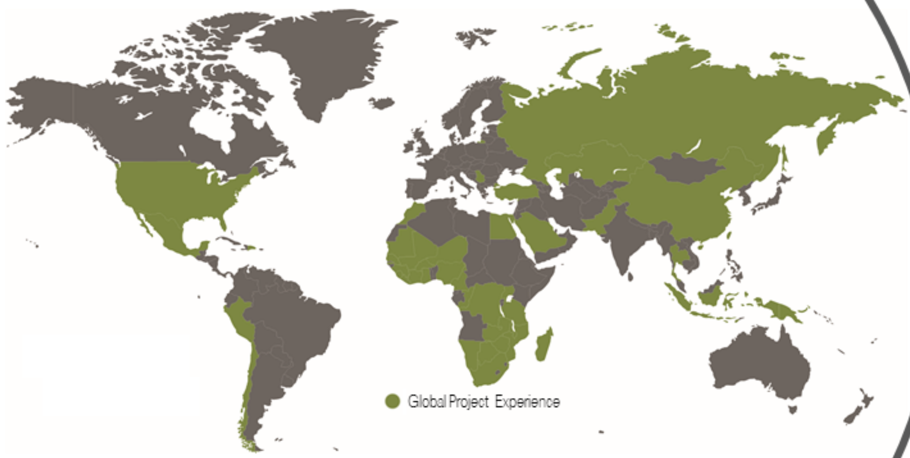

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Hydropedological Assessment Report for New Clydesdale Colliery - Middeldrift Resources

Hydropedological Impact Assessment

Prepared for:
Universal Coal New Clydesdale Colliery

Project Number:
UCD6587

June 2021

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Report Type:	Hydropedological Impact Assessment
Project Name:	Hydropedological Assessment Report for New Clydesdale Colliery - Middeldrift Resources
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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been requested by Universal Coal Development IV (Pty) Ltd, New Clydesdale Colliery (hereinafter Universal Coal) to undertake an Integrated Environmental Application Process for the inclusion of the Middeldrift resources into the Existing Universal Coal Development IV (UCDIV) New Clydesdale Colliery (NCC) Mine. This hydropedology study forms part of the required specialist studies to support this Environmental Application.

The proposed activities include the following:

- Mining of a pan (wetland);
- Construction of a bridge over the Steenkoolspruit to access the Middeldrift resources;
- Diversion of the provincial road which runs through the area of the Middeldrift site; and
- Construction of a new road (linked to the diversion) (approximately 4km long).

The project area is located within quaternary catchment B11E in the Olifants Water Management Area and has a Mean Annual Precipitation (MAP) of 682 mm. The New Clydesdale operations fall within the summer rainfall region of South Africa, where more than 80% of the annual rainfall takes place between the months of October to March. January as the wettest month has a 90th percentile of 192 mm and a 10th percentile of 67 mm. The area experiences a Mean Annual Evaporation (MAE) of 1 950 mm, which is much greater than the MAP leading to distinct wet and dry seasons. The Mean Annual Runoff (MAR) was calculated to be 47.6 mm which accounts for about 7% of the MAP for the area. The highest amount of runoff is experienced in the wettest month of January, with the 90th percentile being 35.6 mm and the 10th percentile, 0.6 mm.

Identified soil forms within the Middeldrift project site include the Rensburg (Rg), Longlands (Lo), Witbank (Wb), Fernwood (Fw), Kroonstad (Kd), Avalon (Av), Mispah (Ms), Pinedene (Pn), Glencoe (Gc), Glenrosa (Gs), Clovelly (Cv) and Hutton (Hu). Hillslope crest positions are dominated by Hu and Cv soil forms which are classified as deep recharge soils. Soils within the midslope such as Av, Lo, Fw, Pd and Gc are mainly classified as interflow soils in which lateral movement of water is dominant feeding the Steenkoolspruit further down footslope positions. Hillslope seep wetlands were identified in the study area and cultivation in these areas most likely impacted on the ecological functions of the wetland. It was observed that the pan is already significantly impacted on by cultivation of maize which possibly causes it to behave more like a seasonal pan, almost drying up during the dry season. Witbank soils were also encountered which represent a shallow recharge Hydrological Soil Types (HST). The riparian areas of the Steenkoolspruit variably have shallow responsive Ms and Gs soils which are characterised by overland flow due to saturation from above.

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Groundwater studies coupled with detailed hydropedological surveys should be conducted to assess subsurface hydraulic heads

and hydraulic gradients to get insight into flow directions and establish whether there is any significant interaction between groundwater and surface water including wetlands within the study area. Verified flow paths would need to be quantified to determine their significance and subsequent contribution to hillslope hydrological processes in the area.

During the first site visit that was undertaken during the wet season (12th of February 2021), the pan in the study area was inundated with water. However, during the dry season site visit (19th of May 2021), the pan was almost dry.

Recommendations

- Department of Water and Sanitation (DWS) approval/exemption needs to be applied for to enable permissible mining and clearing of the pan in accordance with GN704 Regulations;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- Minimise disturbance of river channel geometry during installation of the culvert/bridge. Re-profile and stabilise any disturbed soils when the culvert/bridge is constructed;
- Installation of the proposed stormwater management plan is recommended to reduce sedimentation and siltation in nearby watercourses. The recommended perimeter berm around the Middeldrift Opencast Pit will also ensure that clean water is diverted from the dirty opencast pit;
- Practice concurrent rehabilitation, as proposed, reduce the size of the opencast pit that intercepts rainfall and runoff at any time during the course of the mining process;
- Re-profile the topography after backfilling to a slope gradient and angle that supports post-mining land use;
- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Steenkoolspruit;
- In the event of decanting, passive treatment (through application of calcium compounds) should be applied to neutralise and treat the Acid Mine Drainage (AMD) before being discharged back into freshwater resources;
- Ongoing water quality monitoring of surface and groundwater monitoring is imperative during the life of mine to allow for early detection of potential contaminants that may cause unforeseen negative impacts on the receiving environment;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD; and
- Alternatively, when passive treatment fails to correct the situation, active Water Treatment (e.g. Reverse Osmosis) should be considered.

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Appendix A: Impact Assessment Methodology

ACRONYMS, ABBREVIATIONS AND DEFINITION

AMD	Acid Mine Drainage
ARC	Agricultural Research Council
CEC	Cation Exchange Capacity
DMRE	Department of Mineral Resources
EA	Environmental Authorisation
EMP	Environmental Management Plan
ET	Evapotranspiration
HGM	Hydro-Geomorphic
LoM	Life of Mine
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMWA	National Environmental Management: Waste Act (Act 59 of 2008)
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

1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been requested by Universal Coal Development IV (Pty) Ltd, New Clydesdale Colliery (hereinafter Universal Coal) to undertake an Integrated Environmental Application Process for the inclusion of the Middeldrift Resources into the Existing Universal Coal Development IV (UCDIV) New Clydesdale Colliery (NCC) Mine. This hydropedology study forms part of the required specialist studies to support this Environmental Application.

2 Project Description

The Project is located in the Kriel district of the Mpumalanga Province (Figure 2-1). The Middeldrift resources lie North of the UCDIV Diepspruit Mining Area (an underground mining operation that forms part of NCC) and Universal Coal is the holder of the Mining Right (MR), reference number MP30/5/1/2/2/492(EM. The Middeldrift Mining Right area is a greenfield area. The intention is to exploit the resources through opencast mining methodologies. The affected farm portions are presented in Figure 2-2.

The proposed new activities at the Middeldrift Resources to be authorised will entail:

- Opencast coal mining through wetlands;
- Diversion of the district road D1651;
- Construction of a new road (linked to the road diversion) (approximately 4 km long); and
- Construction of a bridge over the Steenkoolspruit to access the current NCC operation to make use of the surface infrastructure and facilities.

The construction, operation and decommissioning phases of the Project shall comprise the activities in Table 2-1. These Project activities will be used for the impact assessment.

Table 2-1: Project Activities

Phase	Activity
Construction	Removal of vegetation / topsoil for establishment of mining and linear infrastructure
	Diesel storage and explosives magazine
	Construction of additional infrastructure, and ventilation fans (Noise generation/ increased noise level)
	Construction of access road and haul roads
	Stockpiling of soils, rock dump and discard dump establishment.
Operational	Ventilation fans and infrastructure area containing stockpile areas
	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.
	Removal of rock (blasting)
	Concurrent rehabilitation as mining progresses
Decommissioning	Demolition and removal of infrastructure
	Post-closure monitoring and rehabilitation
	Closure of the mine

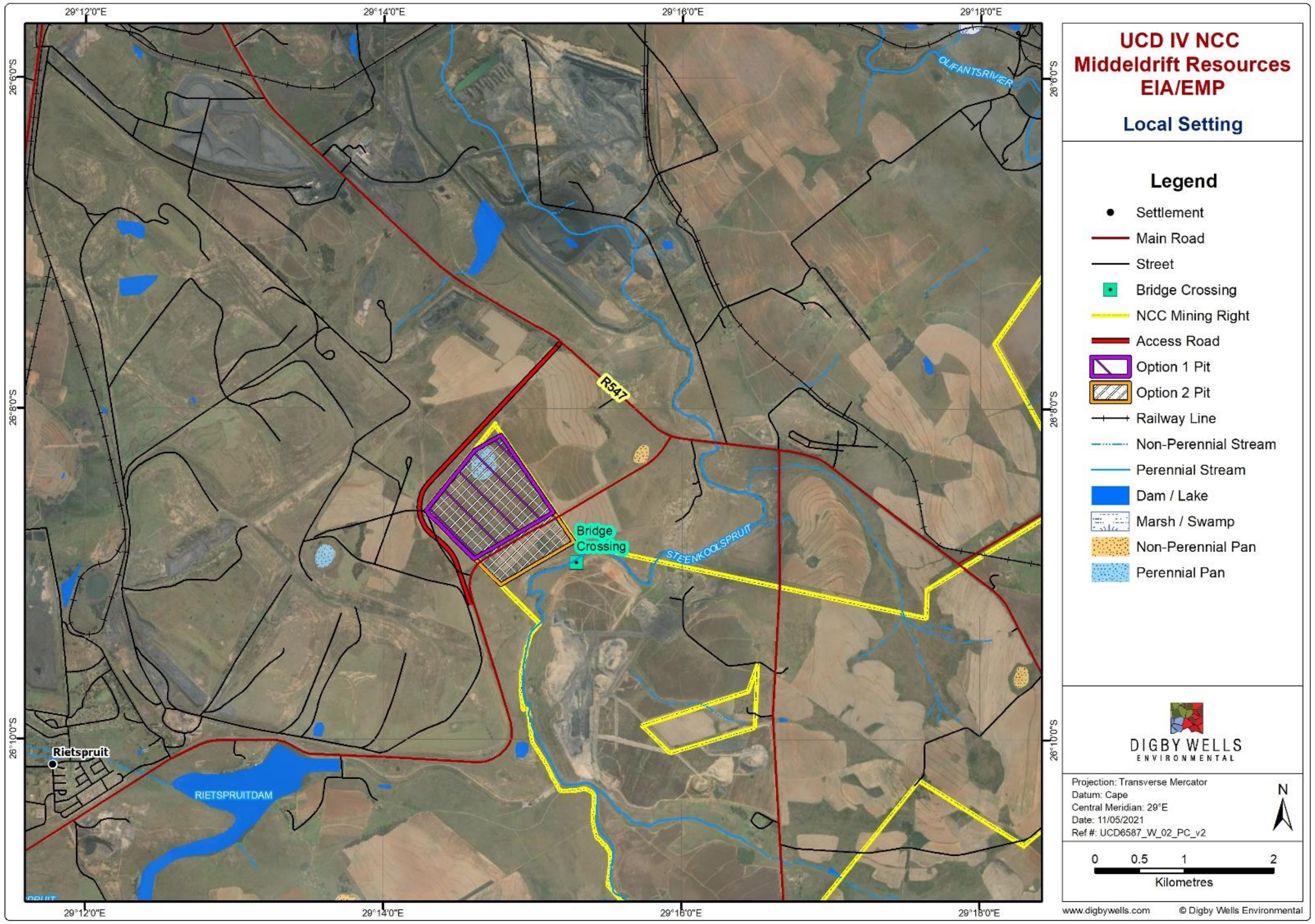

Figure 2-1: Locality map of the Middeldrift Resources

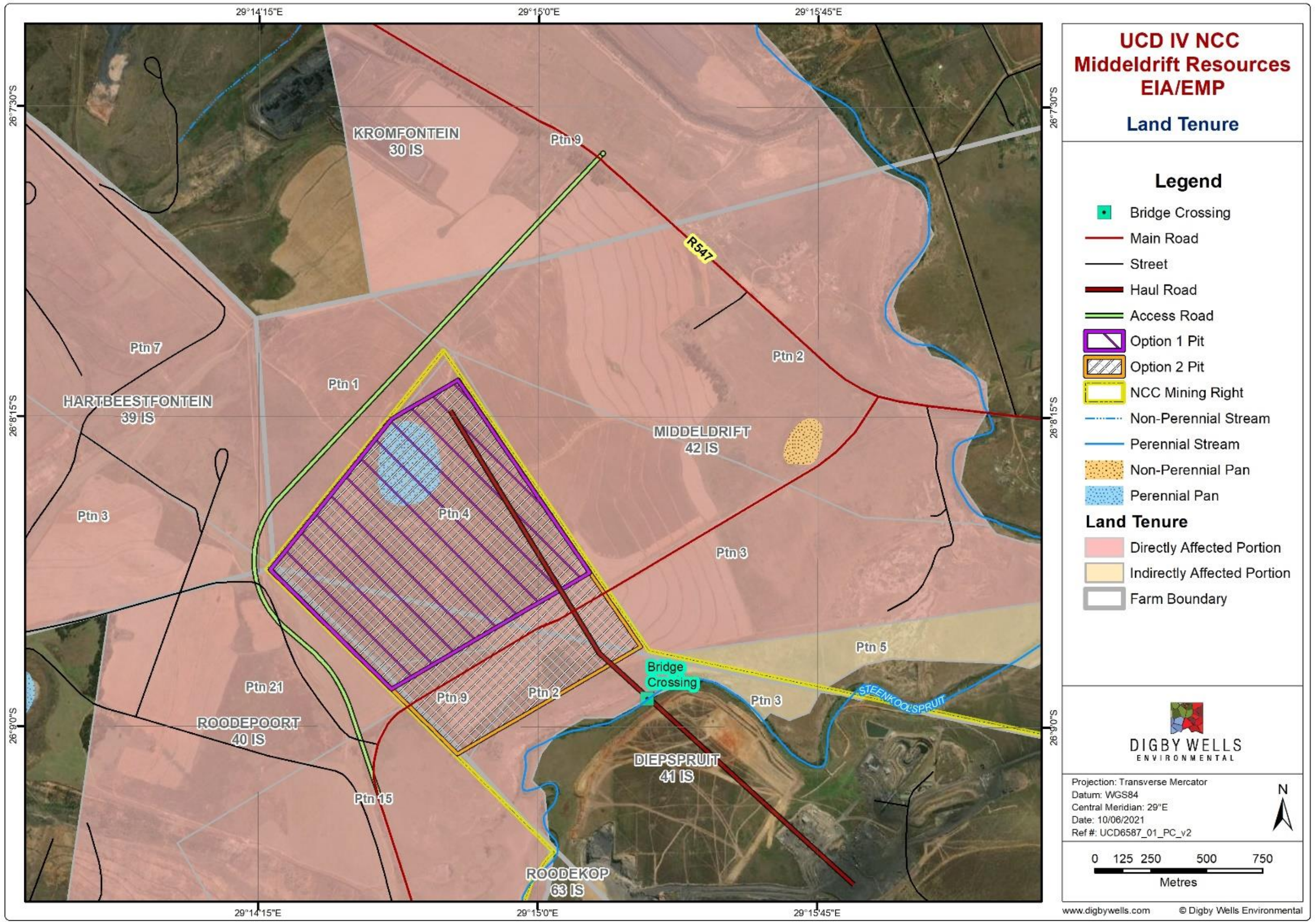

Figure 2-2: Land Tenure Map

3 Legal and Administrative Framework

The table below summarizes the legal framework applicable to this Hydropedology Impact Assessment. The assessment includes the proposed mining and associated activities as detailed in Section 2.

Table 3-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Water Act, 1998 (Act No. 36 of 1998) (NWA) NWA makes provision for water resource management, protection of the quality of water resources and recognising the need for the integrated management of all aspects of water resources to achieve sustainable use of water.	The NWA is applicable for the protection and prevention of pollution of water resources that may arise as a result of the proposed activities within the Middeldrift Resources project site. The hydropedology study will form part of the impact assessment to minimize and remedy the pollution and degradation of the water resources within the project area.
Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) All water uses listed in terms of Section 21 of the NWA need to be licenced, unless it is a permissible water use in terms of Section 22 of the NWA.	The water to be used within the mine does not constitute as a permissible water use in terms of Section 22 of the NWA.
Environmental Impact Assessment Regulations, 2014 Government, Gazette No 40772 including GNR 327 and GNR 328 dated 7 April 2017 The purpose of this Notice is to identify activities that would require environmental authorisations prior to commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.	The proposed mining activities trigger a licence and may result in the release of effluent or pollution of receiving waterbodies.
Section 2 (4) (a) (ii) of the National Environmental Management Act (Act 107 of 1998) (NEMA) Requires that the Environmental Management Plan (EMP) to include a rehabilitation plan, decommissioning plan and mine closure strategy. It must demonstrate pollution control measures and management of mining waste.	The hydropedology study will form part of the impact assessment to minimize and remedy the pollution and degradation of the water resources in the project area.
National Environmental Management: Waste Act (Act 59 of 2008) (NEMWA) Requires that waste generators classify waste material and appropriate handling of waste based on the classification must be adhered to based on the regulations that have been set out within the Act, unless the waste has	The proposed mining will result in waste that needs to be classified and handled appropriately.

Legislation, Regulation, Guideline or By-Law	Applicability
been listed under the waste activities that do not require a waste management licence.	

4 Methodology

This Section details the methodology that was undertaken in this hydropedological impact assessment investigation.

4.1 Desktop Assessment and Literature Review

The following literature was reviewed for better understanding of hydropedological processes within the study area:

4.1.1 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).

The South African land types map represents a marked uniformity of terrain form, soil pattern and climate. Land type data indicates what soils can be expected and where they can be found in the landscape. Furthermore, land type data presents the dominant hillslope within a specific land type. The hillslope is therefore a fundamental landscape unit for understanding hydrological processes (Le Roux, et al., 2011). Dominant streams are preferably used for delineation of the lower side boundary of the identified hillslopes (Le Roux, et al., 2011). The typical terrain units that were used in the land type classification are presented in Figure 4-1.

Land type data and its associated uniformity are limited by scale and the methodology that was available at the time of the survey (Land Type Survey Staff, 1972-2006). Terrain analysis, including slope and elevation parameters was undertaken for improved accuracy of soil form and land type determination.

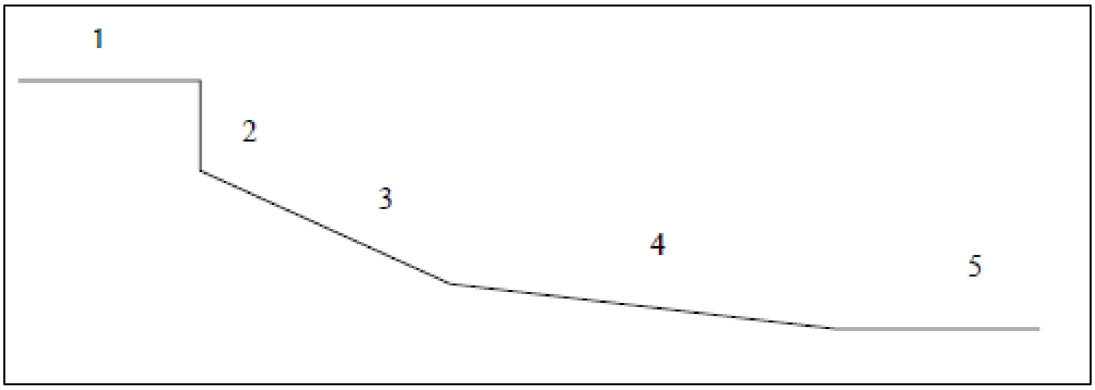

Figure 4-1: Terrain morphological units where 1= crest, 2= scarp, 3= midslope, 4= footslope, 5= valley bottom (Soil Classification Working Group, 1991)

4.1.2 Site Visit

The wet season site assessment was undertaken on the 12th of February 2021 to understand and verify hillslope hydrology which determines the dominant water flow paths within the demarcated landscape units. Soil characteristics which indicate water residence times and leaching effects were assessed during the site visit. Physical and chemical soil characteristics which indicate water residence times (for example, signs of wetness include, grey, low chroma colours, leaching and mottles) were noted during the site visit. Physical indicators of groundwater-surface water interaction were identified such as hillslope seeps, springs and wetlands.

4.2 Hydropedological Classification

Hillslopes were delineated according to methods described by (Le Roux, et al., 2011) and the conceptual hillslope hydrological behaviour determined. The hydrological behaviour was based on identified hydrological soil types as described in the Table 4-1 below.

Table 4-1: Hydrological Soil Types of the hillslopes (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/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)	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.	

4.3 Impact Assessment

The methodology adopted for the hydropedology impact assessment is detailed in Appendix A.

5 Findings

This Section details the findings of the hydropedology survey and impact assessment.

5.1 Baseline Environment

This section describes the baseline environment within and around the project area and this includes the climate, surface water hydrology, topography, land types and land use.

5.1.1 Hydrology and Topography

The Middeldrift Resources is located in the B11E quaternary catchment (Figure 5-1) within the Olifants Water Management Area (WMA 2). The WMA 2 comprises the Olifants River Catchment which is one of the major contributors of flow into the Limpopo River Basin, an international river that is shared between South Africa, Mozambique, Zimbabwe and Botswana. The Olifants River is estimated to contribute a flow of approximately 40% to the shared river basin (USAID, 2019). It drains a total area of 737 x 103 km^2 with an elevation ranging from 0 m to 2400 m above mean sea level (USAID, 2019). The river rises in the Highveld region of the Mpumalanga Province and flows through the Limpopo's platinum belt and the Drakensberg mountains towards the Kruger National Park where it joins the Limpopo River. Then it finally discharges into the Indian Ocean, through Mozambique. This indicates the importance of the Olifants River in sustaining livelihoods and economies in both South Africa and Mozambique, not over-emphasizing sustenance of the great and protected Savanna ecosystems within the Kruger National Park.

The main tributaries of the Olifants River Catchment are the Wilge, Moses, Elands and the Ga-Selati River on the right bank of the river, while the Klein Olifant, Steelpoort River and Blyde River drain the left bank of the river (Gyamfi, et al., 2016). The project area is located close to the Steenkoolspruit which is a perennial river that is a tributary of the Olifants River. The major water uses found within the quaternary catchment are mining and agriculture.

Characteristic of the catchments in this area is the strong relationship between surface water and a shallow, interflow groundwater source (SRK Consulting, 2016). Deeper groundwater does not reveal direct connection to the streams in the upper reaches of these catchments. Responses to rainfall are rapid, with discharges reaching peak flows within 24 hours and dissipating within four to five days, despite the relatively flat topography (SRK Consulting, 2016).

The elevation of the project area ranges from 1 577 – 1 532 metres above sea level (mamsl) which equates to a range of 45 m between the lowest and highest points of elevation within the project area (Figure 5-2). The average slope for the Project Area is approximately 2.4° (Figure 5-3).

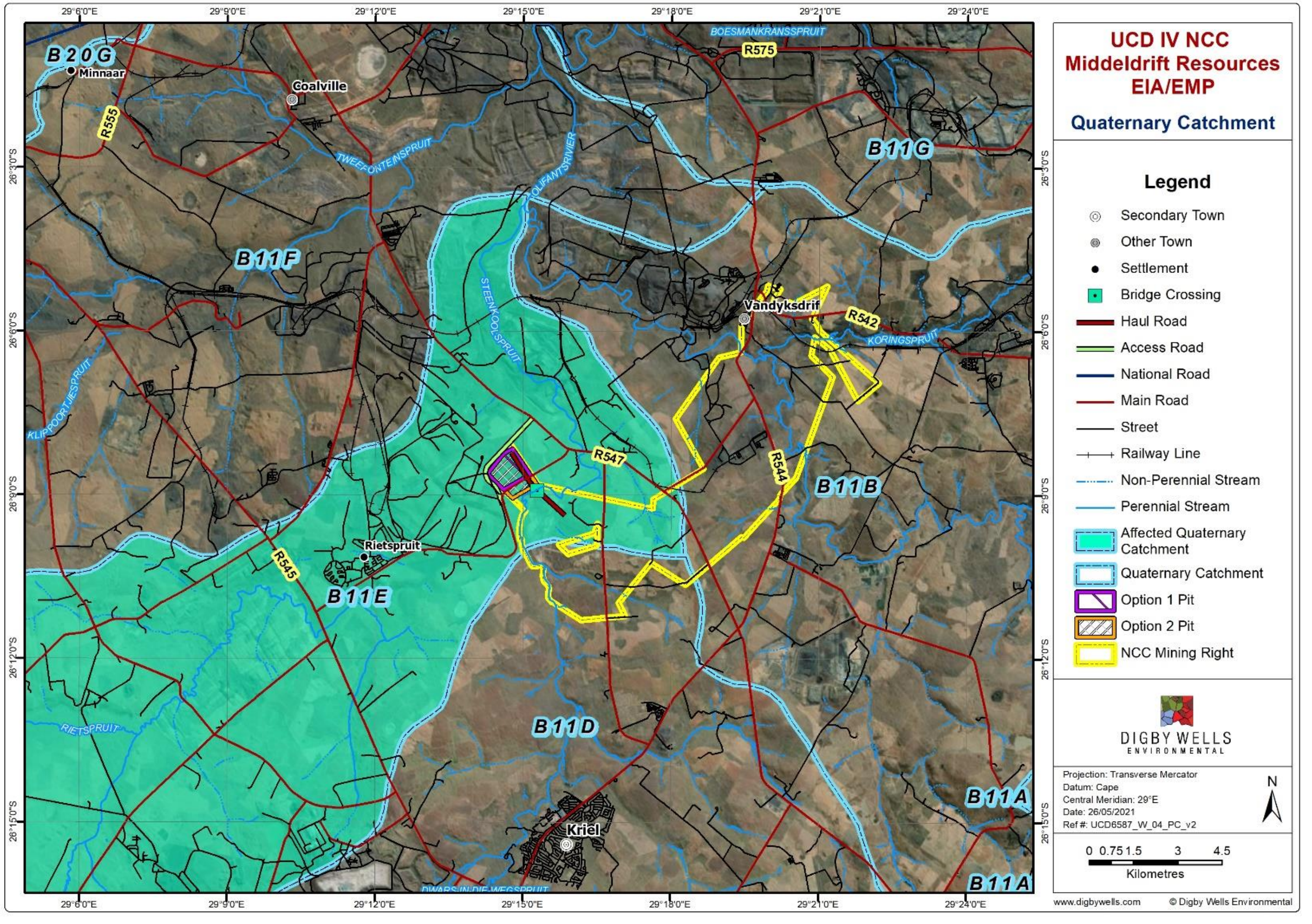

Figure 5-1: Hydrological Setting of Quaternary Catchment B11E

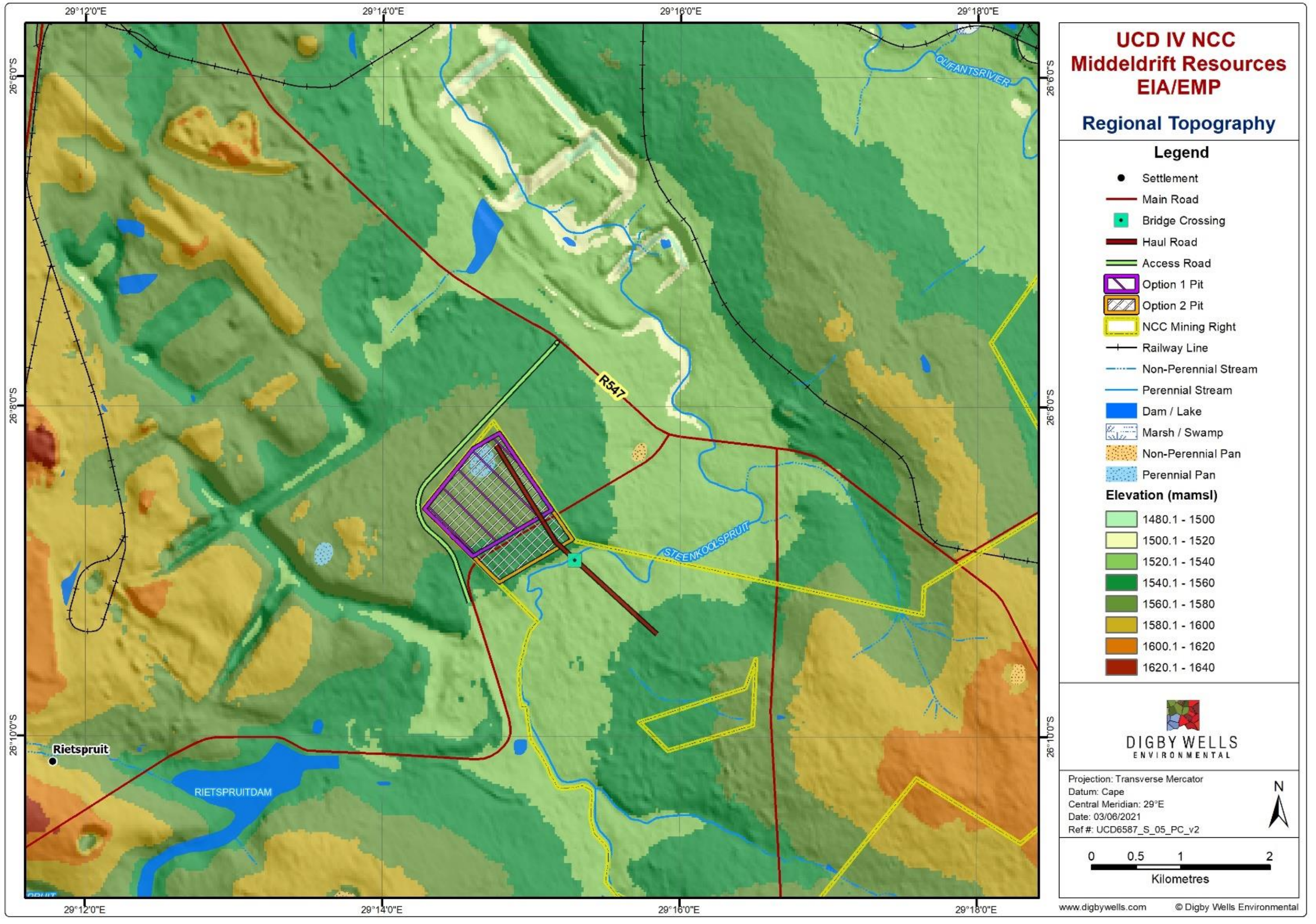
UCD IV NCC
Middeldrift Resources
EIA/EMP
Regional Topography
Legend
Settlement
Main Road
Bridge Crossing
Haul Road
Access Road
Option 1 Pit
Option 2 Pit
NCC Mining Right
Railway Line
Non-Perennial Stream
Perennial Stream
Dam / Lake
Marsh / Swamp
Non-Perennial Pan
Perennial Pan
Elevation (mamsl)
1480.1 - 1500
1500.1 - 1520
1520.1 - 1540
1540.1 - 1560
1560.1 - 1580
1580.1 - 1600
1600.1 - 1620
1620.1 - 1640
Rietspruit
RIETSPRUITDAM
R547
STEENKOOLSPRUIT
OLIFANTSRIVIER
29°12'0"E
29°14'0"E
29°16'0"E
29°18'0"E
26°6'0"S
26°8'0"S
26°10'0"S
Projection: Transverse Mercator
Datum: Cape
Central Meridian: 29°E
Date: 03/06/2021
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Figure 5-2: Topography within the Middeldrift Resources

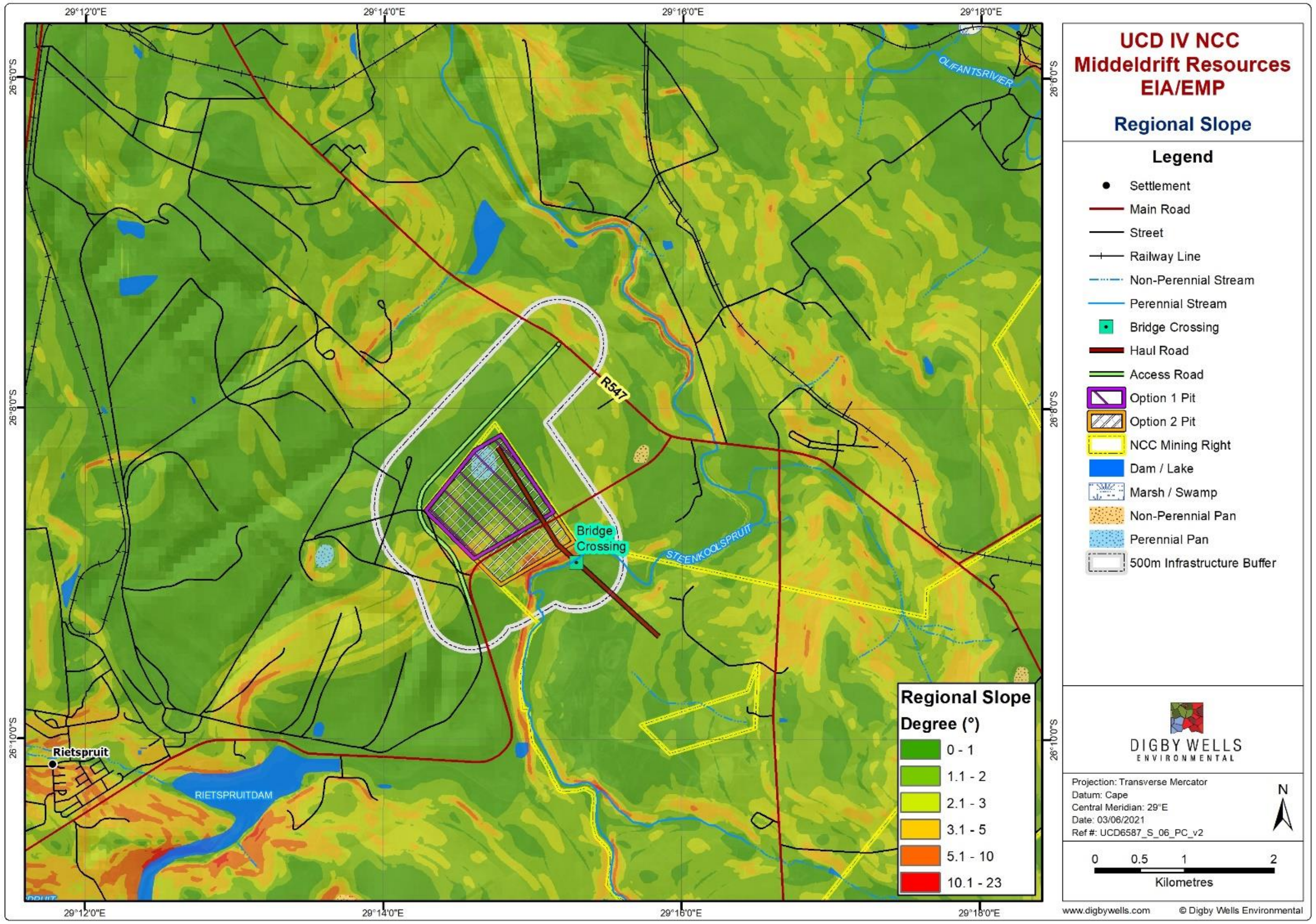
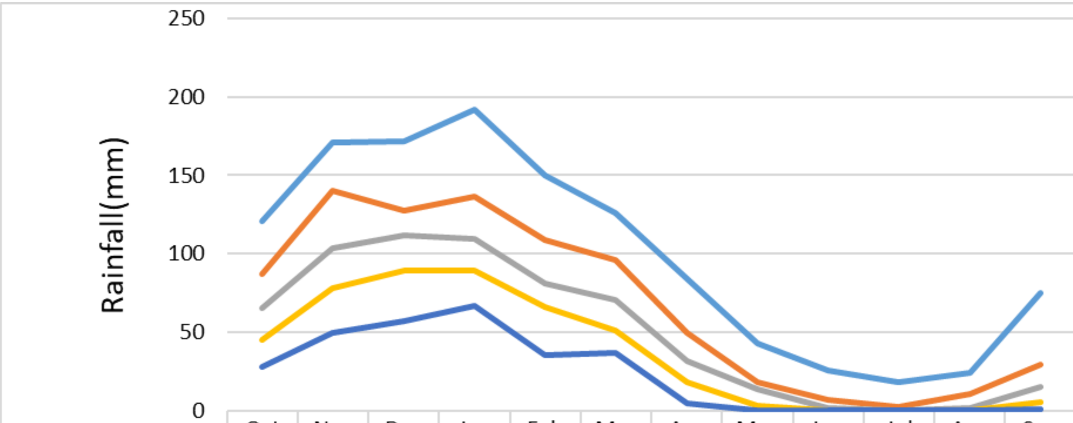


Figure 5-3: Slope within the Middeldrift Resources

5.1.2 Climate

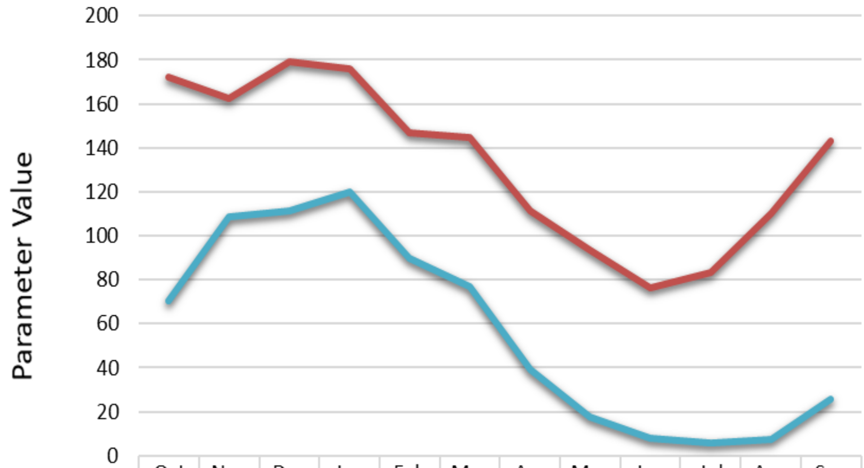
The project area is located within quaternary catchment B11E in the Olifants Water Management Area (WMA 2) and has a Mean Annual Precipitation (MAP) of 682 mm. The New Clydesdale operations fall within the summer rainfall region of South Africa, where more than 80% of the annual rainfall takes place between the months of October to March. Figure 5-4 depicts the likely monthly distribution of rainfall in the catchment. January as the wettest month has a 90th percentile of 192 mm and 10th percentile of 67 mm.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Percentile	121	171	171	192	150	126	84	43	26	18	25	75
70 Percentile	87	140	127	136	108	96	50	19	7	3	11	29
50 Percentile	65	104	112	110	81	71	32	14	2	0	2	15
30 Percentile	45	78	89	89	66	51	18	3	0	0	0	6
10 Percentile	28	50	57	67	36	37	5	0	0	0	0	1

Figure 5-4: The Monthly Rainfall Distribution within the Quaternary Catchment B11E

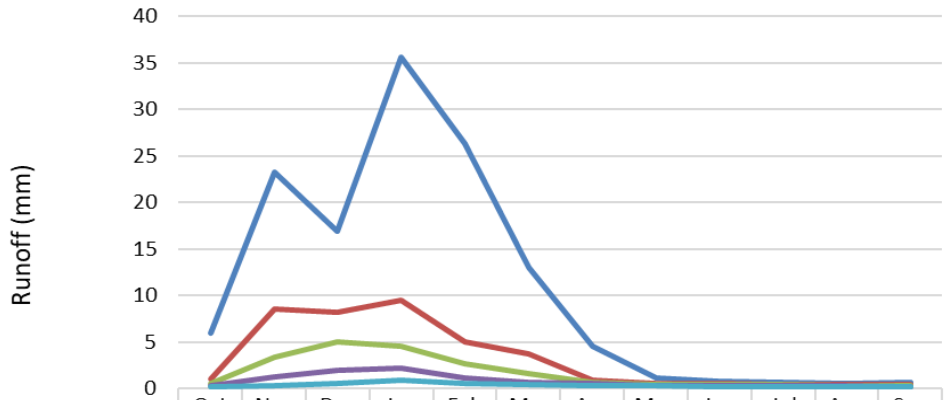
The area experiences a high Mean Annual Evaporation (MAE) of 1 950 mm, which is much greater than the MAP giving rise to distinct wet and dry seasons. The MAP and MAE are likely to be distributed as shown in Figure 5-5.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	172	163	179	176	147	145	111	94	76	83	110	143
Rainfall(mm)	70	108	111	120	90	77	39	17	8	6	7	26

Figure 5-5: Monthly Evaporation and Rainfall within the Quaternary Catchment B11E

The Mean Annual Runoff (MAR) was calculated to be 47.6 mm and accounts for approximately 7% of the MAP in the area. As depicted in Figure 5-6, the highest amount of runoff is experienced in the wettest month of January with the 90th percentile being 35.6 mm while the 10th percentile is 0.6 mm.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Perecentile	6,0	23,3	16,9	35,6	26,3	13,1	4,5	1,1	0,7	0,6	0,5	0,7
70 Percentile	1,0	8,5	8,2	9,4	5,0	3,7	0,9	0,6	0,5	0,5	0,4	0,4
50 Percentile	0,5	3,3	5,0	4,5	2,7	1,6	0,6	0,5	0,4	0,4	0,4	0,3
30 Percentile	0,3	1,3	1,9	2,2	1,1	0,6	0,5	0,3	0,3	0,3	0,3	0,2
10 Percentile	0,2	0,3	0,6	0,9	0,6	0,4	0,3	0,3	0,2	0,2	0,2	0,2

Figure 5-6: Monthly Runoff within the Quaternary Catchment B11E

5.1.3 Land Types

The land types that occur within the Middeldrift Resources and the extent they cover are summarized in Table 5-1. The proposed mine infrastructure is solely within the dominant Land Type Bb4 (Figure 5-8). Based on the Land Types Inventory, the area is dominated by red-apedal, well-drained Hutton soil form and the Glencoe and Avalon soil forms. The Glencoe soil form consists of an orthic A horizon overlying a yellow brown apedal B and hard plinthic B horizon. The Avalon soil form consists of an orthic A horizon overlying a yellow brown apedal B and a soft plinthic B horizon.

The general terrain type within the Bb4 land type is presented in Figure 5-7 below. The Bb4 land type is dominated by terrain unit Type 3, which is characterised by a slope of 3 to 8% (Land Type Survey Staff, 1972-2006). Terrain unit 1 represents the crests while unit 5 represents the lowest point in the topography of the land type, which are the channelled valley bottoms (streams) or unchanneled valley bottoms. These terrain units are correlated to the Land Types from which the distribution of the expected soil type within each terrain unit is given. The soils are described as dystrophic and mesotrophic, which defines the leaching class. Dystrophic soils are highly leached, while mesotrophic soils are moderately leached (Land Type Survey Staff, 1972-2006). The plinthic subsoil is characterized by an accumulation of iron (and frequently Manganese) oxides and hydroxides, with the localization of high chroma mottles and concretions. In a hard plinthic B horizon, an indurated zone of accumulation of iron and manganese oxides forms which is relatively impermeable.

Table 5-1: Distribution of Land Types within the Middeldrift Resources

Land Type	Area (km^2)	Area (%)	Description of broad soil patter code
Bb4	3.61	99	Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise >33% of land type)
Bb5	0.0038	1	

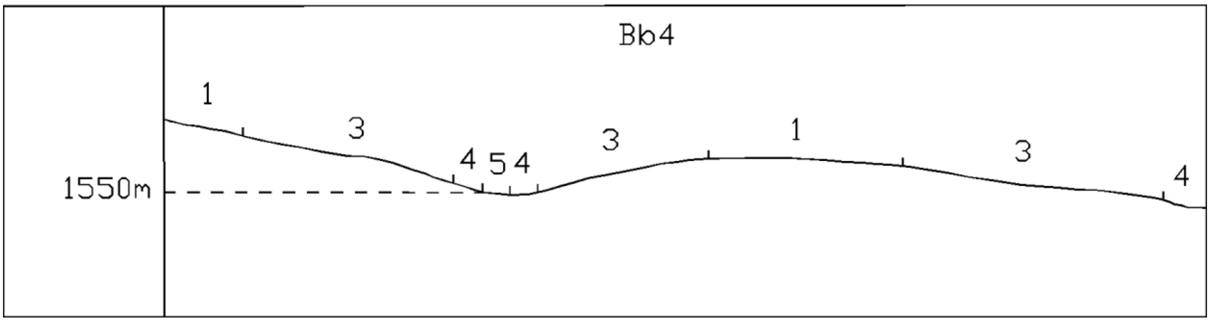


Figure 5-7: General Terrain Type for the Dominant Land Type Bb4 (Adapted from (Land Type Survey Staff, 1972-2006))

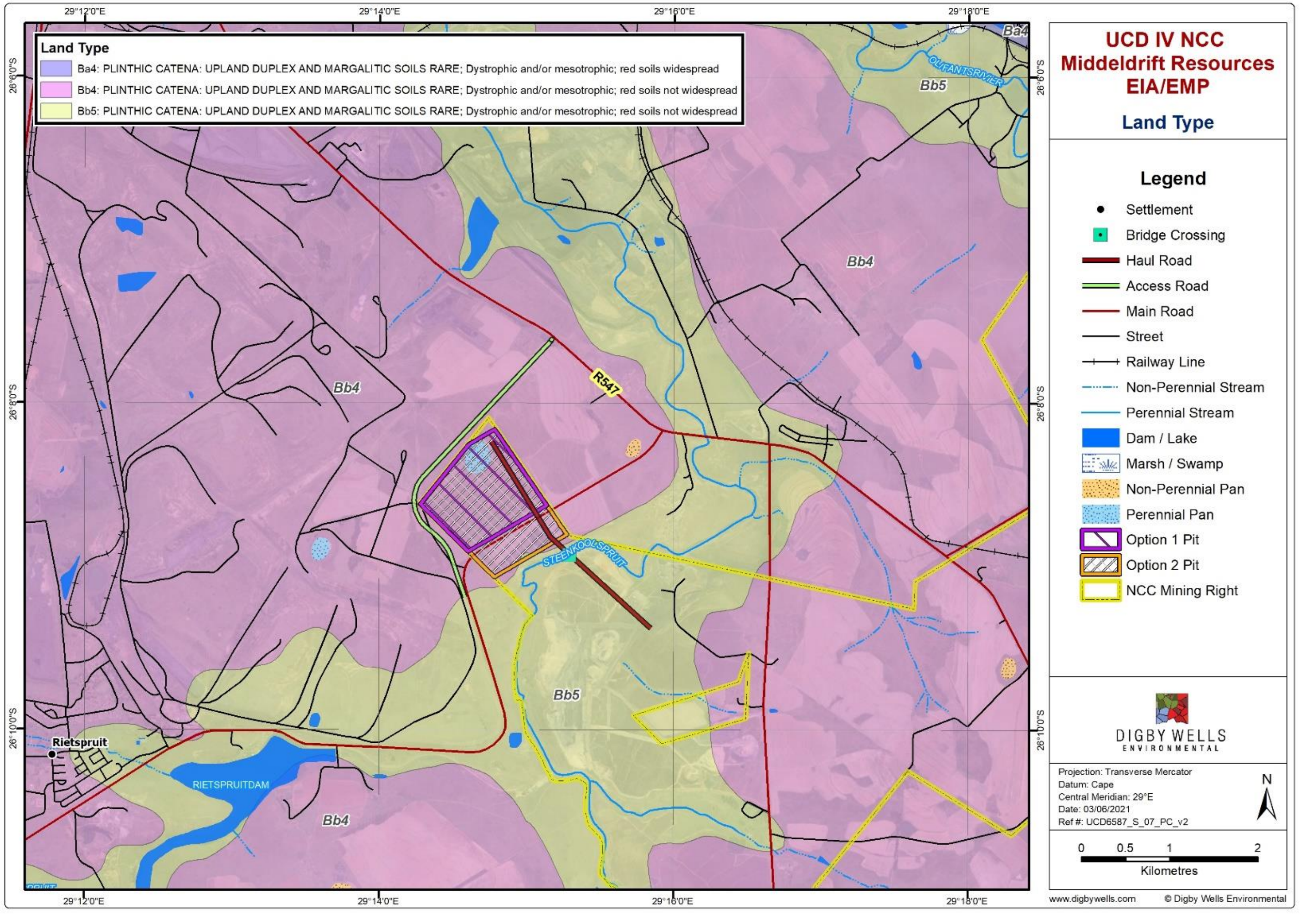


Figure 5-8: Land Type Map within the Middeldrift Resources

5.1.4 Land Use

The current land uses in the region include coal mining, farming, power generation facilities and small residential communities. The dominant land use within the project area is cultivated land. Other land uses within the project area include grassland and small areas are occupied by thickets/dense bush and wetland/ water areas (Figure 5-9).

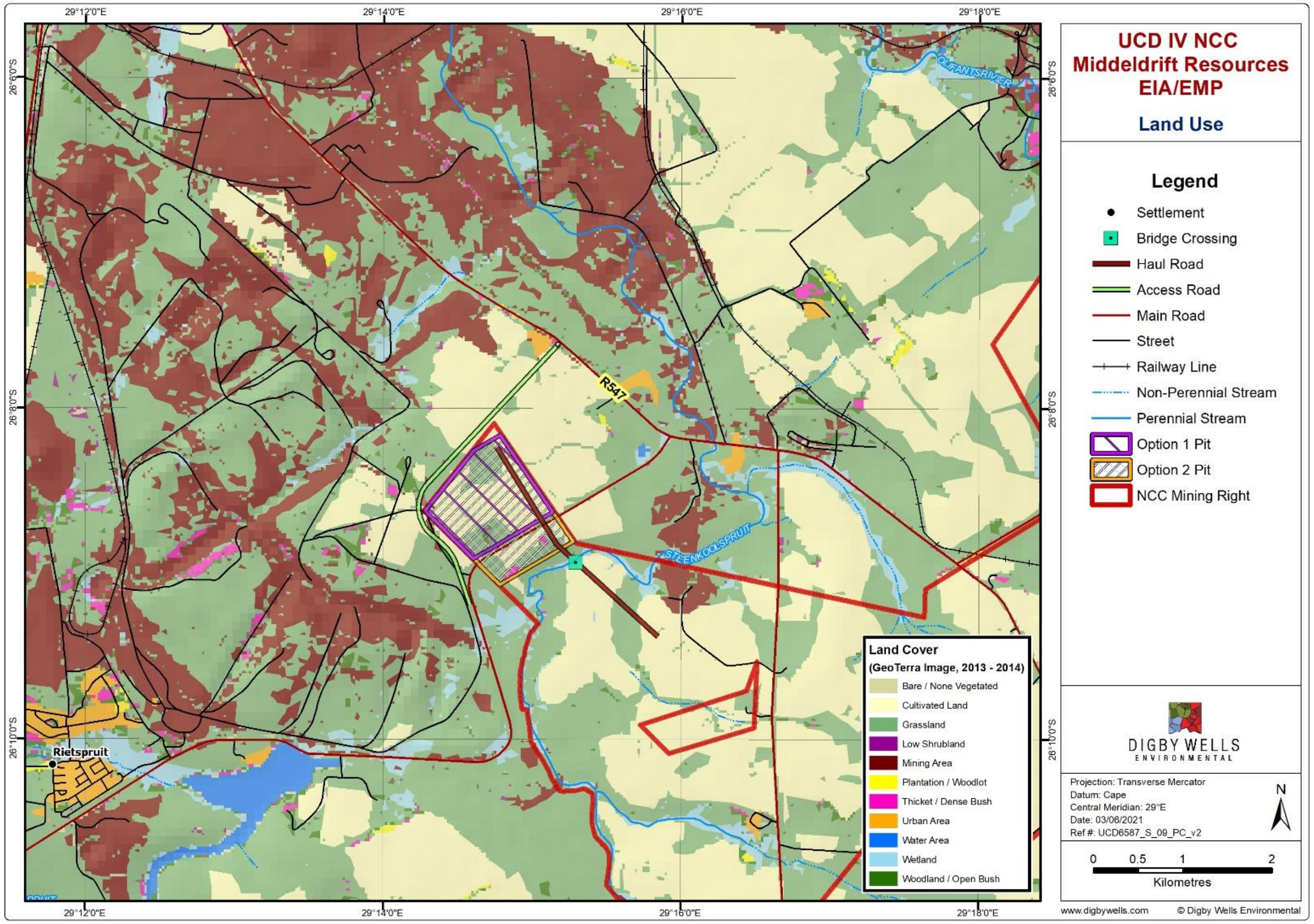


Figure 5-9: Land Use Map within the Middeldrift Resources project area

5.2 Soil Forms and Hydropedological Soil Types

The topography of the surveyed site is dominantly relatively flat, with gentle slopes. Soil augering was undertaken at selected representative sampling points to identify any physical and chemical soil characteristics which indicate water residence times for example signs of wetness including grey, low chroma colours, leaching and mottles) and general hydrological responses in the soil profile. Typical soils observed during the survey are presented and described in Figure 5-10 and Table 5-2. These observations were used to classify the soil forms (Figure 5-11) and associated Hydrological Soil Types (HSTs) (Figure 5-12).

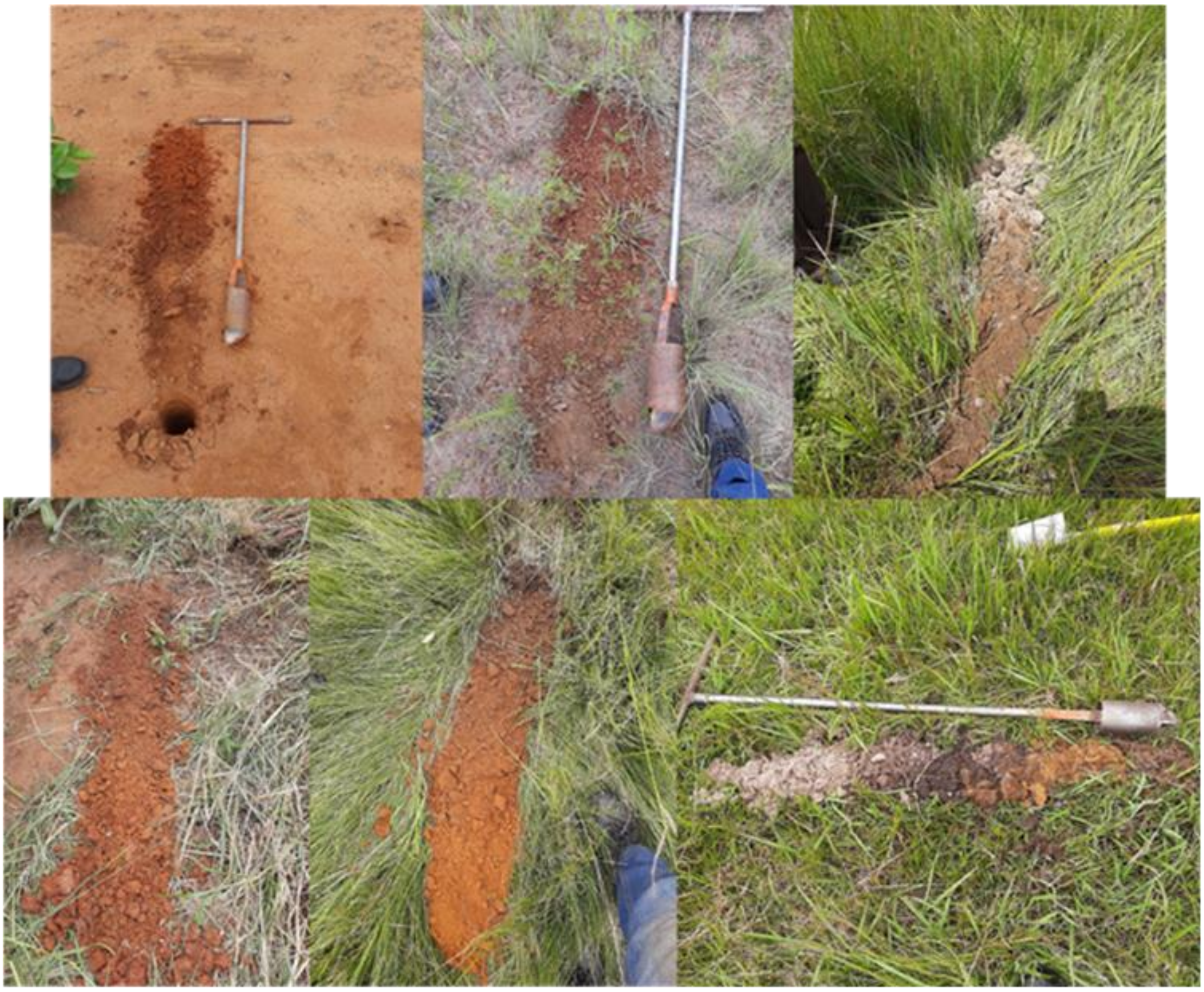


Figure 5-10: Typical soil observations within the Middeldrift Resources project site

Table 5-2: Visual Assessment of Hydropedological Conditions within the Middeldrift Resources

Soil Form	Hydrological Soil Type	Description ((Soil Classification Working Group, 1991))	Observations in the Study Area	
Avalon → Orthic A → Yellow-brown Apedal → Soft Plinthic	Interflow (Soil/Bedrock)	Avalon soils are free draining and chemically active soils with high permeability and leaching potential. Clay, Manganese and iron oxides accumulate with depth under conditions of a fluctuating water table forming localised mottles or soft iron concretions in the soft plinthic B horizon.	Avalon soils in the Study Area covered large areas, dominantly associated with hillslope seep wetlands and intensive cultivated land. The soils are deep, yellow-brown sandy soils overlying a clayey Plinthic layer. The soil depth varies from 500mm to >1200 mm. Avalon soils are often more fertile than Clovelly soils due to the higher clay contents, absorbing more nutrients and organic material.	
Cartref/Glenrosa → Orthic A → E-horizon → Lithocutanic → Lithocutanic	Responsive (Shallow)	Cartref soils consist of leached, sandy E-horizons, overlying a weathered hard Lithocutanic layer containing cutans and signs of wetness (mottles). The soils usually overlie a hard, impermeable sandstone layer.	A very small section of the project area consists of the Cartref soil form to the east. The soils are shallow, leached and overly a hard sandstone layer, restricting hand auguring, water movement and root development. Due to the shallow depths, these soils are not cultivated and used for cattle grazing.	
Clovelly → Orthic A → Yellow-brown Apedal → Unspecified	Recharge	Clovelly soil forms are frequently confused with Hutton soil forms as they share the same characteristics. Clovelly soils have a yellow-brown chroma B-horizon, whereas Hutton soil have a red B-horizon. Both these soil forms have deep, sandy, well-drained characteristics. Yellow-brown Apedal B-horizons form from leached Red Apedal B-horizons and are therefore typically in lower-lying areas, are more wet, has higher permeability potential and lower fertility than red soils. These soils have a high land capability potential and are often intensively cultivated.	Clovelly soils in the Study Area were dominantly used for intensive cultivation. The soils were deep, sandy, freely drained soils with an unspecified B2 horizon (>1200 mm). The soils formed from the weathering of Sandstone parent material and red-apedal soils in the upper catchment. The soils were deep (>1200 mm), sandy, high permeability and well suited for cultivation. The soils are less susceptible to erosion (when vegetated), drain easily and have a high leachability. The soil has a low capacity to supply nutrients to plants and retain nutrients (CEC). These soils were dominantly cultivated and associated with crests, scarps, and mid-slopes.	
Hutton → Orthic A → Red Apedal → Unspecified	Recharge	Hutton soils are characterized by a red apedal B which is more or less uniform in colour and can be defined as red in the moist state, lacks well forms peds other than porous micro-aggregates.	The soil indicated good drainage patterns due to a lack of structure throughout the soil profile. Additionally, no mottles or concretions were observed, indicating an oxidizing environment without any prolonged or periodic saturation in the soil profile.	

Soil Form	Hydrological Soil Type	Description ((Soil Classification Working Group, 1991))	Observations in the Study Area	
Glencoe → Orthic A → Yellow-brown Apedal → Hard Plinthic	Interflow (A/B)	These soils comprise of a Yellow-brown Apedal B-horizon overlying a Hard Plinthic layer containing an accumulation of iron-, and manganese oxides. These soils together with its high clay content and restricted rooting depth (usually shallow soils) prevent free drainage and lower the agricultural potential of the soils.	Glencoe soils within the Project Area were predominantly shallow and had a restricting water, root and auger layer at 600 mm. The Glencoe soils were historically cultivated, had large areas of AIPs, smaller sections of current cultivation and evidence of alterations to the natural hydrology and geomorphology. The topsoil is sandy, freely drained and low in nutrients, overlying a restricted layer, therefore limiting intensive cultivation.	
Glenrosa → Orthic A → Lithocutanic	Recharge (Shallow)	Glenrosa soils are shallow sandy soils overlying a Lithocutanic B-horizon containing cutans and signs of wetness (mottles). Glenrosa soils are often confused with Cartref soils. The Lithocutanic horizon merges into the underlying weathering rock (sandstone) with the same general organisation with respect to the colour, structure and consistency.	The Glenrosa soils were associated with shallow soils adjacent to the large floodplain system in the scarp terrain. The soils had some signs of temporary wetness due to springs and water accumulation due to shallow, rocky sandstone outcrops. The soils were dominantly used for cattle grazing and less disturbed by anthropological activities due to the shallow soil depths (~400 mm).	
Katspruit → Orthic A → G-horizon	Responsive (Saturated)	Katspruit soils are high in clay leading to water accumulation. The restricted water permeability leads to a fluctuating water table and soil wetness for long periods, expressed in the soils as signs of wetness (mottles, clay, gleying). The G-horizon has an accumulation of iron, and manganese oxides, forming mottles. These horizons are saturated for long periods and have noticeable clay accumulation and often referred to hydromorphic soils (wetland soils).	Katspruit soils were identified within the Channelled Valley Bottoms and low-lying areas. The soils are high in clay with mottles and gleying within the first 100 mm. The dominant land use for these soils is wetland and used for cattle grazing and cattle watering/dams. These soils have cultivation restrictions due to the low draining potential causing waterlogging conditions, however, are high in organic material and soil fertility.	
Kroonstad → Orthic A → E-horizon → G-horizon	Interflow (A/B)	Kroonstad soils are referred to as hydromorphic soils due to waterlogging conditions and permanent wetness. These soils consist of a sandy, leached E-horizon overlying a G-horizon with high clay content and clear signs of wetness (mottles/leaching). The soils are saturated for long periods, has a fluctuating water table and have noticeable clay accumulation in the deeper profile. Kroonstad soils have a perched water table resulting in reducing conditions such as mottling, gleying and leaching. These soils are often sandy loams with high permeability in the upper horizon overlying an impermeable/low-permeable B-horizon.	Kroonstad soils in the Project Area are associated with hillslope seep wetlands connected to the pans and floodplain system. The soils are seasonally to temporary wet and was often impacted by adjacent cultivation practices. The soils were leached, very sandy in the A-horizon, overlying a very clayey B-horizon with Fe and Mn accumulation. The soils contribute to subsurface water/ interflow into the pans and CVBs. The soil depth varied, however often deeper than 1200 mm.	

Soil Form	Hydrological Soil Type	Description ((Soil Classification Working Group, 1991))	Observations in the Study Area	
Mispah → Orthic A → Hard rock	Responsive (Shallow)	Mispah soils are dominantly shallow with a restricting water and rooting depth. The soils often have a shallow water table, high surface runoff and associated with sheetrock wetlands. The A-horizon are highly susceptible to erosion when overgrazed, disturbed and low vegetation cover.	Mispah soils in the Project Area are very shallow soils overlying hard rock. The soils can easily be confused with Glenrosa soil forms; however, these soils had no B-horizon overlying the hard rock. The soils were delineated in the scarp, adjacent to the floodplain/CVB system. The soil depth did not exceed 150 mm, therefore restricts cultivation and often had low vegetation cover. These areas were less impacted by anthropological activities.	
Pinedene → Orthic A → Yellow-brown Apedal → Unspecified material with signs of wetness	Interflow (A/B)	Pinedene soils are generally fairly deep (700 – 1200 mm) and have a loamy-sand texture with up to 8% clay content. The soils are yellow-brown with minor drainage limitations in the upper horizons, however, usually contains very high clayey underlying material, limiting free drainage. Due to these high clay sub-horizons, drainage is limited causing waterlogging, potential for wetland formation and accumulation of nutrients, increasing the soil fertility. These soils are often cultivated and has a high land capability.	Pinedene soils on site were deep (>1200 mm) soils with an unspecified, clayey B-horizon. The soils were sandy, well drained and often cultivated due to it high agricultural potential (soil fertility) and easy management rating. Clay increased with depth and often had signs of wetness (mottles) in the deeper horizons, however, were deeper than 500 mm and thus not classified as wetland soils.	
Rensburg → Vertic A → G-horizon	Responsive (Saturated)	Rensburg soils consists of a Vertic-A horizon with high clay, dark colour and high in organic material. The G-horizon subsoil has a grey or gleyic colour pattern (leached) which at times can be hints of green due to the reduction of iron under permanent or periodic anaerobic conditions and has a firmer consistence than the overlying topsoil and is classified as a wetland soil. These soils are often associated with wetlands and classified as a hydrogeomorphic soil.	These soils were augured in the pans and valley bottom wetlands within the Project Area. The soils had a dark, black, clayey A-horizon (vertic) overlying a sandy-clay-loam, light coloured G-horizon. These soils were permanently saturated with water, well vegetated and used for cattle grazing. The soils are high in OM and soil fertility, however restrictions to cultivation due to saturation and waterlogging.	
Witbank → Man-made material	Recharge	Witbank soils are anthropologically impacted soils. These soils are combined and mixed soils with various properties and pedogenesis. These soils are altered from its natural state and include intensive cultivated land.	Witbank soils were dominant in the project area due to historical mining and agropastoral activities. The natural geomorphology of these soils was altered by excavations, compaction, dam building, stockpiling, cultivation and historical infrastructure. Some if these soils were associated with artificial wetness due to compaction, mixing of subsoil and topsoil causing water ponding.	

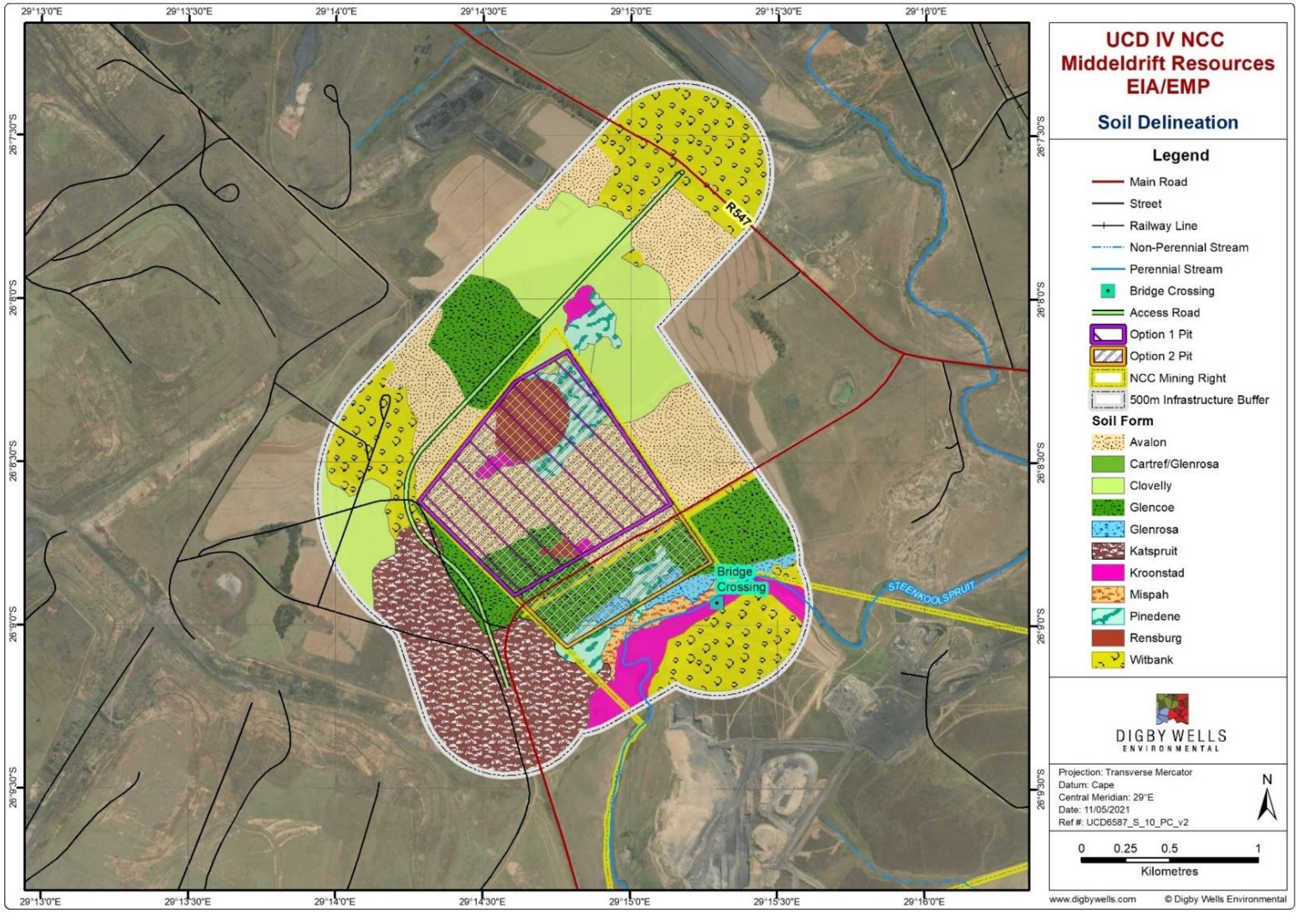


Figure 5-11: Delineated Soil Forms within the Middeldrift Resources

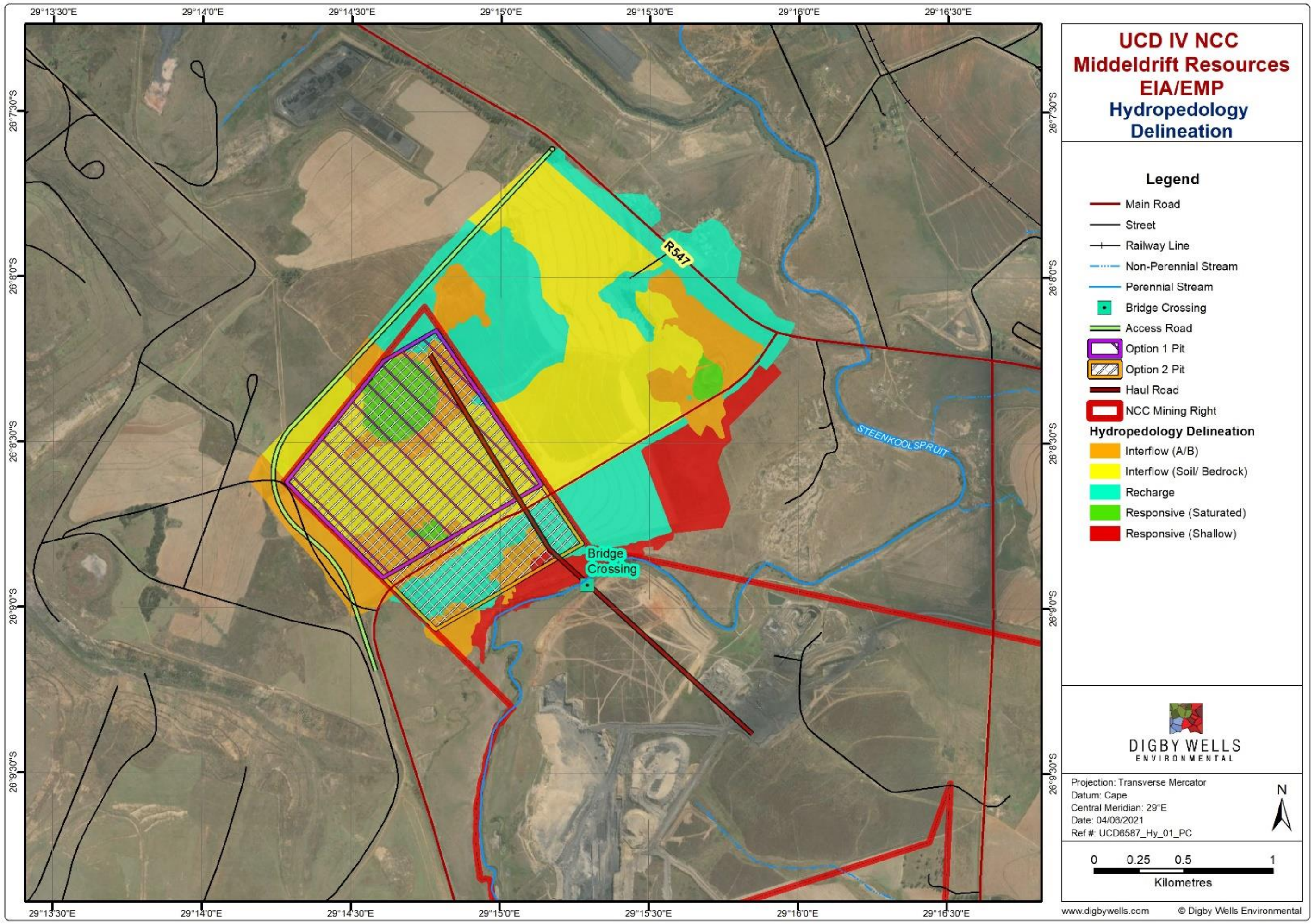


Figure 5-12: Delineated Hydrological Soil Types within the Middeldrift Resources

5.3 Hydropedological Responses in Surveyed Hillslopes

The dominant flow path at the Middeldrift Resources project area is through the interflow (A/B), which is characterized predominantly by lateral flow as a result of difference in soil texture which facilitates temporary build-up of water within the soil profile (

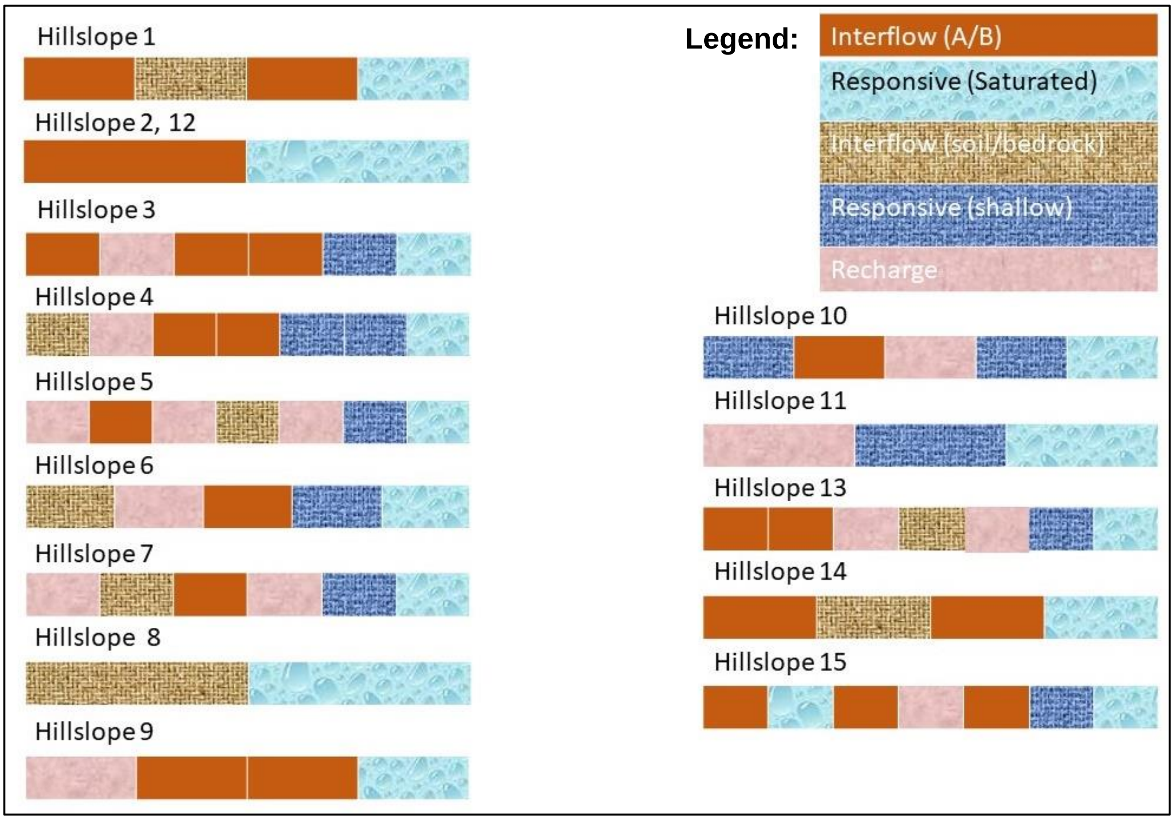


Figure 5-13). The hillslopes showed characteristics of prolonged saturation as evidenced by mottles, concretions and illuviation. As indicated in

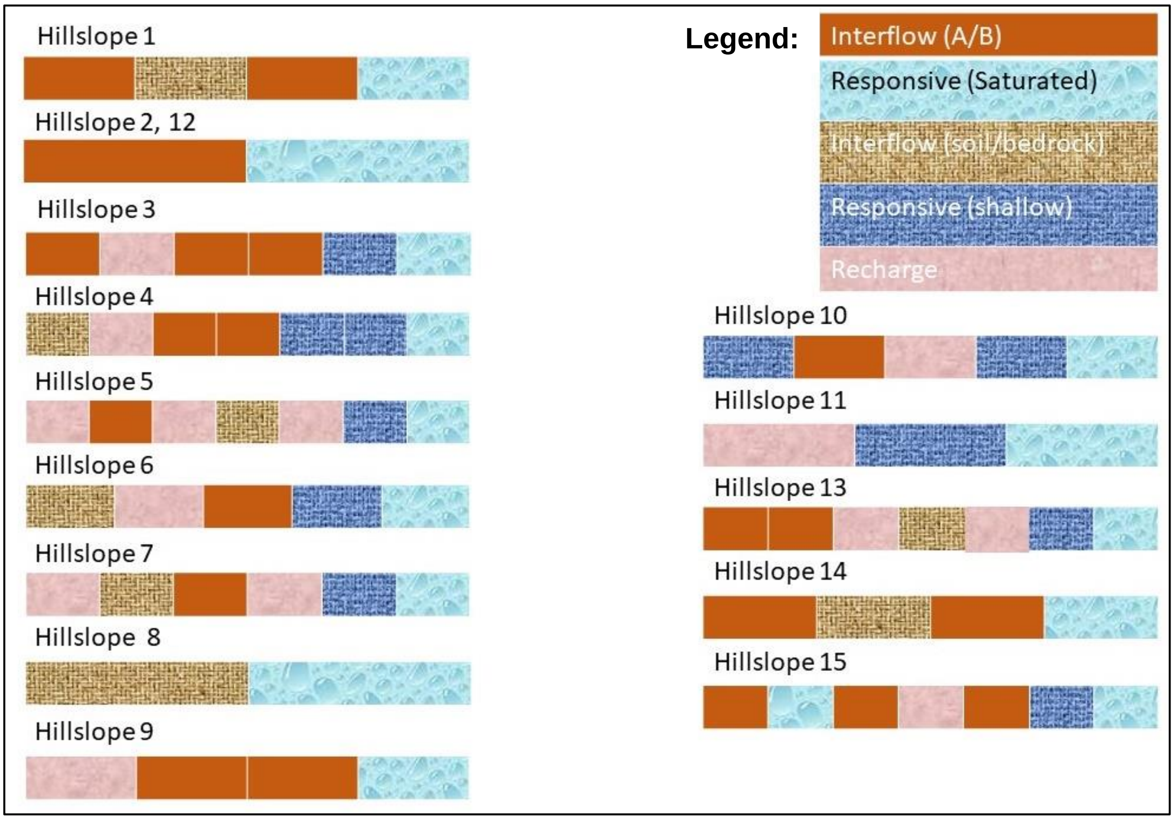


Figure 5-13, most of the delineated hillslopes comprise the Interflow (A/B) and Responsive (Saturated) hydrological soil types. The dominant flow path indicates the potential impact on downstream wetland areas as a result of flow disruptions on upstream hillslope areas. The establishment of an opencast mining will result in the lateral flow into wetlands and may cause the downstream wetland areas to dry up once the opencast pits are dewatered.

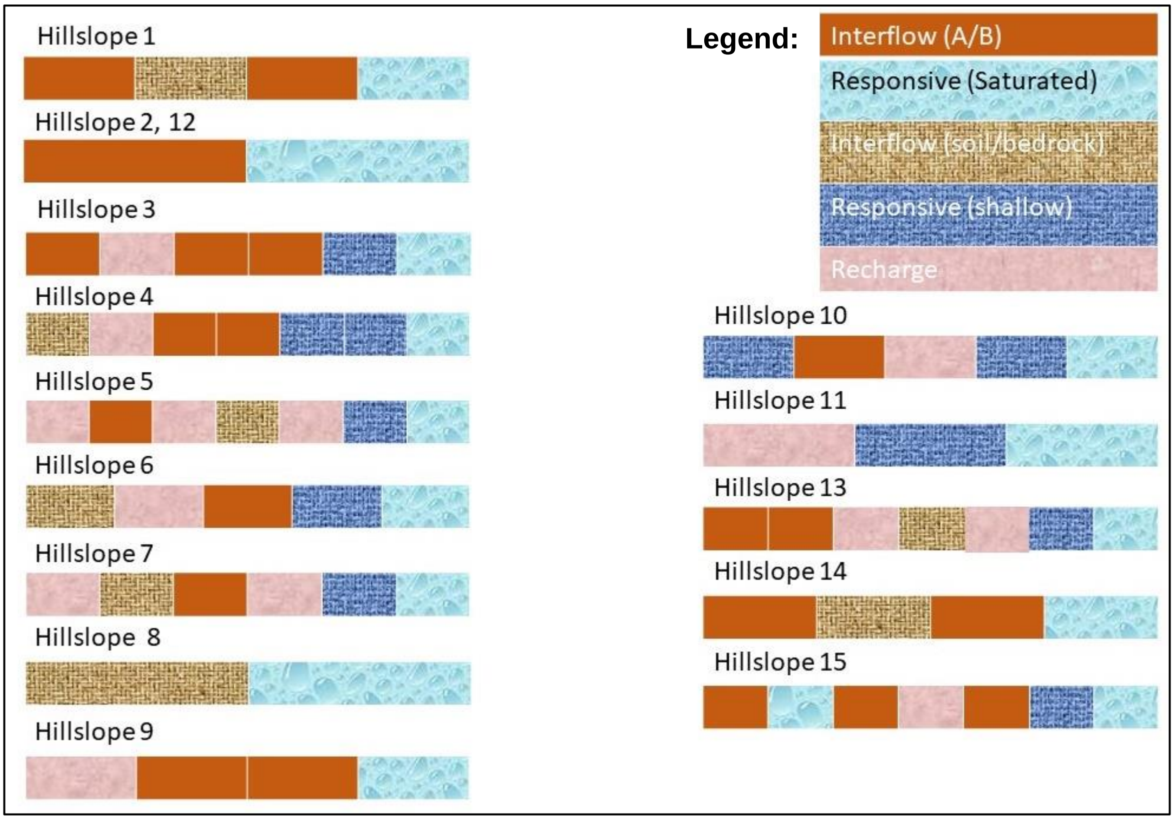


Figure 5-13: Conceptual Hillslope Responses within the Middeldrift Resources

5.4 Hydropedological Implications of Proposed Mining Activities

Hydropedological implications of the proposed mining within the project area were conceptualised by considering dominant flow paths or hydrological response mechanisms, namely overland flow, subsurface flow or interflow and recharge or percolation.

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Groundwater studies coupled with detailed hydropedological surveys should be conducted to assess subsurface hydraulic heads and hydraulic gradients to get insight into flow directions and establish whether there is any significant interaction between groundwater and surface water including wetlands within the study area. Verified flow paths would need to be quantified to determine their significance and subsequent contribution to hillslope hydrological processes in the area.

During the first site visit that was undertaken during the wet season, the pan in the study area was inundated with water. However, during the dry season site visit, the pan was almost dry.

5.5 Impact Assessment

This Section details the impact assessment on the hydropedology in the project area as a result of the proposed mining and associated activities during the construction, operational and decommissioning phases.

5.5.1 Construction Phase

Activities with potential impacts on surface water resources and their mitigation or management measures are listed and described on the table provided below (Table 5-3) and the impact significance rating is given in Table 5-4.

Table 5-3: Interactions and the impacts of activities in the Construction phase

Interaction	Impacts
Clearing and mining through a pan	The mining of a pan will lead to loss of a water resource through disruption of flow paths
Removal of vegetation / topsoil for establishment of opencast mining and construction of linear infrastructure such as the haul road including diversion of the existing provincial road.	Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality
Construction of access road and haul roads (including the construction of a bridge over the Steenkoolspruit)	Alteration of channel geometry at crossings resulting in fluvial erosion and reduced flow regime

5.5.1.1 Impact Description: Loss of a water resource resulting from mining through pan thereby disrupting water flow paths

Mining through a pan will lead to loss of a water resource through disruption of flow paths. This can affect water availability for aquatic ecosystems that depend on the pan.

5.5.1.2 Impact Description: Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality

Vegetation serves as land cover which protects the soil from being eroded during rainfall events. Vegetation cover allows water to seep into vegetation, allowing water to flow at a slow speed and preventing soil from being washed off. Clearing vegetation exposes the soil to the possibility of erosion during a rainfall event or when water flows on that area, therefore increasing the volume of suspended solids in adjacent water resources. Furthermore, the movement of vehicles during construction increases the amount of dust particles which also reduce the quality of nearby surface water resources.

5.5.1.3 Impact Description: Alteration of channel geometry at crossings resulting in fluvial erosion and reduced flow regime

Construction of a culvert across the Steenkoolspruit will have an effect of altering the river channel geometry, increasing fluvial erosion due to the disturbance of soils within the affected riverbanks. Siltation may result and streamflow regime may be reduced affecting the amount of water reaching downstream water users.

5.5.1.4 Management/Mitigation Measures

The recommended management/mitigation measures are as follows:

- DWS approval/exemption needs to be applied for to enable permissible mining and clearing of the pan in accordance with GN704 Regulations;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones; and
- Minimise disturbance of river channel geometry during installation of the culvert/bridge. Re-profile and stabilise any disturbed soils when the culvert/bridge is constructed.

Table 5-4: Impact Significance Rating for the Construction Phase

Dimension	Rating	Motivation	Significance
Impact: Loss of a water resource resulting from mining through pan thereby disrupting water flow paths			
Duration	6	The impact will remain for some time after the life of the project.	90- Moderate (negative)
Intensity	6	Significant impact on highly values species, habitat or ecosystem.	
Spatial scale	3	Impact has the potential to extend across the site and to nearby water resources.	
Probability	6	Almost certain that the impact will occur.	
Post-mitigation			
Duration	6	The impact will remain for some time after the life of the project even if the mitigation measures are applied.	65- Minor (negative)
Intensity	4	Serious medium-term effects on biological or physical environment are expected if the proposed mitigation measures are implemented.	
Spatial scale	3	With proper management, the impact will extend to the immediate downstream of the site and nearby settlements.	
Probability	5	There is a possibility that the impact will occur.	

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality			

Duration	5	The impact will likely occur during construction and decommissioning phases.	-90 Moderate (Negative)
Intensity	5	The impact will have serious, long-term impact on the ecosystem.	
Spatial scale	5	The impacts will go beyond the specified project area.	
Probability	6	It highly possible that it will occur.	
Post-mitigation			
Duration	5	The impact will likely occur throughout the project's life.	18-Negligible (negative)
Intensity	2	The impacts will have minor effects on water resources.	
Spatial scale	2	The impacts will be limited to the project site.	
Probability	2	The possibility of the impact occurring will be reduced due to the implemented mitigation measures.	

Dimension	Rating	Motivation	Significance
Impact: Alteration of channel geometry at crossings resulting in fluvial erosion and reduced flow regime			
Duration	6	The impact will likely remain for some time after the life of the project.	98 - Moderate (negative)
Intensity	5	This may cause very serious, long-term impacts on the water quality and the ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localized extending across the site and to downstream reaches.	
Probability	7	Certain/ Definite: There are sound scientific reasons to expect that the impact will definitely occur.	
Post-mitigation			

Dimension	Rating	Motivation	Significance
Duration	5	The impact will likely occur for the life of the project.	63-Minor (negative)
Intensity	2	With proper management the impact will have low intensity.	
Spatial scale	2	With proper management, the impact will be localized to sites where incidents occur.	
Probability	7	Certain/ Definite: There are sound scientific reasons to expect that the impact will definitely occur.	

5.5.2 Operational Phase

Activities that might have potential impacts on surface water resources during the operational phase are indicated in Table 5-5. Table 5-6 further indicates the impact significance rating. This Section also describes the recommended mitigation/managements measures to limit the effects of the identified impacts.

Table 5-5: Interactions and impacts of activities in the operational phase

Interaction	Impacts
Opencast Pit Excavation during mining will intercept rainfall and runoff which would have otherwise reported to the Steenkoolspruit had the pit not been there.	Runoff and rainfall interception by the opencast pit will affect the availability of water resources for downstream water users
Opencast Pit Excavation during mining and removal of rock through blasting will disrupt hydrological flow paths within affected hillslopes, thereby reducing the amount of water that reports to the Steenkoolspruit.	Disruption of water flow paths will likely reduce the quantity of water reporting to the Steenkoolspruit thereby affecting the availability of water for downstream water users
Concurrent rehabilitation involving backfilling, re-profiling and revegetation of previously disturbed landscapes as mining progresses.	Allowance for free drainage and increase in runoff yield supporting desired post-mining land use

5.5.2.1 *Impact Description: Runoff and rainfall interception by the pit will affect the availability of water resources for downstream water users*

Opencast Pit Excavation during mining will intercept rainfall and runoff which would have otherwise reported to the Steenkoolspruit had the pit not been there.

5.5.2.2 Impact Description: Disruption of water flow paths will likely reduce the quantity of water reporting to the Steenkoolspruit thereby affecting the availability of water for downstream water users

Opencast Pit Excavation during mining and removal of rock through blasting will disrupt hydrological flow paths within affected hillslopes, thereby reducing the amount of water that reports to the Steenkoolspruit.

5.5.2.3 Impact Description: Allowance for free drainage and increase in runoff yield supporting desired post-mining land use

Concurrent rehabilitation involving backfilling, re-profiling and revegetation of previously disturbed landscapes as mining progresses will relatively facilitate free drainage that will support post-mining land use.

5.5.2.4 Management/Mitigation Measures

Recommended management/mitigation measures are as follows:

- Installation of the proposed stormwater management plan is recommended to reduce sedimentation and siltation in nearby watercourses. The recommended perimeter berm around the Middeldrift Opencast Pit will also ensure that clean water is diverted from the dirty opencast pit; and
- Practice concurrent rehabilitation, as proposed, reduce the size of the opencast pit that intercepts rainfall and runoff at any time during the course of the mining process.

Table 5-6: Impact Significance Rating for Operational Phase

Dimensions	Rating	Motivation	Significance
Impact: Runoff and rainfall interception by the opencast pit will affect the availability of water resources for downstream water users			
Duration	5	Impacts will cease after the operational phase.	-84 Minor (Negative)
Intensity	4	Serious medium-term environmental effects. Environmental damage can be reversed in less than a year.	
Spatial scale	3	Impacts will be localised but will likely be felt downstream mostly.	
Probability	7	Certain/ Definite: There are sound scientific reasons to expect that the impact will definitely occur.	
Post-mitigation			
Duration	5	Impacts will occur during the project's life span.	-54

Intensity	2	Limited impacts on the water resources and minimum damage to habitats.	Minor (Negative)
Spatial scale	2	The impacts will be restricted around the project site after the mitigation measures are implemented.	
Probability	6	Almost certain/Highly probable that the impact will occur.	

Dimension	Rating	Motivation	Significance
Impact: Disruption of water flow paths will likely reduce the quantity of water reporting to the Steenkoolspruit thereby affecting the availability of water for downstream water users			
Duration	7	The impact will occur during the operation phase and even post-closure.	-105 Minor (negative)
Intensity	5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate.	
Spatial scale	3	The impact may extend across the site and to nearby settlements.	
Probability	7	It is likely that the impact will occur.	
Post Mitigation			
There are no mitigation measures to prevent this impact from occurring. With concurrent rehabilitation, the restoration of flows into the receiving waterbodies may be achieved, but the dominant flow paths will be permanently altered. The management approach to manage this impact is to ensure that the rehabilitation will benefit the planned post-mining land use as much as practically possible.			

Dimension	Rating	Motivation	Significance
Impact: Allowance for free drainage and increase in runoff yield supporting desired post-mining land use			
Duration	7	Permanent benefits are anticipated once rehabilitation has been undertaken.	84 + Moderate (positive)
Intensity	4	The impacts may take some time to be evident but will be ongoing after the initial benefits of recharging are realized.	

Dimension	Rating	Motivation	Significance
Spatial scale	3	The extent of the benefits will be across the site and to nearby settlements.	
Probability	6	The impact is highly probable.	

5.5.3 Decommissioning and Closure Phase

Table 5-7 indicates activities with potential impacts on soil-water resources during the decommissioning and closure phase. In addition, this section also details the ways in which these impacts can be mitigated or managed. Table 5-8 indicates the impact significance rating for the decommissioning phase.

Table 5-7: Interactions and Impact Activity

Interaction	Impacts
Demolition and removal of infrastructure	Sedimentation and siltation of nearby watercourses leading to reduced water quality
Backfilling, reprofiling and revegetation of the final void	Allowance for free drainage and increase in runoff yield supporting desired post-mining land use
After rehabilitation, dewatering ceases and water accumulates within the backfilled pit and the water reacts with the pyrite in the backfilled material, thereby becoming acidified and starts decanting at low lying positions, including the adjacent Steenkoolspruit.	Contamination of soil and water resources from potential decant of Acid Mine Drainage (AMD) and movement of contamination plume due to the re-watering of the backfilled pit

5.5.3.1 *Impact Description: Sedimentation and siltation of water sources therefore affecting water quality and flow of streams*

Infrastructure demolition and removal will result in debris and exposure of the soil, which may be transported to the nearest surface water resources through runoff. Thus, sedimentation and siltation of watercourses might be result of such activities and consequently affecting the streamflow and quality of receiving water resources.

5.5.3.2 *Impact Description: Allowance for free drainage and increase in runoff yield supporting desired post-mining land use*

Backfilling, reprofiling and revegetation of the final void. However, it should be noted that pre-mining land use will not likely be achieved.

5.5.3.3 Impact Description: Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the backfilled pit

AMD occurs when water reacts with pyrites or sulphide compounds (both coal and the host rock contain pyrite, it is however more abundant in the coal layers (McCarthy, 2011)). After rehabilitation, dewatering ceases and water accumulates within the backfilled pit and the water reacts with the pyrite in the backfilled material, thereby becoming acidified and starts decanting at low lying positions, including the adjacent Steenkoolspruit.

5.5.3.4 Management/Mitigation Measures

The following mitigation/management measures are recommended:

- Re-profile the topography after backfilling to a slope gradient and angle that supports post-mining land use;
- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Steenkoolspruit.
- In the event of decanting, passive treatment (through application of calcium compounds) should be applied to neutralise and treat the AMD before being discharged back into freshwater resources;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD;
- Alternatively, when passive treatment fails to correct the situation active Water Treatment (e.g. Reverse Osmosis) should be considered; and
- Post closure monitoring will allow for monitoring the effectiveness of rehabilitation and will serve as an early detection tool for contamination on water resources.

Table 5-8: Impact Significance Rating for the Decommissioning Phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality			
Duration	5	The impact will likely occur during construction and decommissioning phases.	-90 Moderate (Negative)
Intensity	5	The impact will have serious, long-term impact on the ecosystem.	

Spatial scale	5	The impacts will go beyond the specified project area.	
Probability	6	It highly possible that it will occur.	
Post-mitigation			
Duration	5	The impact will likely occur throughout the project's life.	18-Negligible (negative)
Intensity	2	The impacts will have minor effects on water resources.	
Spatial scale	2	The impacts will be limited to the project site.	
Probability	2	The possibility of the impact occurring will be reduced due to the implemented mitigation measures.	

Dimension	Rating	Motivation	Significance
Impact: Allowance for free drainage and increase in runoff yield supporting desired post-mining land use			
Duration	7	Permanent benefits are anticipated once rehabilitation has been undertaken.	84 + Moderate (positive)
Intensity	4	The impacts may take some time to be evident but will be ongoing after the initial benefits of recharging are realized.	
Spatial scale	3	The extent of the benefits will be across the site and to nearby settlements.	

Dimension	Rating	Motivation	Significance
Probability	6	The impact is highly probable.	

Dimensions	Rating	Motivation	Significance
Impact: Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the backfilled pit			
Duration	7	The impact will potentially persist long after the project ceases.	-119 Major (Negative)
Intensity	6	The impact will have significant impacts on water resources and the environment.	
Spatial scale	4	The impacts will be felt around the mining area and immediate downstream of the project site.	
Probability	7	There is a high probability that this impact will take place.	
Post-Mitigation			
Duration	7	The impacts can occur long after mining operations have ceased and can persist for a few years.	-98 Minor (Negative)
Intensity	4	The impacts will have serious effects on the environment, however, with proper management the adverse effects will be relatively low.	
Spatial scale	3	Municipal Area: Will affect the whole municipal area.	
Probability	7	The impact will occur.	

5.6 Cumulative Impacts

Mines have a huge impact on water resources, both on the availability and quality. In coal mines, a significant amount of water is used for mining and processing, and dust suppressions, thus having huge cumulative impacts on the availability of water. Furthermore, water availability is also reduced with deteriorating water quality because of dirty runoff from mines and contamination from decant water after mine closure.

The project area is situated in the upper Olifant River. There are already reports indicating that the river ecosystems in this part of the catchment are highly polluted, in fact, it is considered one of the most polluted rivers in the Southern Africa (Le Roux, et al., 2012). Therefore, extreme caution and care should be taken when it comes to water quality as to not exacerbate the water challenges already observed prior to the mining activities.

In this view, water quality needs to be closely monitored within and the surrounding surface water resources to ensure adherence with the South African Target Water Quality Guidelines. Additionally, the proposed mining activities will cause the removal of a wetland which provides important ecosystem services. However, it should be noted that the wetland area has already been significantly impacted upon by maize cultivation, which has caused the wetland to dry up during the dry season. The proposed mitigation measures will ensure overall minimum cumulative impacts on the Olifant River.

5.7 Unplanned and Low Risk Events

Unplanned events account for accidental spillages or leakages of dangerous chemicals from waste storage facilities during the operation phase or during loading in construction and demolition phases. It also accounts for pipeline leakages or burst, overflow of dams. Such accidents could have negative impacts on nearby water resources because runoff from these contaminated surfaces will contaminate the freshwater systems, therefore affecting water quality. Table 5-9 summarises the risks of unplanned events and provides management measures.

Table 5-9: Unplanned events, impacts and mitigation measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hazardous chemicals spillage: pipeline burst or leakage	Water and soil contamination	Monitoring/management programs should incorporate emergency response plans for unplanned events. In cases of chemical spillages and leakages, pipe bursts and leakage such response plans and spill kits should be accessible to responsible monitoring or management personnel. The Material Safety Data Sheets (MSDS) should be on standby throughout the project life to ensure proper and safe handling and disposal of chemical products. Regular and continuous monitoring and inspection of wastewater storage dam is of utmost important to identify concerns regarding breaches and potential failures, overflow, or seepages.

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Accidental spillage or overflows of sewage effluent	Surface water contamination and eutrophication of surface water resources. Additionally, heavy metals may be mobilized into the soil solution.	Immediate proper clean-ups should be practised to minimise contamination of soil and water resources.

6 Environmental Management Plan

This Section summarises the proposed activities, the potential impacts of the proposed activities and the environmental aspect affected and the mitigation measures. Table 6-1 details and summarises the frequency of mitigation, timing of implementation, the roles, and the responsible persons in ensuring the implementation of the EMP.

Table 6-1: Environmental Mangement Plan during the Life of Mine withn the New Clydesdale Colliery

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
Clearing and mining through a pan Removal of vegetation / topsoil for establishment of opencast mining and construction of linear infrastructure such as the access or haul road including diversion of the existing provincial road. Construction of a culvert/bridge over the Steenkoolspruit)	• The mining of a pan will lead to loss of a water resource through disruption of flow paths • Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality • Alteration of channel geometry at crossings resulting in fluvial erosion and reduced flow regime	Water quantity and Quality and channel geometry and soil stability	Construction	• DWS approval/exemption needs to be applied for to enable permissible mining and clearing of the pan in accordance with GN704 Regulations; • Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones; and • Minimise disturbance of river channel geometry during installation of the culvert/bridge. Re-profile and stabilise any disturbed soils when the culvert/bridge is constructed.	Control through restricting clearance or disturbance to the project footprint	During the construction phase
Opencast Pit Excavation during mining will intercept rainfall and runoff which would have otherwise reported to the Steenkoolspruit had the pit not been there. Opencast Pit Excavation during mining and removal of rock through blasting will disrupt hydrological flow paths within affected hillslopes, thereby reducing the amount of water that reports to the Steenkoolspruit. Concurrent rehabilitation involving backfilling, re-profiling and revegetation of previously disturbed landscapes as mining progresses.	• Runoff and rainfall interception by the opencast pit will affect the availability of water resources for downstream water users • Disruption of water flow paths will likely reduce the quantity of water reporting to the Steenkoolspruit thereby affecting the availability of water for downstream water users • Allowance for free drainage and increase in runoff yield supporting desired post-mining land use	Water Quantity	Operational	• Installation of the proposed stormwater management plan is recommended to reduce sedimentation and siltation in nearby watercourses. The recommended perimeter berm around the Middeldrift Opencast Pit will also ensure that clean water is diverted from the dirty opencast pit; and • Practice concurrent rehabilitation, as proposed, reduce the size of the opencast pit that intercepts rainfall and runoff at any time during the course of the mining process.	Control through implementation of the stormwater management plan; Rehabilitation through backfilling, re-profiling and revegetation of disturbed landscapes as mining progresses	During the operational phase
Demolition and removal of infrastructure Backfilling, reprofiling and revegetation of the final void After rehabilitation, dewatering ceases and water accumulates within the backfilled pit and the water	• Sedimentation and siltation of nearby watercourses leading to reduced water quality • Allowance for free drainage and increase in runoff yield			• Re-profile the topography after backfilling to a slope gradient and angle that supports post-mining land use; • Soil disturbances during demolition should be restricted to the relevant footprint area;	Control through water quality monitoring; Remedy through passive treatment of AMD; and Rehabilitation through backfilling, re-profiling and revegetation of previously disturbed landscape.	During decommissioning and closure phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
reacts with the pyrite in the backfilled material, thereby becoming acidified and starts decanting at low lying positions, including the adjacent Steenkoolspruit.	supporting desired post-mining land use • Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the backfilled pit	Water Quality and Water quantity	Decommissioning and closure	• All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Steenkoolspruit; • In the event of decanting, passive treatment (through application of calcium compounds) should be applied to neutralise and treat the AMD before being discharged back into freshwater resources; • Use of constructed wetlands can also be considered as a mitigation measure against AMD; • Alternatively, when passive treatment fails to correct the situation, active Water Treatment (e.g. Reverse Osmosis) should be considered; and • Post closure monitoring will allow for monitoring the effectiveness of rehabilitation and will serve as an early detection tool for contamination on water resources.		

7 Monitoring Programme

The monitoring program assists with the early detection of water contamination therefore, allowing mitigation or management strategies to be implemented at an early stage, thus minimising the potential impacts on water resources. Table 7-1 presents the proposed water resources monitoring plan to ensure sustainability of the mining activities within the New Clydesdale Colliery on water resources.

Table 7-1: Monitoring Plan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Ensure regular water quality monitoring in the proposed monitoring sites/locations. This includes water within the mining sites in cases of potential overflow and water discharges into the surface water. Examples of parameters to be monitored include Total Dissolved Solids, Total Suspended solids, pH, Electrical Conductivity; Sulphate; major cations (K, Ca, Mg & Na).	Monitoring should be done on weekly-monthly bases during construction, operation, and decommissioning. After that monitoring should be done at least five years after closure or until rehabilitation becomes sustainable.	Environmental Officer
Sedimentation and Siltation	Investigate the site after a rainfall event, during construction and demolishing to ensure that there is no erosion of soil which may lead to siltation and sedimentation of surface water resources. Rehabilitated sites should be inspected for any signs of erosion. Install filtration material or temporary silt fences and soil stabilizing blankets until vegetation has been established.	After rainfall events or after overland flow	Environmental Officer
Physical structures and Storm Water Management Plan (SWMP) performance	Facilities around the mine should be physically inspected and checked regularly for any anomalies/malfunctions and leakages.	It should be done frequently and continuously	Environmental Officer

Monitoring Element	Comment	Frequency	Responsibility
	Ensure that there is no blockage of inflows in stormwater channels, dams and pipelines in order to maintain good hydraulic conditions. The overall SWMP performance should be monitored to ensure its' effectiveness.		
Surface inspection during rehabilitation	Surface inspection should be done during concurrent rehabilitation until the vegetation cover is established to prevent erosion and sedimentation which will subsequently lead to topsoil loss, sedimentation and siltation of nearby watercourse.	It should be done frequently and continuously	Environmental Officer

8 Recommendations

The following is recommended based on findings of the hydropedological impact assessment:

- DWS approval/exemption needs to be applied for to enable permissible mining and clearing of the pan in accordance with GN704 Regulations;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- Minimise disturbance of river channel geometry during installation of the culvert/bridge. Re-profile and stabilise any disturbed soils when the culvert/bridge is constructed;
- Installation of the proposed stormwater management plan is recommended to reduce sedimentation and siltation in nearby watercourses. The recommended perimeter berm around the Middeldrift Opencast Pit will also ensure that clean water is diverted from the dirty opencast pit;
- Practice concurrent rehabilitation, as proposed, reduce the size of the opencast pit that intercepts rainfall and runoff at any time during the course of the mining process;
- Re-profile the topography after backfilling to a slope gradient and angle that supports post-mining land use;
- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Steenkoolspruit;

- In the event of decanting, passive treatment (through application of calcium compounds) should be applied to neutralise and treat the AMD before being discharged back into freshwater resources;
- Ongoing water quality monitoring of surface and groundwater monitoring is imperative during the life of mine to allow for early detection of potential contaminants that may cause unforeseen negative impacts on the receiving environment;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD; and
- Alternatively, when passive treatment fails to correct the situation, active Water Treatment (e.g. Reverse Osmosis) should be considered.

9 Reasoned Opinion of Whether the Project Should Proceed

Based on findings of the hydropedological assessment, there is no reason why the proposed Middeldrift Opencast Pit mining should not be undertaken, provided all recommended management and mitigation measures are implemented.

10 Conclusions

The project area is located within quaternary catchment B11E in the Olifants Water Management Area and has a MAP of 682 mm. The New Clydesdale operations fall within the summer rainfall region of South Africa, where more than 80% of the annual rainfall takes place between the months of October to March. January as the wettest month has a 90th percentile of 192 mm and a 10th percentile of 67 mm. The area experiences a MAE of 1 950 mm, which is much greater than the MAP leading to distinct wet and dry seasons. The MAR was calculated to be 47.6 mm which accounts for about 7% of the MAP for the area. The highest amount of runoff is experienced in the wettest month of January, with the 90th percentile being 35.6 mm and the 10th percentile, 0.6 mm.

Identified soil forms within the Middeldrift project site include the Rensburg (Rg), Longlands (Lo), Witbank (Wb), Fernwood (Fw), Kroonstad (Kd), Avalon (Av), Mispah (Ms), Pinedene (Pn), Glencoe (Gc), Glenrosa (Gs), Clovelly (Cv) and Hutton (Hu). Hillslope crest positions are dominated by Hu and Cv soil forms which are classified as deep recharge soils. Soils within the midslope such as Av, Lo, Fw, Pd and Gc are mainly classified as interflow soils in which lateral movement of water is dominant feeding the Steenkoolspruit further down footslope positions. Hillslope seep wetlands were identified in the project area and cultivation in these areas most likely impacted on the ecological functions of the wetland. It was observed that the pan is already significantly impacted on by cultivation of maize which possibly causes it to behave more like a seasonal pan, almost drying up during the dry season. Witbank soils were also encountered which represent a shallow recharge HST. The riparian areas of the Steenkoolspruit variably have shallow responsive Ms and Gs soils which are characterised by overland flow due to saturation from above.

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Groundwater studies coupled with detailed hydropedological surveys should be conducted to assess subsurface hydraulic heads and hydraulic gradients to get insight into flow directions and establish whether there is any significant interaction between groundwater and surface water including wetlands within the study area. Verified flow paths would need to be quantified to determine their significance and subsequent contribution to hillslope hydrological processes in the area.

During the first site visit that was undertaken during the wet season, the pan in the study area was inundated with water. However, during the dry season site visit, the pan was almost dry.

11 References

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Appendix A: Impact Assessment Methodology

Impact Rating Methodology

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 11-1. The probability consequence matrix for impacts is displayed in Table 11-2, with the impact significance rating described in Table 11-3.

Table 11-1: Surface water Impact Assessment Parameter ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
7	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great 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.	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. 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.	On-going and widespread positive benefits to local communities which improves livelihoods, as	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational	Likely The impact may occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
	Very serious widespread social impacts. Irreparable damage to highly valued items.	well as a positive improvement to the receiving environment.		life span of the Project.	
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.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem functions. 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.	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	Low positive impacts experience by very few of population.	Limited Limited to the site and its	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
	rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.		immediate surroundings.		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.
1	Limited damage to minimal area of low significance that will have no impact on 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.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

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Table 11-2: 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 11-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which 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	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. 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 social and/or natural environment.	Negligible (negative)

Score	Description	Rating
-36 to -72	An important negative impact which 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 social and/or natural environment.	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)
-109 to -147	A very serious negative impact which 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.	Major (negative)