PES Category:		**C/D**	***1.3***	

The Brakspruit River obtained an overall score that places the feature on the boundary between Category C and Category D, which indicates that the feature has been moderately to largely modified through loss and change of natural habitat and naturally occurring biota. The hydrology and geomorphology of the feature has been significantly impacted by the presence of dirt roads, erosion, livestock grazing and trampling, while vegetation removal has occurred locally and some alien species are present.

3.4.2 Phufane River

Table 12: Results of the IHI Assessment of Phufane River.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,8**		
Hydrology	1	100	1,3	*2,7*	**C**
Geomorphology	2	80	2,3	*3,0*	**D**
Water Quality	3	30	1,8	*2,0*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**1,3**	***3,0***	
Vegetation Alteration Score	1	100	1,3	*3,0*	**C**
OVERALL SCORE:			**1,6**		
	PES %		**69,0**	***Confidence Rating***	
	PES Category:		**C**	***1,3***	

From the IHI assessment, the results obtained show an overall PES falling within Category C, indicating that the feature has been moderately modified through loss and change of natural habitat and naturally occurring biota, with the basic ecosystem functions being predominantly unchanged.

The geomorphology of the feature obtained an overall score that falls within Category D, which implies that the feature has been largely modified, although levels of erosion present are less severe than that observed within the Brakspruit River. The feature has been largely modified by the presence of dirt roads as well as some eroded banks observed within the channel. Due to the presence of several dirt roads traversing the wetland at different points, as well as a road crossing that is situated upstream of the feature, the vegetation around these crossing points was disturbed. The hydrology of the wetland has been moderately modified due to the presence of these road crossings as well as upstream impacts and abstraction of surface water.

3.5 Wetland PES Assessment

A Level 1 WET-Health assessment of the unchannelled valley bottom wetland feature was undertaken in order to determine the PES of the feature. Three modules, namely hydrology, geomorphology and vegetation, were assessed for the HGM unit and subsequently an area weighted score was obtained for the unit. The results obtained are summarised in the table below.

Table 13: Summarised WET-Health results for the wetland feature.

System	Hydrology		Geomorphology		Vegetation		Overall PES Category
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
Wetland feature	C	↓	C	↓	B	↓	C

Limited disturbances due to trampling from livestock, removal of vegetation or erosion and sedimentation were observed within this unchannelled valley bottom wetland feature. The wetland feature is relatively extensive and incorporates several small impoundments, which have impacted on the hydrology of the wetland and has led to alteration of downstream wetland conditions.

The vegetation within the wetland has been moderately modified by the presence of impoundments and dirt roads observed within the feature. Vegetation was removed at these points for the development of these roads and dams which led to a minimum introduction of alien plants along those areas such as *Bidens pilosa* and *Verbena bonariensis*, with the geomorphology of the wetland having been altered by the presence of both dams and dirt roads.

3.6 Ecological Importance and Sensitivity (EIS) Assessment

The results of the wetland and riparian function assessment, IHI and WET-Health assessment were utilized to inform the EIS assessment.The results of the EIS Assessment of the wetland features and riparian features observed are tabulated below.

Table 14: EIS Scores for the wetland and riparian features.

Determinant	Brakspruit River	Phufane River	Wetland feature	Confidence
	Score	Score	Score	
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	1	1	0	2
2. Populations of Unique Species	0	0	1	2
3. Species/taxon Richness	1	1	2	3
4. Diversity of Habitat Types or Features	1	1	1	3
5. Migration route/breeding and feeding site for wetland species	3	3	3	3
6. PES as determined by WET Health /IHI assessment	1	2	2	3
7. Importance in terms of function and service provision	1	1	2	3
MODIFYING DETERMINANTS				
8. Protected Status according to NFEPA Wetveg	3	3	3	4
9. Ecological Integrity	2	2	2	3
TOTAL	13	14	16	
MEAN	1.4	1.6	1.8	
OVERALL EIS	**C**	**C**	**C**	

The score for the EIS assessment places the wetland and the riparian features within EIS Category C (moderate), which implies that the wetland and riparian features are considered to be ecologically important and sensitive on a provincial or local scale.

3.7 Recommended Ecological Category (REC)

The results obtained from the wetland and riparian function assessment, IHI assessment, WET-Health assessment, together with the results of the EIS assessment, were used to inform the determination of the appropriate Recommended Ecological Category (REC) for the wetland and riparian features. The riparian features scored moderately low levels of ecological service provision, while the wetland feature scored an intermediate level, with PES of the features ranging between moderately modified and largely modified. The EIS of all features were determined to fall within Category C (Moderate).

The wetland and the riparian features were therefore assigned a REC Category C, in order to ensure the maintenance of present levels of ecological services and functioning of the aquatic resource, as well as to potentially enhance the PES of the components of the wetland that have undergone higher levels of transformation. Appropriate mitigatory measures as provided in this report should therefore be implemented in order to prevent further degradation to the system and ultimately enhance the ecology and functionality thereof.

3.8 Wetland and Riparian Sensitivity Mapping

The Brakspruit River and its associated tributaries within the study area, the Phufane River and unchannelled valley bottom wetland feature are regarded as being of increased ecological sensitivity due to the contribution of these features to faunal migratory connectivity, wetland eco-services provision and the habitat provided for faunal and especially protected, endemic and unique floral species.

The main drainage channels associated with the Brakspruit River and its tributaries and the Phufane River, including the portion of the Phufane River in the vicinity of the proposed powerline crossing were delineated during the field assessment and it is recommended that all requirements in terms of the NWA (Act 36 of 1998) and associated regulations be adhered to in the development and upgrade of road and powerline stream crossings. In addition, the main drainage feature associated with the unnamed tributary of the Brakspruit

was delineated during the field assessment and it is recommended that all requirements in terms of the NWA (Act 36 of 1998) be adhered to.

These features are also protected in terms of NEMA (Act 107 of 1998), whereby all activities within 32m of watercourses falling outside of urban areas may require environmental authorisation and the 32m therefore acts as a statutory zone of regulation. As none of the proposed smelter and related support infrastructure components are located in the vicinity of the riparian areas, a 32m buffer area around these features is deemed sufficient. The majority of the wetland feature which is located in close vicinity to the smelter infrastructure and a 32m buffer around this area is also considered sufficient to maintain the PES of the wetland feature, limit any further impact the proposed project could have, and to ultimately achieve the REC determined for the features as described above.

Due to the linear nature of the proposed powerline and potential upgrades to existing roads within the Siyanda property, no wetland and riparian zone buffer is practically applicable to these conditions. The wetland and riparian features as well as the associated buffer zones are presented in the figure below.

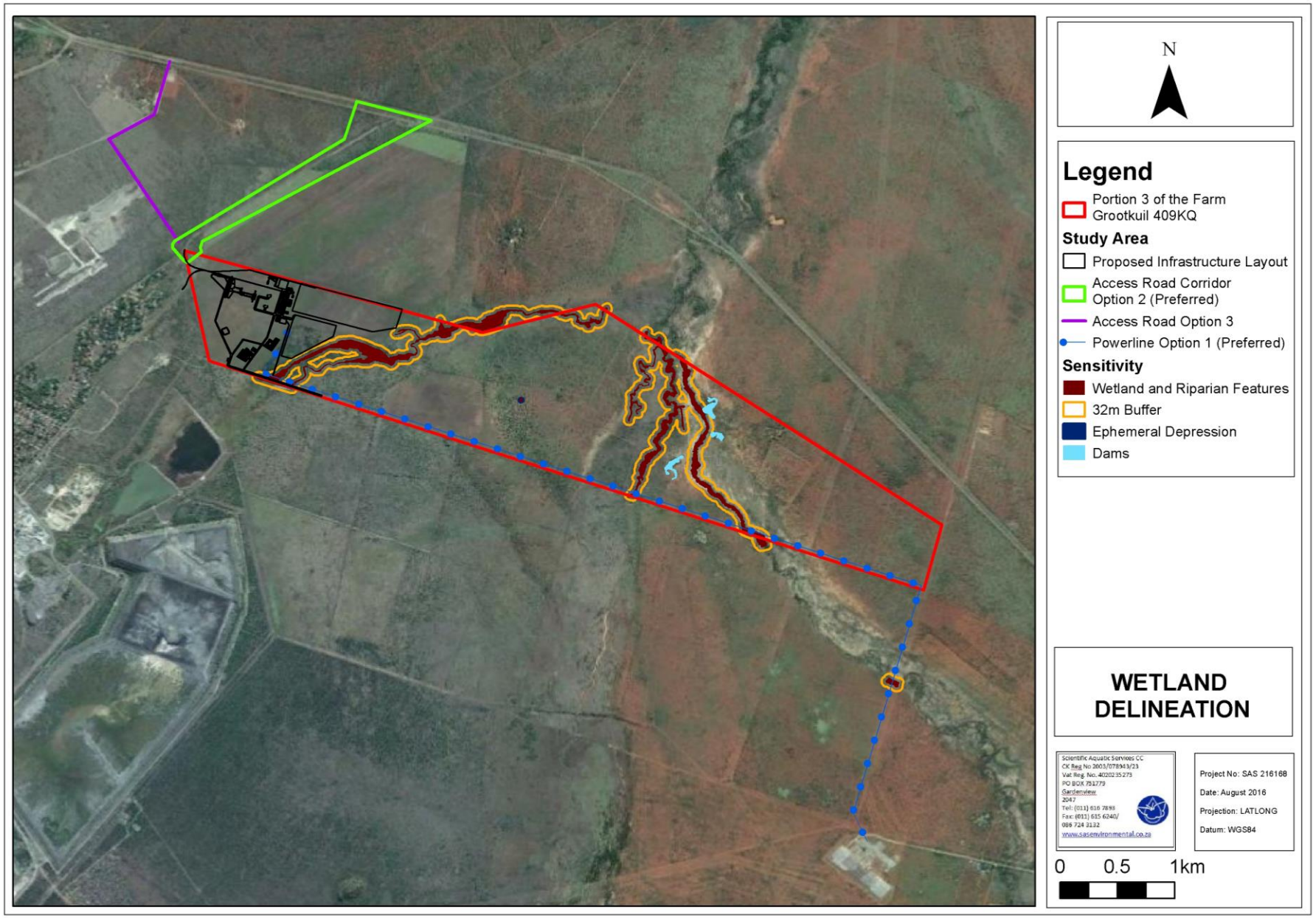

Figure 15: Wetland and riparian features identified within the study area with the associated buffer zones.

4 IMPACT ASSESSMENT

The tables below serve to summarise the significance of perceived impacts on the wetland and riparian ecology and biodiversity of the study area. Summaries for all potential pre-construction, construction, operational phase as well as decommissioning and closure phase impacts are provided for the proposed smelter development, whereas for the proposed powerline only the preconstruction, construction and operational phase summaries are provided. The tables present the impact assessment according to the method described in Section A.

This section also indicates the recommended mitigatory measures required to minimise any perceived impacts. In addition the tables present an assessment of the significance of the impacts taking into consideration the available mitigatory measures assuming that they are fully implemented.

The following essential mitigation measures are considered to be standard best practice measures applicable to a project of this nature, and must be implemented during all phases of the proposed development activities, in conjunction with those stipulated in the individual tables in the following sections, which define the mitigatory measures specific to the minimisation of impacts on wetland and riparian resources within the study area.

General management and good housekeeping practices

Development footprint

- All development footprint areas should remain as small as possible and should not encroach into wetland and riparian areas except where absolutely essential, such as where stream crossings are required for the proposed powerline crossings. It must be ensured that the wetland and riparian habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects within these areas will need to be carefully controlled to prevent impacts on nearby wetland features located in the vicinity of the proposed smelter footprint area;
- Planning of temporary roads and access routes must be restricted to existing roads where possible and no new stream crossings should be created;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;

- All hazardous chemicals as well as soil stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant South African Bureau of Standards (SABS) standards to prevent leakage;
- No fires should be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and "spill" bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicles

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills, should they occur, should be immediately cleaned up and treated accordingly.

Soils

- Sheet runoff from access roads or cleared areas for development should be slowed down by the strategic placement of berms;
- Appropriate soil management, including erosion and run-off control for the construction phase should be implemented;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months;
- All wetland and riparian areas in the vicinity of the development footprint should be regularly monitored for erosion and incision;
- All soils compacted as a result of construction activities falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development and decommissioning phases to prevent impacts on wetland and riparian resources;
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any wetland and riparian areas and other areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site; and

- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.

4.1 Smelter and Access Road Impact Assessment

4.1.1 Impact 1: Loss of Wetland and Riparian Habitat and Ecological Structure

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of placement of road access at areas where there are no existing roads, and thus creating new crossings	Site clearing and the removal of vegetation leading to increased runoff and erosion	Ongoing disturbance of soils as a result of general operational activities	Disturbance of soils as part of demolition activities
Potential placement of smelter infrastructure within wetland habitat	Earthworks in the vicinity of the wetland and riparian areas leading to increased loss of habitat	Spillages and seepage of hazardous waste material into the groundwater	Ongoing seepage and runoff from the development area beyond closure
Potential inappropriate design of infrastructure leading to changes to wetland and riparian habitat	Movement of construction vehicles through wetland and riparian features	Runoff, seepage and potential discharge from the operational areas	Ongoing erosion and sedimentation of wetland and riparian features due to failure to implement rehabilitation measures within disturbed areas
	Dumping of hazardous waste and spills into the wetland and riparian areas resulting in soil and water contamination	Sedimentation and incision leading to altered habitats and loss of wetland and riparian floral biodiversity	Potential contamination of wetland and riparian areas from the decommissioning of infrastructure
		Dumping of hazardous and non-hazardous waste into the wetland and riparian areas leading to soil and water contamination	Ineffective rehabilitation leading to habitat transformation and ongoing alien vegetation encroachment
			Decommissioning activities leading to wetland and riparian habitat transformation and alien plant species proliferation

Activities relating to the construction of the smelter, such as the removal of the topsoil, movement of vehicles and general earthworks, may lead to habitat disturbance within adjacent wetland areas and along existing stream crossings. This may lead to impacts on biodiversity within these areas as well as impacts on migratory routes for more mobile species. All these activities may extend to downstream areas as well and affect the features beyond the site boundary. In addition the edge effects from the smelter development could

lead to the introduction of alien species within wetland and riparian areas. It is important to note that the two access road alternatives are not located in the vicinity of watercourses and development of the proposed access road is therefore unlikely to impact on wetland habitat.

Operational activities such as dumping of waste and oil leaks from vehicles may result in the contamination of wetland and riparian soils and water, which will lead to the alteration or loss of habitat for wetland and riparian associated floral and faunal species.

If left unmitigated, impacts on the wetland and riparian features will lead to impacts of medium significance on wetland and riparian habitat and ecological structure, mainly due to stream crossing associated with access roads and edge effects associated with disturbance, however with the implementation of mitigation measures the intensity and spatial scale of the impact can be reduced to low significance impacts.

Unmanaged	Intensity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	M	L	M	M	L	M
Operational phase	L	M	L	M	L	M
Decommissioning and closure phase	M	L	M	M	L	M

Essential construction phase mitigation measures:

- During the construction phase, access to the construction site should be limited to existing access roads in order to minimise stream and wetland crossings. It is recommended that no new crossings be constructed. Access to wetland and riparian areas within the remainder of the study area by site personnel should be prohibited to prevent compaction of soils, loss of vegetation and increased erosion.
- Smelter infrastructure, including contractor laydown areas and areas designated for washing, cutting, mixing, etc. should be placed, as planned, within designated low sensitivity areas as far as possible and outside of the wetland buffer zones.
- Placement of infrastructure should be as far as possible from the sensitive wetland and riparian areas and associated buffer zones.
- Vehicles should be limited to travelling only on designated roadways to limit the ecological footprint of the proposed project activities.
- All soils compacted as a result of construction activities falling outside of the proposed project footprint should be ripped and profiled.
- Proliferation of alien and invasive species is expected within any disturbed areas and common agricultural weeds are already present within the proposed smelter and access road footprint areas. These species, as well as emerging species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, also has to be controlled.
- Removal of the alien and weed species must take place in order to comply with existing legislation (NEMBA Alien and Invasive Species Regulations, 2014). Focus should be on the removal of Category 1 alien species (Section B) and should take place throughout the construction, operational and decommissioning and closure phases.
- Species specific and area specific eradication recommendations include the following:
    - As far as possible, alien vegetation removal should take place by hand/ manually.
    - Footprint areas should be kept as small as possible when removing alien plant species.
    - If herbicides are used, care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous floral species occurs due to the herbicide used.
    - If chemical control is implemented in the vicinity of wetlands and riparian areas, the type of herbicide should be on the list of herbicide approved by the DWS and Working for Water.

- No vehicles should be allowed to drive indiscriminately through wetlands and riparian areas during the eradication of alien and weed species.

- Any exposed soils, particularly topsoil stockpiles, must be protected by means of covering with a geotextile such as hessian sheeting or Geojute, and stabilised with sandbags, in order to limit transportation of sediment to the wetland and riparian areas via stormwater runoff.
- After construction has been completed, suitable reprofiling, reseeding with indigenous grasses and revegetation of any bare areas must take place to minimise the potential of sedimentation and erosion of wetland features. Potential disturbed areas in the vicinity of stream crossings must also be suitably rehabilitated if required to ensure adequate vegetation cover, the absence of alien vegetation and stream bank stability.

Recommended construction phase mitigation measures:

- It must be ensured that the proposed project footprint and construction footprint areas remain as small as possible.

Essential operational phase mitigation measures:

- It must be ensured that operational related activities are kept strictly within the development footprint and designated operational areas.
- Alien and invasive vegetation control should take place throughout the operational phase of the development.
- If appropriate, wetland and riparian areas should remain off-limits to unauthorised employees of the smelter facility.
- Vehicles must be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed project activities and in the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.

Essential decommissioning and closure phase mitigation measures:

- All development footprint areas and areas affected by decommissioning and closure and of the smelter should remain as small as possible and should not encroach onto surrounding more sensitive wetland and riparian areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel throughout the decommissioning and closure phase.
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the decommissioning footprint.
- Upon closure and decommissioning, suitable rehabilitation of bare areas and any impacted reseeding with indigenous grasses should be implemented in all affected areas.

Managed	Intensity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	L	VL	VL	VL	L	L
Operational phase	L	L	VL	L	L	L
Decommissioning and closure phase	L	VL	VL	VL	L	L

Probable latent impacts

- Sedimentation of the features may lead to altered wetland and riparian habitats.
- Ineffective rehabilitation may lead to the permanent transformation of the wetland and riparian habitat.
- Proliferation of alien weed species in disturbed areas will lead to altered vegetation communities within the adjacent wetland and riparian as well as associated buffer zones.

4.1.2 Impact 2: Changes to Wetland and Riparian Ecological and Sociocultural Service Provision

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Potential inappropriate design of infrastructure and stream crossings leading changes to wetland and riparian habitat	Site clearing and the removal of vegetation leading to increased runoff and erosion	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
	Site clearing and the disturbance of soils leading to loss of assimilation abilities	Spillages and seepage of hazardous waste material into the groundwater	Ongoing seepage and runoff from the project infrastructure to the groundwater regime beyond closure
	Earthworks and road upgrades in the vicinity of wetland and riparian areas leading to loss of biodiversity maintenance abilities	Erosion and sedimentation of wetland and riparian features leading to loss of flood attenuation abilities	Decommissioning activities may lead to wetland and riparian habitat transformation and alien plant species proliferation
	Topsoil stockpiling and runoff from stockpiles may lead to erosion of the wetland areas	Dumping of waste into the wetland and riparian areas	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment
	Dumping hazardous waste into the wetland and riparian areas leading to changes in water quality		
	Movement of construction vehicles within wetland and riparian features leading to soil compaction		

Construction related activities may result in some loss of ecosystem services and function such as stream flow regulation, sediment trapping, nutrient cycling and chemical assimilation abilities, however due to the proposed smelter being located beyond the wetland area and associated buffer zone, with access roads being planned along disturbance footprints such impacts are unlikely to be highly significant. In addition, although the features play some role in ecological functioning, the features currently do not provide high level of socio-cultural service provision.

Impacts are thus expected to be low prior to mitigation measures being put in place, but may be lowered even further should management be effective.

Unmanaged	Intensity	Duration of impact	Extent	Consequence	Probability	Significance
Construction phase	L	VL	VL	VL	L	L
Operational phase	L	L	L	L	L	L
Decommissioning and closure phase	L	VL	VL	VL	L	L

Essential construction phase mitigation measures:

- A sensitivity map has been developed for the study area, indicating wetland and riparian features that are considered to be of increased ecological importance. It is recommended that this sensitivity map with the associated buffer zone be considered during the planning/ pre-construction and construction phases of the proposed project activities to aid in the conservation of ecology within the study area.
- It must be ensured that planning of smelter infrastructure includes consideration of adjacent wetlands and riparian areas associated with stream crossings to ensure that these areas are avoided as far as possible.
- All demarcated sensitive zones outside of the construction area must be kept off limits during any development and closure phases of the smelter.
- The development footprint area must be limited to what is absolutely essential in order to minimise environmental damage.
- After construction has been completed, suitable reprofiling, reseeding with indigenous grasses and revegetation of any bare areas must take place to minimise the potential of sedimentation and erosion of wetland features. Potential disturbed areas in the vicinity of stream crossings must also be suitably rehabilitated if required to ensure adequate vegetation cover, the absence of alien vegetation and stream bank stability.

Essential operational phase mitigation measures:

- Effective waste management must be implemented in order to prevent construction related waste from entering the wetland and riparian environment.
- Edge effects of activities including erosion and alien vegetation eradication and control need to be strictly managed in wetland and riparian areas.
- It must be ensured that the smelter process water system is managed in such a way as to prevent discharge to the receiving environment.
- Culverts associated with stream crossings must be desilted and regularly cleared of any debris.

Essential decommissioning and closure phase mitigation measures:

- As much vegetation growth as possible should be promoted within the study area, particularly within the vicinity of the Project Infrastructure Area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, landscaping and rehabilitation are to be implemented.
- Any disturbed wetland and riparian areas must be rehabilitated upon decommissioning to ensure that wetland and riparian functions are re-instated to at least pre-development conditions.

Managed	Intensity	Duration of impact	Extent	Consequence	Probability	Significance
Construction phase	VL	VL	VL	VL	VL	VL
Operational phase	L	VL	VL	VL	VL	VL
Decommissioning and closure phase	VL	VL	VL	VL	VL	VL

Probable latent impacts

- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland and riparian areas as well as the buffer zone; and
- Erosion and incision of the wetland and riparian areas may occur.

4.1.3 Impact 3: Impacts on Wetland and Riparian Hydrological Function and Sediment Balance

Aspect and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Potential planning of placement of road access at areas where there are no existing roads, and thus creating new crossings	Site clearing and the removal of vegetation leading to increased runoff and erosion and subsequent sedimentation of wetland riparian habitat	Ongoing disturbance of soils due to general operational activities	Disturbance of soils as part of demolition activities
Potential inappropriate design of infrastructure leading to changes in hydrological function and sediment control capacity	Topsoil stockpiling adjacent to wetland and riparian features as well as runoff from temporary stockpiles leading to sedimentation of the wetland and riparian areas	Earthworks in the vicinity of wetland and riparian areas leading to increased runoff and erosion and altered runoff patterns	Altered hydrology due to stormwater channels and dams
Potential placement of smelter infrastructure within wetland habitat	Earthworks in the vicinity of wetland and riparian areas leading to altered runoff patterns	Topsoil stockpiling adjacent to wetland and riparian features and runoff from stockpiles leading to sedimentation of the wetland	Movement of construction vehicles within wetland and riparian areas leading to soil compaction which
	Movement of construction vehicles within wetland and riparian areas leading to soil compaction which results in increased runoff	Movement of construction vehicles through wetland and riparian areas leading to soil compaction which results in increased runoff	
	Concentration of flow and incision of wetland and riparian boundaries	Altered runoff patterns due to construction of stormwater channels	
	Disturbances of soil and additional clearing of vegetation leading to sedimentation of wetlands and riparian areas	Increased runoff volumes due to increased paved and other impervious surfaces	
		Concentration of flow and incision of wetland and riparian boundaries	

Construction activities such as topsoil removal, stockpiling and excavations as well as the (limited) removal of indigenous vegetation, may alter the hydrology and sediment balance of the wetland and riparian features in the vicinity of construction and road construction/ upgrade activities, while an increase in runoff from disturbed and built-up areas may also alter flow patterns and result in an increase in the severity of floods downstream. Sediment deposition as a result of the disturbance of soils and increased runoff during the construction and operation of the proposed smelter may also result in an impact on the sediment balance of the features and further alter the hydrology of the wetland and riparian areas. Waste dumping will result in the deposition of contaminants into the water, leading to the alteration of water quality.

Due to the location of the smelter and access road within an already disturbed agricultural area and the infrastructure being located outside of the wetland and riparian areas and

buffer zones, this impact is expected to be of medium significance prior to mitigation measures being put in place and post-mitigation may be lowered to low and very low impact significance.

Unmanaged	Intensity	Duration of impact	Extent	Consequence	Probability	Significance
Construction phase	M	L	M	M	L	M
Operational phase	M	M	L	M	L	M
Decommissioning and closure phase	M	L	L	M	L	M

Essential construction phase mitigation measures:

- A sensitivity map has been developed for the study area, indicating the various wetland and riparian features and associated buffer zones which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed project activities to aid in the conservation of ecology within the study area.
- It must be ensured that planning of smelter infrastructure includes consideration of adjacent wetland and riparian areas to ensure that these areas are avoided as far as possible.
- All demarcated sensitive area must remain off limits during the construction phase.
- The footprint area of the proposed project must be limited to what is absolutely essential in order to minimise environmental damage.
- Effective waste management must be implemented in order to prevent construction related waste from entering the wetland and riparian environment.
- The proposed project, particularly road upgrades and stream crossings should not lead to a reduction of stream flow and connectivity of the wetland and riparian features should be maintained.
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the wetland and riparian features have occurred to prevent gully formation and siltation of the aquatic resources.

Recommended construction phase mitigation measures:

- Any riparian features that appear significantly impacted by sediment deposition as a result of disturbance due to road must be carefully desilted.

Essential operational mitigation measures:

- Run-off from dirty water areas must be prevented from entering wetland and riparian areas.
- It must be ensured that smelter process water system is managed in such a way as to prevent discharge to the receiving environment.
- Seepage from the slag dump must be prevented by ensuring that this infrastructure is adequately lined.

Essential decommissioning and closure phase mitigation measures

- It must be ensured that any activities/ facilities with the potential to impacting on geohydrological resources are managed according to the relevant DWS Licensing regulations and groundwater monitoring requirements.
- All wetland and riparian areas that may have been disturbed as part of the project must be rehabilitated upon decommissioning.
- Post closure groundwater management will need to be very carefully managed to ensure that no impact on the wetland and riparian areas and resources in the area takes place after smelter closure has taken place.
- All disturbed areas must be revegetated with indigenous vegetation species upon closure.

Unmanaged	Intensity	Duration of impact	Extent	Consequence	Probability	Significance
Construction phase	L	VL	VL	VL	VL	VL
Operational phase	L	L	VL	L	VL	L
Decommissioning and closure phase	L	VL	VL	L	VL	VL

Probable latent impacts

- Impacts on the wetland and riparian areas may affect service provision of these features beyond closure.
- Erosion and incision of the wetland and riparian areas may occur.

4.2 Powerline Impact Assessment

4.2.1 Impact 1: Loss of Wetland and Riparian Habitat and Ecological Structure

Aspects and activities register

Pre-Construction	Construction	Operational
Potential inappropriate design of infrastructure leading to changes to wetland and riparian habitat	Site clearing and the removal of vegetation leading to increased runoff and erosion and subsequent sedimentation of the wetland and riparian habitat	Ongoing disturbance of soils through general maintenance of powerlines
Powerline infrastructure being potentially planned within the wetland feature and within the active channel of the riparian and resource	Earthworks and excavations in the vicinity of wetland and riparian areas leading to increased loss of habitat, erosion and altered flow patterns	Further erosion and sedimentation of the riparian features in the vicinity of stream crossings arising from increased runoff, leading to loss of and alteration to habitat
	Movement of construction vehicles through wetland and riparian features	Sedimentation and incision leading to altered habitats and loss of wetland and riparian floral
	Dumping of hazardous waste and spills into the wetland and riparian areas resulting in soil and water contamination	Dumping of hazardous and non-hazardous waste materials into wetland areas
	Construction within the vicinity of wetlands and riparian areas resulting in streamflow discontinuation which leads to drying of downstream areas	Ineffective rehabilitation leading to habitat transformation and ongoing alien vegetation encroachment
	Topsoil stockpiling adjacent to the wetland and riparian areas, with runoff from stockpiles leading to increased sedimentation	
	Dumping of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the riparian areas	

Construction related activities, including earthworks and excavations, may lead to habitat disturbance in the vicinity of stream crossings. Such activities may result in a long-term impact on the wetland and riparian features and lead to an increase in alien vegetation and erosion within these areas. During the operational phase of the project, impacts will mainly be related to maintenance of the powerline and potential ongoing erosion if the disturbed are not adequately rehabilitated. Impacts have the potential to extend to downstream areas, beyond the boundaries of study area.

Prior to mitigation measures being put in place, impacts on the wetland and riparian habitat and ecological structure have the potential to be of medium significance, however with the implementation of mitigation measures the overall significance of the impact can be reduced to low significance levels.

Unmanaged	Intensity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	M	L	M	M	M	M
Operational phase	M	M	M	M	M	M

Essential construction phase mitigation measures:

- Wetland and riparian areas upstream and downstream of the proposed powerline stream crossings should remain off limits to construction personnel.
- It must be ensured that flow connectivity along the wetland area and riparian features is maintained throughout the construction phase.
- It must be ensured that no incision and canalisation of the riparian resource takes place as a result of the construction of the powerline.
- Disturbances within the active riparian channels and riverbeds need to be minimised as far as possible. In this regard the following key points are highlighted:
  - The powerline should ideally span the entire delineated riparian zone, with no infrastructure being placed within the active river channels. Placement of the powerline and its support structures must ensure that no upstream ponding and no downstream erosion and scouring occur.
  - The narrowest points in the rivers should be identified and potentially used as the crossing point and the powerline should not cross the rivers longitudinally, i.e. run within or adjacent to the river for extended lengths, with particular reference to the Phufane River where it exits the study area in the south.
  - The powerline should cross the rivers at a 90 degree angle to minimise the damage to riparian areas.
  - The powerline should not cross the rivers in any area where the river or active channel makes sharp bends.
- The duration of impacts on the rivers should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised.
- Effective and strict erosion control throughout the construction phase must be implemented. Erosion berms should be installed below the powerline support structures to prevent gully formation and siltation of the rivers and avoid further degradation in this regard following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.
- Erosion control infrastructure must be regularly maintained, at least every two weeks, and particularly if rain is forecast or after a rainfall event.
- Edge effects (impacts on areas beyond the construction footprint due to ineffective care and management) during construction need to be strictly controlled through ensuring good housekeeping and strict management of activities near the riparian resource or the associated buffer zone.
- Any areas where soils are exposed or destabilised during construction need to be stabilised taking into account the following:
  - As far as possible soft engineering should be used, with special mention of resloping of banks, revegetation of banks and stabilisation using products such as hessian sheets and geotextiles in order to limit transportation of sediment to the river via stormwater runoff.
  - Hard engineering techniques, such as the placement of gabions or reno mattresses, should only be implemented in areas where engineering and hydraulic constraints require such interventions.
- Upon completion of construction any stream banks disturbed as a result of construction activities must be reprofiled.
- All disturbed areas must be revegetated with indigenous grass and floral species.
- An alien vegetation control program within wetlands as well as riparian areas must be implemented
- All wetland and riparian features must be monitored for erosion and incision.

Recommended construction phase mitigation measures:

- It is recommended that construction be restricted to the low flow season, during the drier winter months if possible, to avoid further sedimentation of wetland and riparian features in the vicinity of the proposed powerline infrastructure and to decrease the potential for erosion and sedimentation within disturbed areas due to rainfall.

Essential operational phase mitigation measures:

- Alien and invasive vegetation control in the vicinity of the powerline should take place throughout the operational phase.
- Wetland and riparian area in the vicinity of the powerline must be regularly monitored for erosion and incision.
- Vehicles must be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed project activities.
- Any areas where active erosion is observed in the vicinity of the powerline, must be immediately rehabilitated through reprofiling, revegetation and stream bank stabilisation if necessary. This must be done in such a way as to ensure that the hydrology and geomorphological characteristics of the area are re-instated to conditions which are as natural as possible.
- Effective waste management must be implemented in order to prevent general waste from entering the wetland and riparian environment.

- It must be ensure that all activities impacting on water resources are managed according to the relevant DWS Licensing regulations.

Managed	Intensity	Duration of Impact	Spatial	Consequence	Probability	Significance
Construction phase	VL	L	VL	VL	L	L
Operational phase	VL	M	VL	L	L	L

Probable latent impacts

- Ineffective rehabilitation may lead to the permanent transformation of the wetland and riparian habitat.
- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland and riparian areas.

4.2.2 Impact 2: Changes to Wetland and Riparian Ecological and Sociocultural Service Provision

Aspects and activities register

Pre-Construction	Construction	Operational
Potentially poor planning leading to the placement of infrastructure within wetland and the active channels of riparian areas	Site clearing, including the removal of vegetation and associated disturbance of soils, leading to increased runoff and erosion and subsequent sedimentation of wetland and riparian habitat	Increased impermeable surfaces in the vicinity of the wetland and riparian areas and the greater catchment due to support structures and maintenance roads, leading to increased runoff and erosion and altered runoff patterns
Potential inappropriate design of infrastructure leading changes to wetland and riparian habitat	Earthworks in the vicinity of wetland and riparian areas leading to increased runoff and erosion and altered runoff patterns	Erosion and sedimentation of the wetland and riparian areas arising from increased runoff, leading to loss of habitat
	Topsoil stockpiling adjacent to the wetland and riparian resources and runoff from such stockpiles may lead to further sedimentation of the system	Dumping of hazardous and non-hazardous waste materials into wetland and riparian areas
	Draining water from wetland and riparian areas for construction purposes, resulting in loss of streamflow regulation services	

Construction related activities of the proposed powerline may result in some loss of ecosystem services and ecological functioning. Impacts may result in a decrease in the ability of the features to support biodiversity as a result of increased levels of erosion, disturbance of active stream channels, sedimentation and the alteration of natural hydrological regimes and general anthropogenic activities which will occur within areas where the powerline crosses the wetland and riparian areas.

Prior to mitigation measures being put in place, impacts on the wetland and riparian habitat and ecological structure have the potential to be of medium significance. If mitigation and effective management of potential impacts however take place, the overall significance of the impact can be reduced to low significance levels.

Unmanaged	Intensity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	L	M	M	M	M	M
Operational phase	L	M	M	M	M	M

Essential mitigation measures:

- All essential mitigation measures for the construction phase as detailed in the table above remain applicable and must be adhered to.

Recommended mitigation measures:

- Restrict construction to the drier winter months if possible to avoid further sedimentation of wetland and riparian features in the vicinity of the proposed development areas. and
- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils.

Essential operational phase mitigation measures:

- All essential mitigation measures for the operational phase as stipulated in the table above remain applicable and must be adhered to.
- The wetland and riparian systems, particularly at the stream crossings, must be regularly monitored for erosion and incision in the vicinity of the powerline crossings. The monitoring ideally should be undertaken during the rainy season and photographic records must be maintained. In addition, any necessary maintenance and rehabilitation must be implemented.
- Ongoing maintenance of the powerline, particularly of the support structures must take place during the operational phase.

Recommended operational phase mitigation measures:

- It must be ensured that all activities impacting on water resources of the linear development are managed according to the relevant DWS Licensing regulations completion of the construction phase of the development to ensure that wetland and riparian functions are re-instated.

Managed	Intensity	Duration of Impact	Spatial	Consequence	Probability	Significance
Construction phase	L	L	VL	L	L	L
Operational phase	VL	L	VL	VL	L	L

Probable latent impacts

- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland and riparian areas as well as the buffer zones.
- Erosion and incision of the wetland and riparian areas may occur. and
- Reduced biodiversity support.

4.2.3 Impact 3: Impacts on Wetland and Riparian Hydrological Function and Sediment Balance

Aspect and activities register

Pre-Construction	Construction	Operational
Potential placement of infrastructure within wetland and riparian areas resulting in alteration of runoff patterns and changes to the hydrological regime	Site clearing, including the removal of vegetation and associated disturbance of soils, leading to increased runoff and erosion	Ongoing erosion and disturbance of soils due to general maintenance activities
Potentially inappropriate design of infrastructure leading to changes in hydrological function and sediment control capacity	Earthworks in the vicinity of riparian areas leading to increased runoff and erosion and altered runoff patterns	Movement of vehicles within wetland and riparian areas leading to soil compaction which results in increased runoff
	Topsoil stockpiling adjacent to the riparian resource and runoff from such stockpiles leading to further sedimentation of the system	Increased water runoff into the rivers due to unvegetated areas overlooked after construction
	Movement of construction vehicles within the wetland and riparian areas	
	Dumping of hazardous and non-hazardous waste into the wetland and riparian areas	
	Stream flow discontinuation leading to drying of downstream areas	

Construction activities such as vegetation removal and excavations may alter the hydrology and sediment balance of the features, while an increase in runoff from disturbed areas may also alter flow patterns and may result in sediment deposition and erosion. Ongoing loss of vegetation cover during the operational phase and indiscriminate driving of vehicles during maintenance of the powerline infrastructure may also lead to additional compaction of soils and disturbance of stream banks which may further alter the hydrology of the aquatic features. The significance of the impact on the riparian features in particular will increase in areas where the proposed powerline is constructed to occur longitudinally or immediately adjacent to the riparian features.

This impact is expected to be of medium significance prior to mitigation measures being put in place, but may be lowered to low impact significance levels post-mitigation.

Unmanaged	Intensity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	M	L	M	M	M	M
Operational phase	M	M	M	M	M	M

Essential construction phase mitigation measures:

- All essential mitigation measures for the construction phase as detailed in the table above remain applicable and must be adhered to in addition to those specified in this table.
- The footprint of the powerlines support structures must be kept as small as possible in order to minimise the loss of catchment yield in the various systems.

Recommended construction phase mitigation measures

- Construction activities must be restricted to the drier winter months if possible to avoid sedimentation.

Essential operational mitigation measures

- A monitoring programme of the sections of the powerline running through the wetland and riparian features must be implemented, to ensure no erosion is occurring.
- Effective waste management must be implemented in order to prevent general waste from entering the wetland environment.
- It must be ensured that all activities impacting on water resources of the proposed powerline are managed according to the relevant DWS Licensing regulations.

Recommended operational mitigation measures

- Ongoing monitoring of the riparian resources in the vicinity of the stream crossings for erosion, incision and proliferation of alien vegetation must take place.

Managed	Severity	Duration of Impact	Extent	Consequence	Probability	Significance
Construction phase	L	VL	L	L	L	L
Operational phase	L	L	L	L	L	L

Probable latent impacts

- Erosion and incision of wetland and riparian areas may occur.

4.3 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts that may affect the wetland and riparian ecology within the study area for the proposed smelter construction, the access road construction as well as the powerline construction.

The tables below summarise the findings indicating the significance of the impacts of the proposed development before mitigation takes place and the likely impact levels if management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs. From the table it is evident that both prior to mitigation, impact levels are of medium or low significance, while post-mitigation impact levels may be reduced to low or very low significance.

Table 15: A summary of the results obtained from the assessment of wetland ecological impacts for the smelter development.

CONSTRUCTION PHASE		
Impact	**Unmanaged**	**Managed**
1: Loss of wetland and riparian habitat and ecological structure	M	L
2: Changes to wetland and riparian ecological and sociocultural service provision	L	VL
3: Impacts on wetland and riparian hydrological function and sediment balance	M	VL
OPERATIONAL PHASE		
Impact	**Unmanaged**	**Managed**
1: Loss of wetland and riparian habitat and ecological structure	M	L
2: Changes to wetland and riparian ecological and sociocultural service provision	L	VL
3: Impacts on wetland and riparian hydrological function and sediment balance	M	L
DECOMMISSIONING AND CLOSURE PHASE		
Impact	**Unmanaged**	**Managed**
1: Loss of wetland and riparian habitat and ecological structure	M	L
2: Changes to wetland and riparian ecological and sociocultural service provision	L	VL
3: Impacts on wetland and riparian hydrological function and sediment balance	M	VL

The tables below summarise the findings of the impact assessment of the proposed powerline development, indicating the likely significance of the impacts prior to mitigation taking place and the significance of the impacts if appropriate and effective management and mitigation takes place. From the table it is evident that both prior to mitigation, impact levels are of medium significance levels, while post-mitigation impact levels may be reduced to a low significance level.

Table 16: A summary of the results obtained from the assessment of wetland ecological impacts for the powerline development.

CONSTRUCTION PHASE		
Impact	**Unmanaged**	**Managed**
1: Loss of wetland and riparian habitat and ecological structure	M	L
2: Changes to wetland and riparian ecological and sociocultural service provision	M	L
3: Impacts on wetland and riparian hydrological function and sediment balance	M	L
OPERATIONAL PHASE		
Impact	**Unmanaged**	**Managed**
1: Loss of wetland and riparian habitat and ecological structure	M	L
2: Changes to wetland and riparian ecological and sociocultural service provision	M	L
3: Impacts on wetland and riparian hydrological function and sediment balance	M	L

5 ALTERNATIVES ASSESSMENT

A map indicating the location of the various infrastructure site layout alternatives is included in Section A: Figure 3 of this report.

Project Infrastructure Area

As a site layout alternative to Project Infrastructure Area Option 1 (preferred), which has been included as part of this assessment, Project Infrastructure Area Option 2 has been identified. As with Project Infrastructure Area Option 1 (with the exception of the southeastern portion of the Proposed Infrastructure Area, where no or very limited infrastructure is expected to be placed), Project Infrastructure Area Option 2 is located within an area where no wetlands appear to be present. Both Project Infrastructure Area Options 1 and 2 are therefore expected to have similar wetland ecological impact levels, provided that the infrastructure footprint areas do not encroach on wetland habitat and the associated buffer zones.

Access Road

Neither Access Road Corridor Option 2 (preferred) nor Access Road Option 3 are located in the vicinity of wetland features and both these options are expected to have no impact on wetland ecology in the region. Access Road Option 3 will require upgrades to several stream crossings and is therefore the least preferred alternative (although it should be kept in mind that the Proposed Powerline Option 1 follows a similar alignment and watercourse crossings are therefore unlikely to be avoided).

Powerline

In addition to Powerline Option 1 (preferred), three other alternatives have been identified, namely Powerline Option 2, Powerline Option 3 and Powerline Option 4. All powerline alignments will involve the crossing of several watercourses and therefore are expected to have similar impact levels. Powerline Option 3 is however not located on an existing dirt road, where some impacts on the watercourses is likely to have occurred historically and this is therefore the least preferred alternative in terms of wetland ecology.

6 CONCLUSION AND RECOMMENDATIONS

Based on the findings of the wetland assessment it is the opinion of the ecologists that from a wetland ecological viewpoint, the proposed project be considered favorably, provided that

the essential mitigation measures as set out below be adhered to. It must be kept in mind that the proposed smelter infrastructure has been purposefully placed outside of the delineated wetland and riparian areas, thereby greatly lowering the potential impacts of the project on the aquatic ecology associated with the study area.

Although roads and powerline crossings of wetland and riparian areas will not be avoided in the planning of the project, these infrastructure components have been placed along existing roads and adjacent to exiting powerlines as far as possible. In addition, the proposed powerline servitude has been limited to a maximum of 30m wide.

Implementation of the following recommendations should be strongly considered:

- A sensitivity map has been developed for the study area, indicating wetland and riparian features that are considered to be of increased ecological importance. It is recommended that this sensitivity map with the associated buffer zone be considered during the planning/ pre-construction and construction phases of the proposed project activities to aid in the conservation of ecology within the study area;
- During the construction phase, access to the construction site should be limited to existing access roads in order to minimise stream and wetland crossings. It is recommended that no new crossings be constructed. Access to wetland and riparian areas within the remainder of the study area by site personnel should be prohibited to prevent compaction of soils, loss of vegetation and increased erosion;
- Smelter infrastructure, including contractor laydown areas and areas designated for washing, cutting, mixing, etc. should be placed, as planned, within designated low sensitivity areas as far as possible and well outside of the wetland buffer zones;
- The proposed project, particularly road upgrades and stream crossings should not lead to a reduction of stream flow and connectivity of the wetland and riparian features should be maintained;
- It must be ensured that no incision and canalisation of the riparian resource takes place as a result of the construction of the powerline;
- Disturbances within the active riparian channels and riverbeds need to be minimised as far as possible. In this regard the following key points are highlighted:
    - The powerline should ideally span the entire delineated riparian zone, with no infrastructure being placed within the active river channels. Placement of the powerline and its support structures must ensure that no upstream ponding and no downstream erosion and scouring occur;
    - The narrowest points in the rivers should be identified and potentially used as the crossing point and the powerline should not cross the rivers longitudinally, i.e. run

within or adjacent to the river for extended lengths, with particular reference to the Phufane River where it exits the study area in the south;

- The powerline should cross the rivers at a 90 degree angle to minimise the damage to riparian areas; and
- The powerline should not cross the rivers in any area where the river or active channel makes sharp bends.

- The duration of impacts on the rivers should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised; and
- It is recommended that construction be restricted to the low flow season, during the drier winter months if possible, to avoid further sedimentation of wetland and riparian features in the vicinity of proposed road or powerline stream crossings and to decrease the potential for erosion and sedimentation within disturbed areas due to rainfall.

7 REFERENCES

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