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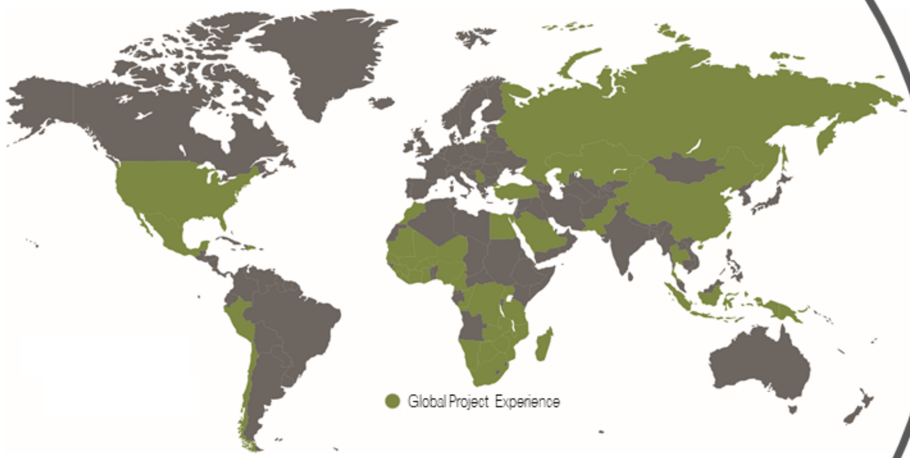

Providing innovative and sustainable solutions throughout the resources sector

Environmental Authorisation for the Expansion of the Copper Sunset Mining Right Area

Hydropedological Impact Assessment

Prepared for:
Copper Sunset Sand (Pty) Ltd

Project Number:
COP6679

May 2021

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This document has been prepared by Digby Wells Environmental.

Report Type:	Hydropedological Impact Assessment
Project Name:	Environmental Authorisation for the Expansion of the Copper Sunset Mining Right Area
Project Code:	COP6679

Name	**Responsibility**	**Signature**	**Date**
Daniel Fundisi	Report writer		May 2021
Mashudu Rafundisani	Technical review		May 2021

DETAILS AND DECLARATION OF THE SPECIALIST

Digby Wells and Associates (South Africa) (Pty) Ltd

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Title/ Position:	Hydrologist and Soil Scientist
Qualification(s):	MSc Hydrology & Soils
Experience (years):	10 years
Registration(s):	Pr. Sci.Nat

I, __Daniel Fundisi______, declare that: –

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

- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

17 May 2021

Signature of the Specialist *Date*

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EXECUTIVE SUMMARY

Digby Wells was appointed by Copper Sunset (Pty) Ltd (hereinafter Copper Sunset) to undertake a hydropedological assessment study for the application of Environmental Authorisation to expand their Mining Right Area (MRA). The Copper Sunset project area is located within Viljoensdrif, a coal-mining village, under the jurisdiction of the Metsimaholo Local Municipality, which is in the Fezile Dabi District Municipality, Free State Province near the Vaal River and Lethabo Power Station.

Copper Sunset has an approved Mining Right (DMRE Ref. No. FS30/5/1/1/2/164 MR) and Environmental Management Programme (EMPr), in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), for the mining of sand on the Farm Bankfontein No. 9. The Mining Right was approved in 2008 and amended in 2011, 2016 and 2017 to incorporate additional areas into the MRA. The applicant now intends to expand its MRA to incorporate adjacent properties to extend the Life of Mine (LoM). The intent is to expand the current mining operations to include additional portions of the Remaining Extent (RE) of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Zandfontein No. 259. The proposed extension of the MRA amounts to approximately 1642 ha (Bankfontein) and 1153.6 ha (Zandfontein), for the mining of sand.

Summary of Study Findings and Recommendations

The Copper Sunset project site is situated at the boundary of 3 quaternary catchments (C22F, C22G and C22K). The Mean Annual Precipitation (MAP) for quaternary catchments C22F, C22G and C22K is 655 mm, 613 mm and 644 mm, respectively (WRC, 2015). The normal rainfall (70% of events) for the wettest month (January) will likely not exceed 132 mm, while 90% of the events during the wettest month will likely not exceed 169 mm. The Mean Annual Runoff (MAR) depth for the area was calculated to be 27.72 mm. This runoff accounts for approximately 4% of the MAP for the area. The 90^{th} (extreme flow) and 70^{th} (normal flow) runoff percentiles during the month of January are 11.9 mm and 4.4 mm, respectively. The Mean Annual Evaporation (MAE) for quaternary cathments C22F, C22G and C22K is 1 650 mm, 1 600 mm and 1 625 mm, respectively (WRC, 2015). The region experiences higher evaporation than precipitation, giving rise to dry winters and wet summers with a negative natural water balance.

Sixteen different soil forms were identified within the Copper Sunset Mining Right Extension Area (MREA). The surveyed soils are generally characterised by the following (Digby Wells , 2021):

- Orthic A-horizons, overlying yellow brown to red apedal B-horizons with a plinthic B-horizon. These soils were deep, sandy-loam soils with increased clay content with depth;
- Vertic A-horizons overlying an unspecified material in the low-lying areas. These soils are high in clay content, young soils with evidence of emerging soil development in the

form of colour variations and clay lamellae. These soils were mainly associated with wetlands and low-lying areas; and

- Shallow Orthic A-horizon overlying hard rock (dolerite). These soils were identified within the eastern area, between the floodplain and hillslope.

Hydropedological assessment indicates the prevalence of recharge at hillslope crests, interflow at soil/bedrock and variably at A/B and A, E and/or B Horizons within midslope positions and overland flow at the footslope. Since sand mining at the Copper Sunset MREA is proposed for depths not exceeding 5 m, soil/bedrock interflow pathways will least likely be interrupted within deep soils (>2 m). This implies that the soil/bedrock subsurface flows which are currently feeding the Vaal River and the Taaibosspruit will likely continue unhindered. Surface runoff or overland flow, at footslope positions of the Vaal River and the Taaibosspruit, will likely not be interrupted if proposed areas to be mined are adhered to. Interflow at soil A/B and A, E and/or B interfaces will likely be interrupted resulting in ponded water after excavations on mined-out strips and most of this water will be lost to evaporation.

Overland flows at unchannelled and channelled valley bottom wetlands will be interrupted due to sand mining even when conducted to the proposed shallow depths of < 2 m. Pronounced impacts are envisaged where wetland areas are mined out because this implies total removal of temporary natural water storages. Two major wetlands and several minor ones connected to the Vaal River and the Taaibosspruit will partially or totally be mined-out and their water flow contributions to the river systems will be lost. Wetlands cover an approximate area of 1638.733 ha which accounts for 58.62 % of the total 2795.7 ha of the Copper Sunset MREA.

Hydropedological impacts that are envisaged to occur due to the proposed mining activities include disruption of hillslope flow paths that feed into wetlands and contribute to baseflow in adjacent streams and rivers. This negatively impacts on the wellbeing of the water resources in that the wetlands that are not directly mined-out will experience desiccation, while rivers and streams may have reduced baseflows during the dry season. The proposed sand mining activities disturb soils and vegetation thereby increasing the occurrence of water and wind erosion resulting in sedimentation and possible siltation of proximal watercourses, namely, the Vaal River and Taaibosspruit and their tributaries. Construction of the haul road to access the proposed mining areas, will likely disrupt stream channel geometry at crossing points, subsequently increasing chances of fluvial erosion and in-stream sedimentation. Movement of machinery and vehicles during land preparation, mining operations and at the decommissioning phase will likely allow contamination of land and water resources from hydrocarbon (fuels, oils and grease) spills and leakages should they not be correctly managed.

The following is recommended to manage and mitigate identified impacts:

- Proper stormwater management planning is, therefore, recommended to control stormflows and subsequently reduce soil erosion and associated sedimentation and siltation of watercourses.

- The 1:100-year floodline should guide placement of infrastructure and to demarcate starting point for any mining activities on site.

- A proper waste management plan should be in place to guide handling of potential pollutants (general and hazardous waste) at the proposed project site.
- Where possible the 500 m wetland buffers should be considered for wetlands that are not directly in the line of sand mining operations. In situations where avoidance is not possible, Wetland Offsets should be assessed and applied to determine the total wetland loss and to compensate for significant residual adverse impacts.
- At areas where the proposed haul road crosses watercourses, the crossing should be at the narrowest point and should be at 90° angle with suitable drainage designed not to impede flows.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

DMRE	Department of Mineral Resources
EA	Environmental Authorisation
EMPrs	Environmental Management Programmes
HGM	Hydro-Geomorphic
LoM	Life of Mine
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRA	Mining Rights Area
MREA	Mining Rights Extension Area
MTIS	Mineable tonnes in-situ
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
S&EIR	Scoping and Environmental Impact Reporting
WMA	Water Management Area
WRC	Water Research Commission
WUL	Water Use Licence

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 1.3
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Before Executive Summary on Page iv
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.2
cA	And indication of the quality and age of the base data used for the specialist report;	Sections 5.2 and Section 6
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 5.2
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Section 5
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	Section 2 and Section 672, Figure 6.13
(g)	an identification of any areas to be avoided, including buffers;	Section 7
(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;	Section 2 and Section 672, Figure 6.13
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6 and Section 7
(k)	any mitigation measures for inclusion in the EMPr;	Section 7
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Section 13
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 10
(n)	a reasoned opinion (Environmental Impact Statement) -	Section 12

Legal Requirement		Section in Report
	whether the proposed activity, activities or portions thereof should be authorised; and	Section 7
	if the opinion is that the proposed activity, activities 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;	Section 9
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 10
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 11
(q)	any other information requested by the competent authority.	None

1. Introduction

Digby Wells Environmental (hereinafter Digby Wells) was appointed by Copper Sunset (Pty) Ltd (hereinafter Copper Sunset) to undertake a hydropedological assessment study to apply for the required Environmental Authorisations and Water Use Licence to expand their Mining Right Area (MRA).

2. Project Description

Copper Sunset has an approved Mining Right (MR) (DMRE Ref. No. FS30/5/1/1/2/164 MR) and EMPr, in terms of the MPRDA, for the mining of sand on the Farm Bankfontein No. 9. The Mining Right was approved in 2008 and amended in 2011, 2016 and 2017 to incorporate additional areas into the MRA.

The existing operations are situated on the Farm Bankfontein No. 9, the Remaining Extent (RE) of the Farm Zandfontein No. 259, a Portion of the RE of the Farm Bankfontein No. 9 and a Portion of the Farm Rietfontein No. 152, situated in the Free State Province.

Copper Sunset currently holds the following EAs and EMPrs, which are applicable to the MR boundary:

- The original EMPr associated with the application for a MR on the Farm Bankfontein No. 9, approved in 2008 (DMRE Ref. No. FS30/5/1/1/2/164 MR dated 28/04/2009);
- The 2011 EA and EMPr associated with the construction of a washing plant, a Return Water Dam (RWD), a settling dam and brick building (DMRE Ref. No. FS30/5/1/2/3/2/1 (164) EM dated 19/09/2011);
- The 2015 and 2016 EA and EMPr associated with the incorporation of additional areas into the MRA (DMRE Ref. No. FS30/5/1/2/3/2/1 (164) EM dated 08/03/2016 and 20/12/2016); and
- The 2017 EMPr associated with incorporation of additional areas into the MR (DMRE Ref. No. FS30/5/1/2/2 (164) MR dated 30/05/2018).

The applicant now intends to expand its MRA to incorporate adjacent properties to extend the Life of Mine (LoM). The intent is to expand the current mining operations to include additional portions of the Remaining Extent (RE) of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Zandfontein No. 259. The proposed extension of the MRA amounts to approximately 1642 ha (Bankfontein) and 1153.6 ha (Zandfontein), for the mining of sand.

The extension of the existing MRA triggers activities incorporated in Listing Notice 2 of the EIA Regulations, 2014 (GN R982 of 04 December 2014 as amended), promulgated under the NEMA. The Listed Activities require a S&EIR process to be carried out as part of the authorisation process.

As mentioned, Digby Wells has been appointed by Copper Sunset as the independent EAP to conduct the required environmental authorisation process to expand their existing and approved MR for the mining of sand over the proposed areas.

Additionally, it is recommended that as part of this application Digby Wells consolidate all EAs and EMPrs into one consolidated EMPr that is applicable to the approved MR and the new area being incorporated.

2.1. Proposed Infrastructure and Activities

Copper Sunset began sand mining in 2009. There is currently approximately nine months remaining of the Life of Mine. Therefore, Copper Sunset wishes to expand the MRA to include additional portions of the RE of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Zandfontein No. 259. The properties are located within Seriti's MRA. The intention of the Application is to maximise the mineral resource and to further extend the LoM.

The current mining infrastructure will be utilised for the expansion area., However, mobile offices will be established at the entrance to the new mining areas. Two new mobile offices each approximately 1ha will be established, one and each mining area when mining commences in these areas. The mobile office areas will include the following:

- Mobile offices;
- Hydrocarbon storage tank (14,000 L) with associated bund. Machinery will be refuelled in the area;
- Waste storage area;
- Parking area for the storage of mobile infrastructure; and
- A generator and solar panels to provide electricity.

The sand deposit lies between 0.4 – 5 m below the surface. Strip mining will be utilised to recover the resource, with the sand mined in strips of 30 – 35 m in width and 0.4 - 5 m in depth. The length of the strips is dependent on the area to be mined but approximate lengths are 180 – 600 m. The mining method to be applied includes:

- Stripping and stockpiling of topsoil;
- Construction of a temporary haul road (20 m wide and length will be approximately 10 km);
- Mining of the sand resource including screening;
- Backfilling of the mined excavations with stockpiled topsoil; and
- Concurrent rehabilitation.

Table 2-1 provides project phases and activities to be undertaken per phase while the proposed infrastructure layout is shown in Figure 2-1 .

Table 2-1: Project Phases and Associated Activities

Project Phase	Description of Activities
Establishment Phase	Site Clearance: Vegetation and topsoil will be removed with a bulldozer and stockpiled along the mined-out strip
	Construction of a haul road (20m width) to gain access to the sand mining area
Operational Phase	Operation of a fleet of tipper trucks, front-end loaders, excavators, water trucks, tractor, bulldozers and screening machines; Operation of a mobile office, portable toilets and diesel bowser.
	Strip mining will take place in sequences of 30 – 50 m wide to extract the sand by means of light weight excavators
	Movement of customer trucks (100-200 trucks per day) through the haul road into and out of the mining area
	Refuelling of equipment at the mobile office area within the expanded mining area
	Dust suppression on the expansion area and haul road.
	Concurrent rehabilitation will be implemented during the sand mining process
Rehabilitation Phase	Backfilling mined-out areas with the waste material from the screening plant and topsoil, stockpiled during the operation phase
	Levelling and contouring of backfilled area to avoid ponding of water
	Revegetation with natural or indigenous seed mix

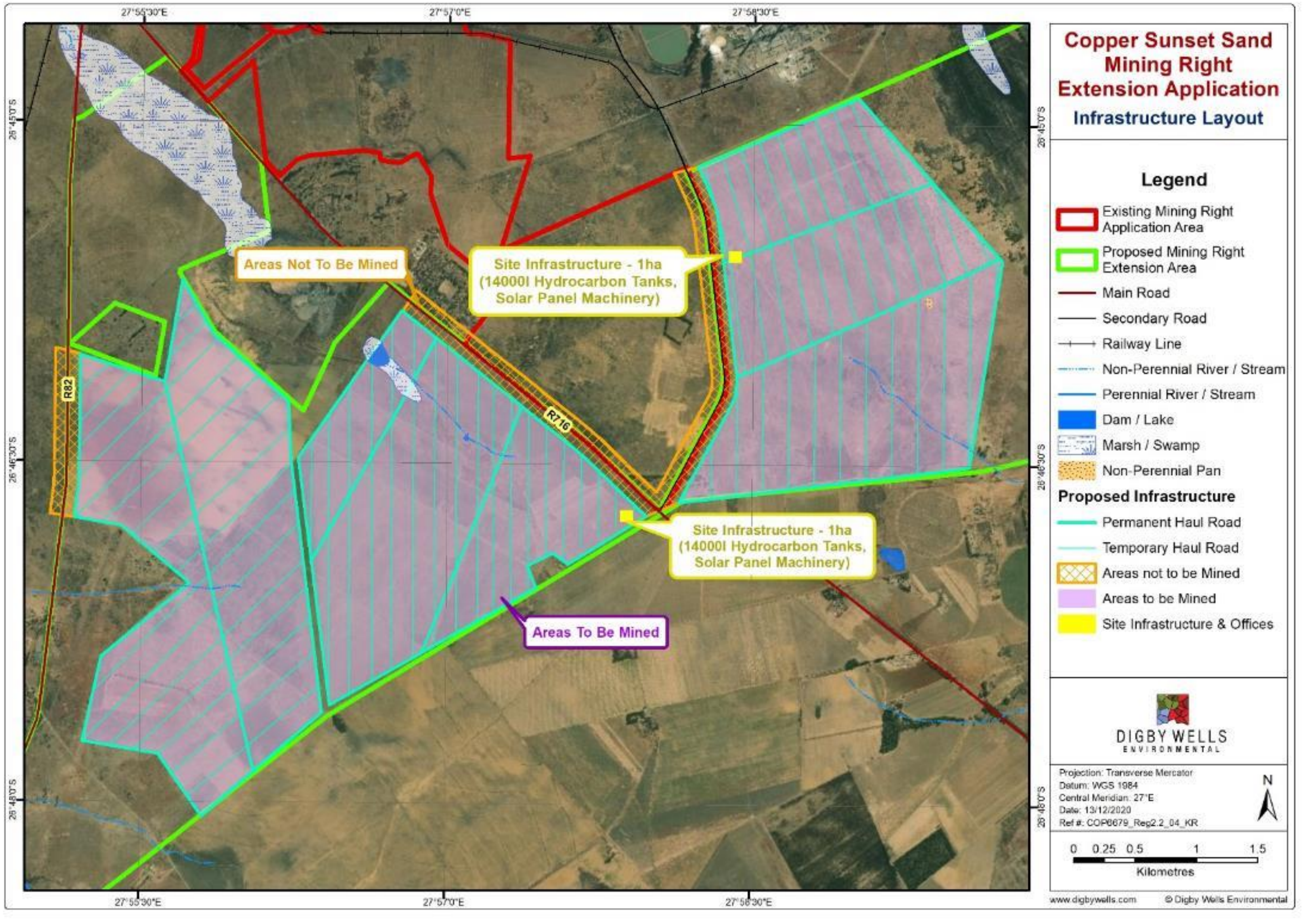


Figure 2-1: Proposed Infrastructure Layout

3. Terms of Reference

Copper Sunset appointed Digby Wells as the Independent Environmental Assessment Practitioner (EAP) to complete the following processes in support of the Project.

- A Section 102 amendment application process as per the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) to amend the Mining Right boundary;
- A Scoping and Environmental Impact Reporting (S&EIR) process to authorise the new Listed Activities as per the NEMA;
- An integrated Water Use Licence Application (IWULA) process in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) to mine the wetland areas found within the expansion area; and
- A Regulation 31 amendment process to consolidate the Environmental Authorisations (EAs) and Environmental Management Programme (EMPr) into one consolidated report as per the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

3.1. Scope of Work

The Scope of Work for the Hydropedological Impact Assessment is summarised below, and the details are provided in Section 7:

- Desktop Assessment;
- Site Visit and Field Surveys;
- Soil Forms Determination;
- Hydropedological Soil Types Grouping;
- Conceptualisation of Hillslope Hydropedological Responses;
- Development of Conceptual Hydrological Process Models; and
- Hydropedological Impact Assessment.

3.2. Details of the Specialist

- **Daniel Fundisi** is a Hydrologist and Soil Scientist with over 10 years work experience and currently working at Digby Wells Environmental. He is a registered Professional Natural Scientist (Reg. 400034/17) within the Water Resources Science category (SACNASP) who holds a Master of Science (MSc) degree in Hydrology from the University of KwaZulu-Natal (UKZN). Daniel has completed numerous surface water and soils specialist studies that include, but are not limited to; Floodlines Modelling, Storm Water and Management Planning, Water and Salt Balance modelling, Water Conservation & Water Demand Management Plan (WCWDM), Water Quality Assessment, Hydropedological Assessments, Water Availability Assessments and

Water Resource Impact Assessments, Soils, Land Capability and Suitability Assessments, Land Contamination Assessments, Soil Erosion Modelling and Sediment Yield Determination. He has working experience on projects within South Africa, DRC, Mali, Lesotho, Malawi, Rwanda, Namibia, Zimbabwe, Swaziland and Mozambique.

- **Mashudu Rafundisani** is a Hydrologist with over 8 years working experience at Digby Wells Environmental. He holds an Honours Degree in Environmental Management from the University of Venda (South Africa). Mashudu has completed numerous surface water specialist studies that include, but are not limited to; floodline modelling using HEC-RAS software, development of storm water management plans, water and salt balance modelling, sampling and analysis/ interpretation of surface water quality, surface water specialist studies for input into environmental impact assessments and environmental management plans, Integrated Water and Waste Management Plans (IWWMP), Water Use Licence Applications (IWULA) and auditing. He has working experience on projects within South Africa, Mali, Ivory Coast, Malawi and other parts of Africa. Mashudu is also a Certified Natural Scientist - Water Resources Sciences (SACNASP).

4. Project Location

The Copper Sunset project area is located within Viljoensdrif, a coal-mining village, under the jurisdiction of the Metsimaholo Local Municipality, which is in the Fezile Dabi District Municipality, Free State Province near the Vaal River and Lethabo Power Station. Table 4-1 and Figure 4-1 indicate the location of the mine in relation to nearest towns.

Table 4-1: Project Locality

Town	Distance from Copper Sunset	Direction from Town
Vereeniging	8 km	South
Vanderbijlpark	10 km	South-East
Sasolburg	13 km	North-East

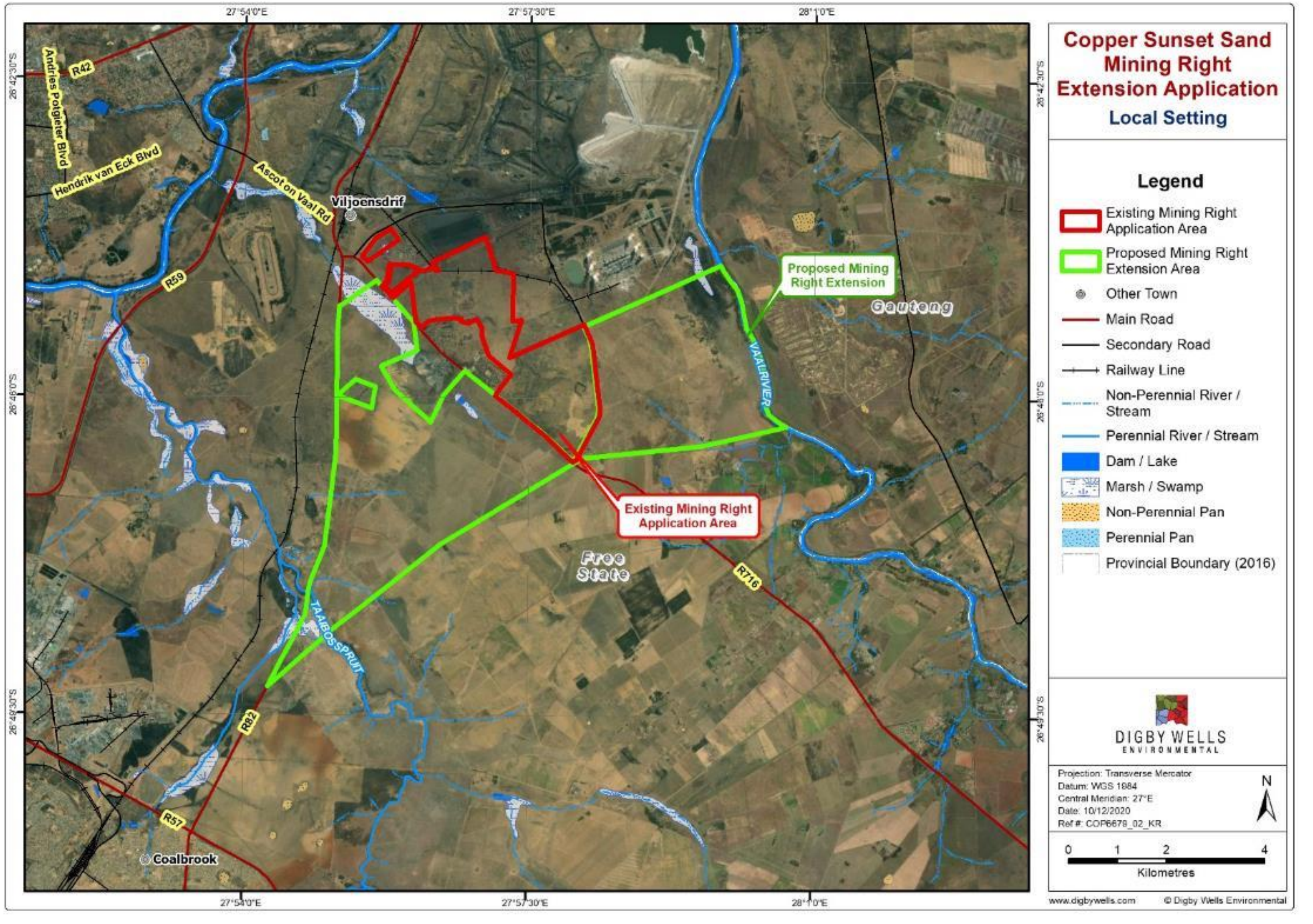


Figure 4-1: Locality of the Copper Sunset Project Area

5. Relevant Legislation, Standards and Guidelines

The table below summarises the applicable legal framework for the surface water impact assessment.

Table 5-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) All water uses listed in terms of Section 21 of the National Water Act (NWA) need to be licenced, unless it is a permissible water use in terms of Section 22 of the NWA	The proposed activities at the Copper Sunset Mine do not constitute as permissible water use in terms of Section 21 of the NWA. Therefore, a IWUL for Section 21 is required.
National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended (NEMA), GNR 544 and GNR 545 (Section 24 (1)) Requires that the EMPr to include a rehabilitation plan, decommissioning plan and mine closure strategy. It must demonstrate pollution control measures and management of mining waste.	The proposed activities will result in environmental impacts which need to be documented and mitigation measures put in place to ensure minimal impacts on the receiving environment.

6. Assumptions, Limitations and Exclusions

The compilation of this report is based on the assumptions and limitations listed in Table 6-1.

Table 6-1: Limitations and Assumptions with Resultant Consequences of this Report

Assumptions and Limitations	Consequences
The area surveyed was based on the layout presented by the Copper Sunset in December 2020.	The study does not include any information other than for Farm Bankfontein No. 1849, the Remaining Extent (RE) of the Farm Zandfontein No. 259, a portion of the RE of the Farm Bankfontein No. 9 and a portion of the RE of the Farm Rietfontein No. 152. The field verification focused on the proposed extension areas.
Soils are contiguous hence differentiation is not abrupt, and the transition zone cannot be completely captured during any given soil survey.	The soil distribution map of the MREA may not be absolutely accurate and so are the hydrological soil types and process models.
Hydrological fluxes were not quantified but only conceptualized as quantification was out of the scope of this study	No volumes of intercepted water (were envisaged) are provided but only descriptions of water interception potential are provided and explained

Assumptions and Limitations	Consequences
It was assumed that the surveyed hillslopes are dominantly representative of the entire site despite inherent heterogeneity within the landscapes	Hydropedological process models do not entirely represent all the heterogeneity within the catchments

7. Methodology

The following was conducted to complete the hydropedology study:

7.1. Desktop Assessment

A desktop study was undertaken to characterise the site through reviewing relevant literature/reports and satellite imagery of the project area. The following reports were reviewed:

7.1.1. Agricultural Research Council (ARC) Land Type Inventories

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the proposed project site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of relatively uniform terrain, soil pattern and climate (Land Type Survey Staff, 1972 - 2006). These maps and their accompanying reports provide a statistical estimate of the different soils that can be expected in the area.

7.1.2. Soil Classification, Land Capability Assessment Report

The reviewed soil study report (Digby Wells Environmental, 2021) provided insight into the distribution of soil forms and the general soil physical characteristics within the Copper Sunset MREA.

7.1.3. Wetlands Report

The reviewed wetlands report (Digby Wells Environmental, 2021) enabled understanding of wetland delineations which are driven by hydropedological soil responses within hillslope catenas.

7.2. Site Visit and Field Surveys

A site visit was undertaken on the 17th of December 2020 to verify the desktop findings on the landscape and characteristics of soil profiles. The site visit date was suitable because it was during the rainy season where physical indicators of groundwater-surface water interactions could be observed, such as seeplines. A hand-held auger was used to verify soil forms and to evaluate soil hydrological response indicators. Hydropedological survey of hillslope catenas was conducted according to assessment guidelines by Le Roux *et al*. (2011) and the Department of Water and Sanitation (DWS) guidelines (Van Tol et al., 2021). A hand-held auger was used to verify soil forms and to evaluate soil hydrological response indicators.

Physical and chemical soil characteristics which indicate water residence times (for example, signs of wetness including, grey, low chroma colours, leaching and mottles) were noted during the site visit. Any signs which indicated groundwater-surface water interaction were identified such as hillslope seeps, springs and wetlands.

Soil observations were made at regular intervals, not exceeding 100 m, on hillslope transacts. On average, 2 m deep auger holes were made to assess soil profiles. Soil form descriptions and classification were conducted based on the South African Soil Classification system up to family level (Soil Classification Working Group, 1991).

The following morphological properties were assessed:

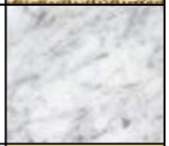
- Thickness of horizons;
- Structure (size, grade, type);
- Estimated texture;
- Matrix Munsell colour (moist and dry);
- Mottles (colour, size, frequency, prominence and type);
- Concretions (colour, size, frequency, prominence and type);
- Precipitation of carbonates, gypsum or salts;
- Roots (abundance);
- Macropores (frequency and size); and
- Nature of transition between horizons/bedrock/saprolite.

Profiles were then regrouped into one of the seven hydropedological groups (van Tol and Le Roux, 2019).

7.3. Conceptualisation of Hydrological Responses

- Determination of hydrological soil types was based on field assessment findings, on hydrological and wetland indicators, including soil form distribution information. A systematic procedure was followed (Le Roux et. al, 2011) and the DWS guidelines were considered (Van Tol et al., 2021). Typical hydrological soil types and their descriptions are presented in Table 7-1;
- Conceptualisation of hydrological behaviour of representative hillslopes was undertaken based on interpretations of spatial distribution of soil morphological and hydraulic properties (dominant drivers and responses) across the project site; and
- Development of conceptual hydrological process models was conducted to reflect perceived flow paths within surveyed hillslopes.

Table 7-1: Hillslope hydrological soil types (Adapted from (Le Roux *et al*., 2011))

Hydrological Soil Type	Description	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out of the profile into the underlying bedrock is the dominant flow direction. These soils can either be shallow on fractured rock with limited contribution to evapotranspiration or deep freely drained soils with significant contribution to evapotranspiration (ET).	
Interflow (A,E and/or B)	Duplex soils where the textural discontinuity facilitates build-up of water in the topsoil. The duration of drainable water depends on rate of ET, position in the hillslope (lateral addition/release) and slope (discharge in a predominantly lateral direction).	
Interflow (Soil/Bedrock)	Soils overlying relatively impermeable bedrock. Hydromorphic properties signify temporal build of water on the soil/bedrock interface and slow discharge in a predominantly lateral direction.	
Responsive (Shallow/Slow Infiltration)	Shallow soils overlying relatively impermeable bedrock. Limited storage capacity results in the generation of overland flow after rain events.	
Responsive (Saturated)	Soils with morphological evidence of long periods of saturation. These soils are close to saturation during rainy seasons and promote the generation of overland flow due to saturation excess.	

7.4. Hydropedological Impact Assessment

Potential impacts on the hydropedological or soil-water responses that result from existing and proposed mining and related activities at the project site were identified. Impacts envisaged to arise as surface, subsurface and groundwater flow paths are disturbed or altered during construction, operation and decommissioning phases of the project life cycle were described and mitigation measures were recommended. The impact assessment rating methodology used in this study is described Appendix A.

8. Findings and Discussion

8.1. Hydrological Setting and Sensitivities

The MR Boundary of the Copper Sunset Operations stretches across three different quaternary catchments, namely C22F, C22G and C22K within the Vaal Water Management Area (WMA 5). The catchment area is drained by the Vaal River and the Taaibosspruit, a tributary of the Vaal River. The water quality in the Vaal River catchments varies from poor in the highly developed areas to good in the less developed areas (Digby Wells & Associates, 2010). The hydrological setting of the Copper Sunset region is indicated in Figure 8-1.

Water features such as rivers, dams, pans and wetlands within and around the project area (Figure 8-2) constitute features which are sensitive to developmental impacts and due care should be taken to ensure that they are protected from degradation. Contamination of the water resources will impact on downstream water users including aquatic ecosystems which rely on these resources for water supply and habitat. Mechanisms and management measures should be put in place to ensure that no water quality and quantity deterioration or any form of degradation occurs because of mining and related activities. If not well-managed, wetlands and pans can dry up, thereby losing habitats for several faunal and floral species of organisms.

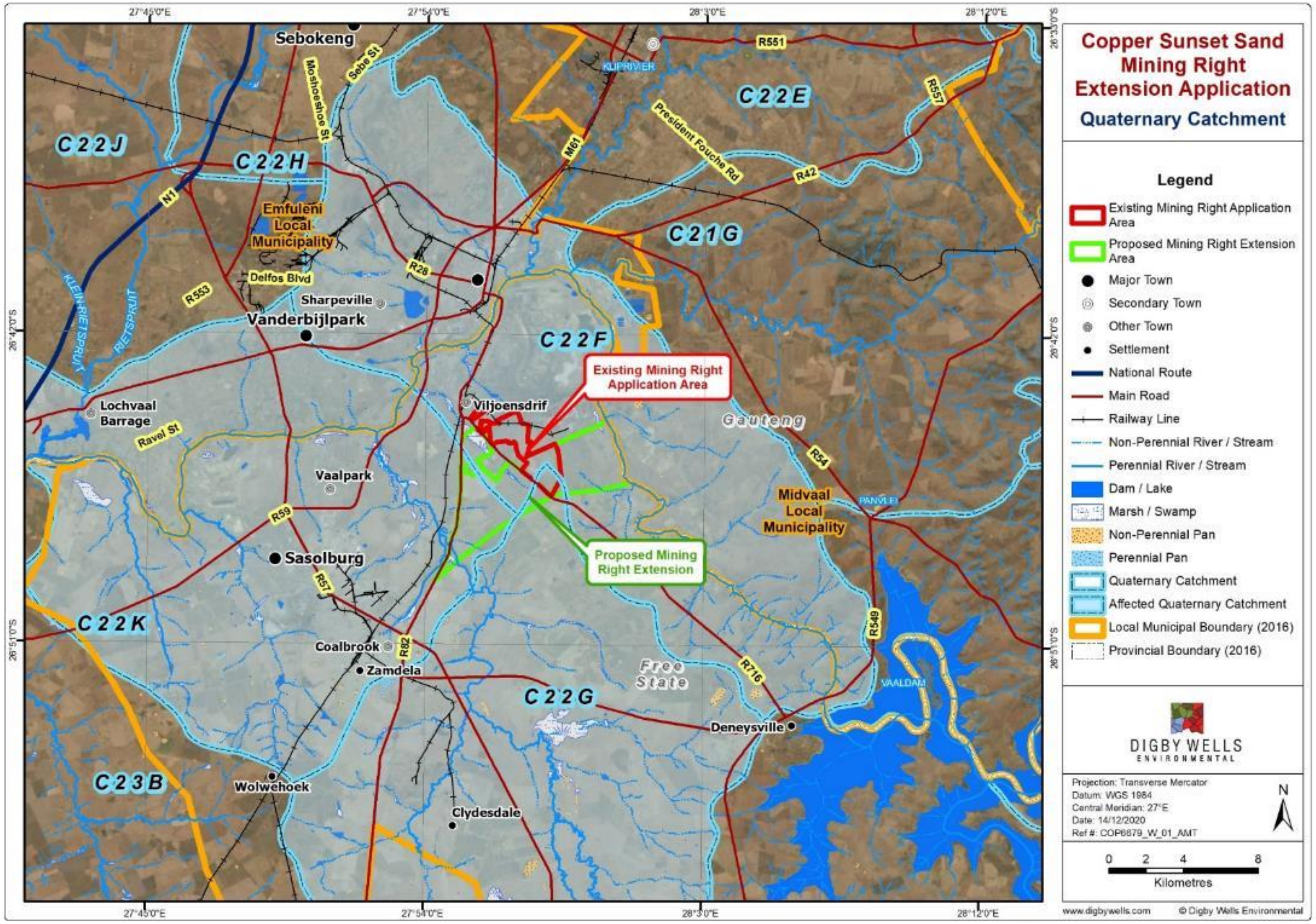


Figure 8-1: Hydrological Setting of the Copper Sunset Operations

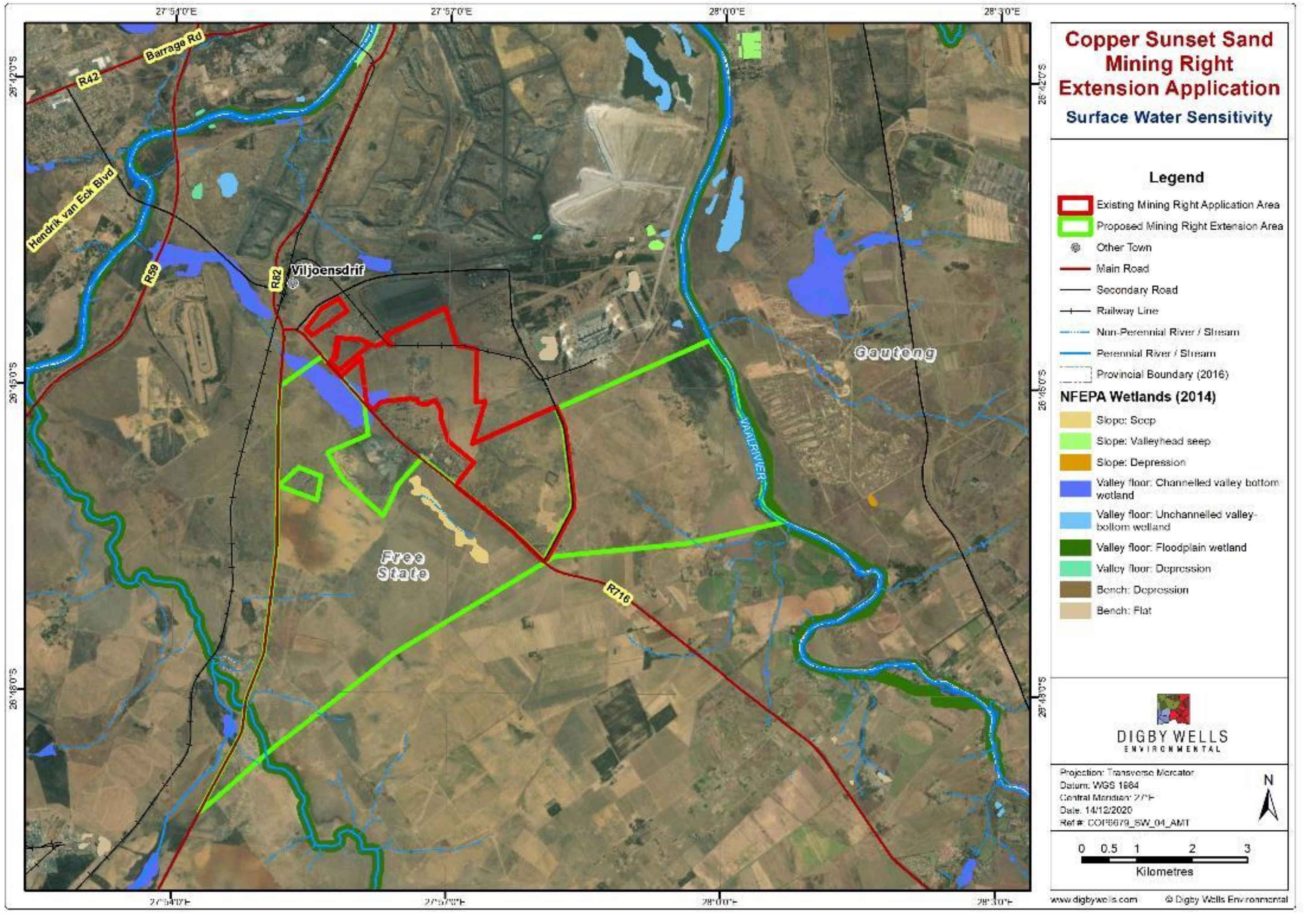


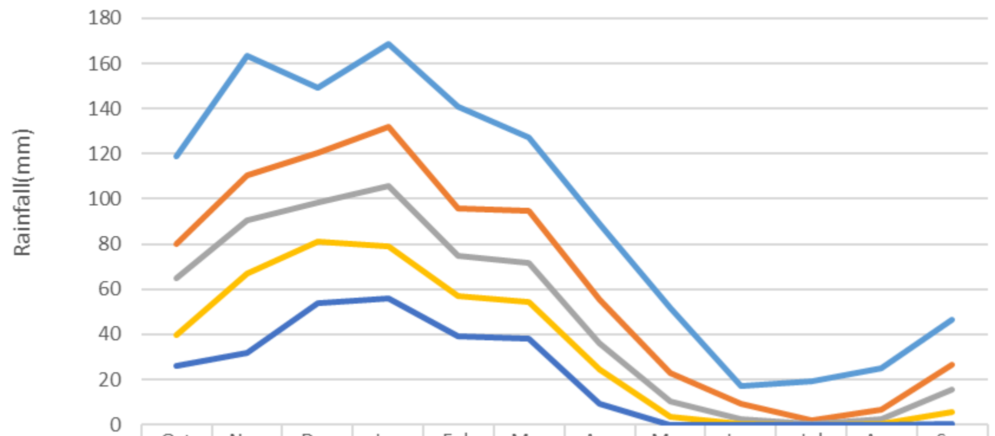
Figure 8-2: Sensitive Water Features Within and Around Copper Sunset Mining Right Extension Area

8.2. Hydrometeorology

The Mean Annual Precipitation (MAP) for quaternary catchments C22F, C22G and C22K is 655 mm, 613 mm and 644 mm, respectively (WRC, 2015). The combined average MAP for the three quaternary catchments is likely to be distributed as indicated in Figure 8-3. The normal rainfall (70% of events) for the wettest month (January) will likely not exceed 132 mm, while 90% of the events during the wettest month will likely not exceed 169 mm. This implies that the region experiences moderate to high rainfall.

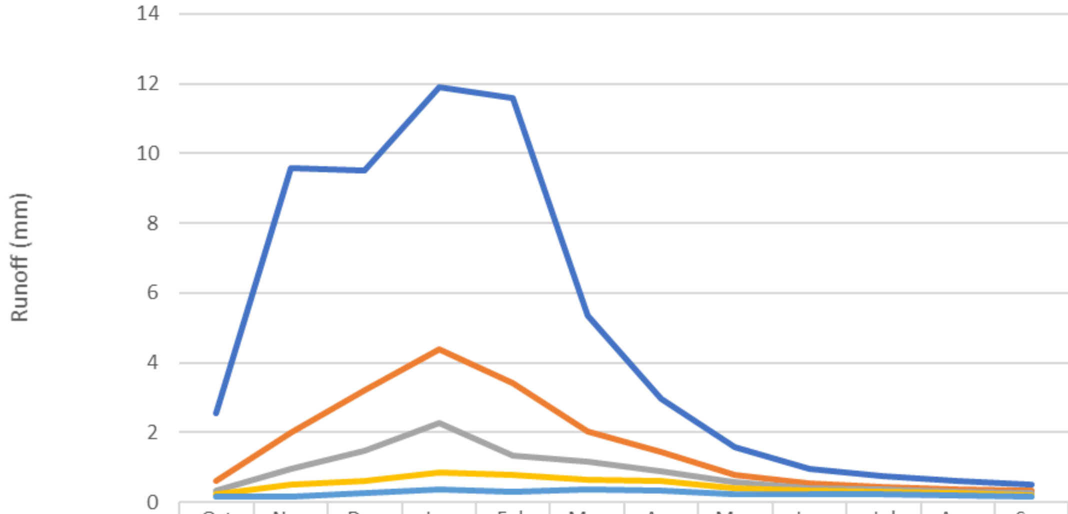
The Mean Annual Runoff (MAR) depth for the area was calculated to be 27.72 mm. This runoff accounts for approximately 4% of the MAP for the area. The 90th (extreme flow) and 70th (normal flow) percentiles of runoff during the month of January are 11.9 mm and 4.4 mm, respectively. The MAR for quaternary catchments C22F, C22G and C22K is likely to be distributed as indicated in Figure 8-4.

The Mean Annual Evaporation (MAE) for quaternary cathments C22F, C22G and C22K is 1 650 mm, 1 600 mm and 1 625 mm, respectively (WRC, 2015). The region experiences higher evaporation than precipitation, giving rise to dry winters and wet summers with a negative natural water balance. The average monthly distribution of potential evaporation and rainfall for the quaternary catchments can be seen in Figure 8-5.



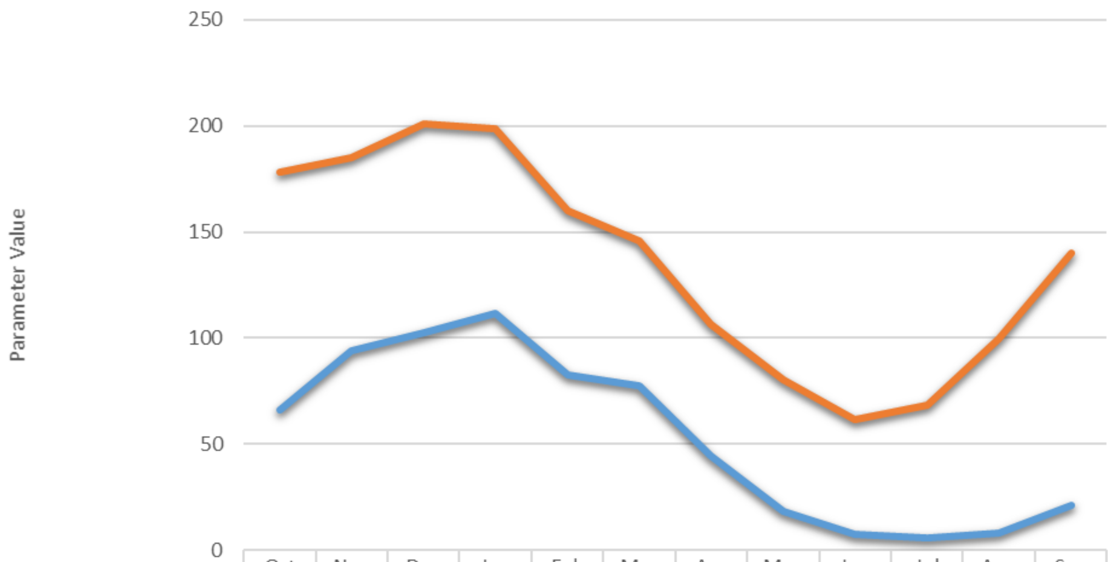
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Percentile	119	163	149	169	141	127	89	52	17	19	25	46
70 Percentile	80	110	120	132	96	95	56	23	9	2	7	27
50 Percentile	65	90	98	106	75	72	36	10	3	0	2	15
30 Percentile	40	67	81	79	57	54	25	3	0	0	0	6
10 Percentile	26	32	54	56	39	38	9	0	0	0	0	0

Figure 8-3: Average Monthly Rainfall for Quaternary Catchments C22F, C22G and C22K



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Perecentile	2.5	9.6	9.5	11.9	11.6	5.4	3.0	1.6	0.9	0.7	0.6	0.5
70 Percentile	0.6	2.0	3.2	4.4	3.4	2.0	1.4	0.8	0.6	0.4	0.4	0.3
50 Percentile	0.3	0.9	1.5	2.3	1.3	1.1	0.9	0.6	0.4	0.4	0.3	0.3
30 Percentile	0.2	0.5	0.6	0.8	0.8	0.6	0.6	0.4	0.3	0.3	0.3	0.2
10 Percentile	0.2	0.2	0.3	0.4	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2

Figure 8-4: Average Monthly Runoff for Quaternary Catchments C22F, C22G and C22K



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	178	185	201	199	160	146	106	80	61	69	99	140
Rainfall(mm)	66	94	103	112	83	77	44	19	7	6	8	21

Figure 8-5: Average Monthly Runoff for Quaternary Catchments C22F, C22G and C22K

8.3. Topography and Slope

The topography of the proposed Copper Sunset MREA, as depicted in Figure 8-6, ranges from higher elevations in the centre of the MREA to lower-lying areas in the east and west towards the Vaal River and Taaibosspruit. The MREA is characterised by moderate undulating plains running towards low-lying valleys of the Vaal River on the eastern side and the Taaibosspruit on the western side of the MREA. The overall elevation of the MREA is approximately 1 415 meters above mean sea level (mamsl). The elevation difference gives rise to a slope of between 0 and 2 degrees (°), with a ridge near the Vaal River floodplain and Taaibosspruit having a slope of 3 - 4° (Figure 8-7).

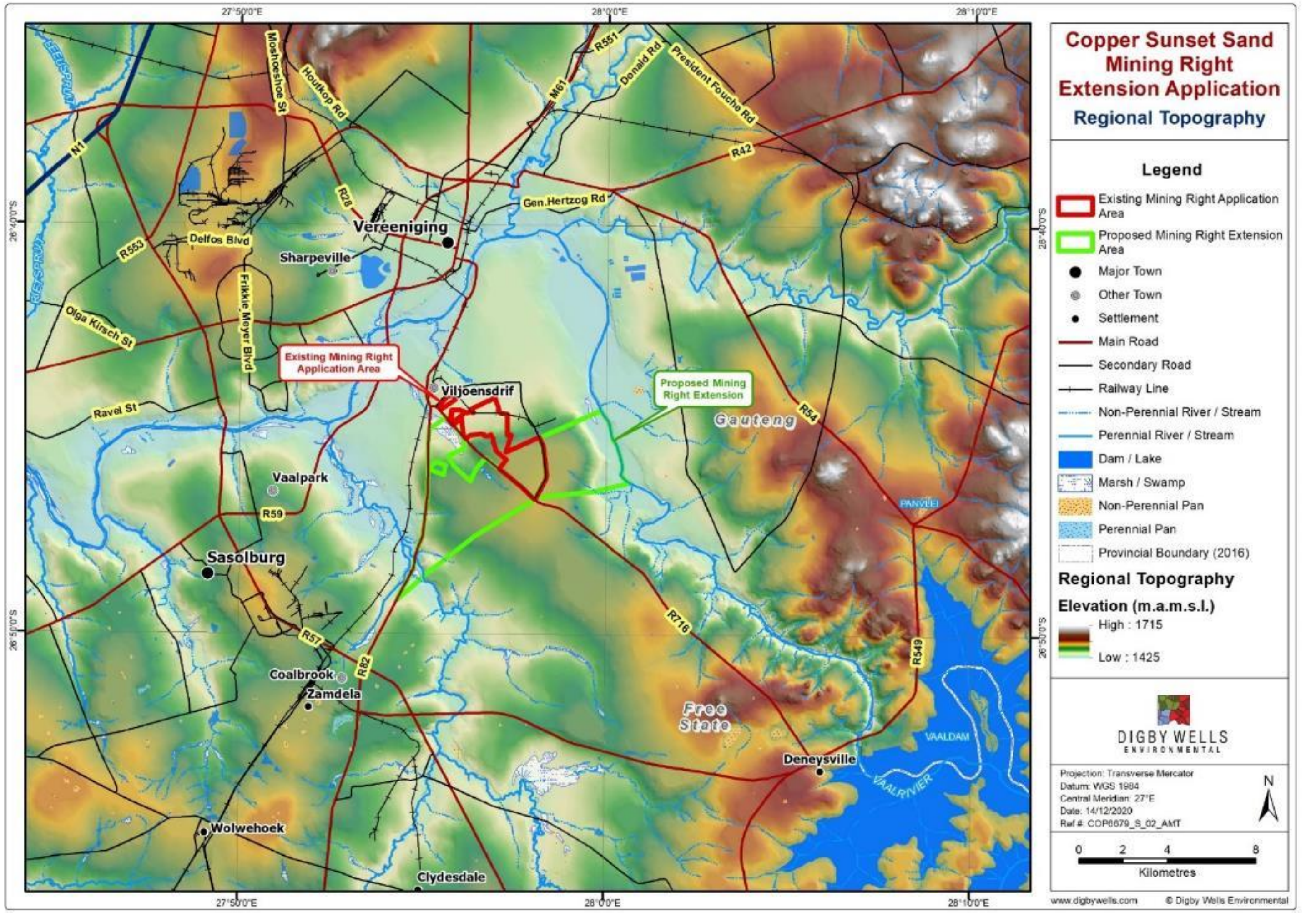


Figure 8-6: Regional topography for the Copper Sunset Mining Right Extension Area

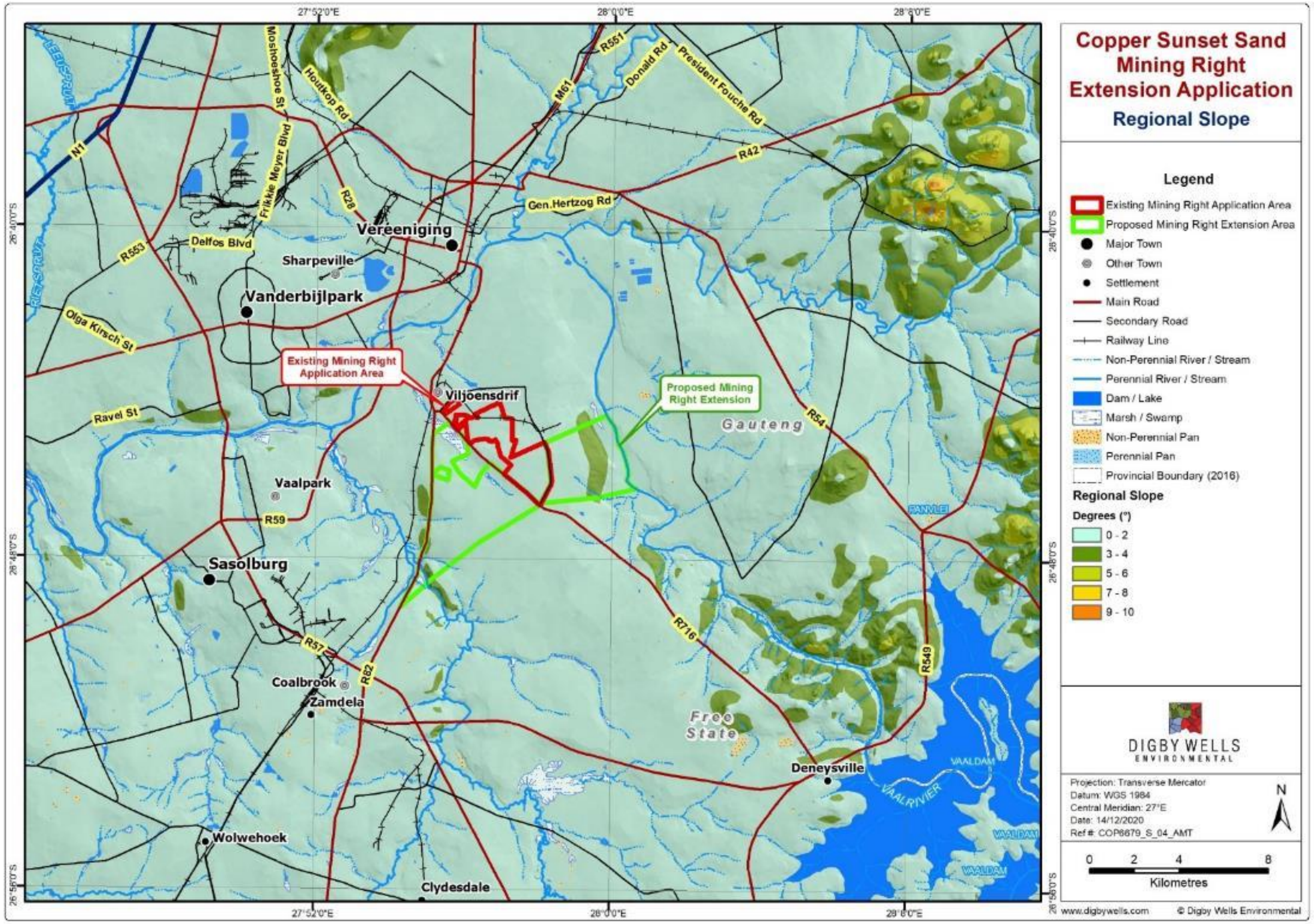


Figure 8-7: Regional Slope Distribution for the Copper Sunset Mining Right Extension Area

8.4. Geology

The western section of the proposed Copper Sunset MREA falls predominantly on fine- to coarse-grained sandstone, shale and coal seams, with a minor area in the northern corner consisting of quaternary sediments or soil cover (Figure 8-8) and a network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup within the southern corner.

The eastern section of the MREA consists predominantly of quaternary sediments or soil cover, with minor areas consisting of fine- to coarse-grained sandstone, shale and coal seams and alluvium, quartzite and conglomerates along the Vaal River. Within the eastern section, a small area consists of a network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup (Figure 8-8).

The dominant sandstone and shale geology of the MREA explains the sandy loam apedal nature of the soils found during the site assessment. Whereas, the quarts, conglomerates and network of dolerite sills, dykes and sheets contribute to the heavy clays, vertic soils along the Vaal River and wetland systems.

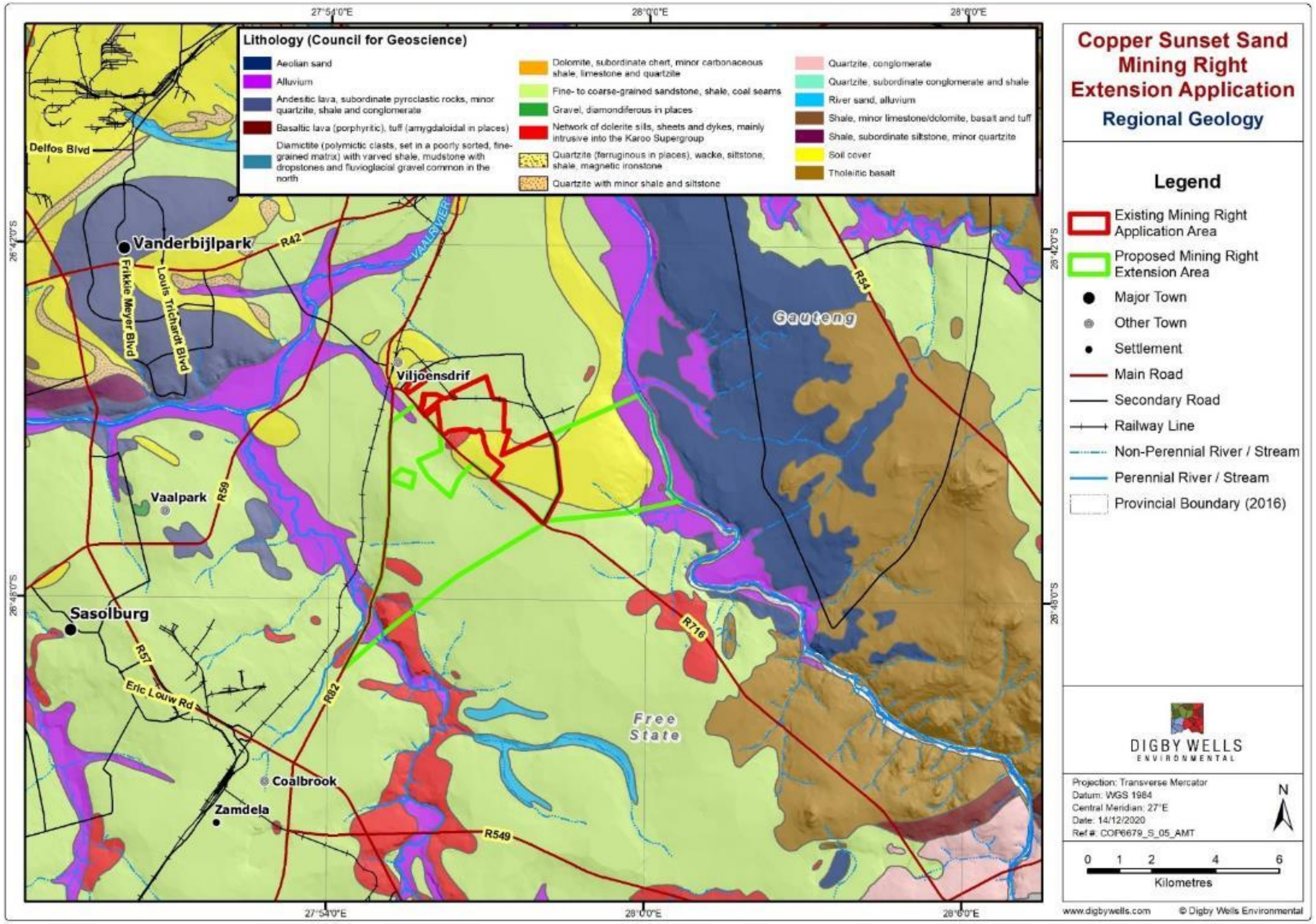


Figure 8-8: Regional Geological Map for the Copper Sunset Mining Right Extension Area

8.5. Land Use

The current land use was identified using Google Earth satellite imagery and land use delineations by the Land Type Survey Staff (1972 - 2006) during the desktop assessment of the Scoping Phase and was verified through onsite field investigation. Generally, land uses in the area were identified to include:

- Plantations;
- Natural vegetation;
- Waterbodies;
- Mining;
- Urban built-up; and
- Crop cultivation; and
- Grazing land.

The land use distribution is presented in Figure 8-9.

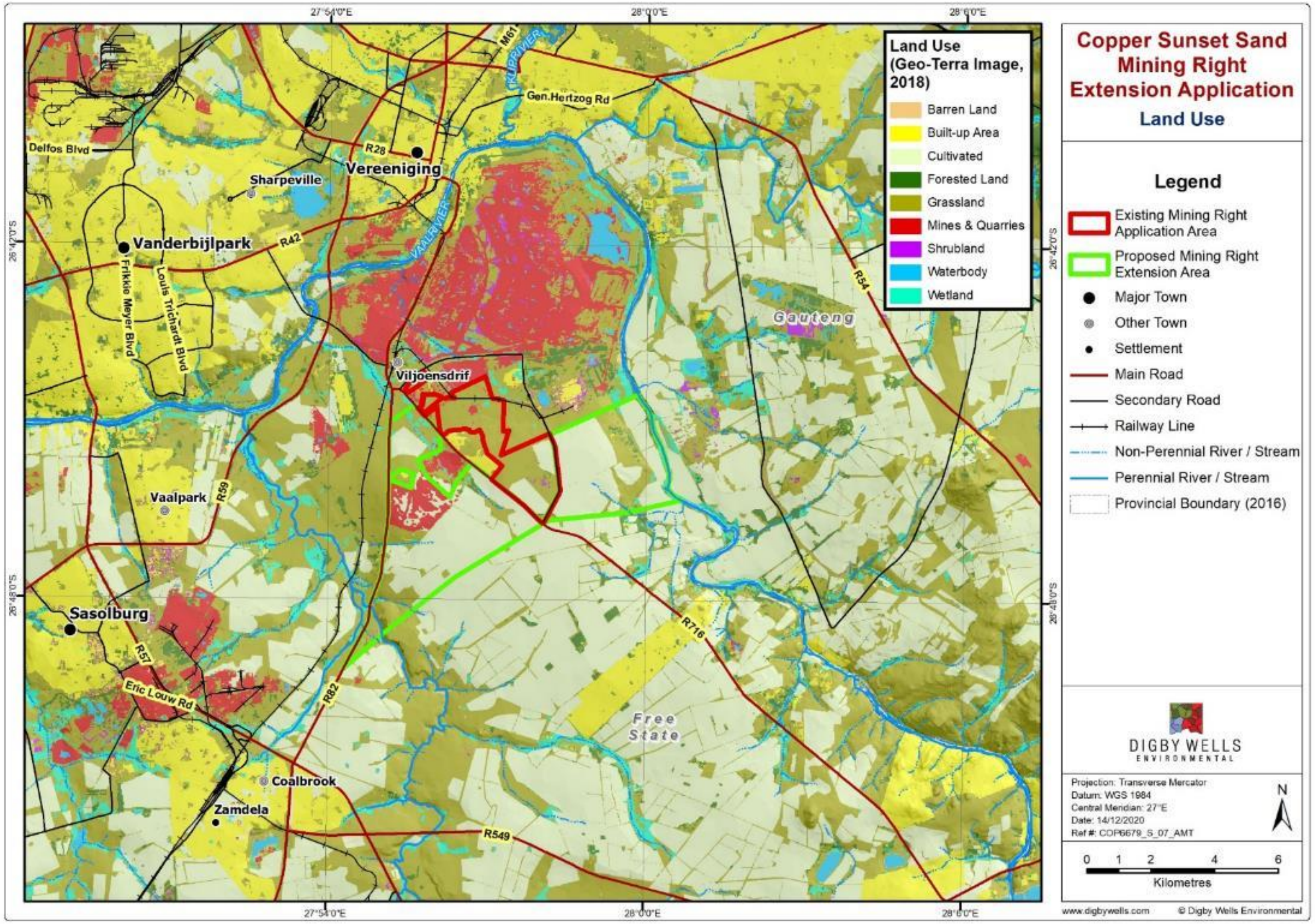


Figure 8-9: Land Uses Within and Around the Copper Sunset Mining Right Extension Area

8.6. Land Types

Existing Land Type and soil data were used to obtain generalised soil patterns and terrain types for the Project Area. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of similar climate and pedosystems which include areas of uniform terrain and soil patterns (Land Type Survey Staff, 1972 - 2006).

Baseline data suggests that the land types for the proposed Copper Sunset MREA are predominantly of the Ca1 type, with two small sections of Bb23 and Dc7 on the western side. The land types and dominant soil forms are briefly described in Table 8-1 and Figure 8-11 (Land Type Survey Staff, 2006). General terrain types for identified Land Types are presented in Figure 8-10. The terrain unit 1 (hillslope crest) constitutes 50% of the dominant Land Type Ca1. The midslope (terrain unit 3) makes up 40% of the dominant Land Type Ca1. The riparian zone (terrain unit 4) and the floodplain (terrain unit 5) both constitute 5% each of the dominant Land Type Ca1 (refer to Figure 8-10).

Table 8-1: Distribution of Land Types within the Copper Sunset Project Area (Land Type Survey Staff, 1972 - 2006)

Land Type	Soil Forms	Geology	Characteristics
Bb23	Avalon, Clovelly, Estcourt, Glencore, Glenrosa, Hutton, Katspruit, Kroonstad, Longlands, Mispah, Rensburg, Sterkspruit, Valsrivier, Wasbank, Willowbrook	Ecca shale and sandstone with occasional dolerite sills; Pretoria shale and quartzite with diabase sills; sporadic occurrence of Ventersdorp lava, Witwatersrand quartzite, dolomite and Black Reef quartzite. Occasional small pans on Ecca Group	Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise <33% of land type)
Ca1	Avalon, Valsrivier, Rensburg, Clovelly, Estcourt, Glencore, Glenrosa, Hutton, Katspruit, Kroonstad, Longlands, Mispah, Wasbank, Westleigh, Fernwood	Sandstone and grit of the Ecca Group, Karoo Sequence	Land type qualifies as Ba-Bd, but >10% occupied by upland duplex/margalitic soils.
Dc7	Valsrivier, Sterkspruit, Swartland, Estcourt, Bonheim, Rensburg, Mispah	Ecca shale and sandstone, with many dolerite sills. Sporadic occurrence of Basement Complex granite in the west. Occasional small pans occur.	Either red or non-red duplex soils (sandier topsoil abruptly overlying more clayey subsoil) comprise >50% of land type; plus >10% occupied by black or red clays

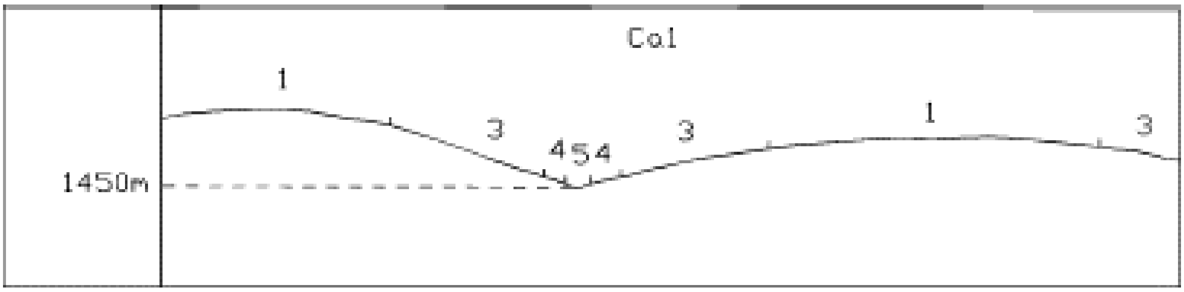


Figure 8-10: General Terrain Type for the Dominant Land Type Ca1. Source: (Land Type Survey Staff, 2006)

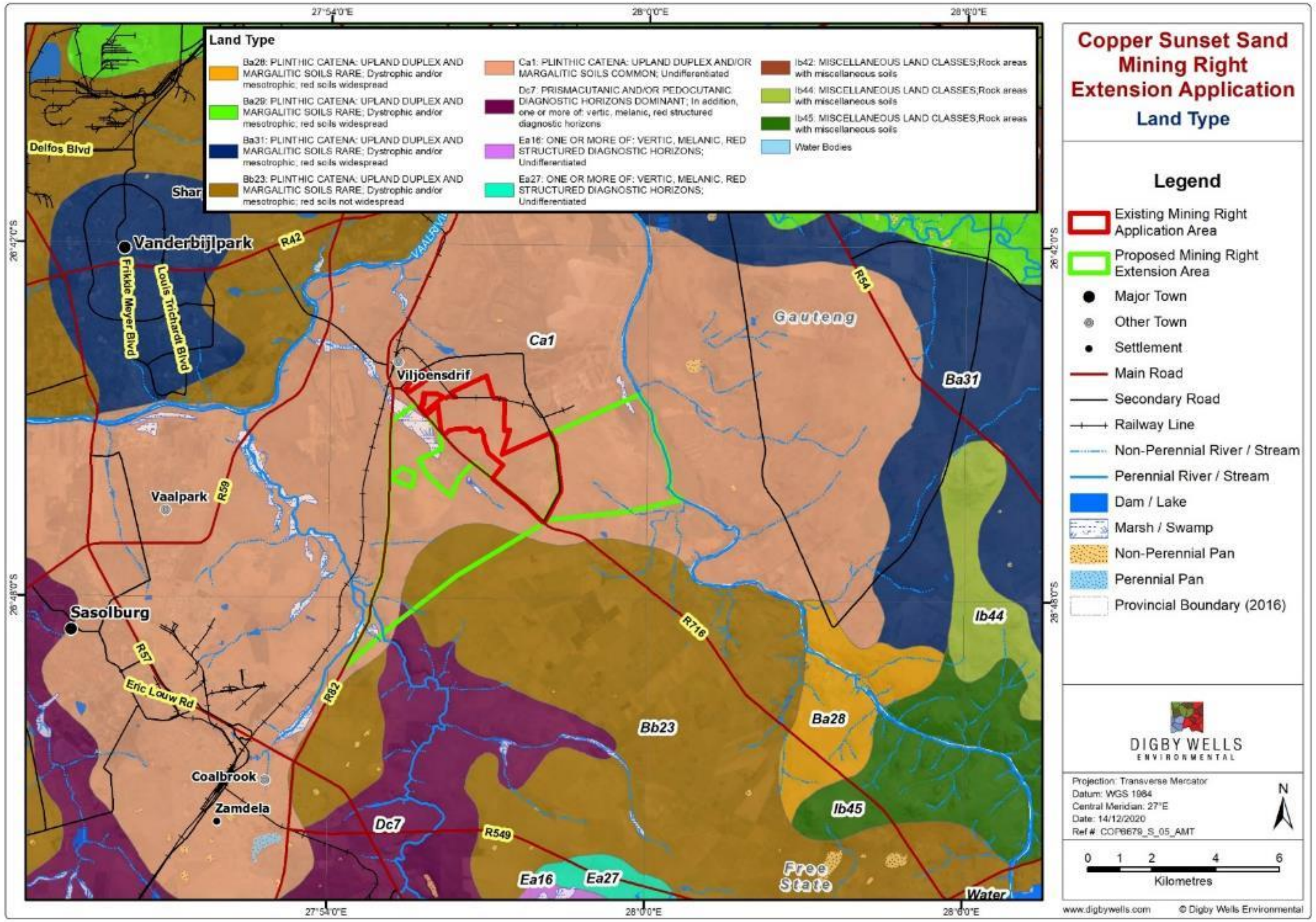


Figure 8-11: Land Types Within and Around the Copper Sunset Mining Right Extension Area

8.7. Hydropedological Assessment

8.7.1. Soil Form Distribution

Sixteen different soil forms were identified within the Copper Sunset MREA. Generally, the surveyed soils are characterised by (Digby Wells , 2021):

- Orthic A-horizons, overlying yellow brown to red apedal B-horizons with a plinthic B-horizon. These soils were deep, sandy-loam soils with increased clay content with depth;
- Vertic A-horizons overlying an unspecified material in the low-lying areas. These soils are high in clay content, young soils with evidence of emerging soil development in the form of colour variations and clay lamellae. These soils were mainly associated with wetlands and low-lying areas; and
- Shallow Orthic A-horizon overlying hard rock (dolerite). These soils were identified within the eastern area, between the floodplain and hillslope.

The soil form distribution is presented in Figure 8-12.

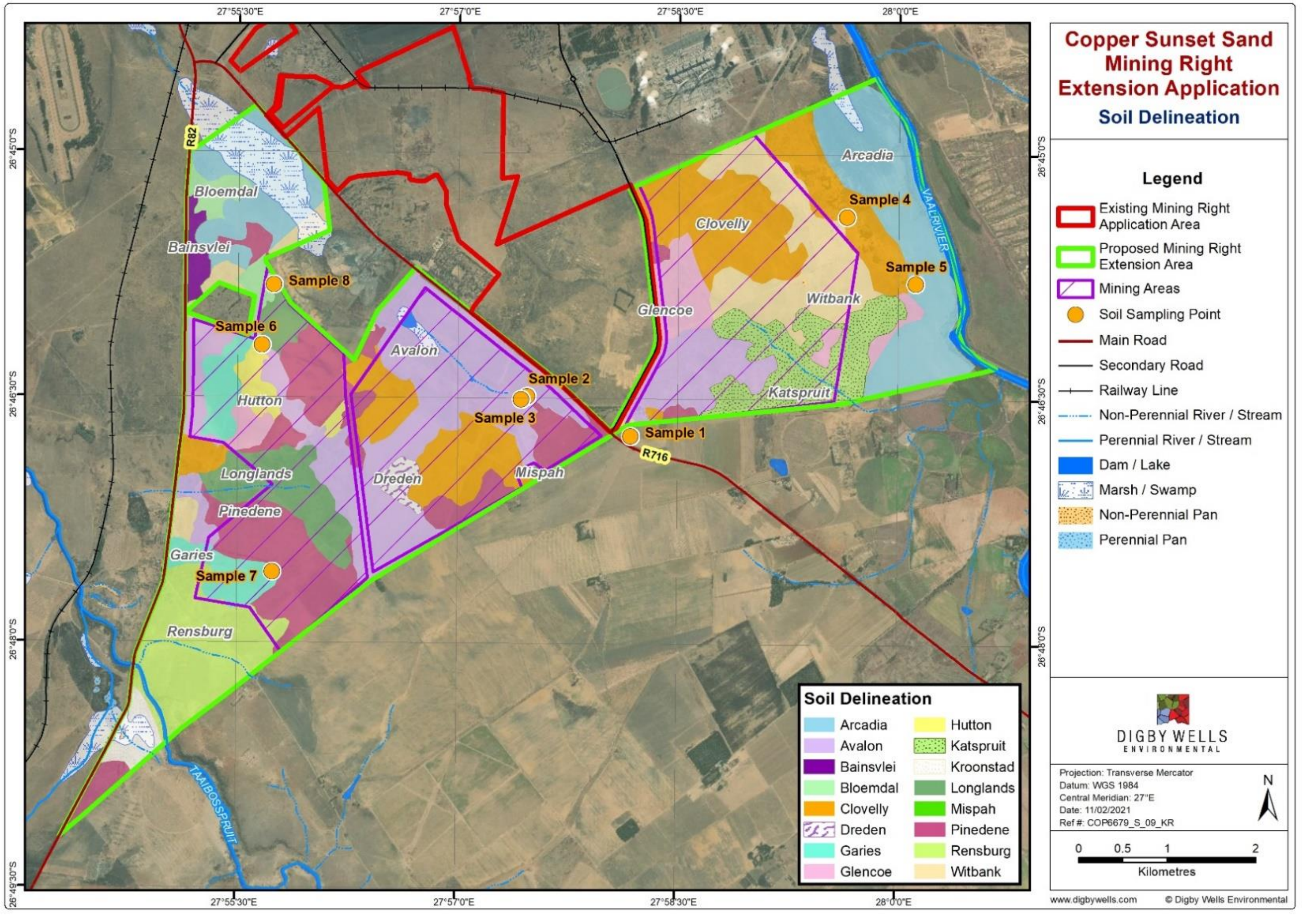


Figure 8-12: Soil Form Distribution within the Copper Sunset MREA

8.7.2. Hydrological Soil Types and Conceptual Hydrological Process Models

8.7.2.1. Hydrological Soil Types

Determined hydropedological soil types and associated soil forms and families are summarised in Table 8-2 and their distribution presented in Figure 8-13.

Table 8-2: Soil Forms, Families and Hydrological Responses within the Copper Sunset MREA

Soil Form	Description	Soil Family	Observations	Hydrological Type
Clovelly	Dystrophic, Luvic B1 horizon	1200 Brereton	Deep (>1500 mm) unstructured well-drained characteristics	Recharge (Deep)
Katspruit	Non-calcareous G horizon	1000 Lammermoor	Poorly drained with relatively higher clay content	Responsive (Saturated)
Arcadia	Dark coloured, non-calcareous A horizon	1100 Lonehill	Poorly drained with relatively higher clay content	Responsive (Saturated)
Dresden	A horizon not bleached	1000 Tevreden	Shallow Orthic A horizon overlying a hard plinthic layer	Interflow (Soil/Bedrock)
Pinedene	Dystrophic, Luvic B1 horizon	1200 Jutland	Gradual transition from well-drained Orthic A & apedal B horizons to less permeable Unspecified material with signs of wetness	Interflow (Soil/Saprolite)
Garies	Non-luvic B1 horizon	1000 Nuwerus	Abrupt transition from apedal B to less permeable dorbank layer	Recharge (Shallow)
Rensburg	Non-calcareous upper G hroizon	1000 Greendale	Usually permanently saturated poorly drained wetland soil	Responsive (Saturated)
Bainsvlei	Dystrophic, non-luvic B1 horizon	1100 Morningside	Gradual transition from more permeable Orthic A to less permeable Soft Plinthic B horizon	Interflow (Soil/Bedrock)

Soil Form	Description	Soil Family	Observations	Hydrological Type
Avalon	Dystrophic, Luvic B1 horizon	1200 Woodburn	Gradual transition from more permeable Orthic A to less permeable Soft Plinthic B horizon	Interflow (Soil/Bedrock)
Mispah	Not bleached, non-calcareous A horizon	1100 Myhill	Shallow with a restricting water and rooting depth at 200 mm	Recharge (Shallow)
Glencoe	Eutrophic, luvic B1 horizon	3200 Vlakput	Gradual transition from more permeable Orthic A to less permeable Hard Plinthic B horizon	Interflow (Soil/Bedrock)
Hutton	Dystrophic, non-luvic B1 horizon	1100 Lillieburn	Deep (>1500 mm) unstructured well-drained characteristics	Recharge (Deep)
Bloemdal	Dystrophic, non-luvic B1 horizon	1100 Aandrus	Deep (>1500 mm) unstructured well-drained characteristics	Interflow (Soil/Bedrock)
Longlands	E horizon grey when moist	1000 Sherbrook	Poorly drained with relatively higher clay content	Soil (A, E and/or G) Interflow
Kroonstad	E horizon grey when moist	1000 Morgendal	Poorly drained with relatively higher clay content	Soil (A/E) Interflow
Witbank	Non-calcareous within 1500 mm of soil surface	1000 Thornlea	Compacted anthropic soils restrictive to water and root penetration	Recharge (Shallow)

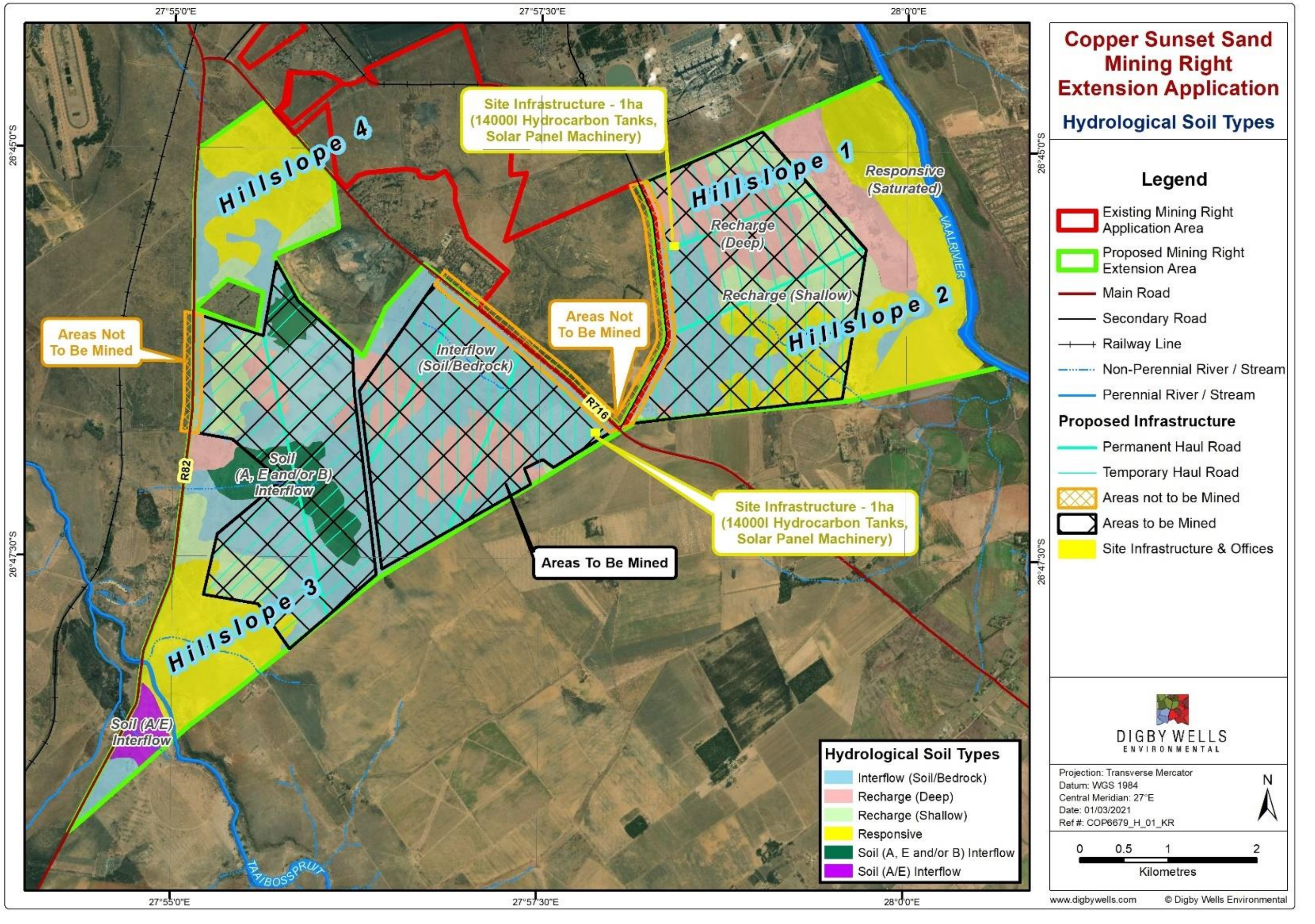


Figure 8-13: Distribution of Hydrological Soil Types at the Copper Sunset MREA

8.7.2.2. Conceptual Model of Hillslope Hydrological Processes

Hydropedological assessment indicates the prevalence of recharge at hillslope crests, interflow at soil/bedrock and variably at E/B and E/G Horizons within midslope positions and overland flow at the footslope (Figure 8-14). Since sand mining at the Copper Sunset MREA is proposed for depths not exceeding 5 m, soil/bedrock interflow pathways will least likely be interrupted within deep soils (>2 m). This implies that the soil/bedrock subsurface flows which are currently feeding the Vaal River and the Taaibosspruit will likely continue unhindered. Surface runoff or overland flow, at footslope positions of the Vaal River and the Taaibosspruit, will likely not be interrupted if proposed areas to be mined are adhered to (see Figure 8-15). Interflow at soil E/B and E/G interfaces will likely be interrupted resulting in ponded water following excavations on mined-out strips and most of this water will be lost to evaporation.

Overland flow at unchannelled and channelled valley bottom wetlands will be interrupted due to sand mining even when conducted to the proposed shallow depths of < 2 m. Pronounced impacts are envisaged where wetland areas are mined out because this implies total removal of temporary natural water storages. Two major wetlands and several minor ones connected to the Vaal River and the Taaibosspruit will partially or totally be mined-out and their water flow contributions to the river systems will be lost (see Figure 8-15).

Wetlands cover an approximate area of 1638.733 ha which accounts for 58.62 % of the total 2795.7 ha of the Copper Sunset MREA. The breakdown of the wetland Hydro-Geomorphic (HGM) units areas are detailed in Table 8-3 (Digby Wells, 2021).

Table 8-3: Wetland HGM Units of the Copper Sunset MREA (Digby Wells, 2021)

HGM Unit	Associated river system	Area (ha)
CVB and seep (east)	Vaal River	125.53
Floodplain (east)	Vaal River	268.52
Seep (east)	Vaal River	158.408
CVB (west)	Taaibosspruit River	508.9
Floodplain and associated VBs (west)	Taaibosspruit River	549.25
Valley head seep and CVB (west)	Taaibosspruit River	28.125
Total wetland coverage of the MREA		**1638.733**

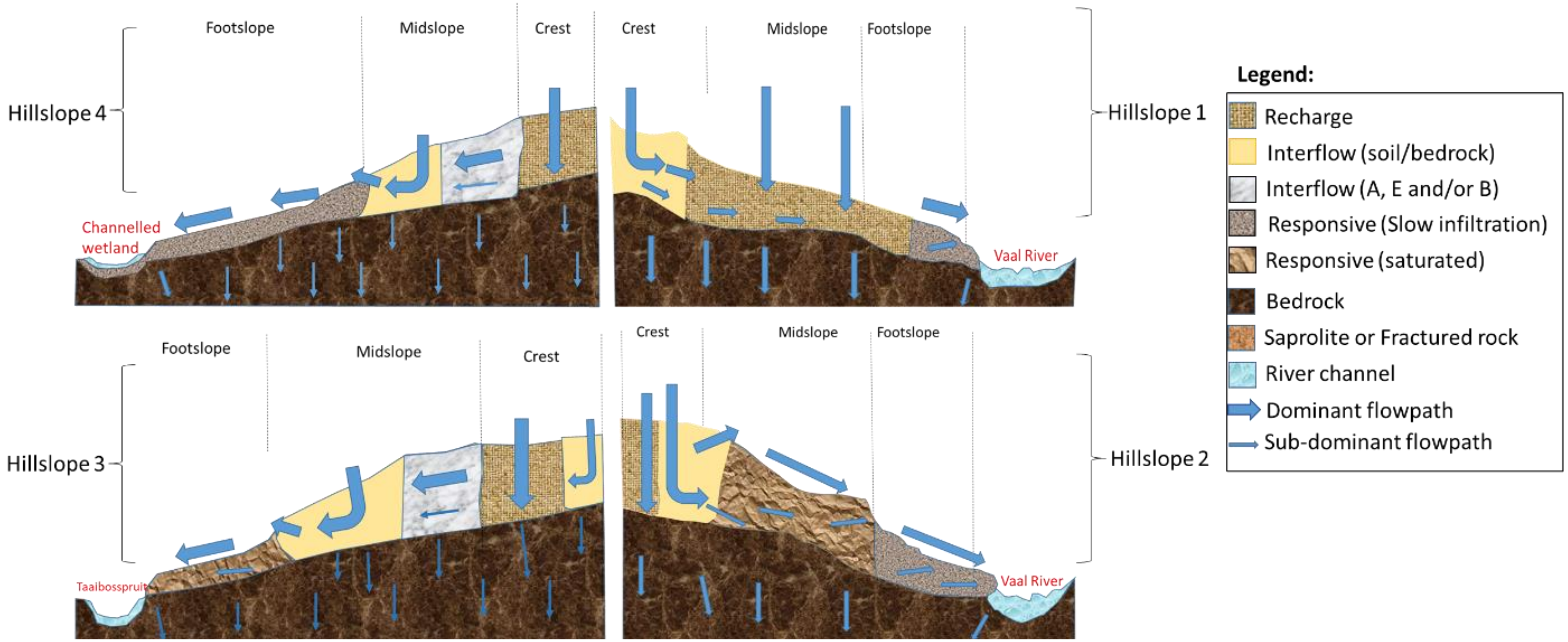


Figure 8-14: Conceptual Hydrological Process Models of 4 Surveyed Hillslopes

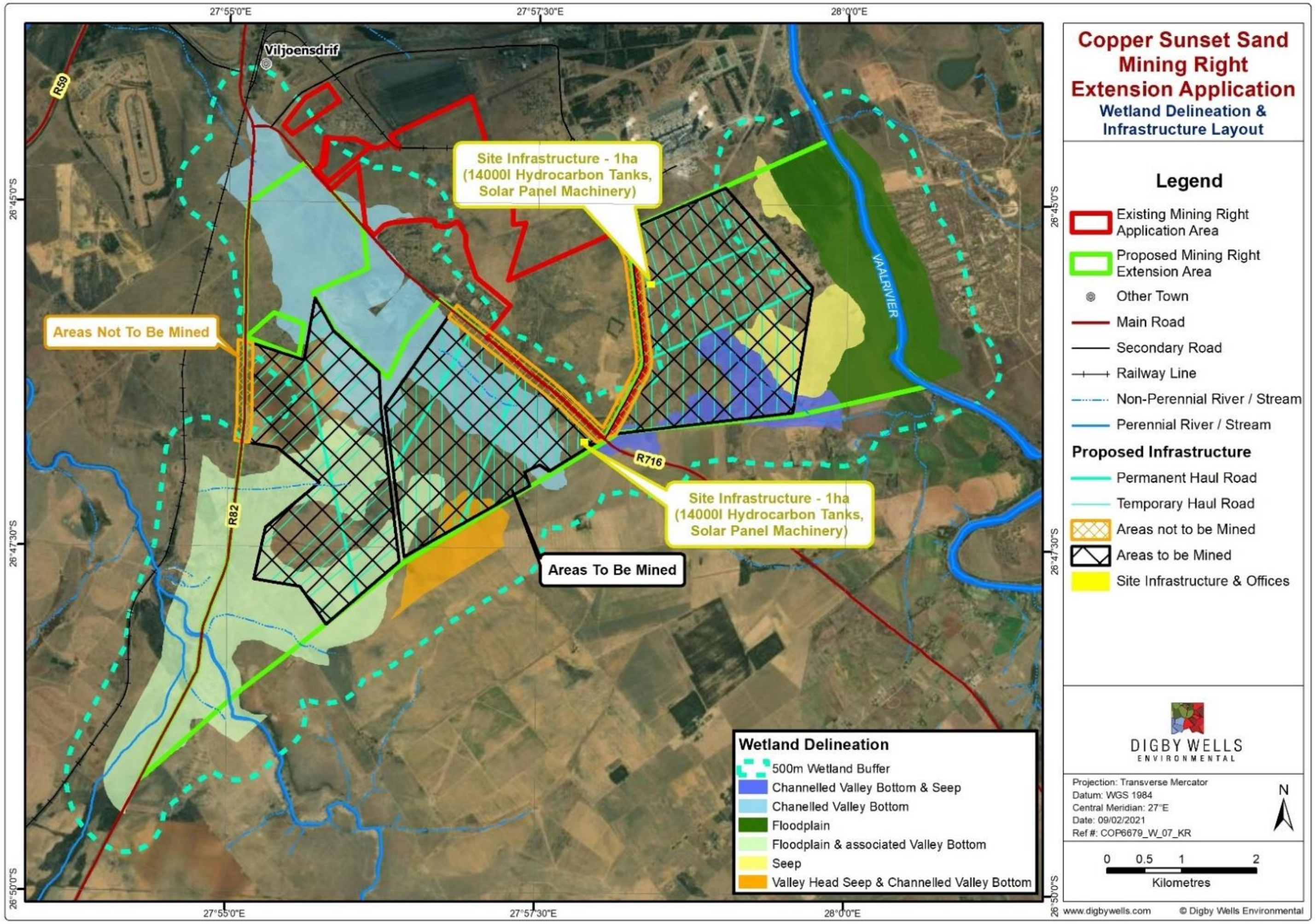


Figure 8-15: Delineated Wetlands at the Copper Sunset MREA

9. Impact Assessment

A hydropedological impact assessment was conducted for the establishment, operation and decommissioning phases of the proposed project. Descriptions of activity interactions and associated hydropedological impacts are presented in the following subsections.

9.1. Establishment Phase

Activities during the Establishment Phase that may have potential impacts are described in Table 9-1.

Table 9-1: Interactions and Impacts of Activity

Interaction	Impact
Site Clearance: Vegetation and topsoil removal to a depth of about 0.3 – 0.4 m with a bulldozer and stockpiled along the mined-out strip; Construction of 20 m wide haul/access road to the sand mining area	Sedimentation and siltation of nearby watercourses due to erosion of disturbed soils
Construction of 20 m wide haul/access road to the sand mining area	Alteration of watercourse geometry and fluvial patterns of disturbed river channels
Movement of vehicles and machinery during construction of haul road and during site clearance activities will likely results in spillages and leakage of hydrocarbon fuels, oils and grease which can be washed into nearby watercourses through surface and subsurface flows. Use of mobile toilets on site and the handling of general waste on site may contaminate water and soil resources, if not well managed	Contamination of water resources from general waste, sewage and from spillage and leakage of hydrocarbon fuels, oils and grease

9.1.1. Impact Description: Sedimentation and Siltation of Nearby Watercourses due to Erosion of Disturbed Soils

Establishment activities at Copper Sunset will include vegetation clearance and topsoil removal to a depth of about 0.3 – 0.4 m with a bulldozer and topsoil stockpiling along the mined-out strip. Construction of a 20 m wide haul/access road to the sand mining area will also be undertaken. The clearance of vegetation and topsoil stripping in preparation for the mining of underlying sand deposits will disturb and expose the soils, making it susceptible to erosion mainly by surface runoff. Proximal watercourses and wetlands are bound to be the most likely receptors of the eroded sediments resulting in sedimentation and ultimately siltation of the affected water resources. Sedimentation reduces the quality of water resources while siltation reduces the quantity of water within the affected rivers, streams and wetlands. The process of constructing the proposed 20 m wide haul/access roads to the sand mining area will result in the compaction of soils along the road. Compacted soils experience reduced infiltration and promote surface runoff which subsequently may increase surface runoff flow velocity and soil erodibility.

9.1.2. Impact Description: Contamination of Water Resources from General Waste, Sewage and from Spillage and Leakage of Hydrocarbon Fuels, Oils and Grease

Movement of vehicles and machinery during construction of haul road and during site clearance will likely result in spillage and leakage of hydrocarbon fuels, oils and grease which may migrate through the soil matrix and/or through overland flow, causing land and water resources contamination. Spillage of sewage waste from mobile toilets used on site is another source of contamination of soil and water resources. The handling of general waste on site may contaminate water and soil resources, if not well managed.

9.1.3. Impact Description: Alteration of Watercourse Geometry and Fluvial Patterns of Disturbed River Channels

Construction of 20 m wide haul/access road to the sand mining area will cross rivers, streams and wetlands thereby disturbing channel geometry (bed and banks) and destroying riparian vegetation.

9.1.3.1. Mitigation/Management Objectives

The probability of identified impacts occurring is almost certain hence management or mitigation measures should be put in place to reduce the significance of the impact occurring. The following measures are recommended:

- Keep vegetation clearance and soil disturbance to a minimum, within the confines of the mining footprint;
- Reprofile disturbed portions of the affected streams, rivers or wetlands to allow free drainage;
- Adhere to sound storm water management planning to effectively separate sediments from runoff with the use of silt fences;
- Movement of vehicles and machinery should be confined to the designated access road to minimise the extent of soil compaction;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited vendors;
- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites; and

- Any hydrocarbon spills should quickly be cleaned-up and contaminated soils removed before wash-offs and/or further infiltration into the ground occurs.

9.1.3.2. Impact Ratings

Identified impacts are rated in the tables below to reflect pre-mitigation and post-mitigation significance for the Establishment Phase.

Table 9-2: Impact Significance Rating for the Establishment Phase

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses due to erosion of disturbed soils			
Duration	5	The impact will likely occur for the life of the project	78- Moderate (negative)
Intensity	4	Serious to medium term environmental effects	
Spatial scale	4	Impact has the potential to affect a wider area beyond the mining right area	
Probability	6	Almost certain that the impact will occur	
Post-mitigation			
Duration	2	The impact will only likely occur in the short term given implementation of recommended mitigation measures	18- Negligible (negative)
Intensity	2	Minor effects on biological or physical environment are expected if silt traps and soil stabilisation procedures are followed	
Spatial scale	2	With proper management, the impact will be localized to the immediate downstream of the site	
Probability	3	There is a possibility that the impact will occur	

Impact: Alteration of watercourse geometry and fluvial patterns of disturbed river channels			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	6	The impact will remain for the life of the Project.	91-Moderate (negative)
Intensity	4	Serious medium-term environmental effects. Environmental damage is reversible	
Spatial scale	3	The impact will be local extending across the site and to nearby environments	
Probability	7	The impact will definitely occur	
Post-mitigation			
Duration	2	The impact will remain for the life of the Project but only in areas where mining will be active since the haul road is constructed as mining progresses	32-Negligible (negative)
Intensity	4	Serious medium-term environmental effects. Environmental damage is reversible	
Spatial scale	2	Limited to the site and its immediate surroundings	
Probability	4	Impact will likely occur	

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination leading to deterioration of water quality			
Duration	5	The impact will likely occur for the life of the project	60- Minor (negative)
Intensity	4	Moderate impact on water quality and ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localised extending across the site and to nearby settlements.	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)

Dimension	Rating	Motivation	Significance
Intensity	2	With proper management of hydrocarbon fuels, oils, grease and general waste on project site, the impact will have low intensity	
Spatial scale	2	With proper management, the impact will be localised to sites where incidences occur	
Probability	2	The possibility of the impact occurring is very low if mitigation measures are adequately implemented	

9.2. Operational Phase

Potential impacts resulting from sand mining operations and related activities on soil-water resources and associated responses are summarised in Table 9-3.

Table 9-3: Interactions and Impacts of Activity

Interaction	Impact
Strip mining will take place in sequences of 30 – 50 m wide to extract the sand by means of light weight excavators. Excavations during strip mining will likely disrupt flow paths, subsequently causing deterioration of onsite wetlands, streams and rivers and associated ecosystems. Movement of customer trucks (100-200 trucks per day) through the haul road into and out of the mining area will compact soils along the haul road route increasing runoff and flooding potential in nearby watercourses.	Disruption of hillslope water flow paths and reduction of flows into rivers, streams and wetland resources
Handling of hydrocarbon fuels, oils, grease during the operation of a fleet of tipper trucks, front-end loaders, excavators, water trucks, tractor, bulldozers and screening machines; Operation of a mobile office; mobile screening plants, portable toilets, diesel bowser and a water bowser. Refuelling of equipment at the mobile office area within the expanded mining area	Contamination of water resources from general waste, sewage and from spillage and leakage of hydrocarbon fuels, oils and grease
Concurrent rehabilitation (backfilling, reprofiling and revegetation) of mined-out strips as sand mining progresses	Restoration of close to natural hydrological responses through concurrent rehabilitation of mined-out landscapes

9.2.1. Impact Description: Disruption of Hillslope Water Flow Paths and Reduction of Flows into Rivers, Streams and Wetland Resources

Strip mining will take place in sequences of 30 – 50 m wide to extract the sand by means of light weight excavators. Excavation of sand disrupts hillslope water flow paths and intercepts water that was supposed to report to watercourses at the footslope, including channelled or unchannelled valley bottom wetlands, subsequently causing deterioration of the wetlands, streams, and rivers ecosystems. Movement of customer trucks (100-200 trucks per day) through the haul road in and out of the mining area will compact soils, impede infiltration, interflow and recharge processes thereby affecting streamflow regimes and wetlands functioning.

9.2.2. Impact Description: Contamination of Water Resources from General Waste, Sewage and from Spillage and Leakage of Hydrocarbon Fuels, Oils and Grease

Refuelling of equipment and vehicles at the mobile office area, including handling of oils and grease during the operation of a fleet of tipper trucks, front-end loaders, excavators, water trucks, tractor, diesel bowser, bulldozers and screening machines may result in leakages and spills that will likely contaminate water resources within the Vaal River and Taaibosspruit systems. General and process waste will be produced during the operation of the mobile office, mobile screening plants and the water bowser. Use of portable toilets has the potential of causing sewage waste impacts at the project site.

9.2.2.1. *Mitigation/Management Objectives*

The following mitigation and management measures should be implemented:

- Restrict any excavations to less than the proposed 5 m depths and any vehicle or machinery movements should be confined to the designated sand extraction areas in order to minimise disruption of water flow paths within hillslopes;
- The edge of the non-directly impacted freshwater resources, and at least a 100 m buffer or 1:100 flood line buffer, should be demarcated in the field with wooden stakes painted white as no-go zones that will last for the duration of the operational phase;
- Establishment of a 500 m buffer zone to protect wetland areas from the proposed developments within the mining area. This would require that development occur further than 500 m from a delineated wetland area, as much as practically possible;
- Development of a Wetland Offset Strategy and Rehabilitation plan for the wetlands in the Project area (Digby Wells, 2021);
- Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities;

- Hydrocarbon materials (fuel, oil & grease) storage areas should be located on hard-standing impermeable and bunded areas in accordance with SANS1200 specifications. This helps to prevent mobilisation of leaked hazardous substances;
- Mine workers should be trained in the use of spill kits to contain and immediately clean up any leakages or spills;
- Servicing and washing of vehicles and machinery should be conducted at appropriately designated paved areas. All used oils should be disposed of by accredited vendors from the mine site;
- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites;
- Ensure that storm runoff from wash bays is controlled by storm water management infrastructure and should not be allowed to flow into the watercourses; and
- Concurrent rehabilitation through backfilling, reprofiling and revegetation of mined-out landscapes to allow free drainage should be implemented as proposed for the MREA to comply with rehabilitation guidelines.

9.2.2.2. Impact Ratings

Identified impacts were rated in the tables below to reflect pre-mitigation and post-mitigation significance for the Operation Phase.

Table 9-4: Impact Significance Rating for the Operation Phase

Dimension	Rating	Motivation	Significance
Impact: Disruption of water flow paths and subsequent alteration of streamflow regime and deterioration of wetlands functioning			
Duration	6	The impact will likely occur beyond the LOM	119- Major (negative)
Intensity	6	Significant impact on highly valued river and wetland resources in terms of water quality and quantity and associated ecosystems	
Spatial scale	5	The impacts will be localised but will likely extend to beyond the MREA	
Probability	7	The impact will definitely occur	
Post-mitigation			
Duration	6	The impact will likely occur beyond the LOM	70- Minor (negative)

Dimension	Rating	Motivation	Significance
Intensity	2	With proper management and concurrent rehabilitation being practiced the intensity will be low	
Spatial scale	2	With proper management, the impact will be localised to relevant operational areas within the mine's footprint.	
Probability	7	The impact will definitely occur	

Dimension	Rating	Motivation	Significance
Impact: Water Contamination from hydrocarbon and chemical spillages and leakages			
Duration	5	The impact will only likely occur during the entire life of the project	48- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localised but may extend to downstream environments	
Probability	4	Without appropriate mitigation, it is probable that this impact will occur.	
Post-mitigation			
Duration	5	The impact will only likely occur for the LOM	27-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will rarely be of significance and water quality in nearby watercourses will be maintained for optimal functionality of ecosystems and downstream	
Spatial scale	2	With proper management, the impact will be localised to relevant operational areas within the mine's footprint.	
Probability	3	With the implementation of recommended mitigation measures the impact's probability of occurrence will be very low.	

Dimension	Rating	Motivation	Significance
Impact: Restoration of close to natural hydrological responses through concurrent rehabilitation (backfilling, reprofiling & re-vegetation) of mined-out landscapes			
Duration	7	Rehabilitation, reprofiling and revegetation of disturbed landscapes will likely restore close to natural flows into the valley bottom wetland benefitting ecosystems and downstream water users	90- Moderate (positive)
Intensity	4	Average to intense environmental enhancements	
Spatial scale	4	Localised positive effects which extend to downstream water users within the municipality	
Probability	6	The positive impact will likely occur	

9.3. Decommissioning Phase

Potential impacts resulting from decommissioning and related activities after the life of mine are summarised in Table 9-5.

Table 9-5: Interactions and Impacts of Activity

Interaction	Impact
Reshaping or profiling and backfilling of mined-out areas with waste material from the screening plant and topsoil that was stockpiled during the operation phase. Levelling and contouring of backfilled area to avoid ponding of water.	Sedimentation and siltation of nearby watercourses
Leakage of oils, fuels and grease from moving vehicles and machinery during backfilling, reprofiling and revegetation activities	Contamination of surface water resources leading to deterioration of water quality
Soil stabilisation and re-vegetation with natural or indigenous seed mix. Erosion monitoring at rehabilitated, reprofiled and re-vegetated surfaces. Water quality monitoring upstream and downstream of the decommissioning project site.	Restoration of free drainage to rehabilitated landscapes that suits desired post-closure land use

9.3.1. Impact Description: Sedimentation and Siltation of Nearby Watercourses

Interactions bringing about the above negative impact include the reshaping, or reprofiling of disturbed landscapes. This impact is expected to be low negative, especially after implementation of mitigation measures.

9.3.2. Impact Description: Contamination of Surface Water Resources Leading to Deterioration of Water Quality

Leakage or spills of oils, fuels and grease from moving vehicles and machinery during backfilling, reprofiling and revegetation activities.

9.3.3. Impact Description: Restoration of Free Drainage to Rehabilitated Landscapes that Suits Desired Post-Closure Land Use

Soil stabilisation and re-vegetation with natural or indigenous seed mix. Erosion monitoring at rehabilitated, reprofiled and re-vegetated surfaces. Water quality monitoring upstream and downstream of the decommissioning project site.

9.3.3.1. Mitigation/Management Measures

- Reseeding of exposed rehabilitated surfaces should be undertaken to reduce soil evacuation and sedimentation in nearby watercourses;
- Prior to vegetation establishment, seeded areas should have temporary silt fences to keep soils from being washed away;
- Implement wetland rehabilitation measures to restore mined-out wetlands and disturbed channel geometry at haul road crossings;
- Only designated access routes should be used to reduce unnecessary impacts to the undisturbed environment including wetlands; and
- Disposal of general and other forms of waste should continue to be conducted using clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites.

9.3.3.2. Impact Ratings

Identified impacts were rated in the tables below to reflect pre-mitigation and post-mitigation significance for the Decommissioning Phase.

Table 9-6: Impact Significance Rating for the Decommissioning Phase

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses and deterioration of water quality			
Duration	2	The impact duration will be short term during the decommissioning phase.	63-Minor (negative)
Intensity	4	Serious to medium term environmental effects which are reversible in less than a year	
Spatial scale	3	The impacts might extend across the site and to nearby settlements	
Probability	7	The impact will definitely occur	
Post-mitigation			
Duration	2	The impact will likely only occur during the decommissioning phase	12-Negligible (negative)
Intensity	2	Due to implementation of mitigation measures, impact intensity will be low	
Spatial scale	2	The impacts will be localised to sites where disturbance will be undertaken and contained by silt fences on site	
Probability	2	The possibility of the impact occurring is very low due to implementation of adequate mitigation measures.	

Dimension	Rating	Motivation	Significance
Impact: Contamination of surface water resources leading to deteriorated water quality			
Duration	5	The impact will remain for some time after the decommissioning process.	48-Minor (negative)
Intensity	4	Serious medium-term environmental effects which can affect aquatic ecosystems	
Spatial scale	3	The impact will be local extending across the site and to nearby environments	
Probability	4	The impact will likely occur	
Post-mitigation			

Impact: Contamination of surface water resources leading to deteriorated water quality			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	2	The impact will be short term with a duration of less than 1 year, if mitigation measures are adequately implemented	8-Negligible (negative)
Intensity	1	Limited damage to minimal area of low significance that will have no impact on the environment	
Spatial scale	1	Limited to specific isolated parts of the site	
Probability	2	If mitigation measures are correctly implemented, it will be rare/improbable for this impact to occur	

Dimension	Rating	Motivation	Significance
Impact: Restoration of free drainage to rehabilitated landscapes that suits desired post-closure land use			
Duration	7	The impact will be permanent remaining long after the life of the Project.	112-Major (positive)
Intensity	4	Noticeable, on-going environmental benefits which improve the natural land and water environments	
Spatial scale	5	The positive impact will extend across the project area and to nearby settlements	
Probability	7	It is definite that this positive impact will occur (there is no mitigation for this impact)	

10. Cumulative Impacts

Existing developments within and around the Copper Sunset MREA have contributed to losses of water resources including wetlands and rivers systems and continued impacts on the remaining areas. The alteration of the vegetation due to crop cultivation and cattle grazing that has led to overgrazing, the contamination of water resources because of industrial process and increased surface inflows, have all contributed to the physical impacts on the wetlands and rivers such as erosion and sedimentation.

The mining activities within the catchment have led to losses in wetland areas that may have facilitated increased water flow and quantity of pollutants flowing into the water resources. The alteration of vegetation and surface flow has led to the onset of erosion in the wetland areas, and this may be perpetuated further by mining and related activities within the MREA. Mining may disturb the hydrological patterns further which could in turn lead to large scale desiccation of wetland areas and the direct loss of some of the wetland areas because of water flow being cut off.

11. Environmental Management Plan

The EMP is described in Table 11-1.

Table 11-1: Environmental Management Plan

<table>
<tr><th>Phase</th><th>Activities</th><th>Potential Impacts</th><th>Mitigation Measure</th><th>Mitigation Type</th><th>Period for Implementation</th></tr>
<tr><td rowspan="3">Establishment/Construction</td><td>• Vegetation and topsoil will be removed with a bulldozer and stockpiled along the mined-out strip</td><td>• Sedimentation and siltation of nearby watercourses due to erosion of disturbed soils</td><td rowspan="2">• Limit vegetation removal and construction activities to the infrastructure footprint area only, where removed or damaged vegetation areas should be revegetated as soon as possible with a suitable mix of plant species as determined by a qualified botanist;
• Reprofile disturbed portions of the affected streams, rivers or wetlands to allow free drainage;
• Adhere to sound storm water management planning to effectively separate sediments from runoff with the use of silt fence.
• Movement of vehicles and machinery should be confined to designated access road to minimise the extent of soil compaction accelerated flow velocities;
• Wherever possible, surface infrastructure should be relocated outside of wetland areas and a buffer of at least 100 m should be put in place to ensure there is no risk of impacts to the wetland systems;
• Monitor revegetated areas to ensure successful re-establishment of vegetation;
• Environmentally friendly barrier systems, such as silt nets/fences or, in severe cases, use of trenches, downstream from construction sites should be used to limit erosion and possibly trap contaminated runoff from construction;
• Re-fuelling must take place on a sealed surface area away from river systems and wetlands to prevent the ingress of hydrocarbons into the topsoil.
• Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited vendors;
• Movement of vehicles and machinery should be confined to the designated access road to minimise the extent of soil compaction;
• All vehicles must be regularly inspected for leaks;
• Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites; and
• Any hydrocarbon spills should quickly be cleaned-up and contaminated soils removed before wash-offs and/or further infiltration into the ground occurs.</td><td>Control through storm water management planning</td><td>Daily during the Construction Phase</td></tr>
<tr><td>• Construction of a temporary haul road (20 m width) to gain access to the sand mining area. It is important to note that the haul road will move as mining progresses through LoM</td><td>• Contamination of water resources from general waste, sewage and from spillage and leakage of hydrocarbon fuels, oils and grease</td><td>Control through waste management planning</td><td></td></tr>
<tr><td>• Construction of haul road</td><td>• Alteration of channel geometry and fluvial patterns of disturbed river channels</td><td>• Reprofile disturbed portions of the streams to allow free drainage; and
• At areas where the haul road crosses watercourses, the crossing should be at the narrowest point and should be at 90° angle with suitable drainage designed not to impede flows;</td><td>Control through storm water management planning; and
Rehabilitation through reprofiling and revegetation of affected watercourse geometry</td><td>Soon after construction at the river crossing point</td></tr>
</table>

Operational	• Mining of sand resources including screening (if required) to approximately 0.3 – 0.4 m and stockpiled in a separate area	• Disruption of hillslope water flow paths and reduction of flows into rivers, streams and wetland resources	• Restrict any excavations to less than the proposed 5 m depths and any vehicle or machinery movements should be confined to the designated sand extraction sites in order to minimise disruption of water flow paths within hillslopes; • The edge of indirectly impacted freshwater resources (rivers/streams) and wetlands, should at least have a 1:100 floodline buffer and /or a 100 m buffer; and • Develop a Wetland Offset for critical mined-out wetlands, which can be determined by a wetland offset assessment study	Remedy through concurrent rehabilitation; and Remedy through wetland offsetting	After every mined-out strip during the Operational Phase; Once-off for identified critical mined-out wetlands
	• Transportation of material on haul roads and refuelling of machinery within the mining area or at the mobile offices	• Contamination of water resources from general waste, sewage and from spillage and leakage of hydrocarbon fuels, oils and grease	• Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities; • Hydrocarbon materials (fuel, oil & grease) storage areas should be located on hard-standing impermeable and bunded areas in accordance with SANS1200 specifications. This helps to prevent mobilisation of leaked hazardous substances; • Mine workers should be trained in the use of spill kits to contain and immediately clean up any leakages or spills; • Servicing and washing of vehicles and machinery should be conducted at appropriately designated paved areas. All used oils should be disposed of by accredited vendors from the mine site; • Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites; • Ensure that storm runoff from wash bays is controlled by storm water management infrastructure and should not be allowed to flow into the watercourses; and • Concurrent rehabilitation through backfilling, reprofiling and revegetation of mined-out landscapes should be conducted to allow free drainage as proposed for the MREA to comply with rehabilitation guidelines.	Control through monitoring of water quality; Control through training of personnel on best waste management practices; and Remedy through concurrent rehabilitation	Monthly water quality monitoring
	• Concurrent rehabilitation (topsoil cover, ripping and vegetation establishment) and monitoring of vegetation establishment	• Restoration of close to natural hydrological responses through concurrent rehabilitation of mined-out landscapes			
Decommissioning	• Rehabilitation processes/activities including backfilling, topsoiling of mined-out areas and ripping of decommissioned haul road	• Sedimentation and siltation of nearby watercourses	• Reseeding of exposed rehabilitated surfaces should be undertaken to reduce soil evacuation and sedimentation in nearby watercourses; and • Prior to vegetation establishment, seeded areas should have temporary silt fences to keep soils from being washed away.	Remedy through rehabilitation	Throughout the Decommissioning Phase
	• Leakage of oils, fuels and grease from moving vehicles and machinery during backfilling,	• Contamination of surface water resources leading to deterioration of water quality	• Disposal of general and other forms of waste should continue to be conducted using clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites.	Control through monitoring	Throughout the Decommissioning Phase

	reprofiling and revegetation activities				
	• Soil stabilisation and revegetation with natural or indigenous seed mix. Erosion monitoring at rehabilitated, reprofiled and re-vegetated surfaces. Water quality monitoring upstream and downstream of the decommissioning project site.	• Restoration of free drainage to rehabilitated landscapes that suits desired post-closure land use	• Reseeding of exposed rehabilitated surfaces should be undertaken to reduce soil evacuation and sedimentation in nearby watercourses; • Prior to vegetation establishment, seeded areas should have temporary silt fences to keep soils from being washed away; • Implement wetland rehabilitation measures to restore mined-out wetlands and disturbed channel geometry at haul road crossings; and • Only designated access routes should be used to reduce unnecessary impacts to the undisturbed environment including wetlands.	Remedy through monitoring the success of implemented rehabilitation measures; and Control through post-closure monitoring	2 years post-closure

12. Monitoring

Periodic monitoring of wetlands conditions should be undertaken to detect any impacts on the size and wetness status of the wetlands (refer to the Wetland Report: Digby Wells, 2021); and

Baseflow monitoring upstream and downstream of the Copper Sunset MREA on the Vaal River and the Taaibosspruit to detect any changes in flow regimes. Flow monitoring points are provided in Table 12-1 below.

Table 12-1: Flow monitoring localities

Monitoring Point	Latitude	Longitude
Vaal River Upstream	-26.773083	28.014469
Vaal River Downstream	-26.735082	27.993810
Taaibosspruit Upstream	-26.813703	27.921453
Taaibosspruit Downstream	-26.754495	27.875265

13. Stakeholder Engagement Comments Received

The consultation process affords Interested and Affected Parties (I&APs) opportunities to engage in the EIA process. The objectives of the Stakeholder Engagement Process (SEP) include the following:

- To ensure that I&APs are informed about the Project;
- To provide I&APs with an opportunity to engage and provide comment on the Project;
- To draw on local knowledge by identifying environmental and social concerns associated with the Project;
- To involve I&APs in identifying methods in which concerns can be addressed;
- To verify that stakeholder comments have been accurately recorded; and
- To comply with the legal requirements.

The Public Participation Process (PPP) has been completed in part, as a process separate to the EIA. No formal consultation was undertaken as part of this assessment. Should any I&AP comments be submitted in relevance to soil resources during the SEP, these will be considered in the final EIA report.

14. Recommendations

The following actions are recommended to reduce adverse effects on water resources including wetlands, streams and rivers within and around the project area:

- Keep vegetation clearance and soil disturbance to a minimum, within the confines of the mining footprint;
- Continue to adhere to sound storm water management planning to effectively separate sediments from runoff with the use of silt fences;
- Movement of vehicles and machinery should be confined to designated access road to minimise the extent of soil compaction;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited vendors;
- Any hydrocarbon spills should quickly be cleaned-up and contaminated soils removed before wash-offs and/or further infiltration into the ground occurs;
- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites;
- Restrict any excavations to less than or equal to the proposed 5 m depths, and any vehicle or machinery movements should be confined to the designated access/haul road in order to minimise disruption of water flow paths within hillslopes;
- The edge of the indirectly impacted wetlands should have a 500 m buffer or should be outside the 1:100 floodline if it is a river or stream;
- Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities;
- Hydrocarbon materials (fuel, oil & grease) storage areas should be located on hard-standing impermeable and bunded areas in accordance with SANS1200 specifications. This helps to prevent mobilisation of leaked hazardous substances;
- Mine workers should be trained in the use of spill kits to contain and immediately clean up any leakages or spills;
- Servicing and washing of vehicles and machinery should be conducted at appropriately designated paved areas. All used oils should be disposed of by accredited vendors from the mine site;
- Ensure that contaminated storm runoff from wash bays is controlled by storm water management infrastructure and should not be allowed to flow into the watercourses;

- Concurrent and final rehabilitation through backfilling, reprofiling and revegetation of mined-out landscapes should be conducted to allow free drainage as proposed for the MREA to comply with rehabilitation guidelines;
- Reseeding of exposed rehabilitated surfaces should be undertaken to reduce soil evacuation and sedimentation in nearby watercourses;
- Prior to vegetation establishment, seeded areas should have temporary silt fences to keep soils from being washed away;
- It is recommended to do a Wetland Offset Assessment to calculate the total wetland lost and determine the number of wetlands to be offset. The complete removal of wetlands in the headwaters of the catchment may cause loss of water inputs to the lower catchment and therefore have a major effect on the downstream biodiversity, aquatic systems, fauna and flora;
- It is recommended that quantification of fluxes be conducted to provide more information on the magnitude of envisaged water losses due to disruption of hillslope flow paths by partial disturbance or total mining-out of wetlands in the project area;
- Periodic monitoring of wetlands conditions should be undertaken to detect any impacts on the size and wetness status of the wetlands (refer to the Wetland Report: Digby Wells, 2021); and
- Baseflow monitoring upstream and downstream of the Copper Sunset MREA on the Vaal River and the Taaibosspruit to detect any changes in flow regimes.

15. Reasoned Opinion Whether Project Should Proceed

Based on the qualitative hydropedological assessment findings, the study may proceed with careful implementation of recommended mitigation measures including implementing the Wetland Offsetting strategy to reduce the significance of identified impacts on streams, rivers and wetlands.

16. Conclusion

Hydropedological assessment indicates the prevalence of recharge at hillslope crests, interflow at soil/bedrock and variably at soil A, E and /or B Horizons within midslope positions and overland flow at the footslope. Since sand mining at the Copper Sunset MREA is proposed for depths not exceeding 5 m, soil/bedrock interflow pathways will least likely be interrupted within deep soils (>2 m). This implies that the soil/bedrock subsurface flows which are currently feeding the Vaal River and the Taaibosspruit will likely continue unhindered. Surface runoff or overland flow, at footslope positions of the Vaal River and the Taaibosspruit, will likely not be interrupted if proposed areas to be mined are adhered to. Interflow at soil A/E and A, E and /or B interfaces will likely be interrupted resulting in ponded water following excavations on mined-out strips and most of this water will be lost to evaporation.

Overland flows at unchannelled and channelled valley bottom wetlands will be interrupted due to sand mining even when conducted to the proposed shallow depths of < 2 m. Pronounced impacts are envisaged where wetland areas are mined out because this implies total removal of temporary natural water storages. Two major wetlands and several minor ones connected to the Vaal River and the Taaibosspruit will partially or totally be mined-out and their water flow contributions to the river systems will be lost. Since these systems (rivers and wetlands) are interconnected disruption of one may result in the desiccation of the other. As such, the sand mining project at the proposed Copper Sunset MREA will result in permanent loss of wetland features, on one hand, and the reduction of flow regimes in rivers that gain baseflow from some of these wetlands.

The impact of mining-out wetlands is great especially where the wetlands are located at the headwaters. Wetland offsetting should, therefore, be undertaken and rehabilitation with correct sloping and vegetation management may assist in reducing this impact (Digby Wells, 2021).

17. References

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Appendix A: Impact Assessment Rating Methodology

18. Impact Assessment Rating Methodology

The impact assessment rating methodology used in this study is described below:

The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact *=* ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weighting assigned to the various parameters for positive and negative impacts is provided for in the formula and is presented in Table 18-1. The probability consequence matrix for impacts is displayed in Table 18-2, with the impact significance rating described in Table 18-3.

Table 18-1: Impact Assessment Parameter Ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
7	Very significant impact on the environment. Irreparable and irreplaceable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable and irreplaceable damage to highly valued items of high cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project. The impacts are irreversible.	Certain/Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Significant management and rehabilitation measures required to prevent irreplaceable impacts. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread positive benefits to local communities which improves livelihoods, as well as a positive improvement to the receiving environment.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the Project.	Likely The impact may occur.
4	Serious medium-term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years to reverse impacts.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years to reverse impacts.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year to completely reverse the impact.	Rare/improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
1	Limited damage to minimal area of low significance that will have no impact on the environment. No irreplaceable loss of a significant aspect to the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	<u>Very limited</u> Limited to specific isolated parts of the site.	<u>Immediate</u> Less than 1 month to completely reverse the impact.	<u>Highly unlikely/None</u> Expected never to happen.

Table 18-2: Probability Consequence Matrix for Impacts

		Significance																																					
Probability	**7**	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
	6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
	5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
	4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
	3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
	2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
	1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Consequence																																							

Table 18-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and/or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and/or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and/or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and/or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)