FINAL

Watercourse Delineation and Assessment Study for Proposed New Mining Infrastructure on the Farms Frischgewaagd and Mimosa, North West Province

March 2016

Report compiled by:

L.E.R. Grobler
(MSc. Botany)

Registered with the South African Counsel for Natural Scientific Professionals
(Registration number: 400097/09)

Specialist reports and reports on specialist processes - Checklist		
	NEMA Regs (2014) - Appendix 6	**Reference to section of specialist report or justification for not meeting requirement**
1	A specialist report or a report on a specialised process prepared in terms of these Regulations must contain -	
(a) i	the person who prepared the report; and	Title page
(a) ii	the expertise of that person to carry out the specialist study or specialised process;	Appendix C
(b)	a declaration that the person is independent in a form as may be specified by the competent authority;	Page ii
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Page 1 – 4
(d)	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Page 6
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Page 6 – 12
(f)	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Page 22 – 50
(g)	an identification of any areas to be avoided, including buffers;	Page 44 – 50
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Page 46 and 47
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Page 4 and 12
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;	Page 45 – 55
(k)	any mitigation measures for inclusion in the EMPr	Page 54 – 55 & 64 – 72
(l)	any conditions for inclusion in the environmental authorisation	Page 64 - 72
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation	Page 64 - 72
(n)	a reasoned opinion -	
.i	as to whether the proposed activity or portions thereof should be authorised and	Page 53-55

.ii	if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Page 53-55
(o)	a description of any consultation process that was undertaken during the course of carrying out the study;	No specific consultation was undertaken or deemed necessary as part of this study.
(p)	a summary and copies if any comments that were received during any consultation process, and -	No specific consultation was undertaken or deemed necessary as part of this study.
(q)	any other information requested by the competent authority.	None

DECLARATION

I, Lourens Erasmus Retief Grobler, declare that I –

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

LOURENS ERASMUS RETIEF GROBLER

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION AND PROJECT DESCRIPTION

1.1 Background and Project Description

Imperata Consulting CC was subcontracted by De Castro and Brits Ecological Consultants CC to conduct a baseline wetland and watercourse study as part of an environmental impact assessment document to be compiled by SLR Consulting for new mining infrastructure components on the Farms Frischgewaagd and Mimosa, as well as an intervening area to the north of the Elands River located between these farms, close to Ledig, North West Province.

Wesizwe Platinum Limited (Wesizwe) is the owner of Bakubung Platinum Mine, currently shaft sinking on the farm Frischgewaagd 96JQ (Portions 3, 4 and 11). The mine is located near Ledig, just south of the Pilanesberg Game Reserve and Sun City. Two reefs will be mined for Platinum Group Elements - platinum, palladium, rhodium and gold, with copper and nickel as by-products. The project area falls within the Rustenburg and Moses Kotane Local Municipalities of the Bojanala District Municipality.

In 2008, Wesizwe conducted an Environmental Impact Assessment (EIA) process for the development of the Bakubung Platinum Mine. The Bakubung Platinum Mine received Environmental Authorisation in 2009, in terms of both the National Environmental Management Act (Act 107 of 1998) (NEMA) and Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA). A Water Use Licence (WUL) was issued in terms of the National Water Act (Act 36 of 1998) (NWA) in 2010.

While construction at the Bakubung Platinum Mine has commenced, not all facilities have yet been constructed. Mining has not yet commenced. Wesizwe is now proposing to make several changes to the approved mine. The changes are required in order to cater for an increase in ore processing capacity, as well as additional support infrastructure which will require additional Environmental Authorisations, a Waste Management Licence (WML) and additional water uses requiring an amendment to their existing WUL.

The following changes are proposed to the Bakubung Platinum Mine (infrastructure components addressed in this specialist report are shaded in grey):

- The construction of a Tailings Storage Facility (TSF) of approximately 235.3ha on the farm Mimosa 81JQ. The height will be approximately 44m.
- An approximately 3.83km long Tailings Pipeline (which in includes a return water pipeline) linking the Concentrator to TSF. The alignment will be situated on the Farms Frischgewaagd and Mimosa and the intervening area to the north of the Elands River between these farms. The pipeline will be 300mm in diameter and will be raised above ground level on plinths, and the construction servitude will be 30m wide.
- The construction of a Concentrator Plant on a footprint of approximately 6.3ha.
- The construction of a Product Stockpiles and Ore Crusher on a footprint of approximately 25.2ha adjacent to the Concentrator Plant.
- The construction of a Waste Rock Dump on a footprint of approximately 5.8ha.
- The construction of a Pollution Control Dam's for the Concentrator on a footprint of approximately 5.1 ha on the farm Frischgewaagd.
- The construction of a Return Water Dam with a footprint of approximately 1.2ha on the farm Mimosa.
- The construction of a Storm Water Dam with a footprint of approximately 14.9ha on the farm Mimosa.
- Relocation of the ore crusher circuit from underground to the surface.
- Inclusion of the minerals in the waste rock into the mining licence, as the waste rock may potentially be crushed and sold as aggregate.

- Construction of erosion control measures along watercourses within the mine.
- Storage and handling of dangerous goods such as diesel and reagents on site.
- Various pipeline and road crossings over watercourses, including a bridge crossing.
- New sewage and water pipelines.
- Settling and return water dams.
- New internal mine roads (some of which will cross watercourses).
- Ventilation shafts and raise boreholes.
- Generators or possibly a solar power plant on site, for back-up power.
- A salvage yard for temporary storage of general and hazardous waste.
- The construction of Phase 1 of the mine housing on a footprint of approximately 19.8ha on the farm Frischgewaagd.
- The construction of Phase 1a of the mine housing on a footprint of approximately 25.2ha on the farm Frischgewaagd.
- The construction of the Eskom Ledig substation on a footprint of approximately 5.1ha adjacent to the Phase 1a mine housing.

This report deals with potential impacts of selected new mining infrastructure features (those shaded in grey), on watercourses present in their proposed footprint areas. These proposed new infrastructure footprints also form the study area that was assessed for the presence, type and ecological condition of watercourses, as defined in the National Water Act (Act Nr. 36 of 1998) (NWA). The assessed study area components are illustrated in Figure 1. The site visit for this study was conducted in November 2015, while the layout for the Tailings Pipeline changed in December 2015 (Figure 1). The November 2015 site visit entailed an assessment within a corridor surrounding the original design and the December 2015 pipeline layout falls mostly within this corridor, the findings of the November 2015 site visit are therefore still deemed relevant. Recent changes in the TSF shape do not impact the findings of this report either and thus the mapping has been kept with the previous TSF layout.

1.2 Overview of Wetlands and Riparian Habitat

In terms of the Ramsar Convention on Wetlands (Iran 1971), to which South Africa is a contracting party, "… wetlands include a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as salt marshes, mangroves, and sea grass beds, but also coral reefs and other marine areas no deeper than six meters at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs" (Ramsar Convention Secretariat 2007).

In South Africa, wetlands are defined as "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil" (National Water Act, 1998 (Act No. 36 of 1998)). Wetlands are also included in the definition of a watercourse within the NWA, which implies that whatever legislation refers to the aforementioned will also be applicable to wetlands.

In addition, the NWA stipulates that "…reference to a watercourse includes, where relevant, its bed and banks…". This has important implications for the management of watercourses and encroachment on their boundaries, as discussed further on in this document.
The NWA defines riparian areas as "…the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of

adjacent land areas…" Note that this does not imply that the plant species within a riparian zone must be aquatic, only that the species composition of plant assemblages must be different within the riparian area and adjacent uplands.
In terms of the wetland delineation document available from the Department of Water Affairs and Forestry (DWAF), now known as the Department of Water and Sanitation (DWS), "wetlands must have one or more of the following attributes" (DWAF, 2005):

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

It follows that the level of confidence associated with a specific area being considered as a wetland is proportionate to the number of confirmed indicators that positively correlate with wetland habitat. Not all indicators are always present within a specific biophysical and land use setting, while not all indicators are always reliable and/or useful under all conditions. The use of additional wetness indicators from different disciplines that are internationally applied therefore adds value and confidence in the identification and delineation of wetland habitats, especially in challenging environments. These types of environments can include mining and urban settings where disturbances to the natural soil and vegetation are common.

1.3 Details of the Author

Retief Grobler has undergrad majors in Botany (UP) and Soil Science (UP), an honours degree in Botany from the University of Pretoria (cum laude), and an MSc (cum laude) from the Department of Plant Sciences (UP) with a focus on peatland wetland systems. He is a registered Pr. Sci. Nat professional natural scientist in the fields of Botanical Science and Ecological Science (Reg. no. 400097/09), and has been working as a watercourse specialist consultant based in Gauteng over the last ten years. He has wetland and related watercourse specialist consulting work experience in Gauteng, Mpumalanga, North-West, Limpopo, Northern Cape, Free State, Eastern Cape and KwaZulu-Natal Provinces. Areas of specialisation include the delineation, description and assessment of watercourses, including wetlands, riparian habitats, and headwater drainage lines. A CV is provided in Appendix D.

2. TERMS OF REFERENCE

2.1 General

Terms of references associated with the specialist watercourse investigation include the following for the study area as defined in Section 1 (Figure 1):

- Desktop analyses and literature review of existing wetland-related information, including available recent and historic aerial imagery.
- A three day field survey by a Pr.Sci.Nat. registered ecologist that will investigate and delineate wetlands and other watercourses according to the DWA method (DWAF 2005; DWAF 2008).
- A one day field survey by a Pr.Sci.Nat. registered soil scientist that will assist with the interpretation of hydromorphic (wetland soil) features and the presence / absence of other soil wetness indicators in other watercourses identified.
- A classification of identified wetland areas into appropriate hydro-geomorphic units according to the National Wetland Classification System for South Africa (Ollis et al., 2013).
- Description of identified wetland and related watercourse indicators; these include

soil, plant, and terrain indicators, as well as others published in literature (e.g. Nobel *et al.,* 2005). Apart from wetlands, other types of watercourses will also be delineated and described, these include riparian areas, dams and natural channels (e.g. headwater drainage lines), as defined in the National Water Act (Act Nr. 36 of 1998) (NWA) within the study area. All watercourses are also subject to Section 21 (c) and (i) Water Use License Applications, as well as listed activities in terms of the National Environmental Management Act (NEMA), Act No. 107 of 1998 and the EIA Regulations of 2014.

- Assessments of the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of delineated wetlands according to the applicable methods developed by either the Department of Water and Sanitation (DWS) or the Water Research Commission (WRC), (DWAF 1999; DWAF 2007; Macfarlane *et al.,* 2008; Rountree & Malan 2013). The accuracy and level of confidence of these assessments will be improved through a wet season survey (approximately November to May) rather than a dry season survey. PES & EIS values are also of relevance for a possible Water Use License Application (WULA) that may be required.
- **Surrounding wetland areas located in a 500m radius around the proposed footprints will be delineated at a secondary level of detail through limited site sampling and a stronger desktop approach (Figure 1)**, in order to meet criteria from the Department of Water and Sanitation (DWS) for a Water Use License Application (WULA) regarding Section (*c*) and (*i*) water use activities present within a 500 m radius of any wetland (DWAF, 2009).
- Creation of watercourse sensitivity maps and associated GIS shapefiles.
- A description of existing and expected project-related impacts that could affect demarcated wetlands and other watercourses.
- The identification of potential project-related watercourse impacts, and the provision of related impact mitigation measures.
- All of the above would be incorporated into a single report.

2.2 Assumptions & Exclusions

- This study assumes that the project proponents will always strive to avoid, mitigate or offset potentially negative project related impacts on the environment, with impact avoidance being considered the most successful approach, followed by mitigation and offset. It further assumes that the project proponents will seek to enhance potential positive impacts on the environment.
- Spatial GIS shapefiles received from the client used to demarcate the different study area components as illustrated in Figure 1 are accurate.
- The project proponents will commission an additional study to assess the impact(s) if there is a change in the size and/or extent of the study area or proposed infrastructure that is likely to have a potentially highly significant and/ or unavoidable impact on watercourses (e.g. wetlands).
- No aquatic ecological assessments, as required for rivers with in-stream habitat and riparian habitat, are required for this watercourse study. Aquatic ecological assessment and riparian habitat delineation based on site sampling are specifically excluded for the Elands River, which is located outside of the study area (Figure 1).

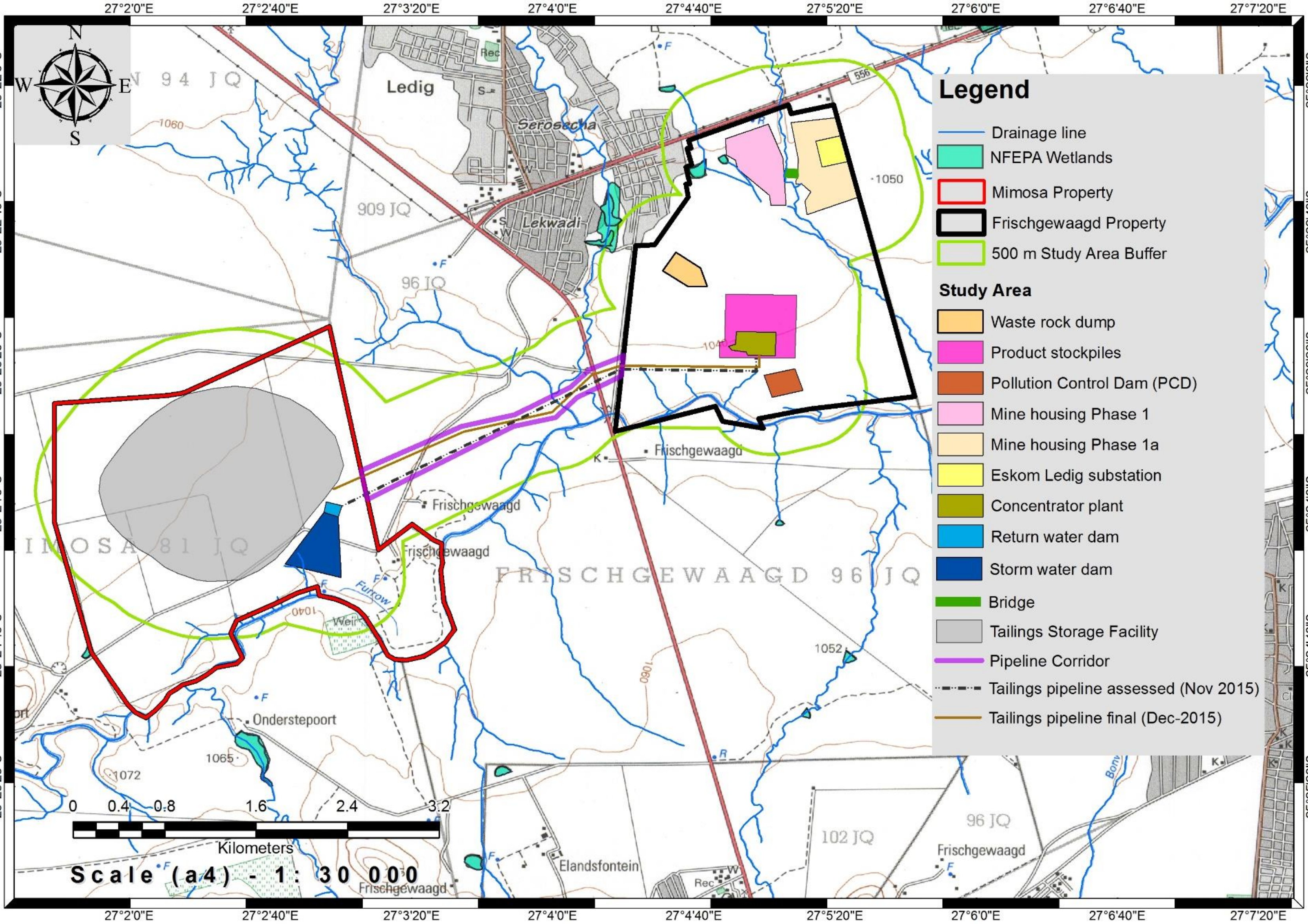

Figure 1: Illustrates the assessed study area consisting of different proposed footprint components along with a surrounding 500m study area buffer and drainage lines from the 1:50000 topographical map 2527AC (Sun City) and wetlands from the National Freshwater Ecosystem Priority Areas (NFEPA, 2011).

3. METHODOLOGY

3.1. Methods and Approach

The following methods and approach were applied as part of the wetland and watercourse investigation:

- Existing spatial datasets that indicate potential watercourses and ecologically important areas were used as part of an initial desktop approach:
  - The 1:50 000 drainage line dataset of the study area and its surroundings was used, as illustrated on the relevant topographic map (2527AC Sun City).
  - The recently completed National Freshwater Ecosystem Priority Areas (NFEPA) spatial dataset was used to help identify potential wetland areas within the study area and its immediate surroundings. This wetland layer has been formed by combing information from the National Land Cover 2000 data set (NLC 2000), 1:50 000 topographic maps and sub national data (Van Deventer *et al.* 2010).
  - The recently released 2013-14 South African National Land Cover dataset, which indicates wetlands, permanent water and seasonal water based on the globally available Landsat 8 imagery (GTI, 2015). This dataset was used to further help identify the presence of wetlands and other watercourses within the study area. The dataset was downloaded from the Maps and Graphics section of the Department of Environmental Affairs (DEA), (GTI, 2015).
  - Recently completed spatial data sets that indicate Critical Biodiversity Areas in the North West Biodiversity Sector Plan (NWBSP) was obtained in February 2016 from Mr. Ray Schaller (NWREAD, 2015), via De Castro and Brits Ecological Consultants. Mr. Schaller is the Conservation Planner at the North West Department Rural, Environment and Agricultural Development (NWREAD).
- Watercourses were identified and delineated within the study area through the procedure described by the Department of Water and Sanitation (DWS; previously also known as DWAF and DWA) in their document entitled: “A Practical field procedure for the identification and delineation of wetlands and riparian areas” (DWAF 2005 & DWAF, 2008).
- Available wetland indicators that were investigated included hydromorphic (wetland soil) features, the presence of wetland plant species (e.g. hydrophytes), presence of riparian species and vegetation features, alluvial soil features, and terrain unit indicators.
- A strong emphasis was placed on the identification of hydromorphic features to identify and delineated wetland areas. Investigated hydromorphic features typically included the presence of mottling, gleying, localised iron depletion, low chroma matrix colours, and organic enrichment in the A horizon.
- Suspected wetland areas were investigated with a Pr.Sci.Nat registered soil scientist with wetland delineation experience, Mr. PS Rossouw from Rossouw and Associates.
- A TLB was used to excavate a few test pits in selected areas to confirm the presence/absence of hydromorphic indicators in soils that where characterised by a high clay content and required verification of wetland indicators at deeper depths.
- Site surveys were undertaken between 24 to 26 November to make use of the summer growing season. Wetland surveys are undertake during the entire year and are not seasonally dependant. Surveys during the growing season do, however, improve the quality and accuracy of Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessments.
- Riparian habitat located within study area footprints were also delineated through the method developed by DWS (DWAF, 2005 & DWAF 2008).

- Additional indicators associated with natural headwater channels and inundated conditions that are published in scientific literature were also used (Gomi *et al*., 2002; Noble *et al*., 2005).
- Sample points were generally arranged along transects perpendicular to discernible flow paths, in order to record gradients of change between terrestrial and watercourse habitats.
- The field surveys primarily focussed on the delineation of watercourses within the study area, while selected areas were investigated within a 500 m radius of study area associated infrastructure features (Figure 1). The majority of suspected wetland areas within the 500m buffer area were mainly delineated and classified through a desktop approach with limited sampling.
- Identified wetland areas and other watercourses were delineated into GIS polygon shapefiles, which were used for map creation.
- All natural wetlands identified within the study area were classified according to the recently completed 'Classification System for Wetlands and other Aquatic Ecosystems in South Africa' up to the hydrogeomorphic (HGM) unit level (Ollis *et al*. 2013).
- The HGM classification system is based on three key parameters pertaining to the wetland: the geomorphic setting of the wetland, the source of water inputs into the wetland, and its hydrodynamics (how does water move through the wetland), (Brinson 1993; Kotze et al. 2008).
- The Present Ecological State (PES) of seep and unchannelled valley bottom wetlands present within the study area and 500m buffer was assessed at a Level 1 WET-Health assessment (Macfarlane *et al.,* 2008), (Table 1). Delineated channelled valley bottom wetlands and floodplain wetlands were assessed according to the Wetland Index of Habitat Integrity (IHI) method (DWAF 2007).
- Aquatic ecological surveys, specifically instream assessments, were excluded from the scope of works for the study, but the PES of delineated riparian habitat that overlapped with study area infrastructure footprints were assessed through the Habitat Integrity Assessment Method for River Ecosystems (DWAF 1999a). This method assesses impacts and changes to the riparian habitat and does not incorporate the response of target biota, such as aquatic invertebrate and fish species. Encroachment by alien macrophytes into riparian and instream habitat are however incorporated. The technique assesses instream habitat and riparian habitat separately from one another.
- Determining the PES of ephemeral channels and smaller drainage lines is problematic as no generally accepted PES technique exists for these watercourses that are not necessarily consistent with wetland and river watercourses, but more consistent with the definition of ‘natural channels with regular or intermittent flow’, based on the watercourse definition in the NWA. The PES method developed by Kleynhans (DWAF 1999a) for the habitat integrity assessment of rivers has been modified to apply to ephemeral channels and drainage lines within the study area.
- The PES method compares the current condition of a wetland, or other watercourse type, to its perceived reference condition, in order to determine the extent to which the watercourse had been modified from its pristine (reference) condition.
- Results from the PES assessments are rated into one of six categories ranging from unmodified/ pristine wetlands (Class A) to critically/ totally modified HGM wetland units (Class F), (Table 1).
- The A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. This situation can be described by the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes. For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D, etc. A similar

approach can be applied to the determination of Ecological Importance and Sensitivity (EIS) categories

- An EIS assessment of identified natural wetland areas were undertaken to provide an indication of the conservation value and sensitivity of demarcated wetlands within this study area. The applied EIS wetland and river ecosystem assessment was based on the classes indicated in Table 2 and the following criteria (DWAF 1999b; Rountree & Malan 2013):
    - Habitat uniqueness
    - Species of conservation concern
    - Habitat fragmentation with regards to ecological corridors
    - Prominent ecosystem services
- The EIS scores for river reaches located within the study area (Figure 1), were calculated using the *Resource Directed Measures* methods (RDM; Kleynhans, 1999c). Available information from the NFEPA database, DWS sub-quaternary catchment EcoStatus tables (DWS, 2015), North West Biodiversity Sector Plan (NWBSP), and the terrestrial ecology and vegetation specialist reports for the study area (De Castro & Brits, 2016) were taken into account when populating the EIS scores (Table 2).
- No water quality assessments were undertaken, but diatom samples were collected in instream river habitat located within the study area, where suitable inundated conditions with emergent macrophytes were present. No upstream and downstream samples were collected for monitoring purposes, but merely a single sample was taken in the river reach that overlapped with proposed new mining footprint areas.
- Diatoms of performed slides were prepared by acid oxidation using hydrochloric acid and potassium permanganate. Clean diatom frustules were mounted onto a glass slide ready for analysis. Taxa were identified mainly according to standard floras (Krammer & Lange- Bertalot, 2000). The aim of the data analysis was to identify and count diatom valves (400 counts) to produce semi-quantitative data from which ecological conclusions could be drawn. The diatom assessment was undertaken by Mrs. Luisa Driskill.

Table 1: Description of A – F Present Ecological State (PES) categories for wetlands and rivers, ranging from "Natural" (Category A) to "Critically Modified" (Category F), (DWAF 1999a & DWAF 1999b).

Category		Description	Combined impact score (Macfarlane *et al.*, 2008)	Score (%) (DWAF, 1999b)
A	Natural	Unmodified, Natural.	0-0.9	90-100
B	Largely Natural	Few modifications, small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	1-1.9	80-89
C	Moderately Modified	A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	2-3.9	60-79
D	Largely Modified	Large loss of natural habitat, biota and basic ecosystem functions has occurred.	4-5.9	40-59
E	Seriously Modified	The losses of natural habitat, biota and basic ecosystem functions are extensive.	6-7.9	20-39
F	Critically Modified	Modifications have reached a critical level and the lotic 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.	8-10	<20

Table 2: Indicates Ecological Importance and Sensnsitivity (EIS) categrories for wetlands and other watercourses (DWAF, 1999c).

Ecological Importance and Sensitivity Category (EIS)	**Range of Median**
Very high Wetlands and riparian watercourses that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these watercourses is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High Wetlands and riparian watercourses that are considered to be ecologically important and sensitive. The biodiversity of these watercourses may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate Wetlands and riparian watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these watercourses is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal Wetlands and riparian watercourses that are not ecologically important and sensitive at any scale. The biodiversity of these watercourses is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

3.2. Impact Assessment Method

The proposed method for the assessment of environmental issues is set out in Table 3. This assessment methodology enables the assessment of environmental issues including: cumulative impacts, the severity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

Table 3: Criteria for assessing impacts

Note: Part A provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

PART A: DEFINITION AND CRITERIA*					
Definition of SIGNIFICANCE		**Significance = consequence x probability**			
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**			
Criteria for ranking of the SEVERITY of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.			
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.			
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.			
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.			
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.			
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.			
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term			
	M	Reversible over time. Life of the project. Medium term			
	H	Permanent. Beyond closure. Long term.			
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.			
	M	Fairly widespread – Beyond the site boundary. Local			
	H	Widespread – Far beyond site boundary. Regional/ national			
PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary	Widespread Far beyond site boundary Regional/

				Local	national
			SPATIAL SCALE		
PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

3.3. Limitations

General limitations that affect the accuracy of information represented within this report include the following.

- Wetland areas within transformed landscapes, such as urban, agricultural settings, or mining areas with existing infrastructure, are often affected by disturbances that restrict the use of available wetland indicators, such as hydrophytic vegetation or soil indicators (e.g. as a result of the dominance of alien vegetation, stock piling, sedimentation, hard surfaces, and infilling). Hence, a wide range of available indicators are considered, to help determine wetland boundaries more accurately.
- Wetland assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation. These methods are, however, largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration.

4. STUDY AREA DESCRIPTION

4.1. Location and Land Use

The study area is situated in the North-West Province approximately 30km northwest of Rustenburg in an area situated between the Pilansberg Game Reserve to the north, the Elands River to the south and the western extremity of the Magaliesburg to the west. The study area is located on two separate 'sections', namely the farms Frischgewaagd 96 JQ (463.48ha) and Mimosa 81 JQ (618.1ha), and a narrow tailings pipeline corridor of approximately 39.5ha, which links the Frischgewaagd and Mimosa properties (Figure 1). The existing Bakubang Mine shaft complex, as well as most of the proposed infrastructure components assessed in this study, are situated on the Frischgewaagd section of the study area, and only the proposed Tailings Storage Facility and adjacent Return Water Dam and Storm Water Dam are situated on the Mimosa section.

The assessed study area, as indicated in Figure 1, has a total area of 383.69ha, which includes the pipeline mapping corridor or 39.79ha. The combined study area within Frischgewaagd is 92.51ha and 251.39ha in Mimosa (Figure 1; Table 4). Individual study area components, consisting of both linear and polygon proposed infrastructure features, along with their sizes, are summarised in Table 4.

Table 4: The study area consists of the following proposed development footprint components in the Frischgewaagd and Mimosa Properties, as well as the pipeline corridor. Information provided include their surface area sizes of polygon features and the length in metre of proposed linear features, such as the tailings pipeline alternatives and the bridge.

Study Area Component	Surface Area in Hectare	Length in Metres
Tailings pipeline assessed in field Nov 2015	-	3699.50m
Tailings pipeline Final December 2015	-	3764.08m
Pipeline Corridor	39.79ha	-
Frischgewaagd Property		
Bridge (connects Mining House Phase 1 with Mining House Phase 1a)	-	115.64m
Concentrator Plant	6.35ha	-
Eskom Ledig Substation	5.07ha	-
Mine Housing Phase 1	19.79ha	-
Mine Housing Phase 1a	25.17ha	-
Pollution Control Dam (PCD)	5.08ha	-
Product Stockpiles	25.21ha	-
Waste Rock Dump	5.83ha	-
Mimosa Property		
Return Water Dam	1.20ha	-
Storm Water Dam	14.90ha	-
Tailings Storage Facility	235.28ha	-
Total Study Area Surface Area	**383.69ha**	

The 500m study area buffer, which was assessed at a secondary level of detail through a mainly desktop approach, has a size of 1093.80ha (excluding study area infrastructure footprints), (Figure 1). The combined area within Frischgewaagd and Mimosa properties that do not overlap with proposed infrastructure footprints and which was also assessed through a predominately desktop approach has a size of 737.69ha (Figure 1).

The Frischgewaagd section is situated immediately to the southeast of Ledig, the Mimosa section is situated some 2.1km to the west between Ledig and Phatsima. The Frischgewaagd and Mimosa sections fall within the quarter degree grid 2527AC (Sun City). Both sections of the study area fall within the Bojanala Platinum District Municipality.

Until approximately 2010 the Frischgewaagd section was entirely undeveloped and used as communal grazing land, though much of the section had been historically cultivated, particularly those parts situated with soils of the Arcadia and Oakley forms. In approximately 2013 the majority of the section was fenced with security fencing and currently the only land-use within the fenced section is mining. Existing mining infrastructure is limited in extent as indicated in the 2013-14 national land cover spatial dataset (Figure 2; Table 5), but has increased in size to currently cover approximately 77.09ha or 16.63% of the surface area of the Frischgewaagd property (Figure 1). The narrow (up to ca. 260m broad) portion of the Frischgewaagd section situated between the security fence and the Elands River, which forms the southern boundary of this section, is used as communal grazing land.

The Mimosa section currently remains entirely undeveloped, though approximately 55% of the section has been historically ploughed (mostly prior to 1990). These historically ploughed areas comprise the vast majority of the central and northern parts of this section as well as smaller areas along the Elands River. Most of the historically ploughed soils are of the Arcadia and Shortlands soil forms and almost all Arcadia soils have been historically ploughed. In 2014 the majority of the section was fenced with security fencing but grazing by cattle and goats belonging to the Phatsima community is still allowed within both the fenced area and the narrow (up to ca. 400m broad) portion of the Mimosa section situated between the security fence and the Elands River, which forms the southern boundary of this section. The entire Mimosa section is therefore currently used as communal grazing land.

The narrow tailings pipeline mapping corridor located between Frischgewaagd and Mimosa is situated on communal land that is used as grazing land for cattle and goats. The area is heavily grazed by livestock belonging to residents of the nearby Ledig and Phatsima residential areas, and the vegetation has also been degraded by extensive and ongoing cutting of trees for fuelwood and construction material and overly frequent and unseasonal burning. Approximately 8.1% of the mapping corridor comprises the completely transformed habitats of infrastructure footprints adjacent to the western boundary of the Frischgewaagd section. Approximately 15.4% of the mapping corridor comprises secondary vegetation of historically ploughed soils of the Shortlands and to a lesser extent Valsrivier soil forms.

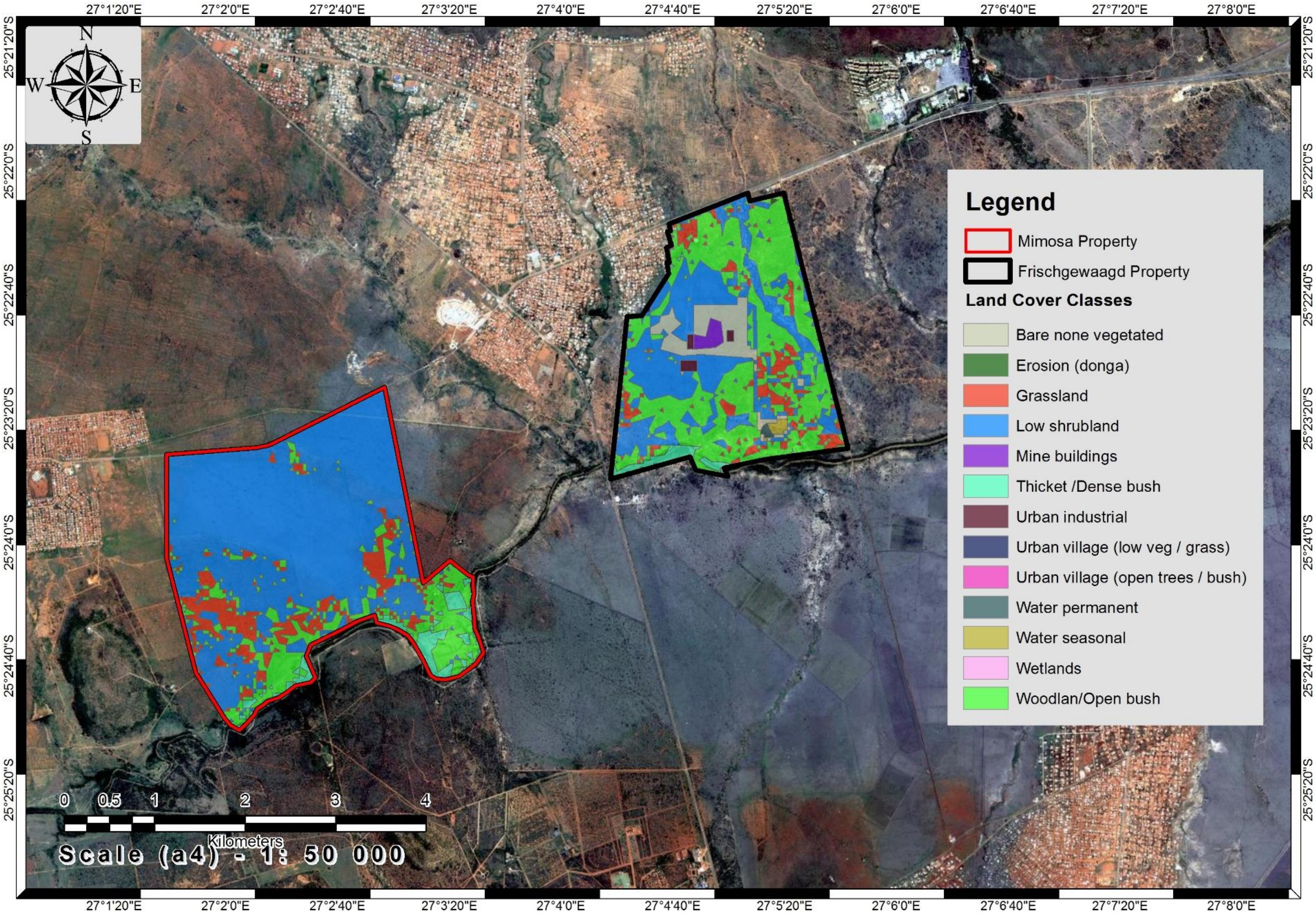

Figure 2. Illustrated land cover categories within the Frischgewaagd and Mimosa properties from the recently released national land cover spatial dataset produced between 2013 and 2014 (GTI, 2015).

Table 5: Indicates different land cover classes within the Frischgewaagd and Mimosa properties as derived from the 2013-14 national land cover dataset (GTI, 2015).

Land Cover Classes	Surface Area	Notes
Bare non vegetated	35.88ha	
Erosion	0.29ha	
Grassland	97.22ha	
Low shrubland	575.62ha	
Mine buildings	5.68ha	Restricted to the Frischgewaagd property
Thicket /Dense bush	37.69ha	
Urban industrial	3.56ha	Restricted to the Frischgewaagd property
Urban village (low veg / grass)	1.02ha	Restricted to the Frischgewaagd property
Urban village (open trees / bush)	0.94ha	Restricted to the Frischgewaagd property
Water permanent	1.23ha	Associated with the existing pollution control dam on Frischgewaagd
Water seasonal	2.29ha	Associated with the existing pollution control dam on Frischgewaagd
Wetlands	0.12ha	Restricted to a localised area along the Elands River in the Frischgewaagd property
Woodland/Open bush	317.81ha	

4.2. Catchment and River Properties

The study area is located within the Crocodile (West) and Marico Water Management Area (WMA) and is located in Eland Sub Water Management Area (sub WMA), which falls within Quaternary Catchment A22F. Quaternary Catchment A22F has a Mean Annual Precipitation (MAP) of 604mm, which falls mainly during summer months (Middleton & Bailey, 2008). The Mean Annual Temperature (MAT) is 18.6°C and frost occurs fairly frequent during winter (Mucina & Rutherford, 2006).

The portion of Quaternary Catchment A22F located around the study area is increasingly being transformed by urban and mining development, although the upper margins of the catchment located within the Pilansberg Nature Reserve is more natural. Middleton & Bailey (2008) determined that the Quaternary Catchment A22F has a Largely Modified (Class D) Present Ecological State (PES) and a Moderate conservation status in 2005. It is expected that the conservation status and PES of the catchment have received increasing pressure over the last 11 years as a result of expanding mining works and associated residential development in the area.

The Elands River borders both properties to the south and forms the primary river of Quaternary Catchment A22F. Available desktop PES and Ecological Importance and Sensitivity (EIS) information associated with reaches of the Elands River in Frischgewaagd and Mimosa properties are indicated in Tables 6-9 (DWS 2015). Both reaches of the Elands River have a Largely Modified (Class D) PES and a Moderate (Class C) EIS. These categories combined indicate a Moderate (Class C) Ecological Condition (EC), (Tables 6-9).

A third river reach is associated with the study area, namely the Sandspruit River, which transects the pipeline corridor from north to south, in between the Frischgewaagd and Mimosa properties (Figure 1). The reach of the Sandspruit that overlaps with the pipeline corridor also as a Largely Modified (Class D) PES, a Moderate EI, Moderate ES and Moderate EC (Tables 10 & 11). All three rivers fall within the Lower foothill geomorphic zone, while flow in the Sandspruit River is ephemeral in nature, and perennial in the two Elands River reaches (Nel *et al.*, 2011). None of the three river reaches are indicated as a Freshwater Ecosystem Priority Area (FEPA), a fish support area or fish corridor, or a Phase

2 FEPA area (Nel *et al.*, 2011). The three river reaches are located in a transitional Ecoregion area (Level 1), which includes the Western Bankenveld to the west, associated with the western portion of the Elands River reach in Mimosa, while the remaining river reaches to the east form part of the Bushveld Basin (Kleynhans *et. al.,* 2005).

Table 6: Driver of change and summary of the overall PES for the sub quaternary reach of the Elands River along the southern boundary of the Frischgewaagd property (DWS, 2015; Figure 1).

Sub-quaternary Reach		A22F-00869
System		**Elands River**
Instream Habitat Continuity Modification		**Moderate**
Riparian/Wetland Zone Continuity Modification		**Moderate**
Potential Instream Habitat Modifying Activities		Large
Riparian-Wetland Zone Modification		Large
Potential Flow Modifying Activities		Large
Potential Physico-Chemical Modifying Activities		Large
PES Overall Comment	The following impacts/activities were identified: CRITICAL: None; SERIOUS: Grazing (land-use); LARGE: Erosion, Overgrazing/trampling, Runoff/effluent: Mining, Runoff/effluent: Urban areas, Sedimentation; MODERATE: Abstraction, Small (farm) dams, Alien vegetation, Inundation, Mining, Vegetation removal; SMALL: Agricultural fields, algal growth, Bed and Channel disturbance, Low water crossings, Roads, Urbanization.	

Table 7: Summary of Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and calculated Ecological Condition (EC) for the sub quaternary reach of the Elands River along the southern boundary of the Frischgewaagd property (DWS, 2015; Figure 1).

Sub Quaternary River Reach (Name and code)	**PES Category Median**	**Mean EI Class**	**Mean ES Class**	**Default EC (Based on median PES and highest of EI or ES means)**
Elands River (A22F-00869)	**D**	**Moderate**	**Moderate**	**C**

Table 8: Driver of change and summary of the overall PES for the sub quaternary reach of the Elands River along the southern boundary of the Mimosa property (DWS, 2015; Figure 1).

Sub-quaternary Reach		A22F-00918
System		**Elands River**
Instream Habitat Continuity Modification		Large
Riparian/Wetland Zone Continuity Modification		Moderate
Potential Instream Habitat Modifying Activities		Serious
Riparian-Wetland Zone Modification		Large
Potential Flow Modifying Activities		Large
Potential Physico-Chemical Modifying Activities		Large
PES Overall Comment	The following impacts/activities were identified: CRITICAL: Inundation; SERIOUS: Small (farm) dams, Grazing (land-use); LARGE: Abstraction, Erosion; MODERATE: Agricultural fields, Overgrazing/trampling, Sedimentation, Vegetation removal; SMALL: Chicken farms, Alien vegetation, Roads, Runoff/effluent: Mining, Runoff/effluent: Urban areas.	

Table 9: Summary of Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and calculated Ecological Condition (EC) for the sub quaternary reach of the Elands River along the southern boundary of the Mimosa property (DWS, 2015; Figure 1).

Sub Quaternary River Reach (Name and code)	PES Category Median	Mean EI Class	Mean ES Class	Default EC (Based on median PES and highest of EI or ES means)
Elands River (A22F-00918)	**D**	**Moderate**	**Moderate**	**C**

Table 10: Driver of change and summary of the overall PES for the sub quaternary reach of the Sandspruit River that transects the pipeline corridor from north to south, in between the Frischgewaagd and Mimosa properties (DWS, 2015; Figure 1).

Sub-quaternary Reach		A22F-00822
System		**Sandspruit River**
Instream Habitat Continuity Modification		Moderate
Riparian/Wetland Zone Continuity Modification		Large
Potential Instream Habitat Modifying Activities		Serious
Riparian-Wetland Zone Modification		Large
Potential Flow Modifying Activities		Moderate
Potential Physico-Chemical Modifying Activities		Large
PES Overall Comment	The following impacts/activities were identified: CRITICAL: Grazing (land-use); SERIOUS: Bed and Channel disturbance, Erosion, Overgrazing/trampling; LARGE: Low water crossings, Sedimentation, Urbanization, Vegetation removal; MODERATE: Abstraction, Chicken farms, Small (farm) dams, Roads, Runoff/effluent: Urban areas; SMALL: Agricultural fields, Alien vegetation, Inundation, Runoff/effluent: Mining.	

Table 11: Summary of Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and calculated Ecological Condition (EC) for the sub quaternary reach of the Sandspruit River that transects the pipeline corridor from north to south, in between the Frischgewaagd and Mimosa properties (DWS, 2015; Figure 1).

Sub Quaternary River Reach (Name and code)	PES Category Median	Mean EI Class	Mean ES Class	Default EC (Based on median PES and highest of EI or ES means)
Sandspruit River (A22F-00822)	D	Moderate	Moderate	C

4.3. North West Biodiversity Sector Plan and Threatened Ecosystems

4.3.1. North West Biodiversity Sector Plan (NWBSP)

The North West Province Biodiversity Sector Plan (NWBSP), provides a map of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) for the entire province (NWREAD, 2015). Categories used in the CBA Map are as follows:

- Protected Areas – Declared and formally protected under the Protected Areas Act, such as National Parks, legally declared Nature reserves, World Heritage Sites and Protected Environments that are secured by appropriate legal mechanisms.
- Critical Biodiversity Areas (CBAs) – terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state, then biodiversity targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses.
- Ecological Support Areas (ESAs) – Terrestrial and aquatic areas that are not essential for meeting biodiversity representation targets (thresholds), but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree or extent of restriction on land use and resource use in these areas may be lower than that recommended for CBA's.
- Other Natural Areas - Remaining natural areas not included in the above CBA or ESA categories. Degraded areas falling with the CBA and ESA categories. Areas that still contain natural habitat but that are not required to meet biodiversity targets.
- No Natural Habitat Remaining – Areas that have been irreversibly modified (i.e. transformed) and do not contribute to maintaining biodiversity pattern or ecological processes. These include urban and rural settlements, crop lands, mining areas and forest plantations.

The vast majority of the study area is mapped as **CBA Category 2** in the NWBSP (NWREAD, 2015), and all of the proposed infrastructure footprints and alignments fall within the area mapped as CBA Category 2. Small areas of ESA Category 1 and ESA Category 2 are mapped in the southern parts of Mimosa, and small areas of No Natural Habitat Remaining (18.0ha) are mapped in Frischgewaagd around the Bakubang mine shaft complex and along the boundary with Ledig.

Critical Biodiversity Area Category 2 (CBA 2) areas include the following:

- 'Critical Patches' of Endangered and Vulnerable ecosystems / vegetation types;

- ‘Critical Patches’ of endemic (NW Province) vegetation types;
- ‘Important Habitats - Features’. Important natural features such as “habitats, springs, scenic landscapes”.
- ‘Important Habitats – Focus Wildlife Areas’. Areas identified as being of importance for maintaining species of conservation concern.

The principal ‘Land Management Objectives’ for CBA 2 areas provided in the NWBSP 2015 are reproduced in the ‘text box’ provided below.

TEXT BOX (extracted from Table 12 of the NWBSP (NWREAD, 2015)	
CBA Map category	Land Management Objective
CBA 2	**Maintain in a natural or near natural state that maximises the retention of biodiversity pattern and ecological process**: • Ecosystems and species fully or largely intact and undisturbed. • Areas with intermediate irreplaceability or some flexibility in terms of meeting biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve biodiversity targets, although the loss of these sites would require alternative sites to be added to the portfolio of CBAs. • These are biodiversity features that are approaching, but have not surpassed their limits of acceptable change.
ESA 1	**Maintain in at least a semi- natural state as ecologically functional landscapes that maintain basic natural attributes:** • Ecosystem still in a natural, near-natural or semi-natural state, and has not been previously developed (e.g. ploughed). • Ecosystems moderately to significantly disturbed but still able to maintain basic functionality. • Individual species or other biodiversity indicators may be severely disturbed or reduced. • These are areas with low irreplaceability with respect to biodiversity targets only.
ESA 2	**Maintain as much ecological functionality as possible (generally these areas have been substantially modified)**: • Maintain current land-use or restore area to a natural state. • Ecosystem NOT in a natural or near-natural state, and has been previously developed (e.g. ploughed). • Ecosystems significantly disturbed but still able to maintain some ecological functionality. • Individual species or other biodiversity indicators are severely disturbed or reduced and these are areas that have low irreplaceability with respect to biodiversity pattern targets only. • These are areas with low irreplaceability with respect to biodiversity targets only. These are areas required to maintain ecological processes especially landscape connectivity.

In terms of managing the loss of natural habitat in CBAs, the NWBSP 2015 states, amongst others, that ‘**further loss of natural habitat should be avoided in CBA 1, whereas loss should be minimised in CBA 2 i.e. land in these two categories should be maintained as natural vegetation cover as far as possible**’. Maps of showing the extent of CBA 2, ESA 1 and ESA 2 areas within the study area and its immediate surrounds, are provided in Appendix 8. The CBA Map categories of each section of the study area are briefly discussed below.

Distribution of CBA 2 and ESAs within the Frischgewaagd and Mimosa properties, as well as the pipeline corridor

Approximately 1 066.1ha (or 94.9%) of the properties and pipeline corridor is mapped as CBA 2 in the NWBSP 2015, and all the proposed infrastructure footprints and alignments fall within the area mapped as CBA Category 2. However, the NWBSP 2015 mapping for the area is not accurate, as CBA 2 includes large areas that have been transformed through cultivation and mining, and currently comprises secondary vegetation of historically cultivated areas or permanently transformed areas (i.e. mine shaft complex and associated infrastructure), (refer to the Botanical Biodiversity assessment report by De Castro & Brits (2016a)].

4.3.2. Presence of Threatened Ecosystems within the study area and remainder of Frischgewaagd and Mimosa property boundaries

No listed Threatened Ecosystem area according to the 2011 Schedule (Government Gazette of December 2011) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA), is present in the study area, the remainder of the two properties or the 500m buffer.

5. WATERCOURSE DESCRIPTIONS AND ASSESSMENTS

5.1. Watercourse Delineation and Classification

- The study area, consisting of different proposed infrastructure footprints, do not overlap with wetland habitat indicated in the National Freshwater Ecosystem Priority Area (NFEPA) spatial dataset of 2011 (Figure 1).
- Two artificial wetlands in the form of dams are indicated on the NFEPA Wetlands dataset in the north-western portion of Frischgewaagd property, immediately west of the proposed Mine Housing Phase 1 development. No other NFEPA (2011) wetland area is present in the two properties nor in the mapping corridor (Figure 1).
- The recently released 2013-2014 South African National Land Cover dataset indicates the presence of a small wetland area of 0.12 ha in the Frischgewaagd property, along the Elands River (Figure 2; Table 5). An area with seasonal water (2.29 ha) and an adjacent area with permanent water (1.23 ha) are indicated in the south-eastern portion of Frischgewaagd (Figure 2; Table 5). Both these waterbodies overlap with an existing pollution control dam (PCD), situated east of the proposed PCD (Figure 1).
- Topographical map 2527AC indicate the presence of drainage lines that flow from north to southeast through the Frischgewaagd property.
- Short first-order drainage lines flow directly into the Elands River from north to south in the southern section of both the Frischgewaagd and Mimosa properties, while the mapping corridor is bisected by the Soutspruit flowing from northwest to southeast (Figure.1).
- All of these drainage lines that overlap with study area infrastructure components and their immediate surroundings were surveyed as they have the potential to be watercourses.
- Site surveys confirmed the presence of different watercourse types within the study area, property boundaries and surrounding 500m study area buffer (Figures 3 & 4).
- Five different types of watercourses were delineated (Table 12; Figure 5):
    - 1 x Unchannelled valley bottom wetlands (2.81ha)
    - 1 x Channelled valley bottom wetland (1.35ha – desktop delineation only)
    - 7 x Ephemeral Channels (combined area of 18.15ha)
    - 3 x Ephemeral drainage lines (combined length of 1044.27m)
    - 3 x Dams (combined area of 1.47ha)
    - Riparian habitat along the Sandspruit, including the active channel (6.10ha)
    - Riparian habitat along the Elands River, including the active channel (combined area of 94.71ha – desktop delineation only)

5.1.1. Unchannelled Valley Bottom Wetland

- The unchannelled valley bottom wetland has been fragmented into two components as a result of existing mining infrastructure (Figure 3). The upstream (northern) section lacks channel features and is characterised by vertic clays that contains localised signs of gleying, but a G horizon remains absent. Soils In the upstream portion of the wetland is therefore consistent with the Arcadia soil form, but is regarded as a wetland area based on the presence of localised gleying (Figure 6).
- The area is consistent with the definition of a watercourse, as it contains signs of soil wetness in the form of mottles and localised gleying, which become more prominent in the downstream portion of the wetland (Figure 6). G horizons and the Rensburg soil form are present near the confluence with Ephemeral channel 2.

- Wetland indicators are more marginal in the upstream portion of the wetland, but are sufficiently to regard the entire delineated feature as a wetland (Figure 3).

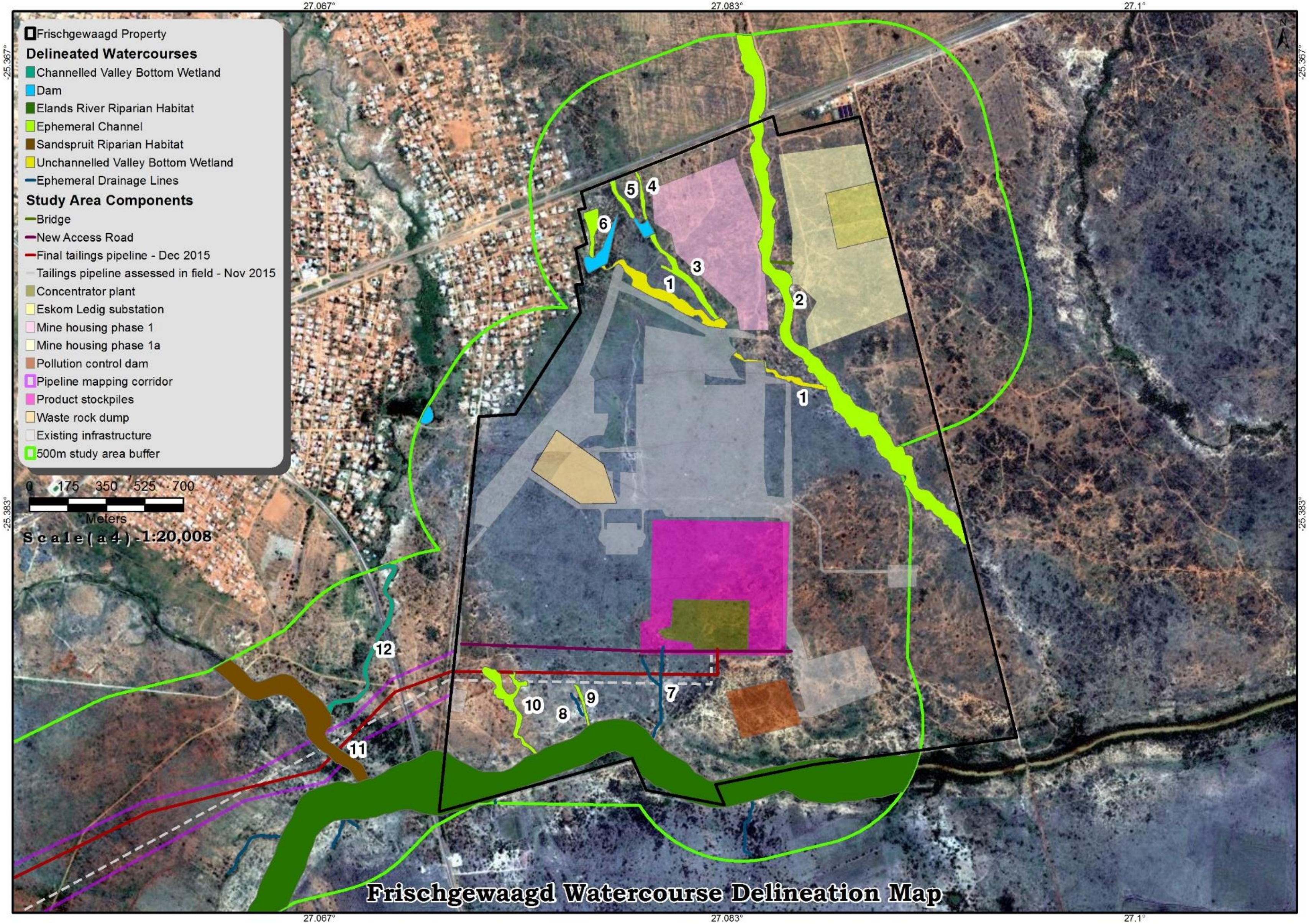

Figure 3: Illustrates delineated watercourses within the Frischgewaagd section of the study area along with the eastern portion of the pipeline corridor, as well as the surrounding 500m study area buffer. Map labels are used to refer to specific watercourses for reference purposes in the text

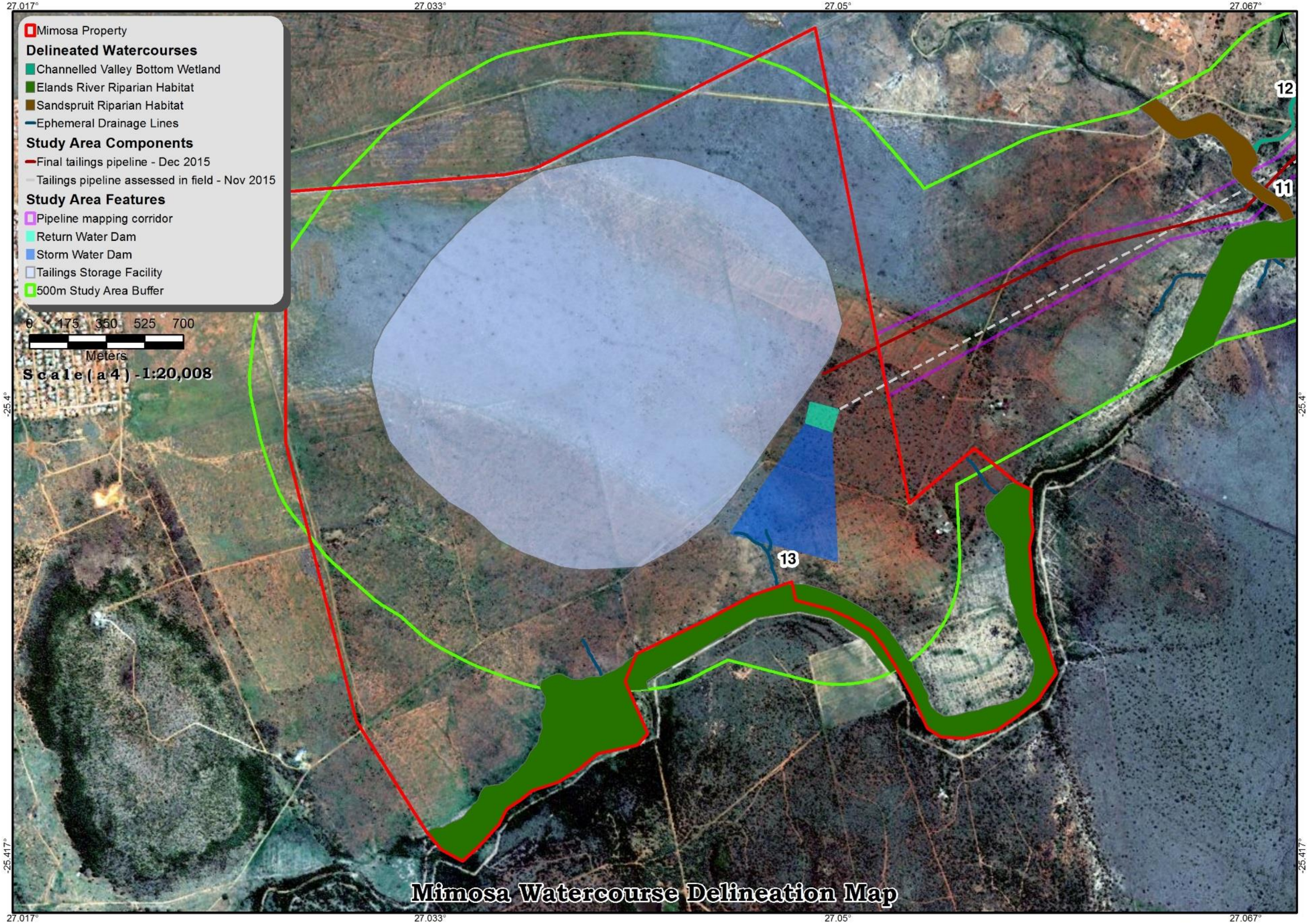

Figure 4: Illustrates delineated watercourses within the Mimosa section of the study area along with the western portion of the pipeline corridor, as well as the surrounding 500m study area buffer. Map labels are used to refer to specific watercourses for reference purposes in the text.

Table 12: Indicates the size of different delineated watercourses and related features within the study area, 500m study area buffer, as well as the Frischgewaagd and Mimosa Properties. Map labels are provided to help identify specific watercourses (also refer to Figure 3).

Watercourse Type	**Watercourse Number**	**Surface area**	**Length**	**Size of upstream dams**
Unchannelled valley bottom wetland	1	2.81ha	-	0.89ha
Ephemeral channel	2	13.9ha	-	
Ephemeral channel	3	1.20ha	-	0.32ha
Ephemeral channel	4	0.28ha	-	
Ephemeral channel	5	0.39ha	-	
Ephemeral channel	6	0.65ha	-	
Ephemeral drainage line	7	-	386.15m + 136.11m	
Ephemeral drainage line	8	-	110.13m	
Ephemeral channel	9	0.22ha	-	
Ephemeral channel	10	1.51ha	-	
Sandspruit River and riparian habitat	11	6.10ha	-	
Channelled valley bottom wetland	12	1.35ha	-	0.26ha (only portion of dam)
Ephemeral drainage line	13	-	314.35m + 97.53m	
Elands River and riparian habitat (downstream section - in and adjacent to Frischgewaagd)	-	45.05ha		
Elands River and riparian habitat (upstream section - in and adjacent to Mimosa)	-	49.66ha		
Total		**123.12ha**	**1044.27m**	**1.47ha**

- Common grasses species that indicated elevated moisture conditions in the wetland and which can be considered as facultative hydrophyte species (Retief & Herman, 1997) include *Botriochloa insculpta, Dicanthium annulatum, Ischaemum afrum, Botricochloa bladhii* and *Cynodon dactylon*. The margins of the wetland are characterised by woody species, such as *Searsia lancea*, *Acacia karroo*. *A. tortilis* and *Ziziphus mucronata*.
- A discontinuous channel with several headcuts are present in the downstream portion of the wetland, which is expected to have been partially caused by existing mining infrastructure within the wetland, such as the steel water reservoirs, which have diverted the natural flow path of the wetland (Figure 3).

5.1.2. Ephemeral Channels

- Ephemeral channels represent watercourses that contain a natural channel with regular or intermittent flow, based on the definition by the NWA, but generally lack signs of hydromorphism. All delineated ephemeral channel watercourses are illustrated in Figures 3 & 4.
- Alluvial sediment depositions are typically present in the channel bed, which implies that these watercourses are more consistent with the interpretation of riparian systems, even though typical woody riparian species are often present at low densities. The presence of channel banks and bed features along with features that indicate surface flow, such as debris, scour holes and headcut erosion features are regarded as important indicators for ephemeral channels (Figure 7).

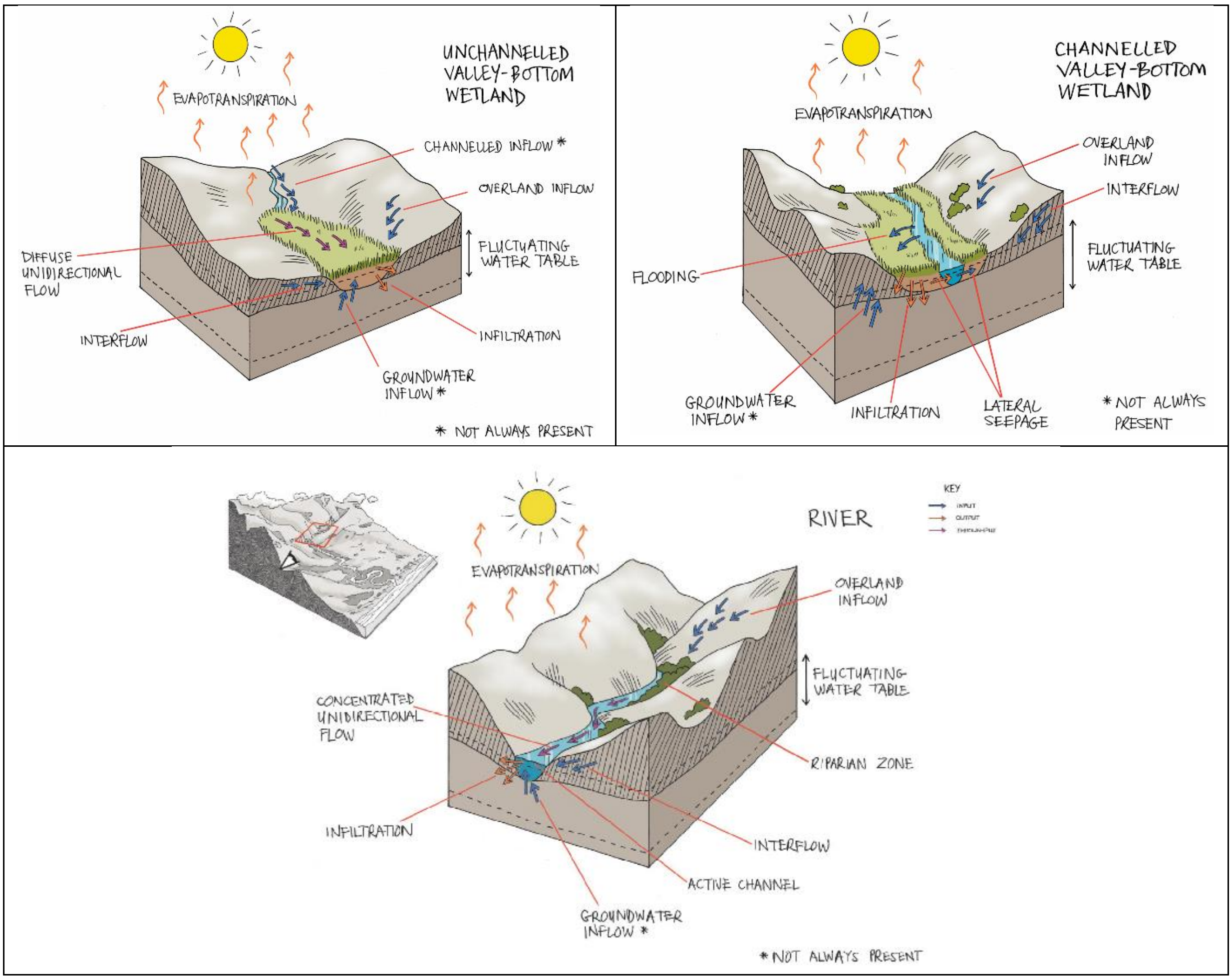

Figure 5: Illustrates two different HGM wetland units and a river unit with an active channel and surrounding riparian habitat, which were identified and delineated within the study area and its surroundings (also refer to Figure 3).

- Several of the ephemeral channels are narrow with swale-like to well-defined channels. Ephemeral channel 2 is particularly well-developed with a macro channel that ranges between 30–90m wide and a channel depth of approximately 7–3m (Figures 7 & 8).
- Ephemeral channel 2 is incised with steep channel banks in its upper reach, but becomes shallower further downstream with a bedrock channel bed that prohibits further incision and gently sloped channel bank slopes that are unlikely to erode (Figures 3 & 7).
- The macro channel banks in Ephemeral channel 2 consists of the Hutton soil form, while the active channel contains neocutanic features and deposited alluvial material on the active channel bed. Other soil forms include the Oakleaf form in its upper reach, Valsrivier form (along a short length of its middle reach) and Arcadia form along its lower reach (Rehab Green, 2007).
- The Sepane soil form comprises an orthic A-horizon which overlies a pedocutanic B-horizon and unconsolidated material with signs of wetness in Ephemeral channel 10 (Figure 3). The A- and B-horizons differ markedly in terms of texture and structure with the former being apedal and sandy while the latter is highly structured and sandy clay in texture (De Castro & Brits, 2016b). The Sepane soil form in Ephemeral channel 10 is border by shallow Glenrosa and rocky Mispah soil forms (De Castro & Brits, 2016b).

Figure 6: Illustrates the following features in the unchannelled valley bottom wetland: An Arcadia soil form with localised gleying (top left); more pronounced signs of hydromorphism in the wetland in the form of mottling and more extensive gleying (top right); The wetland as it appears in its upstream section with visibly greener vegetation (centre row); & A headcut and discontinuous channel in the downstream portion of the wetland (bottom row).

Figure 7: Illustrates the incised and eroded macro channel of Ephemeral channel 2 near the location of the proposed bridge (top) and its active channel with alluvial sands on the surface (second row). Ephemeral channel 2 becomes less incised with gentler sloped channel banks further downstream (third row). Recorded flow features included debris and deposited sand (bottom row).

Figure 8: Illustrates other Ephemeral channels with narrow and well defined channels, such as Ephemeral channel 9 (left), while other channels represent broad swales, such as ephemeral channel 3 (right).

- The vegetation of Ephemeral channel 2 can be described as marginal hygrophilous grassland, especially along the active channel, with scattered riparian large shrubs and small trees, the most common of which is *Searsia lancea*. Other riparian shrubs and small trees include *Acacia karroo, Searsia pyroides* and *Ziziphus mucronata* (De Castro & Brits, 2016a)
- The dominant grasses of Ephemeral channel 2 include *Imperata cylindrica* and *Botriochloa insculpta*, especially along the active channel. Common to sub-dominant grasses include *Botriochloa bladhii, Eragrostis capensis, Hyparrhenia dregeana, Hyparrhenia filipendula, Hyparrhenia hirta* and *Themeda triandra*. Common forbs include *Berkheya radula, Cephalaria zeyheriana, Haplocarhpa lyrata, Lobelia thermalis, Nidorella resediifolia, Salvia runcinata* and *Vigna vexillata* (De Castro & Brits, 2016a).
- Shared species between the different ephemeral channels include small trees that scattered on the naturally eroded areas, such as *Acacia karroo, Acacia mellifera, Maerua angolensis, Olea europaea* subsp. *africana* and *Searsia lancea*. Common shrubs include *Acacia mellifera, Dodonaea viscosa* var. *angustifolia, Euclea undulata, Grewia flava, Searsia lancea* and *Tarconanthus parvicapitulatus* (De Castro & Brits, 2016a).
- The dominant grass in the remainder of the ephemeral channels is *Aristida canescens,* while *Trachypogon spicatus* is sub-dominant. Common grasses include *Cymbopogon pospischilii, Diheteropogon spicatus, Enneapogon scoparius, Fingerhuthia africana, Melinis repens, Schmidtia pappophoroides* and *Schizachyrium sanguineum*. Common forbs include *Ruelliopsis setosa, Bulbostylis hispidula, Chascanum* cf. *hederaceum, Dicoma anomala, Euphorbia davyi, Geigeria burkei, Indigofera heterotricha, Kohautia virgata, Oldenlandia* cf. *herbacea, Polygala krumaniana*. and *Ptycholobium plicatum* (De Castro & Brits, 2016a).

5.1.3. Ephemeral Drainage Lines

- Ephemeral drainage lines are linear headwater (first-order) watercourses that have poorly developed channel features, which are often indistinct and swale-like.
- Channels can also be discontinuous in nature with a series of headcut erosion features.
- No hydromorphic features associated with wetland conditions are present in these drainage line systems, while facultative and obligate hydrophytes are generally rare.
- They do, however, form part of the drainage network and are also regarded as watercourses, as they are often consistent, or partially consistent, with the definition of natural channels with regular or intermittent flow, as defined in the NWA.
- No South African delineation criteria or guideline methods are currently available to help identify and delineated these features. A conservative approach is therefore applied that regard these often indistinct features as watercourses.
- Figures 3 & 4 illustrate delineated Ephemeral drainage lines within the study area and its surroundings.
- Ephemeral drainage lines are therefore more marginal and more indistinct in terms of channel features compared to Ephemeral channels (Section 5.1.2.).
- Indicators that were used to identify and delineated Ephemeral drainage lines include the following:
    - The presence of channel banks and bed, or minor swale-like channel features.
    - Indicators of water flows, such as headcuts, scour pools and flow debris
    - The presence of alluvial sediments
- Several of these indicators were recorded in delineated Ephemeral drainage and are illustrated in Figure 9.
- Recorded plant species within Ephemeral drainage lines include the grasses *Trachypogon spicatus, Ischaemum afrum, Themeda triandra, Hyparrhenia* spp., and *Cymbopogon excavatus.* The forbs *Cephalaria zeyheriana, Vernonia oligocephala, Gladiolus pretoriensis,* and *Euphorbia davyi.* While woody species include *Asparagus laricinus, Grewia flava*, *Acacia karroo, Searsia lancea, S. pyroides* and *Ziziphus mucronata*.
- The species assemblage is similar to that of the Ephemeral channels described in Section 5.1.2., while the Valsrivier soil form is the most common soil form associated with this watercourse type.

Figure 9: Illustrates Ephemeral drainage line features recorded within the study area: A swale-like channel along Ephemeral drainage line 7 (top left); Alluvial material that has been washed over the underlying Valsrivier soil form in Ephemeral drainage line 7 (top right; De Castro & Brits, 2016b); Distinct headcut and channel features in Ephemeral drainage line 13 (left and right images in the centre row); A smaller headcut in the upper reach of Ephemeral drainage line 13 (bottom left); & An indistinct swale-like channel on a rocky area at the origin of the western arm of Ephemeral channel 13.

5.1.4. Sandspruit Riparian Habitat

This watercourse system consists of a river channel with an active channel and larger macro channel banks that contain riparian habitat (Figures 3 & 5). The vegetation of the Sandspruit River macro-channel, including the macro-channel banks, active-channel banks (marginal zone) and channel bed are described in this section (also refer to De Castro & Brits (2016a). The Sandspruit is a weakly perennial stream and contains instream habitat that has an affinity for periodically drying out. This includes soils and rock crevices along bedrock in the channel bed, as is indicated by the small presence of the following diatoms *Hantzschia amphioxys*, *Luticola mutica* and *Pinnularia borealis* (Figure 10; Appendix A).

No significant floodplain habitats are present within the short (ca. 150m) reach of the Sandspruit situated within the pipeline corridor, due to the deeply incised (ca. 8m) macro-channel and the relatively steep slopes above the macro-channel banks. The Sandspruit confluences with the Elands River approximately 110 m downstream of the pipeline corridor. The soils of this unit comprise a mixture of sandy clay loam soils of the Oakleaf, Valsrivier and Mispah forms (De Castro & Brits, 2016b; Figure 11). As is typical of such rivers, there is strong lateral zonation of vegetation as a result of variations in key habitat parameters such as flooding frequency and duration of flooding, speed of floodwaters and substrate characteristics. Though the vegetation of these riverine habitats is still dominated by indigenous species, many aliens (including habitat transformers) are present, and this is reflection of the fact that the upstream reaches of this river channel and catchment, which flow past Ledig, are significantly degraded. The vegetation of this unit falls within a communal grazing area situated between Mimosa and Frischgewaagd, and is overgrazed and subjected to extensive cutting of trees for fuel and construction material.

Alluvial soil and vegetation features are present in the watercourse and it is clear that this is not a wetland system, but a river. The identified Oakleaf soil form consists of an orthic A-horizon that overlies a neocutanic B-horizon and unspecified material. The neocutanic B-horizon is characterised by colour variation due to clay movement and accumulation and exhibits an apedal or weakly developed structure. Within the Sandspruit macro channel the Oakleaf soil form was originally characterised by stratified alluvium (Dundee soil form), but the degree of pedogenesis it has undergone resulted a soil in which almost all signs of stratification have disappear. The soil borders a soil of the Valsrivier soil form (De Castro & Brits, 2016b; Figure 11).

Three major plant communities have been recognised within this unit. The major plant communities include herbaceous vegetation of the channel floor, Open Shrubland on the lower macro-channel banks and riparian Short Closed Woodland on the upper macro-channel banks. These major plant communities are briefly described below.

The exposed macro-channel bed (between pools) comprises alluvial sands and gravel with scattered to dense alluvial rock cover on the surface (Figure 10). The vegetation comprises herbaceous plant communities dominated by hygrophytic grasses and sedges, which include many alien weeds. Frequent flooding by fast flowing waters largely precludes the establishment of mature trees, but rheophytic shrubs occur scattered on the macro-channel bed. Common shrubs include the rheophytes *Gomphostigma virgatum, Salix mucronata,* and the alien *Sesbania punicea*. Dominant grasses and rushes include *Cynodon dactylon* and *Juncus excertus.* Common grasses and sedges include *Agrostis lachnantha, Hemarthria altissima, Paspalum distichum, Cyperus sexangularis* and the alien *Cyperus eragrostis.* Common forbs include *Lobelia thermalis,* and *Pulicaria scabra*, as well as the aliens *Aster squamatus* and *Xanthium strumarium.*

Figure 10: Illustrates different cross sections of the Sandspruit River along the first proposed pipeline alignment (November 2015; Figure 3). Important feature include the macro channel with riparian habitat, a narrow strip of the marginal zone on the banks of the active channel, and the active channel. Pools, alluvially transported boulders and bedrock associated with a dolerite dyke across the macro channel are also visible.

On the lower macro-channel banks the vegetation comprises Open Shrubland with a relatively sparse and heavily grazed herbaceous layer. Frequent flooding by fast flowing waters largely precludes the establishment of mature trees other than rheophytes. Common small trees include *Salix mucronata* and the alien *Morus alba*. The dominant shrub is *Searsia lancea*. Common shrubs include *Conyza scabrida, Gymnosporia buxifolia, Salix mucronata* and the alien *Sesbania punicea.* The dominant species in the herbaceous layer are the sedge *Cyperus sexangularis* and the grass *Cynodon dactylon*. Common grasses include *Hemarthria altissima, Botriochloa insculpta, Sporobolus fimbriatus* and the alien *Paspalum dilatatum.* Common forbs include *Pulicaria scabra* and *Ranunculus multifidus, as well as* the aliens *Juncus excertus* and *Verbena officinalis.*

On the upper macro-channel banks, the vegetation is riparian Short Closed Woodland. The dominant trees are *Searsia lancea* and *Acacia karroo.* Common trees include *Olea europaea* subsp. *africana, Ziziphus mucronata* and the alien *Morus alba*. The dominant shrubs are *Acacia karroo* and *Gymnosporia buxifolia*. Common shrubs include *Asparagus laricinus, Grewia flava, Searsia pyroides, Searsia lancea* and *Tarchonanthus parvipunctulatus.* The dominant species in the herbaceous layer is the grass *Panicum maximum*. Common forbs include *Hypoestes forskaolii* and *Pavonia burchellii.* Young plants of the alien invasive succulent *Agave americana* are locally abundant along the macro-channel banks.

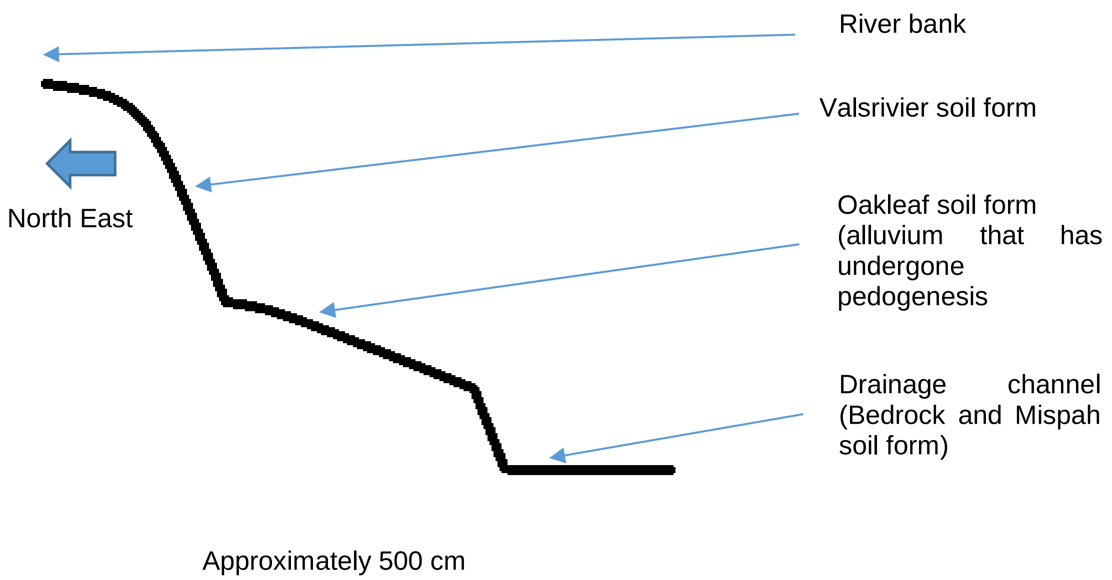

Figure 11: Soil distribution along the Sandspruit macro channel and channel bed (De Castro & Brits, 2016b).

5.1.5. Elands River Riparian Habitat

An assessment of the Elands River did not form part of the scope of works of this project and is not located within the study area footprint (Figures 3 & 4). A desktop delineation of riparian habitat along the Elands River channels was undertaken within the two properties and 500m study area boundary (Figures 3 & 4). This was largely based on the delineation of the watercourse by De Castro and Brits (2016a). A detailed description of riparian vegetation along the Elands River is provided in Section 7 of the Botanical biodiversity report by De Castro & Brits (2016a).

5.1.6. Channelled Valley Bottom Wetland

A channelled valley bottom wetland was identified within the 500 m study area buffer, located upstream of the pipeline corridor. The channelled valley bottom wetland forms a confluence with the Sandspruit, also upstream of the pipeline corridor. The wetland was only delineated through a desktop approach (Figure 3).

5.2. Present Ecological State (PES) Assessments

Each of the assessed watercourses (wetlands, ephemeral channels, ephemeral drainage lines and Sandspruit river habitat), were assessed in terms of their PES.
The PES scores were calculated through different techniques, but made use of the same six classes (Table 2). Ephemeral channels and ephemeral drainage lines were only assessed in terms of the instream habitat according to the River IHI method (DWAF, 1999a), due to their narrow widths and indistinct separation between instream and riparian habitat. **The Present Ecological State (PES) scores of watercourses within the study area range between 'Largely natural' (Class B) and 'Largely modified' (Class D), (Tables 13–20).**

5.2.1. Unchannelled Valley Bottom Wetland

Unchannelled valley bottom wetland habitat has been fragmented by recent infrastructure development within the watercourse. This includes a ‘noise berm’ that effectively blocks surface flow through the wetland (Figures 3 & 12). Channel development within the downstream reach of the wetland is regarded as a natural process, but increased channel incision is expected as a result of the flow diversion around the existing steel tower infrastructure (Figures 3 & 12). The calculated PES of the wetland is regarded as Largely modified (Table 13).

Table 13: Results of the PES assessment and the PES class for Unchannelled valley bottom wetland 1, delineated in close proximity to the study area, as determined through the technique described by Macfarlane *et al.,* (2008; Level 1 assessment).

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation	
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
1	3	100	7.0	1	1.5	0	3.8	0
Area weighted impact scores*			**7.0**	**1.0**	**1.5**	**0.0**	**3.8**	**0.0**
PES Category for individual WET-Health components.			**E**	↑	**B**	→	**C**	→
Combined PES			**Largely Modified (Class D) PES**					

Figure 12: Illustrates existing impacts within Unchannelled valley bottom wetland 1 associated with existing mining infrastructure: A newly created ‘noise berm’ that bisects the wetland and prevents surface flow (top) (also refer to Figure 3 regarding existing infrastructure in the wetland); A diversion of the flow path of the wetland around steel tower infrastructure (centre) (also refer to Figure 3); & Channel development in the wetland downstream of the flow path diversion (bottom).

5.2.2. Ephemeral Channels

Only ephemeral channels located in close proximity to the study area footprint components were assessed in terms of their PES categories. PES results vary from Moderately modified (Ephemeral channels 2, 4 and 5) to Largely natural (Ephemeral channels 3, 9 and 10), (Figure 3; Tables 14 to 17). The PES category for Ephemeral channel 2 may appear higher than expected due to extensive erosion within its upper reach, but erosion is regarded to be a largely natural process in this watercourse. The eroded area is also generally free of alien species with no signs of secondary vegetation. Further downstream Ephemeral channel 2 contains a stable channel with slopes at a lower gradient (Figure 7). It should be noted that the PES of this particular watercourse is very close to a class B and can also be considered as having a B/C PES (Table 14).

Some form of erosion is expected in these headwater watercourses. They are the most numerous of all of the identified watercourse types (Figure 3), and form an important component of drainage networks that overlap with the Frischgewaagd property. All of the delineated ephemeral channels are restricted to the Frischgewaagd property and its immediate surroundings. The downstream portion of Ephemeral drainage line 13 can also be interpreted as an ephemeral channel, as channel development is well defined in this section of the watercourse (Figure 9).

Table 14: Results of the PES assessment and the PES class for Ephemeral channel 2, delineated in close proximity to the study area, as determined through the technique described by DWAF (1999a). Instream and riparian habitat are assessed separately for this prominent and large ephemeral system.

Ephemeral Channel 2		
Instream	**Score**	**Confidence**
Water abstraction	5	Low
Extent of inundation	2	Moderate - High
Water quality	10	Moderate - High
Flow modifications	8	Moderate
Bed modification	7	High
Channel modification	10	High
Presence of exotic macrophytes	0	High
Presence of exotic fauna	0	Low
Presence of solid waste	5	High
Riparian	**Score**	**Confidence**
Water abstraction	3	Moderate
Extent of inundation	1	Moderate - High
Water quality	8	Moderate - High
Flow modifications	7	Moderate
Channel modification	10	Moderate - High
Decrease of indigenous vegetation	5	Moderate - High
Exotic vegetation encroachment	0	Moderate - High
Bank erosion	10	High
Final IHI Scores	**Score**	**PES Class**
IHI (instream)	78.5	**C**
IHI (riparian)	78.9	**C**

Table 15: Results of the PES assessment and the PES class for Ephemeral channel 3, delineated in close proximity to the study area, as determined through the technique described by DWAF (1999a). Only instream habitat is assessed for this ephemeral channel.

Ephemeral Channel 3		
Instream	**Score**	**Confidence**
Water abstraction	0	High
Extent of inundation	0	High
Water quality	7	Moderate
Flow modifications	20	Moderate
Bed modification	13	High
Channel modification	3	Moderate
Presence of exotic macrophytes	2	Moderate
Presence of exotic fauna	0	High
Presence of solid waste	0	High
Final IHI Scores	**Score**	**PES Class**
IHI (instream)	81.4	B

Table 16: Results of the PES assessment and the PES class for Ephemeral channels 4 and 5, delineated in close proximity to the study area, as determined through the technique described by DWAF (1999a). Only instream habitat is assessed for this ephemeral channel.

	Ephemeral Channel 4		Ephemeral Channel 5	
Instream	**Score**	**Confidence**	**Score**	**Confidence**
Water abstraction	0	High	0	High
Extent of inundation	10	Moderate	10	Moderate
Water quality	13	Moderate	13	Moderate
Flow modifications	20	Moderate	20	Moderate
Bed modification	12	Moderate	12	Moderate
Channel modification	15	Moderate	15	Moderate
Presence of exotic macrophytes	3	Moderate	3	Moderate
Presence of exotic fauna	0	Low	0	Low
Presence of solid waste	5	Low	5	Low
Final IHI Scores	**Score**	**PES Class**		
IHI (instream)	66.8	C	66.8	C

Table 17: Results of the PES assessment and the PES class for Ephemeral channels 9 and 10, delineated in close proximity to the study area, as determined through the technique described by DWAF (1999a). Only instream habitat is assessed for this ephemeral channel.

	Ephemeral Channel 9		Ephemeral Channel 10	
Instream	**Score**	**Confidence**	**Score**	**Confidence**
Water abstraction	0	High	0	High
Extent of inundation	0	High	0	High
Water quality	2	Moderate	10	Moderate
Flow modifications	0	Moderate	0	Moderate
Bed modification	11	High	11	High
Channel modification	5	Moderate	5	Moderate
Presence of exotic macrophytes	2	Moderate	2	Moderate
Presence of exotic fauna	0	High	0	High
Presence of solid waste	0	High	0	High
Final IHI Scores	**Score**	**PES Class**		
IHI (instream)	89.8	B	85.4	B

5.2.3. Ephemeral Drainage Lines

All of the assessed ephemeral drainage lines are in a Largely natural (Class B) PES with few existing impacts. This is based on observations related to vegetation, geomorphological and hydrological impacts. The application of PES assessments to these drainage lines is currently not ideal as these watercourses do not have a specific and published assessment method available to determine their PES. The categories provided in Table 18 are therefore inferred from another technique. Different watercourse specialists are therefore likely to have different interpretations regarding their extent and ecological condition. It is again stated that recorded erosion features within these watercourses, such as headcuts, are regarded as natural features associated with headwater drainage lines. Ephemeral drainage lines are also regarded to form part of the drainage networks that overlap with the study area and its surroundings, as illustrated in Figures 3 and 4.

Table 18: Results of the PES assessment and the PES class for Ephemeral drainage lines 7 and 13, delineated in close proximity to the study area, as determined through the technique described by DWAF (1999a). Only instream habitat is assessed for this ephemeral channel.

	Ephemeral Drainage Lines 7 and 8		**Ephemeral Drainage Line 13**	
Instream	**Score**	**Confidence**	**Score**	**Confidence**
Water abstraction	0	High	0	High
Extent of inundation	0	High	0	High
Water quality	6	Moderate	6	Moderate
Flow modifications	5	High	5	High
Bed modification	12	High	8	High
Channel modification	3	Moderate	10	Moderate - High
Presence of exotic macrophytes	2	Moderate	2	Moderate
Presence of exotic fauna	0	High	0	High
Presence of solid waste	0	High	0	High
Final IHI Scores				
IHI (instream)	86.7	B	85.2	B

5.2.4. Sandspruit River

Both instream and riparian habitat within the Sandspruit are regarded to be in a Moderately modified Present Ecological State (PES), (Table 19). Distinct local and catchment impacts are present. The latter includes an increasingly urbanised catchment around the Ledig area, while local impacts include the establishment of alien species, such as *Agave americana, Aster squamatus, Sesbania punicea, Verbena bonariensis,* and *Xanthium strumarium* (Section 5.1.4.).

No instream aquatic ecological assessments were undertaken as it falls beyond the scope of this report, but a single diatom sample taken from the rocky channel bed along the proposed November 2015 alignment, was assessed to provide an indication of water quality conditions. The diatom assessment indicated that the water quality of the site falls within an Ecological Category B (Good quality), in spite of the presence of minor signs of anthropogenic impacts in the form of polluted industrial wastewaters (Appendix A). De Castro (2016a) also states the following:

Though significant invasion by alien trees that are habitat transformers in riparian habitats in this part of the North-West Province is present, the vegetation of the watercourse is still dominated by indigenous species. Riparian habitat transformed by alien plant species was not recorded in the assessed reach of the Sandspruit.

Table 19: Results of the PES assessment and the PES class as derived from a River Index of Habitat Integrity assessment (DWAF, 1999a) for the Sandspruit River (watercourse number 11), (Figure 3). Instream and riparian habitat are assessed separately for this prominent and large riparian river system.

Sandspruit River		
Instream	**Score**	**Confidence**
Water abstraction	15	Low - Moderate
Extent of inundation	5	Moderate - High
Water quality	9	Moderate
Flow modifications	10	Moderate
Bed modification	15	High
Channel modification	5	M
Presence of exotic macrophytes	5	M
Presence of exotic fauna	0	High
Presence of solid waste	5	High
Riparian	10	Low - Moderate
Water abstraction	0	Moderate - High
Extent of inundation	9	Moderate - High
Water quality	10	Moderate
Flow modifications	12	Moderate - High
Channel modification	13	Moderate
Decrease of indigenous vegetation	16	Moderate - High
Exotic vegetation encroachment	10	High
Bank erosion	15	Low - Moderate
Final IHI Scores		
IHI (instream)	68.4	**C**
IHI (riparian)	61.5	**C**

5.2.5. Channelled Valley Bottom Wetland

A purely desktop assessment of the delineated channelled valley bottom wetland located outside and upstream of the study area indicated that the wetland has a Moderately modified (class C) PES, (Table 20). Impacts include upstream road crossings, an urbanised catchment, and upstream development encroachment into the wetland.

Table 20: Results of the PES assessment and the PES class for channelled valley bottom wetland 12, as derived from a Wetland Index of Habitat Integrity assessment developed by Rountree *et al.,* (2007).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	**Weighting**	**Score**	***Confidence Rating***	**PES Category**
DRIVING PROCESSES:		**100**	**2.0**		
Hydrology	1	100	2.1	*3.5*	**C/D**
Geomorphology	2	80	2.2	*2.7*	**D**
Water Quality	3	30	1.2	*3.3*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**1.2**	***3.4***	
Vegetation Alteration Score	1	100	1.2	*3.4*	**C**
OVERALL SCORE:			**1.6**	***Confidence Rating***	
	PES %		**67.2**		
	PES Category:		**C**	***1.5***	

5.3. Ecological Importance and Sensitivity (EIS) Assessments

The assessed Ecological Importance Sensitivity (EIS) of watercourses within a close proximity to the study area range between High to Very High at the one end and Moderate to High at the other end (Table 21). The assessed level of confidence associated with the EIS categories range from Low / Moderate to High (Table 21). Watercourses with a High level of confidence include those for which detailed biodiversity information has been obtained, specifically with regards to the presence of ‘species of conservation concern’ (sensu Raimondo *et al.,* 2009), (De Castro & Brits, 2016a). A Low to Moderate level of confidence is associated with the channelled valley bottom wetland, which was only assessed at a desktop level, as it is located outside of the study area assessed by the biodiversity specialists, but still falls within a 500 m study area buffer (De Castro & Brits, 2016a; Figure 3). The Sandspruit River and its riparian habitat has a Moderate level of confidence as detailed information is available for the riparian habitat, but no sampling of aquatic invertebrates or fish assemblages were undertaken. Desktop information on the Ecological Importance and the Ecological Sensitivity provided by DWS (2015) for the Sandspruit was also used. The assessment of the EIS of individual watercourses relied heavily on the plant ‘species of conservation concern’ assessment. The following summary has been obtained and modified specifically for assessed watercourses based on the information by De Castro & Brits (2015a):

> Prior to the conduction of the field surveys, available database information pertaining to the threatened plant species of the region of the North-West Province within which the study area is situated was obtained from the National Herbarium PRECIS database (http://posa.sanbi.org). All ‘threatened species’, namely Critically Endangered, Endangered and Vulnerable species, and other ‘species of conservation concern’, namely Near Threatened, Declining, Critically Rare and Rare species

(*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded May 2015) historically recorded from the quarter degree grid square within which the study area is situated (2527AC), as well as four immediately adjacent grids (2526BC, 2526BD, 2526DB and 2527CA) which contain similar habitats, were extracted from these lists. Emphasis was placed on searching for these plant species, and potentially suitable habitat for these species, during the field surveys.

The Red List of South African Plants (Raimondo *et al*., 2009 and http://redlist.sanbi.org) provides an assessment of all South African Plant taxa. The Red List therefore contains species that are currently regarded as being threatened with extinction (Critically Endangered, Endangered and Vulnerable) or are close to being threatened with extinction (Near Threatened), as well as species that are currently not regarded as being threatened with extinction (Least Concern), in accordance with IUCN Version 3.1 criteria (IUCN, 2001). In addition to the IUCN categories, the South African Red List also includes unique categories for species which do not currently qualify as Threatened or Near Threatened in accordance with IUCN criteria, and are thus categorised as Least Concern by the IUCN, but which are of some conservation concern (Raimondo *et al*., 2009). These South African categories are Critically Rare, Rare and Declining, and were developed specifically to highlight species that though not threatened with extinction possibly require some conservation effort and monitoring. In terms of the recommended methodology provided by Raimondo *et al*. (2009), the term 'species of conservation concern' includes the IUCN threatened and Near Threatened categories as well as the South African Red List categories (i.e. Critically Rare, Rare and Declining) and this approach is followed here.

The obtained lists of historically recorded 'species of conservation concern' included nine plant 'species of conservation concern', namely *Aloe peglerae* (Endangered), *Prunus africana* (Vulnerable), *Adromischus umbraticola* subsp. *umbraticola* (Near Threatened), *Drimia sanguinea* (Near Threatened), *Boophone disticha* (Declining), *Gunnera perpensa* (Declining), *Ilex mitis* (Declining), *Rapanea melanophloeos* (Declining) and *Frithia pulchra* (Rare).

Of these nine species only five are associated with a variety of watercourse habitats, as either facultative or obligate hydrophyte, hygrophyte or riparian species. They include the following (De Castro & Brits, 2016a):

- *Stenostelma umbelluliferum* (Near Threatened) - Deep black turf in open woodland mainly in the vicinity of drainage lines.
- *Ilex mitis* var. *mitis* (Declining) - Along rivers and streams in forests and thickets, sometimes in the open. Found from sea level to inland mountain slopes.
- *Gunnera perpensa* (Declining) - In marshy, cold or cool, continually moist localities, mainly along upland streambanks. From coast to 2400m.
- *Hypoxis hemerocallidea* (Declining) - Grassland and mixed woodland, including secondary grassland of historically cultivated soils. Usually in moist situations.
- *Rapanea melanophloeos* (Declining) - Coastal, swamp and mountain forest, on forest margins and in bush clumps, often in damp areas from coast to mountains.

Only *Hypoxis hemerocallidea* has a high probability of being present within delineated watercourses (Figure 3), while *Stenostelma umbelluliferum* and *Ilex mitis* both have a low likelihood, and the remaining two species have a negligible likelihood (De Castro & Brits, 2016a). Only one of the eleven 'species of conservation concern' were recorded within the study area, namely *Hypoxis hemerocallidea* (Declining). This species was recorded at four sites, all restricted to Ephemeral Channel 2, located within the Frischgewaagd property (De Castro & Brits, 2016a). *Hypoxis hemerocallidea* is not a threatened species as defined by the IUCN criteria, but is categorised as Declining in the latest Red List of South African Plants (Raimondo *et al*., 2009 and http://redlist.sanbi.org). Declining is a South African Red List category reserved for species which are not threatened or Near Threatened, but which are declining as a result of over-utilisation, and therefore merit some conservation effort. Ephemeral channel 2 therefore has the highest EIS of all of the assessed watercourses (Table 21). Other aspects that were considered as part of the EIS assessment include the presence of a Critical Biodiversity Area Category 2 that overlaps with all of the watercourses.

Table 21: Indicates the EIS categories and associated level of confidence for each of the assessed watercourses.

Watercourse Type	Map Label	EIS Class	Confidence
Unchannelled valley bottom wetland	1	High	High
Ephemeral channel	2	High / Very High	High
Ephemeral channel	3	High	High
Ephemeral channel	4	High	High
Ephemeral channel	5	High	High
Ephemeral drainage line	7	High	High
Ephemeral drainage line	8	High	High
Ephemeral channel	9	High	High
Ephemeral channel	10	High	High
Sandspruit River and riparian habitat	11	Moderate	Moderate
Channelled valley bottom wetland	12	Moderate / High	Low / Moderate
Ephemeral drainage line	13	High	High

6. PROPOSED INFRASTRUCTURE FOOTPRINTS AND WATERCOURSES

All of the delineated watercourses illustrated in Figures 13 & 14 are regarded as sensitive habitats that should be protected from further impacts irrespective of their ecological condition. Demarcated sensitive watercourse habitats include buffer zones around them. A buffer zone of 32m is recommended for all of the watercourses, this excludes the Elands River and its associated riparian habitat, for which a 100m buffer is recommended (Figures 13 & 14). The larger buffer zone of 100m is recommended in order to help maintain a functional corridor along the Elands River and to make provision for uncertainty regarding the ecological condition, sensitivity and importance of the Elands River, as it was not assessed as part of this study apart from a largely desktop delineation. A 32m buffer is regarded as adequate around the remainder of the watercourses, as it specifically pertains to the protection of ephemeral channels and drainage lines: Neither the unchannelled valley bottom wetland (map label no. 1), nor any of the Sandspruit and Elands River channels and their associated riparian habitat are located in close proximity from proposed polygon (non-linear) infrastructure features (Figures 13 & 14). The only possible exception may be Mine housing phase 1, which is located close to the unchannelled valley bottom wetland (still more than 32m), (Figure 13). This section, located near the confluence between the unchannelled valley bottom wetland and ephemeral channel no. 3, has been highly disturbed by recent noise berm and steel tower construction works (Figures 12 & 13). This makes a buffer of more than 32m around the remaining unchannelled valley bottom wetland unnecessary.

Proposed linear infrastructure features do, however, transect a river with riparian habitat (the Sandspruit River).Buffers with a width greater than 32m is not expected to have an increased efficiency to mitigate watercourses impacts associated with linear infrastructure features, such as pipelines and bridges, as overlap between watercourses and linear infrastructure features is often unavoidable. A 32m buffer around the delineated wetland area, ephemeral drainage lines and ephemeral channels is therefore regarded as adequate.

Additional motivation for the use of buffers as a general means of watercourse impact mitigation and the creation of an environmentally sensitive development layout plan is provided below (also refer to Appendix B). Buffers consisting of terrestrial habitat around watercourses are reputed to provide a number of benefits. Some of the potential benefits are listed below (Castelle *et al.* 1992; ELI, 2008):

- Sediment retention.
- Retention of pollutants.
- Lower erosion risk.
- Moderation of flows from uplands into wetlands.
- Provision of faunal habitat.
- Screen a wetland (and other watercourses) from adjacent developed areas.
- Limitation of direct human impacts on a wetland (e.g. waste disposal and trampling).

The extent of overlap between delineated watercourses (both polygon and line features) and proposed study area infrastructure footprints (both polygon and line features) are quantified and summarised in Table 22. In the Frischgewaagd section a combined area of 0.32ha of watercourse habitat (Ephemeral channel 2) overlap with proposed infrastructure features (excluding the linear tailings pipeline and proposed bridge). The combined length of watercourse overlap with linear infrastructure features, such as the bridge and tailings pipeline (Dec 2015 alignment), is 91.56m, while two crossing points are also present between the tailings pipeline and Ephemeral drainage line 7 (Figures 13 & 14; Table 22). Approximately 31.62m (6.05%) of Ephemeral drainage line 7 overlaps with the proposed product stockpiles.

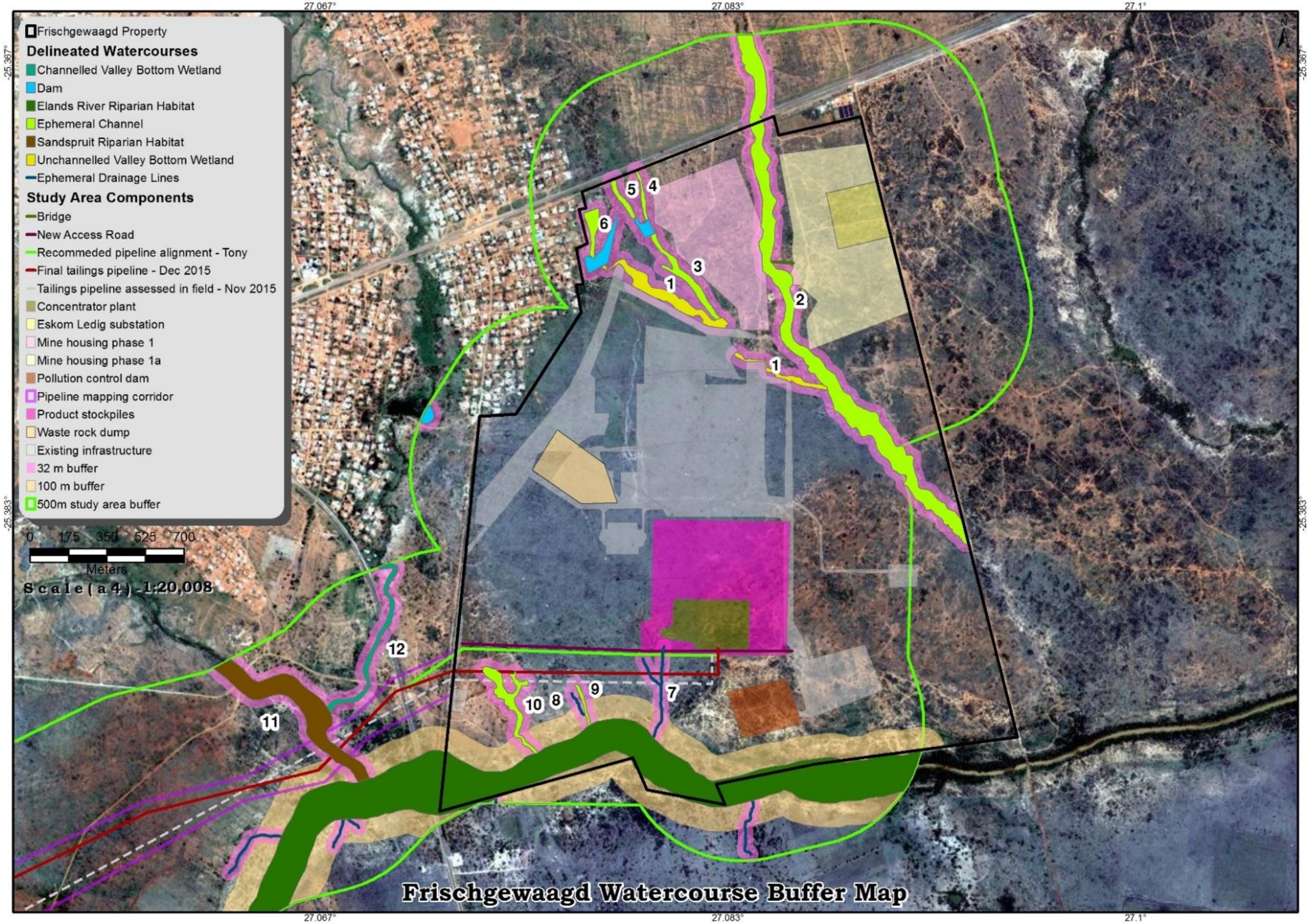

Figure 13: Illustrates delineated watercourses and recommended watercourse buffers within the Frischgewaagd section of the study area along with the eastern portion of the pipeline corridor, as well as the surrounding 500m study area buffer. Map labels are used for watercourses reference purposes in the text.

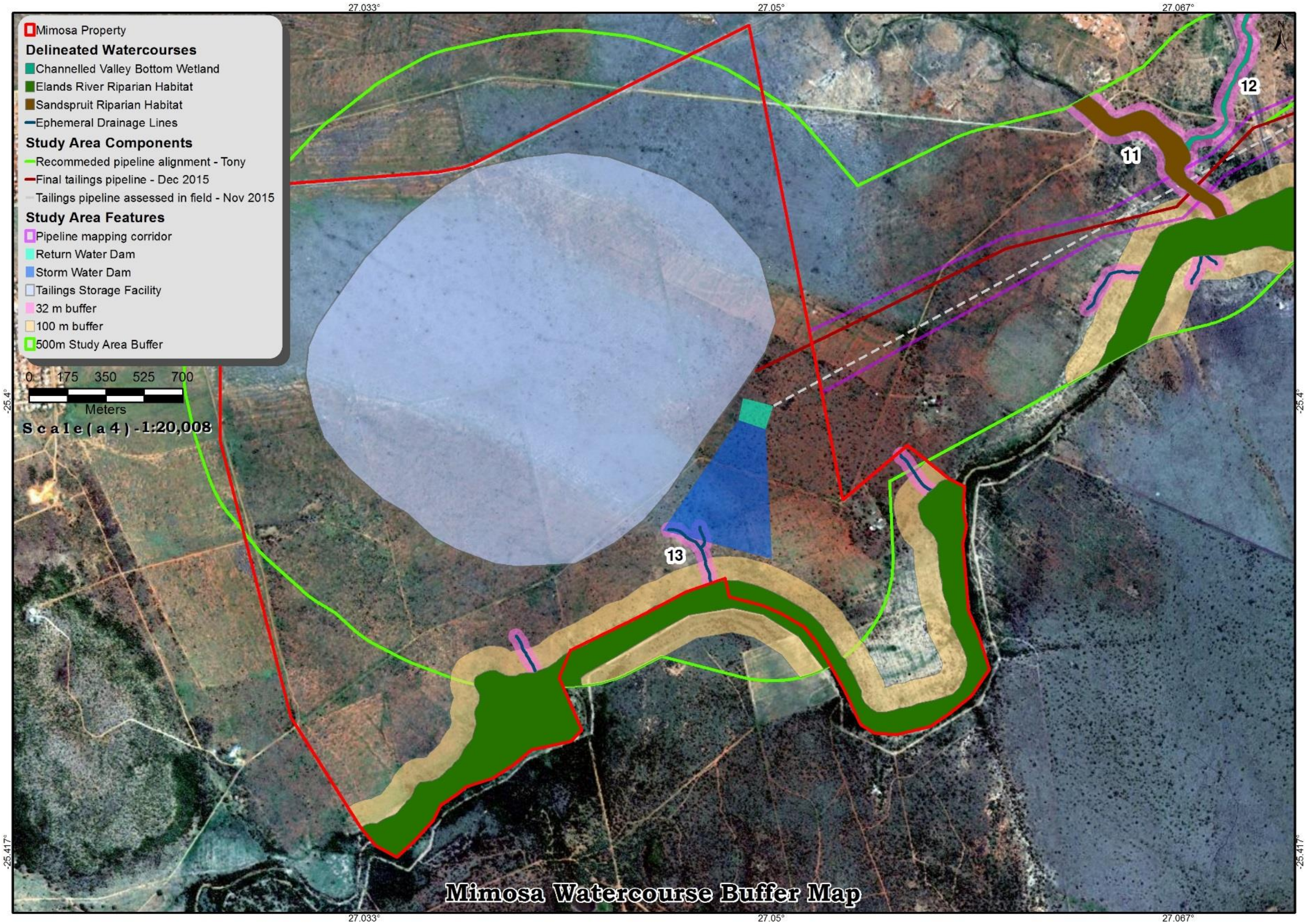

Figure 14: Illustrates delineated watercourses and recommended watercourse buffers within the Mimosa section of the study area along with the western portion of the pipeline corridor, as well as the surrounding 500m study area buffer. Map labels are used for watercourses reference purposes in the text.

Table 22: Summarises the overlap between watercourse surface areas and crossing distances for each of the proposed study area infrastructure features. The same applies to 32m and 100m buffers and proposed infrastructure footprints (also refer to Figures 13 & 14).

Watercourse and buffer feature	**Map label**	**Proposed study area infrastructure feature**	**Area of overlap**	**Length of overlap**	**Percentage of watercourse overlap**
Frischgewaagd property and surroundings					
Unchannelled Valley Bottom Wetland	1	No overlap with study area features	-	-	-
Ephemeral channel	2	Mine Housing Phase 1a	0.07ha	-	0.50%
Ephemeral channel	2	Mine Housing Phase 1	0.25ha	-	1.80%
Ephemeral channel	2	Bridge	-	23.07m	-
Ephemeral channel	3	No overlap with study area features	-	-	-
Ephemeral channel	4	No overlap with study area features	-	-	-
Ephemeral channel	5	No overlap with study area features	-	-	-
Ephemeral channel	6	No overlap with study area features	-	-	-
Ephemeral drainage line	7	Product Stockpiles		31.62m	6.05%
Ephemeral drainage line	7	Tailings Pipeline Final (Dec 2015)	The tailings pipeline alignment cross the narrow watercourse at two locations. No distance or surface area calculations are practical for the 2 x linear crossings		
Ephemeral drainage line	8	No overlap with study area features	-	-	-
Ephemeral channel	9	No overlap with study area features	-	-	-
Ephemeral channel	10	Tailings Pipeline Final (Dec 2015)	-	68.49m	-
Total			**0.32ha**	**123.18m**	
Pipeline corridor					
Sandspruit River and riparian habitat	11	Tailings Pipeline Final (Dec 2015)	-	51.04m	-
Channelled valley bottom wetland	12	No overlap with study area features	-	-	-
Total					
Mimosa property and surroundings					
Ephemeral drainage line	13	Storm Water Dam	-	77.22m + 62m	33.80%
Total				**139.22m**	
32m Buffer intersections					
-	-	Mine Housing Phase 1a	0.37ha	-	-
-	-	Mine Housing Phase 1	1.29ha	-	-

Watercourse and buffer feature	Map label	Proposed study area infrastructure feature	Area of overlap	Length of overlap	Percentage of watercourse overlap
-	-	Product Stockpiles	0.39ha	-	-
-	-	Storm Water Dam	1.04ha	-	-
-	-	Bridge	-	80.52m	-
-	-	Tailings Pipeline Final (Dec 2015)	-	430.16m	-
Total			**3.09ha**	**510.68m**	
100m Buffer intersections					
-	-	Tailings Pipeline Final (Dec 2015)	-	211.48m	-
Total				**211.48m**	

The extent of overlap between delineated watercourses (only polygons) and proposed linear infrastructure footprints in the form of the proposed tailings pipeline alignment is 51.04m (Figures 13 & 14; Table 22). The only overlap between delineated watercourses and proposed infrastructure footprints (Storm water dam) within the Mimosa property and surroundings has a combined length of 139.22m or 33.80% of the 411.88m long drainage line (Figures 13 & 14; Tables 12 & 22).

The combined surface area overlap between the 32m watercourse buffer and all non-linear infrastructure footprints is 3.09ha, while the combined crossing distance length between the same buffer and linear infrastructure features (bridge and proposed tailings pipeline) is approximately 510.68m. The proposed tailings pipeline also overlaps with approximately 211.48m of the 100m wide Elands River riparian habitat buffer (Figures 13 & 14; Table 22).

7. POTENTIAL PROJECT RELATED WATERCOURSE IMPACTS

Potential watercourse impacts associated with the project are assessed under four broad impacts, namely:

- Loss of watercourse habitats
- Sediment mobilisation: deposition and erosion in watercourses
- Low water quality inputs into watercourses
- Encroachment of invasive alien plant species into watercourses

A formal Impact Assessment that describes the impacts, determines the significance of each impact (impact rating) and provides mitigation and monitoring measures for each impact, is provided in Appendix B.

8. SUMMARY AND CONCLUSION

8.1. Introduction

Imperata Consulting CC was subcontracted by De Castro and Brits Ecological Consultants CC to conduct a baseline wetland and watercourse study as part of an environmental impact assessment document to be compiled by SLR Consulting for new mining infrastructure components on the Farms Frischgewaagd and Mimosa, as well as an intervening area to the north of the Elands River located between these farms, close to Ledig, North West Province.

While construction at the Bakubung Platinum Mine has commenced, not all facilities have yet been constructed. Mining has not yet commenced. Wesizwe is now proposing to make several changes to the approved mine. The changes are required in order to cater for an increase in ore processing capacity, as well as additional support infrastructure which will require additional Environmental Authorisations, a Waste Management Licence (WML) and additional water uses requiring an amendment to their existing WUL.

The following changes are proposed to the Bakubung Platinum Mine (infrastructure components addressed in this specialist report are shaded in grey):

- The construction of a Tailings Storage Facility (TSF) of approximately 235.3ha on the farm Mimosa 81JQ. The height will be approximately 44m.
- An approximately 3.83km long Tailings Pipeline linking the Concentrator to TSF. The alignment will be situated on the Farms Frischgewaagd and Mimosa and the intervening area to the north of the Elands River between these farms. The pipeline will be 300mm in diameter and will be raised above ground level on plinths, and the construction servitude will be 30m wide.
- The construction of a Concentrator Plant on a footprint of approximately 6.3ha.
- The construction of a Product Stockpiles and Ore Crusher on a footprint of approximately 25.2ha adjacent to the Concentrator Plant.
- The construction of a Waste Rock Dump on a footprint of approximately 5.8ha.
- The construction of a Pollution Control Dam's for the Concentrator on a footprint of approximately 5.1 ha on the farm Frischgewaagd.
- The construction of a Return Water Dam with a footprint of approximately 1.2ha on the farm Mimosa.
- The construction of a Storm Water Dam with a footprint of approximately 14.9ha on the farm Mimosa.
- The construction of Phase 1 of the mine housing on a footprint of approximately 19.8ha on the farm Frischgewaagd.
- The construction of Phase 1a of the mine housing on a footprint of approximately

25.2ha on the farm Frischgewaagd.
- The construction of the Eskom Ledig substation on a footprint of approximately 5.1ha adjacent to the Phase 1a mine housing.

This report deals with potential impacts of selected new mining infrastructure features (se bulleted points), on watercourses present in their proposed footprint areas. These proposed new infrastructure footprints also form the study area that was assessed for the presence, type and ecological condition of watercourses, as defined in the National Water Act (Act Nr. 36 of 1998) (NWA). The assessed study area components are illustrated in Figure 1. The site visit for this study was conducted in November 2015, while the layout for the Tailings Pipeline changed in December 2015 (Figure 1).

8.2. Terms of Reference and Approach

Terms of references associated with the specialist watercourse investigation include the following for the study area as defined in Section 1 (Figure 1):
- Desktop analyses and literature review of existing wetland-related information, including available recent and historic aerial imagery.
- A three day field survey by a Pr.Sci.Nat. registered ecologist that will investigate and delineate wetlands and other watercourses according to the DWA method (DWAF 2005; DWAF 2008).
- A one day field survey by a Pr.Sci.Nat. registered soil scientist that will assist with the interpretation of hydromorphic (wetland soil) features and the presence / absence of other soil wetness indicators in other watercourses identified.
- A classification of identified wetland areas into appropiate hydro-geomorphic units according to the National Wetland Classification System for South Africa (Ollis et al., 2013).
- Description of identified wetland and related watercourse indicators; these include soil, plant, and terrain indicators, as well as others published in literature (e.g. Nobel *et al.,* 2005). Apart from wetlands, other types of watercourses will also be delineated and described, these include riparian areas, dams and natural channels (e.g. headwater drainage lines), as defined in the National Water Act (Act Nr. 36 of 1998) (NWA) within the study area. All watercourses are also subject to Section 21 (c) and (i) Water Use License Applications, as well as listed activities in terms of the National Environmental Management Act (NEMA), Act No. 107 of 1998 and the EIA Regulations of 2014.
- Assessments of the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of delineated wetlands according to the applicable methods developed by either the Department of Water and Sanitation (DWS) or the Water Research Commission (WRC), (DWAF 1999; DWAF 2007; Macfarlane *et al.,* 2008; Rountree & Malan 2013). The accuracy and level of confidence of these assessments will be improved through a wet season survey (approximately November to May) rather than a dry season survey. PES & EIS values are also of relevance for a possible Water Use License Application (WULA) that may be required.
- **Surrounding wetland areas located in a 500m radius around the proposed footprints will be delineated at a secondary level of detail through limited site sampling and a stronger desktop approach (Figure 1)**, in order to meet criteria from the Department of Water and Sanitation (DWS) for a Water Use License Application (WULA) regarding Section (*c*) and (*i*) water use activities present within a 500 m radius of any wetland (DWAF, 2009).
- Creation of watercourse sensitivity maps and associated GIS shapefiles.
- A description of existing and expected project-related impacts that could affect

demarcated wetlands and other watercourses.

- The identification of potential project-related watercourse impacts, and the provision of related impact mitigation measures.
- All of the above would be incorporated into a single report.

8.3. Findings, Discussion and Recommendations

Information from the wetland study is summarised in Tables 23 and 24, which should be viewed along with Figures 13 & 14. Two wetlands systems were identified and delineation, as well as other watercourses, such as ephemeral channels, smaller and more indistinct ephemeral drainage lines, the Sandspruit River with associated riparian habitat and the Elands River with associated riparian habitat.

The Present Ecological (PES) and Ecological Importance and Sensitivity (EIS) of delineated watercourses within the study area, two properties and 500m study area buffer range from Largely natural (Class B PES) to Largely Modified (Class D PES), while EIS categories range from High / Very High to Moderate (Table 23).

Table 23: Provides a summary of delineated watercourse types along with their surface area, length, PES, EIS and proposed infrastructures that overlap with each watercourse.

Watercourses Type	**Watercourse Number**	**Surface area**	**Length**	**Size of upstream dams**	**PES Category**	**EIS Category**	**Overlapping study area infrastructure features**
Unchannelled valley bottom wetland	1	2.81ha	-	0.89ha	**D**	High	None
Ephemeral channel	2	13.9ha	-		**C**	High / Very High	Mine housing phase1a, phase 1, and a connecting bridge
Ephemeral channel	3	1.20ha	-	0.32ha	**B**	High	None
Ephemeral channel	4	0.28ha	-		**C**	High	None
Ephemeral channel	5	0.39ha	-		**C**	High	None
Ephemeral channel	6	0.65ha	-		Not assessed	Not assessed	None
Ephemeral drainage line	7	-	386.15m + 136.11m		**B**	High	Product stockpiles and 2 x Tailing pipeline crossings
Ephemeral drainage line	8	-	110.13m		**B**	High	None
Ephemeral channel	9	0.22ha	-		**B**	High	None
Ephemeral channel	10	1.51ha	-		**B**	High	2 x Tailing pipeline crossings
Sandspruit River and riparian habitat	11	6.10ha	-		**C**	Moderate	1 x Tailing pipeline crossings
Channelled valley bottom wetland	12	1.35ha	-	0.26ha (only portion of dam)	**C**	Moderate / High	None
Ephemeral drainage line	13	-	314.35m + 97.53m		**B**	High	Storm water dam
Elands River and riparian habitat (downstream section - in and adjacent to Frischgewaagd)	-	45.05ha			Not assessed	Not assessed	None
Elands River and riparian habitat (upstream section - in and adjacent to Mimosa)	-	49.66ha			Not assessed	Not assessed	None
Total		**123.12ha**	**1044.27m**	**1.47ha**			

Table 24: Summary of infrastructure features in the proposed 32m and 100m buffers around delineated watercourses.

Overlapping study area infrastructure features	Area of overlap	Length of overlap
32m Buffer		
Mine Housing Phase 1a	0.37ha	-
Mine Housing Phase 1	1.29ha	-
Product Stockpiles	0.39ha	-
Storm Water Dam	1.04ha	-
Bridge	-	80.52m
Tailings Pipeline Final (Dec 2015)	-	430.16m
Total	**3.09ha**	**510.68m**
100m Buffer		
Tailings Pipeline Final (Dec 2015)	-	211.48m
Total	-	**211.48m**

Wetlands and other watercourses are protected water resources in the National Water Act (NWA), Act 36 of 1998. Development within watercourses is regarded as a water use, which can only be allowed through an approved Water Use License, irrespective of the condition of the affected watercourse.
Section 21 of the NWA defines different types of water use in a watercourse. Water uses activities associated with wetland and riparian stream typically include the following:

(c) impeding or diverting the flow of water in a watercourse
(i) altering the bed, banks, course or characteristics of a watercourse.

The implication is that authorization will have to be obtained from the Department of Water and Sanitation (DWS) before water use activities can be initiated in demarcated wetlands, and riparian areas. This will have to be done through a Water Use License Application (WULA). In addition, a recent DWA stipulation published in Government Gazette No 32805 (December 2009) also require that a Water Use License should be applied for when any wetlands are present within a 500 m radius (buffer) of a section 21 *(c)* and section 21 *(i)* water use activities.

All of the delineated watercourses along with their buffers are regarded as sensitive features that should be protected from project-related impacts. These watercourses should therefore receive thorough attention and consideration during the environmental planning phase, and changes should be made to infrastructure components that currently overlap with them as far as possible.

Four project-related watercourse impacts have been identified, namely:

- Loss of watercourse habitats
- Sediment mobilisation: deposition and erosion in watercourses
- Low water quality inputs into watercourses
- Encroachment of invasive alien plant species into watercourses

All four of these impacts have a High impact significance without mitigation, but with mitigation their significance can be reduced to Medium, apart from the expected negative water quality impact associated with possible tailings spillages along the pipeline, which remains High (Appendix B). The proposed mining development in its current layout is not regarded as a suitably sensitive proposal to allow environmental authorisation. Impact avoidance through a re-design of proposed infrastructure features will help to make the proposed development more accommodating to delineated watercourses and buffers. Provided mitigation recommendations suggested in this report are implemented, the project is not considered to contain any fatal flaws in terms of wetlands and other watercourses that were identified, delineated and assessed in this report. There is therefore no objection to the project from a watercourse perspective.

The following impact mitigation recommendations have been made with regards to expected project-related watercourse impacts (also refer to Figures 13 & 14):

- Modify infrastructure footprints so as to avoid overlap between watercourses, as well as the 32m and 100m buffers as far as possible. This pertains specifically to changes to the two Mine housings phases (Phases 1a and 1), the product stockpiles, and storm water dam.
- The proposed bridge can remain at its current location as an access road through Ephemeral channel 2 that connects the two housing phases appears to be unavoidable. The bridge will have to be modified to prevent further habitat loss due to expected anthropogenic erosion damage (see next impact discussion).
- The proposed tailings pipeline should move further to the north along the new access road (Figure 13 in the main report) in order to avoid overlap with Ephemeral channels 9 and 10, as well as Ephemeral drainage line 8. Overlap with Ephemeral drainage line 7 appears to be unavoidable, but the servitude width should be minimised as far as practical during the construction process. The pipeline should be spanned across the watercourse with plinths, which will need to be located outside of Ephemeral drainage line 7.
- The alignment of the tailings pipeline along the new access road can also serve as a maintenance road for the pipeline, which will remove the need for a new access road along the pipeline alignment.
- No new access roads may be created through watercourses along the pipeline alignment. All new tracks and roads that intersect delineated watercourses and the 32m buffer will have to receive environmental approval before they can be constructed.
- Overlap between the tailings pipeline and the Sandspruit River is unavoidable, but a restricted servitude width should be used, while no construction activities should occur within the instream and riparian habitat along the macro channel. Plinths can be located within the 32m buffer, but not within delineated riparian habitat.
- It follows that a portion of the tailings pipeline will also have to be moved north to avoid overlap with the 100m buffer.
- Delineated watercourses and buffers should be treated as sensitive no-go areas as far as possible. No unauthorized access is allowed in these features.
- Repair erosion damage within watercourse through the use of either soft or hard rehabilitation interventions. Hard interventions, such as gabion drop inlets and other features, will require design by an engineer with rehabilitation experience. Note also that rehabilitation works in watercourses require a Water Use License (WUL).
- A well designed and implemented stormwater management system will be required to attenuate flood peak events within the property and thereby prevent erosion and sediment impacts in watercourses.
- Stormwater outflows should not be allowed to enter directly into watercourses, but need to be attenuated before they are released into watercourses.
- Interventions and mechanisms in the storm water management system can include measures to facilitate a higher percentage of infiltration and reduce runoff volumes and velocities, without concentrating their outflows as far as practically possible.
- Discharged stormwater must be released in a controlled manner in a diffuse flow pattern across a buffered vegetation strip and be accompanied by energy dissipating interventions to prevent erosion damage.
- Stormwater release impacts can be addressed in two main ways (CSIRO, 2006; EPA, 1996): The first is to make use of preventative construction techniques (source

controls), such as to limit the amount of impervious material near watercourses as far as possible, and to demarcate setbacks from watercourses in the form of a buffer zone with a natural vegetation cover.

- Secondly, structural control measures such as treatment techniques or naturally vegetated detention basins could be used to improve storm water quality.
- Other structural control measures include grass swales, infiltration trenches and basins, wet ponds, and constructed wetlands to intercept and partially treat storm water before it is released. A combination of source controls and structural controls can result in an integrated solution, which is likely to provide the best benefits.
- Buffer zones are not walk away solutions and need to be maintained during the operational phase of the project in order to be effective. This includes the maintenance of a well vegetated grass cover that is free of aliens and erosion features. Any aliens and/or erosion features observed within the buffer zone need to be addressed in order to ensure buffer functioning.
- The storm water management plan needs to give special consideration to buffer zones in order to prevent erosion impacts and the creation of channelised flows at discharge points, which would largely negate the benefits of any buffers present.
- The proposed bridge crossing through Ephemeral channel 2 should contain culverts across the length of the crossing and armouring on the downstream channel banks and bed to avoid further channel incision and channel bank scour during high flow events. Pipes are not recommended as they can become easily blocked with alluvial material, which can lead to further scour damage in the watercourse.
- A watercourse rehabilitation plan should be developed during the latter part of the construction process to help address remnant impacts that were not successfully mitigated. Note that rehabilitation works in a watercourse will require a Water Use License. It is therefore recommended that rehabilitation needs and flexibility are considered as part of the Water Use License Application (WULA).
- Maintain the pipeline in a good working order with regular checks and inspections to help reduce the risk of spillage events.
- If spillage occurs, the spill must be contained with swales and berms after the leakage has been repaired, the spilled material should be removed and pollution plume should be determined a soil chemist and hydrologist (De Castro & Brits, 2016b).
- A remediation plan must be compiled by a soil chemist and hydrologist after a spill event (De Castro & Brits, 2016b).
- Ensure that geotechnical and geohydrological mitigation measures are in place around the proposed tailings storage facility to prevent seepage into nearby watercourses.
- Ensure that the storm water dam, tailings storage facility and product stockpiles are constructed and operated according to specifications, in order to help reduce the likelihood of structure failure, which can result in disastrous water quality impacts in downstream watercourses over a short space of time.
- No refuelling of heavy motorised vehicles (HMVs) or other vehicles, stockpiling of material or the positioning of portable toilets should be allowed within any of the watercourses or their associated buffer zones.
- Dewatering that may be required during excavation activities should not be released directly into watercourses.
- Stockpiles should be protected from erosion during the wet season to prevent sedimentation in watercourses.
- Implement sediment control structures upslope of watercourses, in between stockpiles and constriction activities that may act as sources of sediment.
- Maintain these features in a functional manner during the entire construction phase.
- Develop and implement a site specific alien control plan during the latter half of the construction phase based on the evaluation of weed species present within

watercourses located within or in close proximity to infrastructure features. Alien species in remaining areas of the properties should also be addressed as part of the alien control plan.

9. REFERENCES

Brinson M. 1993. A hydro-geomorphic classification for wetlands. Wetland Research Programme Technical Report WRP-DE-4. US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Castelle, A.J., Conolly, C., Emers, M., Metz, E.D., Meyer, S., Witter, M., Mauermann, S., Erickson, T. and Cooke, S.S. 1992. Wetland Buffers: use and effectiveness. In Adolfson Associates, Inc., Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia, Publication No. 92-10.

De Castro & Brits. 2016a. Botanical Biodiversity Assessment Report for Proposed New Development Infrastructure Footprints at The Bakubang Platinum Mine (Ledig, North-West Province). Specialist EIA Report by De Castro & Brits Ecological Consultants, Krugersdorp.

De Castro & Brits. 2016b. Soil, Agricultural Potential, Land Capability and Land Use Study: Impact of a Proposed Tailings Pipeline on the Farms Frischgewaagd and Mimosa, Near the Town of Ledig, North West Province. Specialist EIA Report prepared by P.S. Rossouw for De Castro & Brits Ecological Consultants, Krugersdorp.

Department of Water Affairs and Forestry (DWAF). 1999a. Habitat Integrity Assessment Method for River Ecosystems.

Department of Water Affairs and Forestry (DWAF). 1999b. R7: Assessment of Ecological Importance and Sensitivity. Resource Directed Measures for Protection of Water Resources: River Ecosystems Version 1.0. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Department of Water Affairs and Forestry (DWAF). 2007. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. XXXXXXXXX. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2009. Government Gazette No. 32805. Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)] and Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)]. Pp66-71, Pretoria.

Department of Water and Sanitation (DWS). 2015. PES, EI and ES Scores for sub-quaternary catchments in Secondary Catchment A2. Pretoria, South Africa.

Dodds W.K. & Oaks R.M. 2008. Headwater influences on downstream water quality. Environmental Management 41:367–377.

Environmental Law Institute (ELI). 2008. Planner’s Guide to Wetland Buffers for Local Governments. Washington D.C. USA. http://www.eli.org.

EPA 1996. Protecting Natural Wetlands – A Guide to Stormwater Best Management Practices. Environmental Protection Agency (EPA). Washington, United States of America.

GeoTerraImage (GTI), 2015. 2013 - 2014 South African National Land Cover Dataset version 05. DEA Open Access. Obtained from: https://www.environment.gov.za/mapsgraphics.

Gomi, T., Sidl, R.C., Richardson, J.S. 2002. Understanding processes and downstream linkages of headwater systems. BioScience, 52, 10, 905-916.

Kleynhans, CJ, Thirion, C and Moolman, J. 2005. A Level I River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Macfarlane D.M, Kotze D, Walters D, Ellery W, Koopman V, Goodman P, and Goge C. 2008. WET-Health: A Technique for Rapidly Assessing Wetland Health. WRC Report TT 340/08. Water Research Commission, Pretoria.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E., & Smith-Adao, L.B. 2011. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No. TT 500/11.

North West Department Rural Environment and Agriculture Development (NWREAD), 2015. North West Biodiversity Sector Plan (NWBSP).

Retief, E, & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characters. Strelitzia No. 6.

Rountree, M.W., Malan, H. & Weston, B. (Editors). 2013. Manual for the Rapid Ecological Reserve Determination of inland wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission study. Pretoria.

APPENDIX A: DIATOM ASSESSMENT REPORT FOR THE SANDSPRUIT TAILINGS PIPELINE CROSSING

Diatom Analysis Report

CLIENT: **Imperata Consulting**
retief@imperata.co.za

CONSULTANT: **Luisa Riato**

CONTACT DETAILS: **Telephone number: 0764765245**
E-mail: luisariato@gmail.com

NUMBER OF SAMPLES RECEIVED: **1**

DATE OF REPORT: **8TH JANUARY 2016**

APPROACH

Diatoms are the unicellular algal group most widely used as indicators of river and wetland health as they provide a rapid response to specific physico-chemical conditions in the water and are often the first indication of change. The presence or absence of indicator taxa can be used to detect specific changes in environmental conditions such as eutrophication, organic enrichment, salinisation and changes in pH. They are therefore useful for providing an overall picture of trends within an aquatic system.

ANALYSIS

A diatom slide was prepared by acid oxidation using hydrochloric acid and potassium permanganate. Clean diatom frustules were mounted onto a glass slide ready for analysis. Taxa were identified mainly according to standard floras (Krammer & Lange- Bertalot, 2000). The aim of the data analysis was to identify and count diatom valves (400 counts) to produce semi-quantitative data from which ecological conclusions can be drawn.

FINDINGS

The site was sampled within slow flowing waters which may be subject to strong fluctuations in its condition, specifically salinity, organic and nutrient levels. Any attempt to use existing diatom indices suitable for freshwater ecosystems (Specific Pollution sensitivity Index (SPI), Coste in CEMAGREF, 1982, Biological Index for Diatoms (BDI), Lenoir and Coste, 1996, Prygiel and Coste, 2000) to determine the biological integrity of such a system will likely result in misleading conclusions.

Existing diatom indices used to determine anthropogenic stress in freshwater systems relate to the abundances of stress-tolerant species, which may be equally tolerant to natural stressors (elevated salinity/organics/nutrients) as to anthropogenic ones. Analyses of diatoms were therefore based on measures of relative abundance and species composition (i.e. assemblage patterns) to infer baseline water quality conditions at the site. Addendum 1 displays a list of species and abundances recorded at the site. A list of the dominant species occurring at the site, expressed as a percentage of the total sample is displayed in Table 1.

Table 1 List of dominant diatom species occurring at the site expressed as a percentage of the total sample.

Taxa	**Relative Abundance (%)**
Achnanthidium minutissima Kützing	18
Brachysira neoexilis Lange-Bertalot	14
Caloneis aequatorialis Hustedt	5
Denticula kuetzingii Grunow	23
Encyonopsis minuta Krammer & Reichardt	15
Nitzschia linearis(Agardh) W.M.Smith var. *subtilis*(Grunow) Hustedt	7

Diatom assemblage patterns at the site suggest the following (remembering that ‘pollution indicators’ used to determine anthropogenic stress in moderate flowing, freshwater systems may be equally tolerant to the *natural* stressors that accompany slow flowing waters with naturally elevated salinity/organics/nutrients):

- Recorded at the site is the presence of dominant taxon *Denticula kuetzingii* which is found in good quality waters with moderate to high electrolyte content. This taxon has previously been recorded in abundance downstream of a dolomitic eye.
- Other dominant taxa recorded at the site are *Achnanthidium minutissima*, *Encyonopsis minuta*, *Brachysira neoexilis* and *Nitzschia linearis* var. *subtilis* which are generally found in well oxygenated, clean, oligo- to mesotrophic freshwaters (Slàdecek, 1986; Leclercq and Maquet, 1987; Prygiel and Coste, 2000).
- *E. minuta*, *B. neoexilis* and dominant taxon *Caloneis aequatorialis* generally favour calcareous, alkaline biotopes with moderate electrolyte content.
- Also recorded at the site is the small presence of taxa *Hantzschia amphioxys*, *Luticola mutica* and *Pinnularia borealis* which have an affinity for periodically dry habitats, including soils and rock crevices, and suggests that the system is prone to drying out.
- The small presence of taxon *Fragilaria pulchella,* which occurs in waters with high electrolyte content and is frequently reported from critically polluted industrial wastewaters, may suggest minor signs of anthropogenic impacts.
- For reasons outlined above, the water quality at this site can be assigned an Ecological Category B (Good quality).

REFERENCES

CEMAGREF.1982. Etude des méthodes biologiques quantitatives d'appréciation de la qualité des eaux. Rapport Division Qualité des Eaux Lyon - Agence Financiére de Bassin Rhône- Méditerranée-Corse. Pierre-Benite.

Krammer, K. and H. Lange-Bertalot. 2000. Süßwasserflora von Mitteleuropa, Bd. 2/2: Bacillariophyceae: Teil 2: Bacillariaceae, Epithemiaceae, Surirellaceae. Spektrum Akademischer Verlag GmbH. Berlin Ed.

Leclercq L, Maquet B. Deux nouveaux indices chimique et diatomique de qualité d'eau courante. Application au Samson et à ses affluents. Comparaison avec d'autres indices chimiques, biocénotiques et diatomiques. Bulletin Institut Royal Sciences Naturelles de Belgique, Documents de Travail 1987;38:113.

Lenoir, A. and M. Coste. 1996. Development of a practical diatom index of overall water quality applicable to the French National Water Board network. In: Whitton B.A and E. Rott (eds) Use of Algae for Monitoring Rivers *11*. lnstitut für Botanik. Universität lnnsbruck: 29-43.

Prygiel, J. and M. Coste. 2000. Guide méthodologique pour la mise en oeuvre de l'Indice Biologique Diatomées. NF T 90-354. Agence de l'eau Artois Picardie, Douai.

Slàdecek, V. 1986. Diatoms as indicators of organic pollution. *Acta Hydrochim. Hydrobiol.,* 14 (5): 555 - 566.

Addendum 1

List of diatom species and associated abundances at the site in December 2015.

Taxa	Abundance
Achnanthidium minutissima Kützing	73
Brachysira neoexilis Lange-Bertalot	54
Caloneis aequatorialis Hustedt	18
Craticula buderi (Hustedt) Lange-Bertalot	1
Denticula kuetzingii Grunow var.kuetzingii	92
Encyonopsis minuta Krammer & Reichardt	61
Fragilaria pulchella (Ralfs ex Kutz.) Lange-Bertalot	1
Gomphonema auritum A.Braun ex Kützing	2
Gomphonema parvulum (Kützing)	8
Gyrosigma rautenbachiae Cholnoky	3
Hantzschia amphioxys (Ehr.) Grunow	4
Luticola mutica (Kützing) D.G. Mann	1
Navicula cryptocephala Kutzing	2
Navicula erifuga Lange-Bertalot	1
Navicula vandamii Schoeman & Archibald	16
Navicula zanoni Hustedt	2
Nitzschia archibaldii Lange-Bertalot	11
Nitzschia fruticosa Hustedt	16
Nitzschia linearis(Agardh) W.M.Smith var.subtilis(Grunow) Hustedt	29
Pinnularia borealis Ehrenberg var. borealis	1
Sellaphora pupula (Kutzing) Mereschkowksy	4

APPENDIX B: IMPACT RATING AND DISCUSSION

IMPACT TYPE: LOSS OF WATERCOURSE HABITATS
Rating of Impact

Severity / Nature
This impact refers to the loss of watercourse habitat as a result of the encroachment of development infrastructure into delineated watercourses, such as the unchannelled valley bottom wetland, ephemeral channels, ephemeral drainage lines and riparian habitat associated with the Sandspruit. The eleven footprint study area features, excluding the linear tailings pipeline and bridge crossing, have a total combined overlap area of 0.32ha with delineated watercourses, which specifically includes Mining housing phase 1a and 1 with Ephemeral channel 2 (Figure 13 in the main report). Linear distances of overlap include 31.62m of Ephemeral drainage line 7 that overlaps with the Product stockpiles and 139.22m of Ephemeral drainage line 13 that overlaps with the proposed Storm water dam. In addition, proposed linear infrastructure features, such as the proposed tailing pipeline, overlap with 68.49m of Ephemeral channel 10, while it also crossed Ephemeral drainage line 7 twice and forms a crossing of approximately 51.40m with the Sandspruit River and its riparian habitat. Lastly, the proposed bridge that connects the two mining housing developments has a crossing width of approximately 23.07m through Ephemeral channel 2

The ecological condition of the affected watercourses range between Largely natural (Class B PES and High/Very High EIS) to Moderately modified (Class C PES and Moderate EIS). The severity of watercourse habitat loss as a result of the overlapping proposed infrastructure features is High, especially so in the case of polygon infrastructure features, such as the mine housing phase1 and 1a developments, the proposed bridge between them, the product stockpiles and the storm water dam. The impact is slightly less severe in the case of the proposed tailings pipeline, which will be constructed on plinths, but a servitude will still have to be cleared around the centre line of the pipeline during the construction phase. The assessed severity of the impact isHigh in the unmitigated scenario, but changes to Medium in the mitigated scenario. The change from High to Medium is based on the partial avoidance of the impact by moving a section of the pipeline in the Frischgewaagd property along the existing access road and making changes to the layout of polygon infrastructure features, such as Mining housing phases, the Storm water dam and the product stockpile (see mitigation measures below).

Duration
This impact will start during the construction phase and will be permanent. Permanent watercourse habitat loss is therefore expected based on the current development layout. Duration therefore remains High in both the unmitigated and mitigated scenarios.

Spatial scale
The clearing of watercourse habitat will be confined to the infrastructure footprints, which are limited within the site, but present none the less. The spatial scale is therefore localised and remains localised based on available selection options even with the use of mitigation measures. The spatial scale remains Low in both the unmitigated and mitigated scenarios. No other option smaller than the local scale is available in the impact assessment method. Even though a decrease in the special extent of the impact will occur as a result of the proposed mitigation measures, no change will be reflected in the spatial scale due to the robustness of the impact assessment method (Section 3.2).

Consequence

The consequence is High for the unmitigated scenario and Medium for the mitigated scenario.

<u>Probability</u>
The probability for watercourse habitat loss remains High in both the unmitigated and mitigated scenarios, even with realignments and adjustments to the currently layout, certain infrastructure features, specifically linear infrastructure features will still transect with different watercourse systems.

<u>Significance</u>
The significance rating is High prior to mitigation and Medium in the mitigated scenario, as the severity changes from High to Medium after mitigation.

Overall mitigation objectives for each assessed impact or group of impacts:

- Avoid impacts as the first priority as far as possible by placing the proposed infrastructure features in areas where the impact on watercourses will be minimum. In other words adjust the layout to avoid overlap with delineated watercourses.
- Reduced servitude widths should be used where linear infrastructure features transect watercourse areas. Impact avoidance should, however, first have received priority as part of the mitigation process.

Mitigation measures:

- Modify infrastructure footprints so as to avoid overlap between watercourses, as well as the 32m and 100m buffers as far as possible. This pertains specifically to changes to the two Mine housings phases (Phases 1a and 1), the product stockpiles, and storm water dam.
- The proposed bridge can remain at its current location as an access road through Ephemeral channel 2 that connects the two housing phases appears to be unavoidable. The bridge will have to be modified to prevent further habitat loss due to expected anthropogenic erosion damage (see next impact discussion).
- The proposed tailings pipeline should move further to the north along the new access road (Figure 13 in the main report) in order to avoid overlap with Ephemeral channels 9 and 10, as well as Ephemeral drainage line 8. Overlap with Ephemeral drainage line 7 appears to be unavoidable, but the servitude width should be minimised as far as practical during the construction process. The pipeline should be spanned across the watercourse with plinths, which will need to be located outside of Ephemeral drainage line 7.
- The alignment of the tailings pipeline along the new access road, as recommended in the soil and vegetation specialist reports, can also serve as a maintenance road for the pipeline, which will remove the need for a new maintenance road along the servitude of the current pipeline alignment (Figure 13) The recommended pipeline alignment in the Frishgewagd property along the existing and new access track is illustrated in Figure 13. The need for a pipeline servitude track has not been specified in the received project description, but based on experience on other similar projects, an access track along a tailing pipeline is often needed after construction of the pipeline, in order to help undertake maintenance work on the pipeline and to clean up potential tailing spills. The movement of a section of the pipeline along the existing road will reduce the need for a new pipeline maintenance track in future that will unnecessarily cross though delineated watercourses.
- No new access roads may be created through watercourses along the pipeline alignment. All new tracks and roads will have to receive environmental approval before they can be constructed.
- Overlap between the tailings pipeline and the Sandspruit River is unavoidable, but a restricted servitude width should be used, while no construction activities should

occur within the instream and riparian habitat along the macro channel. Plinths can be located within the 32m buffer, but not within delineated riparian habitat.

- It follows that a portion of the tailings pipeline will also have to be moved north to avoid overlap with the 100m buffer.
- Delineated watercourses and buffers should be treated as sensitive no-go areas as far as possible. No unauthorized access is allowed in these features.

Mitigation type
The recommended mitigation measures include modify, control and remedy types

The degree to which the impact can – be reversed: Not reversible (once the proposed mining infrastructure features overlap with watercourse habitats, permanent loss occurs)
Cause irreplaceable loss of resource: Definite
Be avoided, managed or mitigated: Partially avoided

Monitoring recommendations:

- Continuous monitoring by an Environmental Control Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints. Temporary structures, such as stockpiles and lay down areas should be excluded from delineated footprints.
- ECOs should ensure that signage to identify watercourses and their buffers are kept in place and remain well visible during the construction process and that no unauthorised access occurs. Toolbox talks should address the importance and sensitivity of wetlands and other watercourses.
- Fix point photography of wetlands and other watercourses should be undertaken prior to the start of construction activities and during the construction process.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	H	H	L	H	H	H
Mitigated	M	H	L	M	H	M

IMPACT TYPE: SEDIMENT MOBILISATION: DEPOSITION AND EROSION IN WATERCOURSES

Rating of Impact

<u>Severity / Nature</u>

This impact refers to the deposition of sediment in watercourses as a result of runoff from poorly vegetated areas and/or stockpiles areas during the construction and operational phases of the project. It also includes the development of new erosion features or the worsening of existing erosion features within delineated watercourses due to concentrated flow patterns caused by hydrological obstructions (e.g. bridge and road crossings) and concentrate flow discharge points (e.g. stormwater outlets).

This impact is regarded as High in the unmitigated scenario, as it can reduce the ecological integrity of a watercourse (e.g. erosion disturbances may enable the establishment of alien species) and cause hydrological changes to the watercourses (e.g. the creation or worsening of desiccation impacts). The impact changes to Medium in the mitigated scenario as erosion and stormwater control meaures will be include during the construction and operation phases of the project. .

Duration
Without mitigation measures taken, soil erosion and sedimentation within watercourses can extend well beyond the life of the mine. The duration is ranked as High during the unmitigated and mitigated scenarios.

Spatial scale
The impact can extend beyond the study area boundaries, especially in the event of a sudden release of sediment and water, such as a breach in the wall of the storm water dam. With mitigation the impact is more likely to remain within the site.

Consequence
The consequence is High for the unmitigated scenario and Medium for the mitigated scenario.

Probability
The probability of erosion and sedimentation within delineated watercourses is High in the unmitigated scenario, but becomes Medium with mitigation.

Significance
The significance rating is high prior mitigation, but becomes medium with mitigation.

Overall mitigation objectives for each assessed impact or group of impacts:

- Control runoff volumes and velocities within the site
- Protect poorly vegetated areas and stockpiles from erosion during rainfall events
- Maintain sediment control structures
- Design and implement a site specific storm water management plan
- Address erosion features in watercourses and adjacent to watercourses once recorded

Mitigation measures:

- Repair erosion damage within watercourse through the use of either soft or hard rehabilitation interventions. Hard interventions, such as gabion drop inlets and other features, will require design by an engineer with rehabilitation experience. Soft rehabilitation interventions include rehabilitation interventions that do not consists of rock and concrete, examples include earth berms, revegetation with indigenous species and biojute fabrics. Note also that rehabilitation works in watercourses require a Water Use License (WUL).
- A well designed and implemented stormwater management system will be required to attenuate flood peak events within the property and thereby prevent erosion and sediment impacts in watercourses.
- Stormwater outflows should not be allowed to enter directly into watercourses, but need to be attenuated before they are released into watercourses.
- Interventions and mechanisms in the storm water management system can include measures to facilitate a higher percentage of infiltration and reduce runoff volumes and velocities, without concentrating their outflows as far as practically possible.
- Discharged stormwater must be released in a controlled manner in a diffuse flow pattern across a buffered vegetation strip and be accompanied by energy dissipating interventions to prevent erosion damage.
- Stormwater release impacts can be addressed in two main ways (CSIRO, 2006; EPA, 1996): The first is to make use of preventative construction techniques (source controls), such as to limit the amount of impervious material near watercourses as far

as possible, and to demarcate setbacks from watercourses in the form of a buffer zone with a natural vegetation cover.

- Secondly, structural control measures such as treatment techniques or naturally vegetated detention basins could be used to improve storm water quality.
- Other structural control measures include grass swales, infiltration trenches and basins, wet ponds, and constructed wetlands to intercept and partially treat storm water before it is released. A combination of source controls and structural controls can result in an integrated solution, which is likely to provide the best benefits.
- Buffer zones are not walk away solutions and need to be maintained during the operational phase of the project in order to be effective. This includes the maintenance of a well vegetated grass cover that is free of aliens and erosion features. Any aliens and/or erosion features observed within the buffer zone need to be addressed in order to ensure buffer functioning.
- The storm water management plan needs to give special consideration to buffer zones in order to prevent erosion impacts and the creation of channelised flows at discharge points, which would largely negate the benefits of any buffers present.
- The proposed bridge crossing through Ephemeral channel 2 should contain culverts across the length of the crossing and armouring on the downstream channel banks and bed to avoid further channel incision and channel bank scour during high flow events. Pipes are not recommended as they can become easily blocked with alluvial material, which can lead to further scour damage in the watercourse.
- A watercourse rehabilitation plan should be developed during the latter part of the construction process to help address remnant impacts that were not successfully mitigated. Note that rehabilitation works in a watercourse will require a Water Use License. It is therefore recommended that rehabilitation needs and flexibility are considered as part of the Water Use License Application (WULA).

Mitigation type
The recommended mitigation measures include mainly control and one remedy types

The degree to which the impact can – be reversed: Partially reversible
Cause irreplaceable loss of resource: Possible irreplaceable loss
Be avoided, managed or mitigated: Mitigated

Monitoring recommendations:

- Regular monitoring by an Environmental Control Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints.
- ECOs should ensure that signage to identify watercourses and their buffers are kept in place and remain well visible during the construction process and that no unauthorised access occurs. Toolbox talks should address the importance and sensitivity of wetlands and other watercourses.
- Sediment control and storm water control measures should be monitored and maintained to ensure they remain functioning, especially during the wet season.
- Fix point photography of wetlands and other watercourses should be undertaken prior to the start of construction activities and during the construction process.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M	H	L	M	M	M

IMPACT TYPE: LOW WATER QUALITY INPUTS INTO WATERCOURSES

Rating of Impact

Severity / Nature

Sediment deposition in watercourses, as assessed in the previous section, can reduce water quality in watercourses, but other potential project-related impacts are more hazardous to the receiving water quality in these systems. These risks include possible spillages of tailings material transported in the pipeline, which can be rich in heavy metals, specifically Cr, Ni, Cu, Al, Zn, Pb, Mn and Fe, as well as sulphate, chloride, fluoride and sodium. These are elements and ions that are potentially detrimental to human health and environmental quality, which will cause negative impacts if these pollutants are directly spilled or transported via runoff into wetlands and other watercourses (De Castro & Brits, 2015b). Other secondary sources of water pollution include stockpiles, hydrocarbon stockyards and seepage from the tailing storage facility.

Duration
Contamination of watercourses with pollutants associated with mining operations can extend well beyond the life of the mine. The duration is ranked as high.

Spatial scale
Created pollution plume may slowly migrate through the soils to reach underground water bodies or nearby wetlands and other watercourses. In the case of a spill of large volumes, overland flow may result in tailings entering watercourses, which can increase the extent of the pollution far beyond the site boundaries in the unmitigated scenario. Through the use of mitigation spill events can be cleaned up faster and more effectively to help reduce the spatial extent of the impact.

Consequence
The consequence is High for the unmitigated scenario and remains High for the mitigated scenario.

Probability
The probability of a leak or spillage occurring along the pipeline or elsewhere during the life of mine is High and remains High in the mitigated scenario. The probability of the released tailings or other pollutants (e.g. hydrocarbons) having a negative impact on watercourses within the site is high.

Significance
The significance rating is high prior mitigation and high after mitigation.

Overall mitigation objectives for each assessed impact or group of impacts:

- Avoid spillage from occurring.
- Contain spill and pollution plume when spillage has occurred (De Castro & Brits, 2016b).

Mitigation measures:

- Maintain the pipeline in a good working order with regular checks and inspections to help reduce the risk of spillage events.

- If spillage occurs, the spill must be contain with swales and berms after the leakage has been repaired, the spilled material should be removed and pollution plume should be determined a soil chemist and hydrologist (De Castro & Brits, 2016b).
- A remediation plan must be compiled by a soil chemist and hydrologist after a spill event (De Castro & Brits, 2016b).
- Ensure that geotechnical and geohydrological mitigation measures are in place around the proposed tailings storage facility to prevent seepage into nearby watercourses.
- Ensure that the storm water dam, tailings storage facility and product stockpiles are constructed and operated according to specifications, in order to help reduce the likelihood of structure failure, which can result in disastrous water quality impacts in downstream watercourses over a short space of time.
- No refuelling of heavy motorised vehicles (HMVs) or other vehicles, stockpiling of material or the positioning of portable toilets should be allowed within any of the watercourses or their associated buffer zones.
- Dewatering that may be required during excavation activities should not be released directly into watercourses.
- Stockpiles should be protected from erosion during the wet season to prevent sedimentation in watercourses.
- Implement sediment control structures upslope of watercourses, in between stockpiles and construction activities that may act as sources of sediment.
- Maintain these features in a functional manner during the entire construction phase.

Mitigation type
The recommended mitigation measures include control and remedy types

The degree to which the impact can – be reversed: Partially (depending on spill volume, tailings composition and soil-contaminant interactions)
Cause irreplaceable loss of resource: Definite
Be avoided, managed or mitigated: Avoided (maintain pipeline so that spillage does not occur)

Monitoring recommendations:

- Regular monitoring and maintenance by a suitably qualified specialist to ensure that the pipeline remains in a good working order and that weak points are repaired once observed.
- ECOs should ensure that signage to identify watercourses and their buffers are kept in place and remain well visible during the construction process and that no unauthorised access occurs. Toolbox talks should address the importance and sensitivity of wetlands and other watercourses.
- Sediment control and storm water control measures should be monitored and maintained to ensure they remain functioning, especially during the wet season.
- Fix point photography of wetlands and other watercourses should be undertaken prior to the start of construction activities and during the construction process.

Summary of assessment:

Management	**Severity**	**Duration**	**Spatial scale**	**Consequence**	**Probability**	**Significance**
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H	H	L	H	H	H

IMPACT TYPE: ENCROACHMENT OF ALIEN SPECIES INTO WATERCOURSES

Rating of Impact

Severity / Nature
The establishment and encroachment of alien plant species in watercourses, specifically after construction activities have created disturbances within watercourse habitats that opportunistic alien species can utilise. The establishment of alien species is already present in the Sandspruit riparian system and may encroach into other watercourses. The severity of the impact can be High without mitigation, but changes to Medium with mitigation.

Duration
The duration of the impacts without mitigation is expected to be Long term, but van be reduced to Medium term with mitigation.

Spatial scale
The spatial scale is likely to be localised without and with mitigation.

Consequence
The consequence is High for the unmitigated scenario and remains High for the mitigated scenario.

Probability
The probability of alien establishment and encroachment into watercourses is High without mitigation, but changes to Medium with mitigation.

Significance
The significance rating is High prior mitigation and Medium after mitigation.

Overall mitigation objectives for each assessed impact or group of impacts:

- Control alien species in wetlands and other watercourses located within and in close proximity to the proposed infrastructure features

Mitigation measures:

- Develop and implement a site specific alien control plan during the latter half of the construction phase based on the evaluation of weed species present within watercourses located within or in close proximity to infrastructure features. Alien species in remaining areas of the properties should also be addressed as part of the alien control plan.

Mitigation type
The recommended mitigation measure is a remedy

The degree to which the impact can – be reversed: Partially to Fully
Cause irreplaceable loss of resource: Potentially
Be avoided, managed or mitigated: Managed

Monitoring recommendations:

- The proposed alien control plan should include a monitoring phase to evaluate successes achieved. Timing of treatments are essential, as control for most alien plant species can only be done during the growing season.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	H	H	L	H	H	H
Mitigated	M	M	L	M	M	M

APPENDIX C: CURRICULUM VITAE

Name: RETIEF GROBLER

Name of Firm: IMPERATA CONSULTING CC
Position: Wetland Ecologist
Nationality: South African
Languages: Afrikaans (mother tongue), English

EDUCATIONAL QUALIFICATIONS

- BSc (Botany), University of Pretoria (1999–2001)
- BSc Hons (Botany) (cum laude), University of Pretoria (2004)
  Title of Thesis: "*The Impact of subsistence banana (Musa x paradisiaca) farming on the vegetation of peat swamp forest surrounding the Kosi Bay Lake System.*"
- MSc Botany (cum laude), University of Pretoria (2009)
  Title of Thesis: "*Phytosociology of Peat Swamp Forests of the Kosi Bay Lake System.*"

KEY QUALIFICATIONS

- **Watercourse Investigations, Including Wetland and Riparian Habitat Delineation (Mapping), Assessments, Management & Rehabilitation**:

Involved in wetland inventories, classification and description of watercourses, mapping of drainage lines (e.g. wetlands, rivers and ephemeral headwaters), ecological assessments, and wetland rehabilitation studies. A selection of projects demonstrating relevant experience, include:

Wetland rehabilitation

- Wetland rehabilitation assessment plans for the South African National Biodiversity Institute (SANBI) for several wetlands in the Eastern Free State. 2005.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2007-2009.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2010-2011
- Wetland health and rehabilitation assessments for two wetland rehabilitation projects, upstream of Boksburg Lake, Ekurhuleni Metropolitan Municipality, Gauteng. Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2011
- Wetland rehabilitation and assessment report for the Hogsback area (Eastern Cape Province), as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2011

- Wetland & river reinstatement and monitoring guideline report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2010
- Alien plant control in watercourse crossings (wetlands & rivers) report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2012

Wetland studies for a variety of strategic planning, residential, commercial and industrial projects

- Ecological functional assessment of wetland areas surrounding the Orlando Power Station for the proposed Ekhaya development, Soweto, Gauteng. Strategic Environmental Focus (SEF), (Pty) Ltd 2005.
- Wetland Audit for the City of Johannesburg. Reviewer and sub-consultant for Strategic Environmental Focus (SEF), (Pty) Ltd. 2008
- Elsburgspruit wetland and habitat assessment, Ekurhuleni Metropolitan Municipality, Gauteng Province. Sub-consultant for Van Riet & Louw Landscape Architects (Pty) Ltd. 2008
- Wetland and watercourse delineation and assessment for the proposed Sun City Vacation Club and Golf Course Phase 3 Development, North West Province. EkoInfo CC. 2008
- Wetland delineation & assessment study for the proposed construction and operation of an aluminium fluoride production facility and associated infrastructure on the farm Jobarne 489 JR, Ekandustria, Gauteng Province. African Geo-Environmental Services (AGES). 2010
- Development of a prioritisation framework for wetland rehabilitation in Ekurhuleni Metropolitan Municipality. Land Resources International (Pty) Ltd. 2011
- Surface watercourse and wetland desktop investigation for the Ivory Park Urban Development Framework, City of Johannesburg, Gauteng Province. Aurecon Group. 2011
- Wetland Study (Delineation & Assessment) for the proposed Witfontein Commercial & Residential Development, Ekurhuleni Metropolitan Municipality, Gauteng Province. Aurecon Group. 2011

Wetland & watercourse assessments in linear developments (power lines, roads, railway and pipeline projects) and other projects in the energy sector (e.g. solar electricity installations):

- Wetland investigation for The Hills road alternatives, Pretoria-East, Gauteng. African-EPA. 2007
- Wetland and river bio-monitoring assessments for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2009-2013
- Wetland and surface watercourse study for the proposed Ariadne-Venus 475 kV transmission line, Kwa-Zulu Natal. Baagi Environmental Consultancy. 2010
- Surface watercourse assessment study for the proposed R5 Rand Water pipeline between Rietvlei N.R. and Mamelodi, Gauteng. Aurecon Group. 2010
- Wetland and surface watercourse study for the proposed Paulputs-Aggeneys 220kV transmission line, Northern Cape. SSI Engineers and Environmental Consultants. 2011
- Surface watercourse investigation for a proposed 20MW solar electricity installation at Kalgold Mine, North West Province. Mark Wood Consultants. 2011
- Wetland and surface watercourse study for the proposed Arnot-Ginaledi 475 kV transmission line, Mpumalanga Province. Baagi Environmental Consultancy. 2012

- Watercourse investigation for the proposed upgrade of a section of the N4 Platinum Highway, Rustenburg, North West Province. Environamic. 2012.
- Wetland delineation review for the proposed 80 MW photovoltaic solar electricity installation, Grootvlei, Mpumalanga Province. Mark Wood Consultants. 2012
- Wetland and watercourse assessment study for a proposed 75MW Photovoltiac (PV) plant and associated infrastructure on a portion of the remaining extent of Erf 1, Prieska Northern Cape Province. Enviro Insight. 2012
- Water Use License application & watercourse assessment for permanent access roads on Section PL1-PL4 (Durban to Kendal) of Transnet's New Multi Product Pipeline (NMPP) Project. Transnet Capital Projects. 2012-2014
- Watercourse assessments for the Ngqura 16 MTPA manganese ore rail expansion: Area 1 & 3 (Coega – De Aar; Eastern & Northern Cape). Hatch South Africa. 2013
- Watercourse assessment for the Douglas-Hopetown road upgrade project, Northern Cape. EIMS. 2013.
- Specialist Wetland & Drainage Line Investigation for the Proposed Hermes 132 kV Distribution Line and Substation, Klerksdorp, North West Province. Envirolution Consulting. 2013
- Specialist Medupi-Borutho 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Lines. North West Province. Baagi Environmental Consultancy. 2013.
- Specialist Gromis-Orangemund 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Systems, Northern Cape Province. Baagi Environmental Consultancy. 2013
- Watercourse delineation, PES & EIS assessment specialist study for a Water Use License Application for 8 proposed distribution lines around Ngwedi MTS, SA Chrome, Boschkoppie, Impofu Substation, Styldrift, Bakubung, Ledig, Sun City, Mokwase Industries, and Manyane Substations, North West Province. Baagi Environmental Consultancy. 2014
- Environmental Impact Assessment for the Sasol PSA and LPG Project: Botanical Biodiversity and Terrestrial and Wetland Habitat. Specialist Report, Inhassoro, Mozambique. In collaboration with De Castro & Brits C.C. for Mark Wood Consultants on behalf of SASOL. 2014.
- Specialist Watercourse and Wetland Study For the Proposed 500kV Nzhelele to Triangle Eskom Powerline Project (RSA Section Only) EIA Project, Limpopo Province. Baagi Environmental Consultancy. 2014

Green Star eco-conditional office development assessments:

- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 2 development, Gauteng. Aurecon Group. 2011
- Green Star eco-conditional office assessment for the GCIS Hatfield head office development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the USAID expansion development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the Atrium on 5th development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 3 development, Gauteng. Aurecon Group. 2013
- Green Star eco-conditional office assessment for the Athol Towers development, Gauteng. Aurecon Group. 2013

Wetlands and surface watercourse assessments for mining-related developments:

- Wetland and drainage line watercourse study for a proposed Fluorspar Mine in Dinokeng, Gauteng Province. African Geo-Environmental Services (AGES), (Pty) Ltd. 2009.
- Wetland assessment study for the proposed Northern Coal Colliery near Breyton, Mpumalanga Province. Terra Soil Science. 2010.
- Desktop wetland & watercourse assessment for Harmony Gold's Kusasalethu Mine as part of their ISO 14000 environmental management certification, North West Province. DD Science. 2012.
- Watercourse assessment for a water re-use and reclamation project at Mponeng Mine, North West Province, De Castro & Brits Ecological Consultants. 2013

- **Additional Wetland Related Training:**
  - Attended a two-day DWAF (DWA) facilitated wetland training course on the Wetland Index of Habitat Integrity assessment technique (Wetland IHI methodology) presented by Mark Rountree, June 2009.

- **Training - Course Lecturer :**
  - Co-lecturer and founding member of an Introductory Wetland Training Course, presented by the Department of Botany (University of Pretoria) through the University's Continued Education at UP (CE@UP) program, and the Gauteng Department of Agriculture, Conservation and Environment (GDACE). Aspects focused on include the legislation, delineation, drivers and ecology, assessments, management and rehabilitation of wetlands. This course was started in November 2004 and presented since then on September 2005, November 2005, May 2006, July 2007, May 2008, May 2010, and May 2012.

- **Publications:**
  - Grobler, R., Bredenkamp, G. & Grundling, P-L. 2004. Subsistence farming and conservation constrains in coastal peat swamp forests of the Kosi Bay Lake System, Maputaland, South Africa. Géocarrefour 79: 4.
  - Grundling, P-L. & Grobler, R. 2005. Peatlands and mires of South Africa. In: Steiner, G.M. (ed.) Mires from Siberia to Tierra Del Fuego. Stapfia 85, Landesmuseen Neue Serie 35, pp. 379-396.
  - Sliva J., Grundling P-L., Kotze D., Ellery F., Moning C., Grobler R., Taylor P.B. (2005). *MAPUTALAND – Wise Use Management in Coastal Peatland Swamp Forests in Maputaland, Mozambique / South Africa.* Wetlands International, Project No: WGP2 – 36 GPI 56.

MEMBERSHIPS IN PROFESSIONAL AND GENERAL SOCIETY

- **Professional Society**
  - Pr. Sci. Nat (Professional Natural Scientist) in the fields of Botanical and Ecological Science (Registration No. 400097/09).
  - Please refer to the SACNASP website to undertake a search of their registered scientists in order to authenticate that Mr. LER Grobler is registered SACNASP member and is registered for the two fields indicated. Searches can be done according to employer (Imperata Consulting) or other criteria provided in this document. http://www.sacnaspregister.co.za/search/

- **General Society**
  - International Mire Conservation Group (IMCG), since 2003.
  - Gauteng Wetland Forum (GWF), since 2006.

- South African Wetland Society (SAWS), since 2007.

EMPLOYMENT EXPERIENCE

- **Wetland Ecologist and Project Manager: Imperata Consulting** (March 2007 – Present) Tasks include:
  - Wetland and riparian habitat delineation according to the DWAF (2005) prescribed delineation guideline, as well as the demarcation of other drainage line types (e.g. headwater streams or A Section Channels)
  - Wetland Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessments.
  - Ecosystem assessments based on phytosociological investigations (vegetation unit identification, description, and assessment), as well as associated mapping and sensitivity rating of vegetation assemblages.
  - Inventory, classification and mapping of wetland ecosystems.
  - Wetland rehabilitation and monitoring.
  - Wetland management and recommendation of impact mitigation measures.
  - Environmental risk assessments related to the presence of wetland and riparian ecosystems.
  - Project management related to specialist wetland, riparian and headwater ecosystem investigations.

- **Wetland Ecologist: SEF** (January 2006 – February 2007) Tasks included:
  - Wetland and riparian habitat delineation and wetland ecosystem functional assessments.
  - Strategic wetland assessments and mapping.
  - Vegetation analysis and description, including mapping of sensitive vegetation assemblages.

- **Nature Conservator: Tshwane Nature Conservation** (July 2005 – December 2005) Tasks included:
  - General management of the ecological integrity of greenbelt areas in the eastern section of the City of Tshwane Metropolitan Municipality, including the Colbyn Valley Peatland, Faerie Glen Nature Reserve, Moreletakloof Nature Reserve, Meyerspark Bird Sanctuary, and Murrayfield Koppie.

REFERRALS

- **Mr. Tim Liversage:** NMPP Environmental Manager at Transnet Capital Projects
  Email: Timothy.Liversage@transnet.net

  Mr. Umesh Bahadur: Director: Working for Wetlands at the Department of Environmental Affairs (DEA)
  Email: Ubahadur@environment.gov.za
  Office: 012 399 8980

- **Mr. Piet-Louis Grundling:** Independent Wetland Consultant and Researcher, as well as Chair of the South African Wetland Society (SAWS) and the International Mire Conservation Group (IMCG).

Email: peatland@mweb.co.za