EIMS (PTY) LTD

MOOIPLAATS COLLIERY

HYDROLOGICAL IMPACT ASSESSMENT REPORT

17 JULY 2019

MOOIPLAATS COLLIERY

HYDROLOGICAL IMPACT ASSESSMENT REPORT

EIMS (PTY) LTD

DRAFT

PROJECT NO.: 41101537
DATE: JULY 2019

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WAIVER

Purpose and basis of preparation of this Report

This Surface Water Impact Assessment Report (Report) has been prepared by WSP Environmental Proprietary Limited (WSP) on behalf and at the request of EIMS (Pty) Ltd (Client), to provide the Client an understanding of the Relevant Documents.

Unless otherwise agreed by us in writing, we do not accept responsibility or legal liability to any person other than the Client for the contents of, or any omissions from, this Report.

To prepare this Report, we have reviewed only the documents and information provided to us by the Client or any third parties directed to provide information and documents to us by the Client. We have not reviewed any other documents in relation to this Report and except where otherwise indicated in the Report.

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1 INTRODUCTION

WSP Environmental (Pty) Ltd (WSP) was commissioned by Environmental Impact Management Services (EIMS) (Pty) Ltd to undertake a Hydrological Impact Assessment for the Mooiplaats Colliery situated in the Ermelo Coalfield in the jurisdiction of Msukaligwa Local Municipality within the Gert Sibande District Municipality. The regional and local settings of the site are shown in **Figures 1** and **2**, respectively.

The project forms part of a Water Use License Application (WULA) in terms of Section 21 of the National Water Act (Act 36 of 1998) and a Section 102 application in terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002). This document forms Phase 2 of a two-phased study. Phase 1 covered the scoping phase and Phase 2 includes a detailed Hydrological Impact Assessment for the Water Use License (WUL) and Section 102 applications.

1.1 PROJECT BACKGROUND

Mooiplaats Colliery is an underground coal mine that utilises the board and pillar mining method. Access to the underground workings is obtained through a decline box cut, situated near the northern boundary of the Mooiplaats property. The total life of the mine is approximately 15 years.

The Mooiplaats Colliery is approximately 126 ha in extent with a mining area of approximately 74 ha. The mining area lies within the Ermelo Coalfield; three coal seams occur in the area of interest. The Upper A, C and Lower B coal seams are poorly developed and not economically viable to mine. The Upper B seam is sufficiently developed and is the target seam for underground mining. Access to the underground workings is obtained through a T-shaped box cut. Mining is taking place at approximately 100m below ground level and is divided into four sections. When the mine is fully developed the underground areas will consist of five sections.

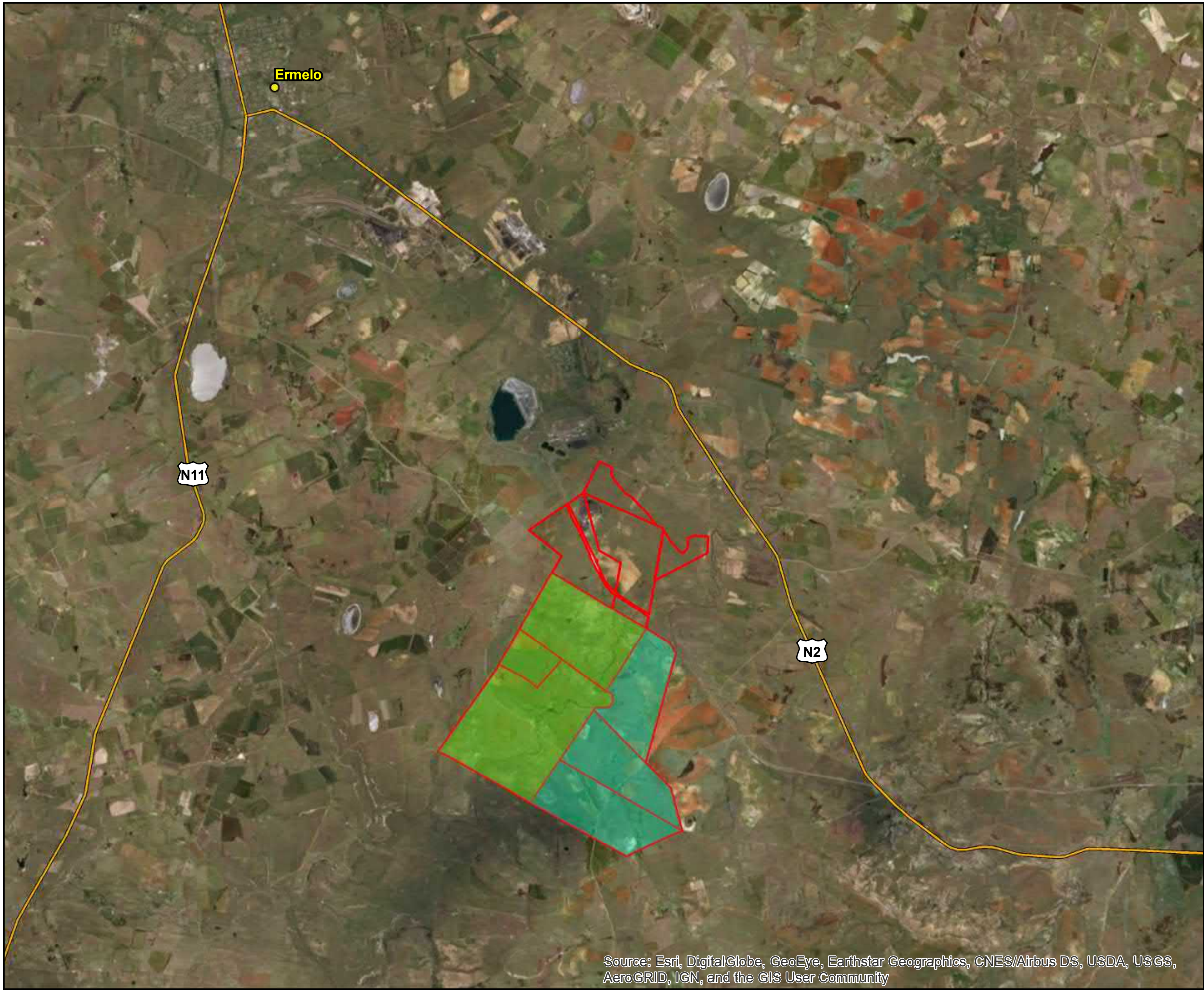
The mine has an existing WUL (License Number; 08/C11B/AGJ/2141). The Colliery has a mining right (MP 30/5/1/2/68MR) in terms of the MPRDA for the Colliery.

The colliery has identified two prospecting areas; PR 677 and PR 676, where expansion is intended. As such, the existing WUL and Section 102 application is required to be amended to include the proposed surface infrastructure.

1.2 PROJECT OBJECTIVES

The objective of the impact assessment phase (Phase 2) of the study is to provide a detailed impact assessment of surface water as part of a WUL and Section 102 applications. In order to meet this objective, the following scope of work has been undertaken:

- Site walkover;
- Indicative flood risk assessment;
- Conceptual storm water management plan (SWMP);
- Static water balance update;
- Water quality monitoring plan; and
- Detailed risk assessment.



EIMS MOOIPLAATS
LOCALITY MAP

Legend

- Towns
- National Routes
- Portion 677PR
- Portion 676PR
- Property Boundary

N

0 750 1,500 2,250 3,000 3,750

Metres

DISCLAIMER

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DATA SOURCE:

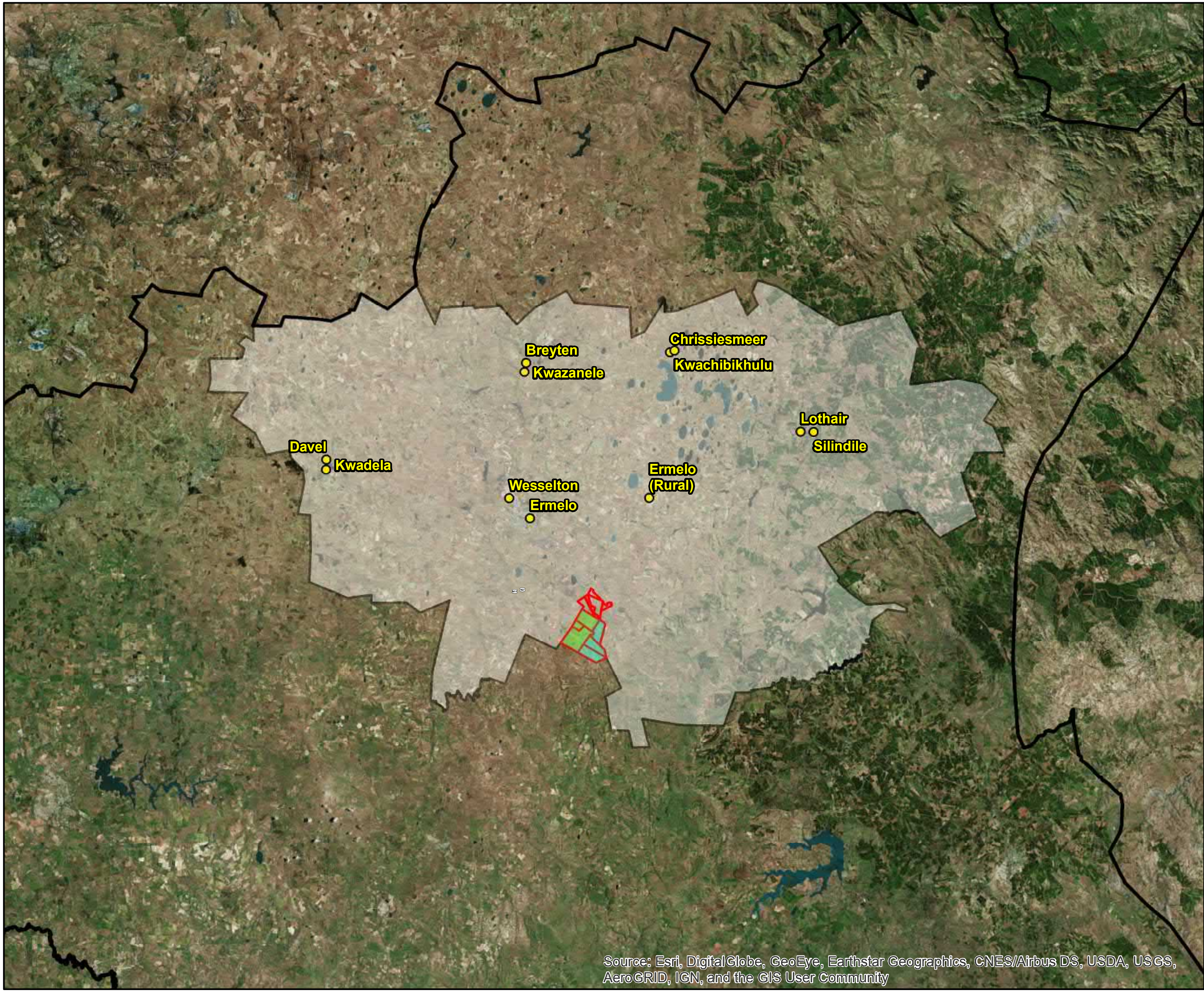
SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM- CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION.

PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:150,000	DRAWN BY: SINENHLANHLA RADEBE
DATE: 2019/06/12	REVIEWED BY: ZAKARIYA NAKHOODA
FIGURE NO: 1	PROJECT NO: 41101537 — REV:



EIMS MOOIPLAATS

REGIONAL SETTING

Legend

- Towns
- Portion 677PR
- Portion 676PR
- Property Boundary
- Msukaligwa Local Municipality
- Gert Sibande District Municipality

N

0 3,900 7,800 11,700 15,600 19,500

Metres

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CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION.

PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:800,000	DRAWN BY: SINENHLANHLA RADEBE
DATE: 2019/06/12	REVIEWED BY: ZAKARIYA NAKHOODA

FIGURE NO: 2	PROJECT NO: 41101537	REV:

2 LEGISLATION AND POLICY FRAMEWORK

The objective of the hydrological assessment is to limit any potential impacts to the surface water and groundwater resources. The National Water Act, Act 36 of 1998 was used as the guidance document to meet this objective. The preamble to the National Water Act recognises that the ultimate aim of water resource management is to achieve sustainable water use for the benefit of all users and that the quality of these resources are protected to ensure ongoing sustainability. The purpose of the National Water Act is stated in **Section 2** as, inter alia:

- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Protecting aquatic and associated ecosystems and their biological diversity;
- Reducing and preventing pollution and degradation of water resources; and
- Meeting international obligations.

The NWA presents strategies to facilitate sound management of water resources, provides for the protection of water resources, and regulates use of water by means of Catchment Management Agencies, Water User Associations, Advisory Committees and International Water Management. The following guidelines were adhered to during the course of the study:

- The National Water Act, Act 36 of 1998 (hereafter referred to as NWA);
- Department of Water and Sanitation (DWS) Government Notice No.704 (GN704);
- Guideline Document for the Implementation of Regulations on use of Water for Mining and Related Activities Aimed at the Protection of Water Resources.
- DWAF (now DWS) Best Practice Guidelines (BPGs):
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A2: Water Management for Mine Residue Deposits, July 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A4: Pollution Control Dams, August 2007.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A6: Water Management for Underground Mines, July 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G1: Storm Water Management, August 2006.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G2: Water and Salt Balances, August 2006.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G4: Impact Prediction, December 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G5: Water Management Aspects for Mine Closure, December 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H1: Integrated Mine Water Management, December 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H2: Pollution Prevention and Minimization of Impacts, July 2008.
  - Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H3: Water Reuse and Reclamation, June 2006.

These documents support Section 26 of the NWA, which regulates any activity that may have an impact on a water resource, and the conservation and protection of this water resource.

3 ENVIRONMENTAL SETTING

This section describes the baseline environment of the mine site, which provided the fundamental understanding of the hydrological assessment.

3.1 GENERAL CLIMATE

The Mooiplaats Colliery site falls within the Highveld region, which is typically characterised by warm wet summers and cold dry winters. The mean annual temperature ranges between 16°C in the west to 12° in the east, with an average of about 15°C for the catchment as a whole. Maximum summer temperatures occur in January and minimum winter temperatures are experienced in July. Rainfall is seasonal and most rain occurs in the summer months (October to April). Precipitation occurs as showers and thunderstorms, and is sometimes accompanied by hail. Frost occurs in winter, with occasional light snow on high lying areas. The mean annual rainfall decreases from the east (1000mm) to the west (500mm), with the mean annual precipitation (MAP) of approximately 700mm

3.2 TOPOGRAPHY

The topography of the area is typical of the upper plateau edge with gentle rolling hills. The moderately flat to rolling hilltop plains are the main cultivated areas, whereas the areas adjacent to the Vaal River and selected tributaries are dominated by steep relief and exposed rock faces. The site drains towards the Vaal River, which flows in a southerly direction. The elevation ranges between 1720 meters above mean sea level (mamsl) on the hilltop plains and 1 586 mamsl in the river valleys.

3.3 DRAINAGE

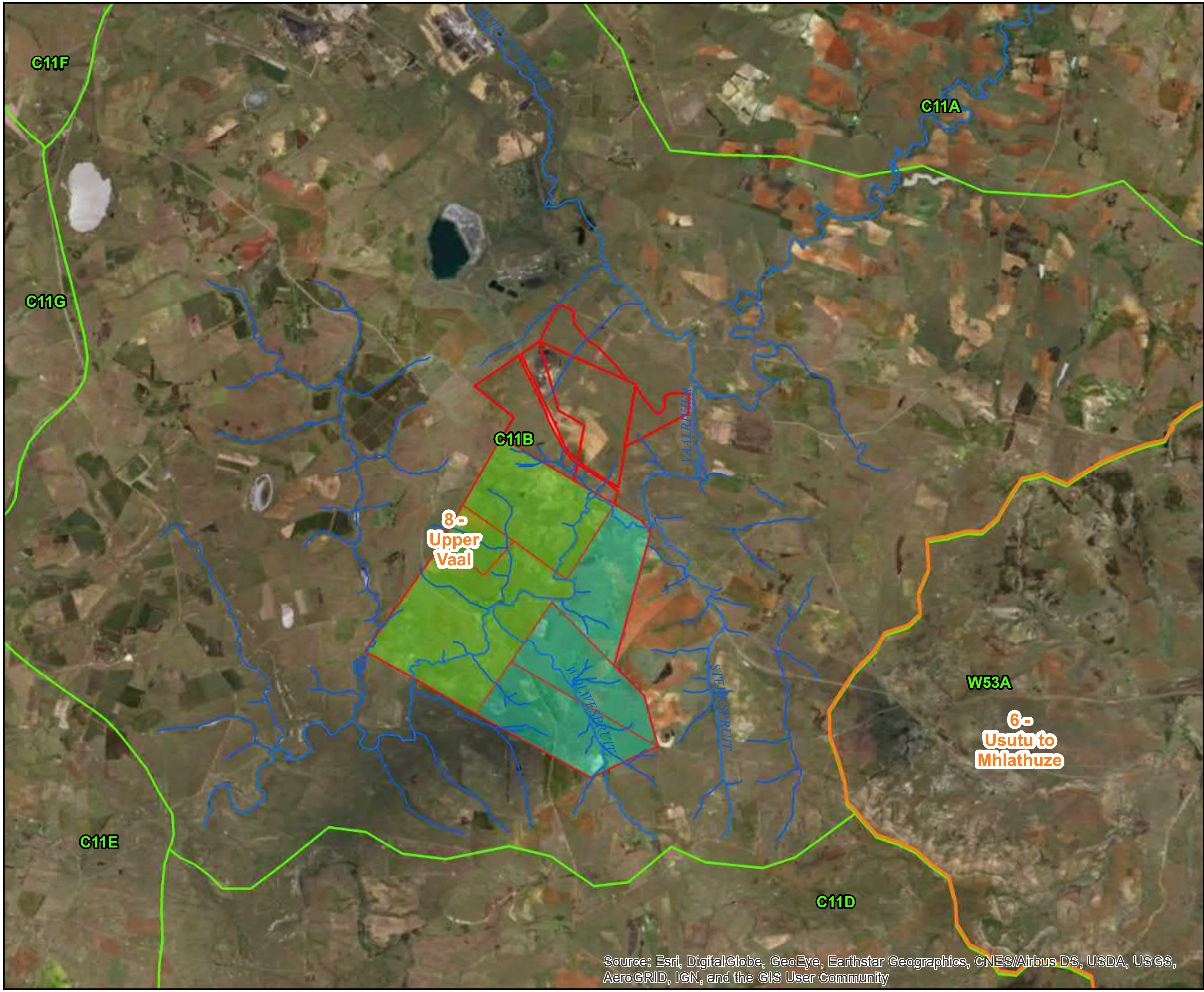
The Upper Vaal water management area lies in the eastern interior of South Africa. Large quantities of water are transferred into the area from two neighbouring areas, as well as water sourced from the Upper Orange River via Lesotho. Similarly, large quantities of water are transferred out to three other water management areas, which are dependent on water from the Upper Vaal water management area to meet much of their requirements. The following river channels are found within the proximity and interconnected to the study site: The Vaal River, which is the third largest river in South Africa, runs north-east of the Mooiplaats colliery boundaries; The Vaal River running along the site is fed by an unnamed tributary, and the Witpunt Spruit. The Vaal River is the largest tributary of the Orange River, which runs westward through South Africa before reaching the Atlantic Ocean.

3.4 QUATERNARY CATCHMENTS

The Mooiplaats Colliery is situated in the Upper Vaal Water Management Area (WMA 8) specifically the C11B quaternary catchment. **Figure 3** presents the WMA and quaternary catchment in relation to the site and catchment information is presented in **Table 1**. The Vaal River is the main tributary within the area flowing in a north south direction towards the Vaal Dam. Other tributaries include the Witpunspruit, Sterkspruit and Wolwespruit, which drain to the Vaal River (**Figure 3**).

Table 1: WMA and Quaternary Catchment Information

WMA	Quaternary Catchment	Catchment Area (km^2)	MAP (mm)	MAE (mm)	MAR (mcm)
Upper Vaal WMA	C11B	536	705	1 400	32.37



EIMS MOOIPLAATS

HYDROLOGICAL SETTING

Legend

- Rivers
- Portion 677PR
- Portion 676PR
- Property Boundary
- WMA
- Quatenary Catchments

N

0 630 1,260 1,890 2,520 3,150

Metres

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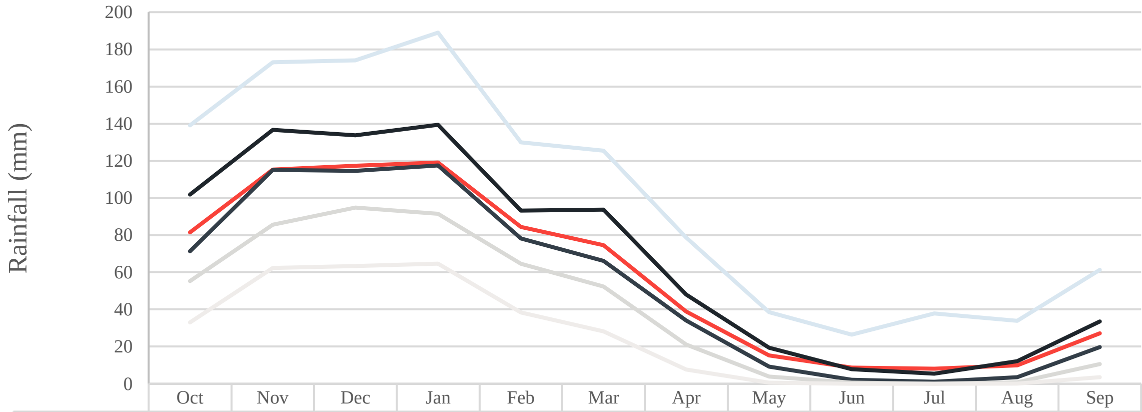
SCALE: 1:125,000	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/06/12	REVIEWED BY: ZAKARIYA NAKHOODA	
FIGURE NO: 3	PROJECT NO: 41101537	REV:

3.5 METEOROLOGICAL AND HYDROLOGICAL CHARACTERISTICS

Meteorological and hydrological characterisation of Quaternary C11B was undertaken and is discussed in the following sub-sections.

3.5.1 RAINFALL DATA

The site falls within rainfall zone C1A associated with quaternary C11B, with an MAP of 705mm. The monthly rainfall distribution is represented in **Figure 4**. The 'E' values show the probability of non-exceedance, so highlight the likelihood that the specific rainfall event will not be exceeded.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average	81	115	117	119	84	75	39	15	9	8	10	27
E10	139	173	174	189	130	125	79	39	26	38	34	61
E30	102	137	134	139	93	94	48	19	8	5	12	33
E50	71	115	115	117	78	66	34	9	2	1	4	20
E70	55	86	95	91	65	52	21	4	1	0	1	11
E90	33	62	63	65	38	28	8	1	0	0	0	4

Figure 4: Monthly Rainfall for Quaternary C11B (WR2012, 2019)

3.5.2 EVAPORATION

Evaporation data for the site was extracted from the WR2012 (WRC, 2019) database. The evaporation zone representative of the site is 13B with an MAE of 1 400 mm. The MAE is clearly considerably higher than the MAP, making this a dry area. The monthly evaporation distribution is presented in **Figure 5**.

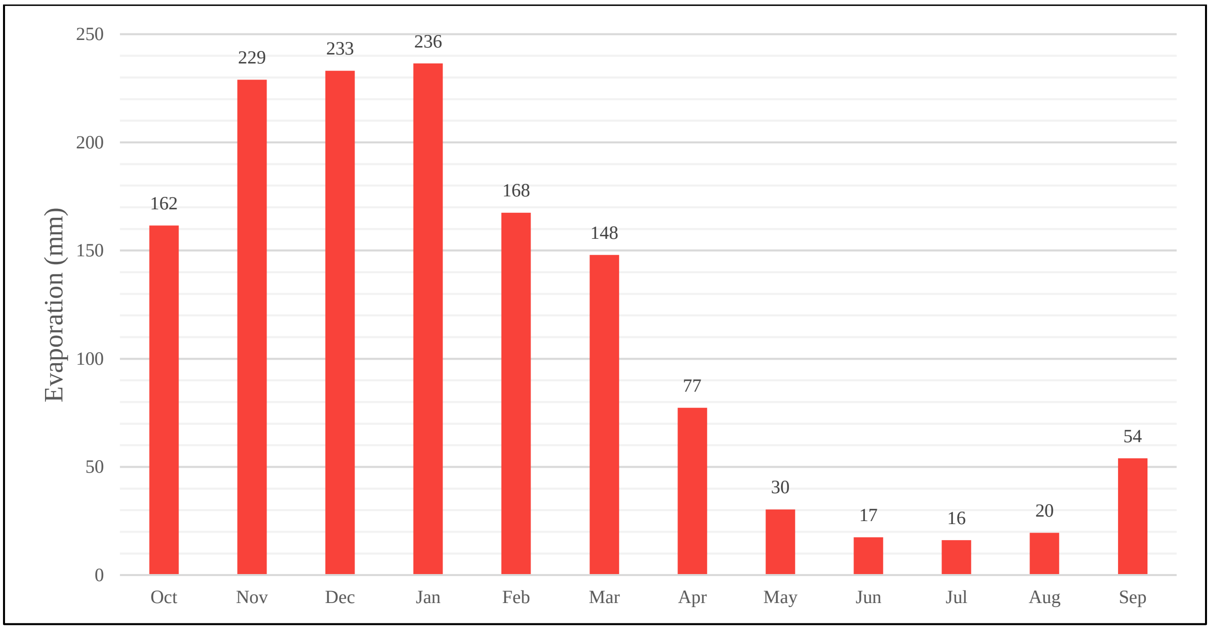
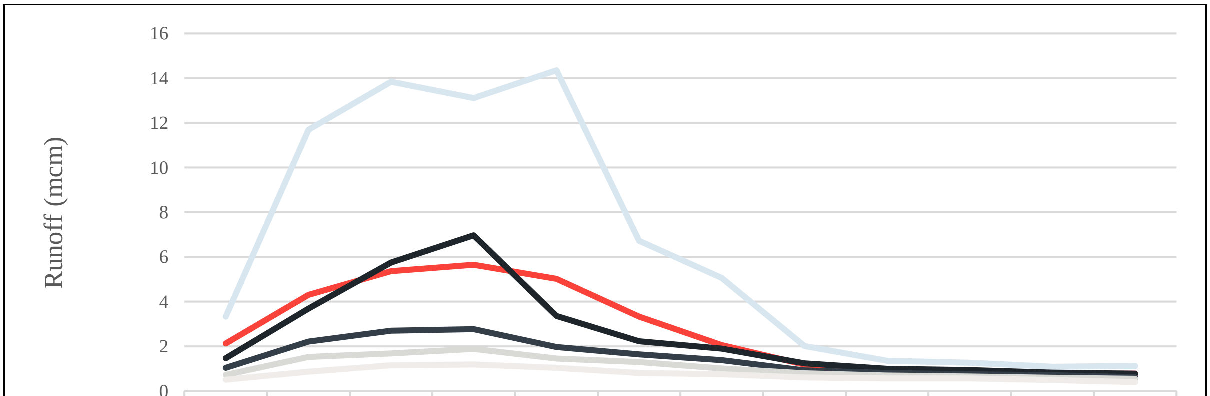


Figure 5: Monthly S-Pan Evaporation for Evaporation Zone 13B (WR2012, 2019)

3.5.3 NATURALISED RUNOFF

WR2012 (WRC, 2019) simulates average runoff of this quaternary at 32.37mcm per annum. The monthly runoff is presented in **Figure 6**. The ‘E’ values show the probability of non-exceedance.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average	2.13	4.3	5.37	5.65	5.02	3.33	2.05	1.19	0.9	0.87	0.78	0.78
E10	3.335	11.69	13.847	13.111	14.354	6.718	5.069	2.01	1.357	1.264	1.089	1.119
E30	1.467	3.694	5.745	6.968	3.355	2.222	1.894	1.247	0.99	0.937	0.824	0.78
E50	1.045	2.22	2.695	2.77	1.975	1.635	1.385	0.93	0.815	0.755	0.715	0.625
E70	0.72	1.533	1.689	1.886	1.455	1.299	1.017	0.8	0.69	0.66	0.59	0.55
E90	0.511	0.861	1.158	1.19	1.044	0.804	0.753	0.61	0.561	0.571	0.491	0.403

Figure 6: Naturalised Runoff for Quaternary Catchment C11B (WR2012, 2019)

3.6 SITE SPECIFIC DATA

3.6.1 DAILY RAINFALL

Rainfall gauging stations located in close proximity to the site were selected from a database compiled by the Institute for Commercial Forestry (ICFR). Data pertaining to the rainfall gauging stations is given in **Table 2**. The De Emigratie rain gauge station was considered representative of the area based on its reliability, distance from site and record length. This dataset is presented in **Figure 7** for the period 1904 to 2000.

Table 2: Rainfall Stations Summary (Kunz, 2003)

Rainfall Station	Station Number	Latitude	Longitude	Distance from site (km)	Record (year)	Reliable data (%)	MAP (mm)
Overvaal	0443338A	26.701°	30.117°	2.5	0	26.8	734
Camden	0443188W	26.601°	30.084°	9.3	95	8.2	751
De Emigratie	**0443196W**	**26.767°**	**30.084°**	**9.3**	**99**	**77.6**	**707**
Goedehoop	0442853W	26.701°	29.984°	11.8	99	43.8	793
Rockdale	0442855W	26.751°	29.967°	15.2	96	10.9	705
Familiehoek	0443018W	26.801°	30.017°	15.4	96	3.8	734

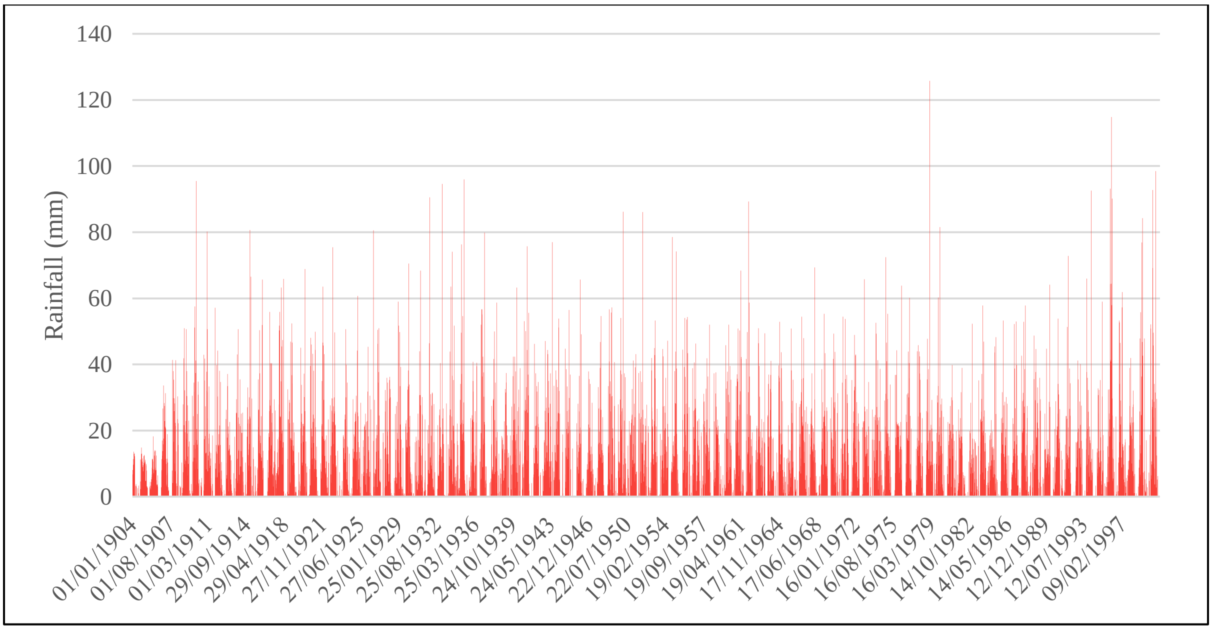


Figure 7: Daily Rainfall of the De Emigratie Rain Gauge

3.6.2 DESIGN RAINFALL

The design rainfall depths for the centroid of the site were extracted using the Design Rainfall Estimation software for South Africa (Smithers and Schulze, 2003). The design rainfall depths (mm) for the 1:2-year, 1:5-year, 1:10-

year, 1:20-year, 1:50-year, 1:100-year and 1:200-year return periods were extracted (**Table 3**). The difference between the 24-hour and the 1-day rainfall is that the 1-day rainfall is measured from 8am on day 1 until 8am on day 2, while the 24-hour rainfall records the 24-hour period that records the highest rainfall.

Table 3: Design Rainfall Depth and Duration for the Site

	Return Period (Year)						
Duration	**2**	**5**	**10**	**20**	**50**	**100**	**200**
5 minutes	8.8	11.7	13.7	15.8	18.6	20.8	23.1
10 minutes	12.7	16.9	19.8	22.8	26.9	30.1	33.5
15 minutes	15.8	21	24.6	28.3	33.4	37.4	41.6
30 minutes	20.2	26.8	31.4	36.1	42.6	47.7	53.1
45 minutes	23.3	30.9	36.3	41.7	49.2	55.1	61.3
1 hour	25.8	34.2	40.2	46.2	54.4	61	67.8
1.5 hour	29.8	39.5	46.3	53.3	62.8	70.4	78.3
2 hour	32.9	43.7	51.3	59	69.5	77.9	86.7
4 hour	39.2	51.9	61	70.1	82.7	92.6	103
6 hour	43.3	57.5	67.5	77.6	91.5	102.5	114
8 hour	46.6	61.7	72.5	83.4	98.3	110.1	122.5
10 hour	49.2	65.3	76.7	88.1	103.9	116.4	129.5
12 hour	51.5	68.3	80.2	92.2	108.8	121.8	135.5
16 hour	55.4	73.4	86.2	99.1	116.8	130.9	145.6
20 hour	58.5	77.6	91.1	104.8	123.5	138.4	153.9
24 hour	61.3	81.2	95.4	109.7	129.3	144.8	161.1
1 day	53.1	70.4	82.6	95	112	125.5	139.6
2 day	65.2	86.4	101.5	116.7	137.6	154.2	171.5
3 day	73.5	97.5	114.5	131.7	155.2	173.9	193.4
4 day	79.8	105.8	124.3	142.9	168.4	188.7	209.9
5 day	85	112.7	132.4	152.2	179.5	201.1	223.6
6 day	89.6	118.7	139.4	160.3	189	211.8	235.5
7 day	93.6	124.1	145.7	167.5	197.5	221.2	246.1

4 SITE WALKOVER

The site walkover was conducted on the 11th of June 2019 which allowed us to groundtruth key areas and infrastructure identified using aerial imagery. . The following was noted:

- Point 1 shows a railway bridge over the Vaal River. The bridge is over a fairly deeply incised, steep sided section of the Vaal River.
- Point 2 is a train bridge over Vaal River, located upstream of Point 3. Point 3 is a low-level concrete causeway over Vaal River, approximately 50 meters downstream of Point 2.
- Point 4 shows a small concrete culvert under private road. There is a large, stagnant pool upstream of culvert.
- Point 5 shows a road bridge over a wide and flat channel of the Vaal River.
- Point 6 shows a concrete pipes under a dirt road, which is roughly 10 m wide.
- Point 7 is a photograph of a very small and narrow stream channel, which appears to originate as a spring approximately 500m east of point 7.
- Point 8 shows a concrete rail culvert that is located under the railway line, which is adjacent to a concrete road culvert. From the photograph, there seems to be no flow at this point at the time of the site walk.
- Point 10 shows a concrete bridge over a river on the farm road. The bridge results in the damming of the stream.
- Point 11 is a photograph of a small concrete culvert that is located under the Transnet service road.

Point	Upstream	Downstream
1		
GPS	26.70178°S 30.08263°E	
2&3		
GPS	26.67893°S 30.12457°'E	

Point	Upstream	Downstream
4		
GPS	26.63740°S 30.08917°E	
5		
GPS	26.64830°S 30.09902°E	
6		
GPS	26.63134°S 30.11290°E	
7		

Point	Upstream	Downstream
GPS	26.63400°S 30.13380°E	
8		
GPS	26.668232°S 30.113448°E	
10		
GPS	26.628783°S 30.115266°E	
11		
GPS	26.637295°S 30.089098°E	

5 INDICATIVE FLOOD RISK ASSESSMENT

5.1 DESIGN FLOOD PEAKS

5.1.1 CATCHMENT DELINATION

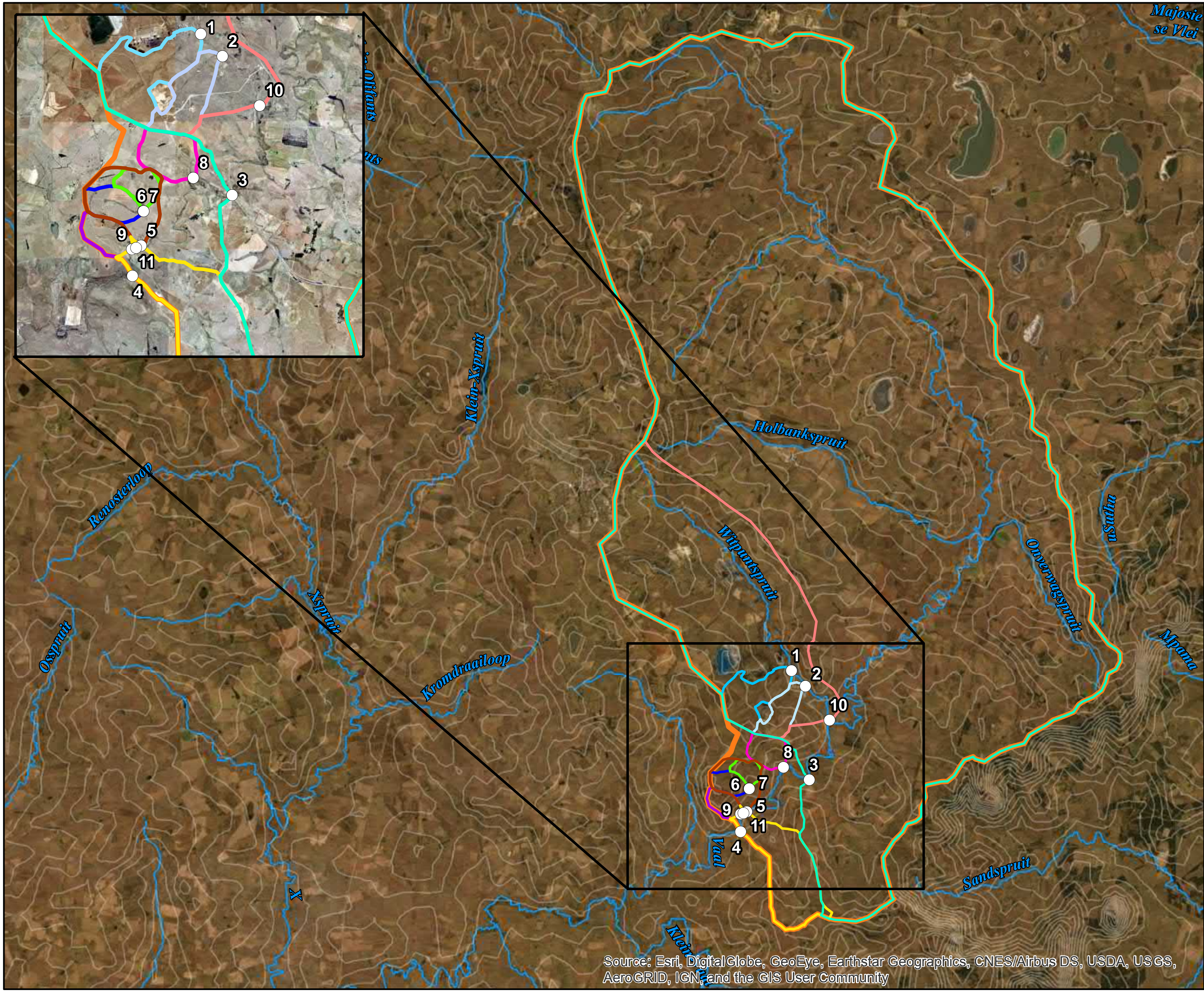
The contributing catchment to the river reach was delineated using readily available topographic data. In order to provide a more accurate delineation, aerial imagery was utilised so that current land use and land transformation practices could be incorporated. Catchment delineation was undertaken using 5m contours.

Mining areas were not accounted for as this was anticipated to be contained on-site within the storm water management system and pollution control dams associated with the facility.

The delineated catchment is represented in **Figure 8**, together with the associated infrastructure that was considered part of the delineation. Catchment information that was used in generating the design flood estimates for the contributing catchment is summarised in **Table 4.**

Table 4: Catchment Parameters

Catchment	Catchment Area (km^2)	Length of Longest Watercourse (km)	Centroid of Catchment (km)	Mean Annual Precipitation (mm)	Average Watercourse Slope (10:85 Method) (m/m)
1	9.22	4.24	2.52	720	0.01226
2	4.96	3.47	2.21	720	0.01153
3	1017.00	79.00	27.00	720	0.00111
4	1064.00	88.00	31.00	720	0.00123
5	6.82	3.59	2.00	720	0.02340
6	2.54	2.06	1.25	720	0.02524
7	1.92	1.85	1.05	720	0.02090
8	4.00	2.67	1.28	720	0.03046
9	2.48	2.12	1.13	720	0.05220
10	132.00	19.01	9.00	720	0.00281
11	19.00	7.85	4.66	720	0.00934



EIMS MOOIPLAATS

MOOIPLATS CATCHMENT

Legend

- Catchment Delineation Points
- 20m contours
- Rivers

Delineated Subcatchments

- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine
- Ten
- Eleven

N

0 1,500 3,000 4,500 6,000 7,500

Metres

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CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION.

PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:298,001	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/07/15	REVIEWED BY: THIGESH VATHER	
FIGURE NO: 5	PROJECT NO: 41101537	REV:

5.1.2 DESIGN FLOOD PEAK METHODS

The following methods were considered to evaluate the relevant design flood peaks for the site:

- Rational Method (Alternatives 1, 2 and 3);
- Unit Hydrograph Method;
- Standard Design Flood Method;
- Soil Conservation Service –South Africa Method, and
- Empirical Methods.

The applicability of the above mentioned design flood peak methodologies to this study is summarised in **Table 5**.

Table 5: Summary of the Design Flood Peak Methodologies' Applicability

Method	Used	Comments
Rational Method Alternative 1	No	Applicable catchment <15km^2
Rational Method Alternative 2	No	Applicable catchment <15km^2
Rational Method Alternative 3	No	Applicable catchment <15km^2
Standard Design Flood Method	**Yes**	Applicable catchment 10km^2 to 40 000km^2
SCS-SA Method	No	Applicable catchment <30km^2
Empirical Methods		
Midgely and Pitman	**Yes**	Applicable to smaller catchments, with preference given to catchments > 100km^2
Regional Maximum Flood (RMF)	**Yes**	Applicable to all catchment sizes.

For this particular study, the Standard Design Flood (SDF) Method, and Empirical Methods (Regional Maximum Flood (RMF) and Midgely and Pitman), were used to determine the flood peaks for each sub catchment. These methods are briefly explained below.

STANDARD DESIGN FLOOD METHOD

The SDF Method specifically addresses the uncertainty in flood prediction under South African conditions. The runoff coefficient (C) used in the Rational Method is replaced by a calibrated value based on the sub division of the country into 29 regions or water management areas (WMAs) by using the 2-year mean of the annual daily maximum rainfall and average number of days per year on which thunder was heard. The method is generally a more conservative estimate than the Rational or UH Methods. The SDF Method can be applied to catchments from 10km^2 to 40 000km^2 in area.

EMPIRICAL METHODS

The empirical methods use formula, which are based on the statistical correlation of observed peak flows in the region in question and the catchment properties to generate regional constants. The accuracy of the predictions is dependent on the similarity of the catchment characteristics to the generalised Kovacs K region constant. The Empirical Formula should be applied to catchments larger than 100 km^2, but can be applied with caution to catchments larger than 10km^2 (SANRAL, 2013).

The empirical methods used consisted of the deterministic method developed by Midgley and Pitman (1971) and RMF developed by Kovacs (1980).

The Midgely and Pitman method makes uses of generic constants (K_T) based on the veld types as generated by the hydrological Research Unit (1979).

The RMF method is based on an investigation undertaken by the Kovacs (1980) where approximately 300 of the highest flood peaks observed in South Africa between 1894 and 1979 (SANRAL, 2013). The information was processed using the Francou-Rodier (Francou and Rodier, 1967) relationship and five regional curves with confidence bands were compiled. Kovacs later undertook a separate study which divided South Africa into eight regions (1988). This work supersedes the previous study.

5.1.3 DESIGN FLOOD PEAKS CALCULATIONS

Design flood peaks were calculated using the RMF, Midgley and Pitman and SDF methods (**Table 6**). The Midgely and Pitman method used a zone number of 4, the RMF method used a Kovacs region K4 and the SDF method used drainage basin number 28.

The relevant flood peaks for the 1:50- and 1:100-year return intervals for the catchment are shown in **Table 6**. The Midgely Pitman method generally produced lower design flood peaks than the RMF method whilst the SDF method produced the higheest flood peaks for each sub catchment. Owing to the differences in the methodology and the resulting design flood peaks, the RMF design flood peaks were used to get the representative flood of the river reach.

Table 6: Design Flood Values (m^3/s)

Catchment	Return Interval	RMF	Midgley Pitman	SDF
1	1:50	**66.08**	61.14	133.26
	1:100	**83.23**	77.22	172.30
2	1:50	**47.28**	39.54	79.01
	1:100	**59.55**	49.94	102.16
3	1:50	**837.62**	718.03	1073.32
	1:100	**1055.08**	906.98	1388.16
4	1:50	**858.31**	715.61	1075.80
	1:100	**1081.13**	903.93	1391.36
5	1:50	**56.15**	55.48	130.66
	1:100	**70.73**	70.08	168.93
6	1:50	**32.94**	31.14	67.62
	1:100	**41.49**	39.34	87.41
7	1:50	**28.32**	25.85	51.50
	1:100	**35.67**	32.65	66.58
8	1:50	**42.09**	43.12	97.38
	1:100	**53.02**	54.47	125.89
9	1:50	**32.52**	33.33	78.90
	1:100	**40.96**	42.10	102.00
10	1:50	**233.98**	254.69	479.73
	1:100	**308.85**	321.71	620.39
11	1:50	**90.36**	82.95	174.75
	1:100	**116.18**	104.77	225.97

5.2 HYDRAULIC MODELLING

The US Army Corp of Engineers (USACE) Hydrologic Engineering Centre River Analysis System (HEC-RAS) model was used to calculate the relevant flood levels. HEC-RAS undertakes hydraulic calculations between user defined, consecutive river cross-sections along the defined length of the river channel. The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A depth of flow is calculated at each cross-section, which represents the level to which water will rise at that section, given the potential peak flows. This was calculated for the 1:50- and 1:100-year recurrence intervals for the river reach sections in question.

5.2.1 TOPOGRAPHICAL SURVEY

The available 5 m contour data were used to generate a Digital Elevation Model (DEM) in order to analyse the hydraulic flow characteristics of the terrain at the project site.

5.2.2 ROUGHNESS COEFFICIENTS

The relevant Manning's roughness coefficients (n) were estimated for channel characteristics, riparian and bank areas based on observations made during the site assessment. Relevant values were obtained via data published in, 'Hec-RAS River Analysis System – Hydraulic Reference Manual Version 4.1' (January 2010).

The Manning's values that were assigned to the river reach were 0.01 for both the river channel and the river banks. A constant Manning's value (n) was utilised as the non-perennial watercourse did not have defined banks and as such the vegetation was considered consistent across the relevant cross sections.

5.2.3 NUMERICAL MODELLING

The calculated flood extents for the 1:50- and 1:100-year flood events are depicted in **Figures 9** and **10** respectively. The flood extents for the 1:50- and 1:100-year flood events illustrate that the extend of the 1:50- and 1:100-year flood events pose a threat to the infrastructure.

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1:50YR FLOODLINE

Legend

Infrastructure

Property Boundary

1: 100yr Floodline

High : 6.40m

Low : 0.01m

N

0 360 720 1,080 1,440 1,800

Metres

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PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:72,480	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/07/17	REVIEWED BY: THIGESH VATHER	
FIGURE NO: 9	PROJECT NO: 41101537	REV:

EIMS (PTY) LTD

1:100YR FLOODLINE

Legend

Infrastructure

Property Boundary

1: 100yr Floodline

High : 6.70m

Low : 0.01m

N

0 360 720 1,080 1,440 1,800

Metres

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PROJECT TITLE:

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SCALE: 1:72,480	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/07/17	REVIEWED BY: THIGESH VATHER	
FIGURE NO: 10	PROJECT NO: 41101537	REV:

6 CONCEPTUAL STORM WATER MANAGEMENT PLAN

6.1 METHODOLOGY

Based on the information gathered during the desktop review and the site walkover, a conceptual SWMP was developed for the Mooiplaats Colliery. 'Dirty' and 'clean' water contributing catchments were discretised based on 5m topographical data, and associated activities and key areas of concern were identified. The discretisation of the catchments factored in existing storm water infrastructure, overall functionality and the most practical and feasible implementation of the final SWMP.

Based on the discretised catchments, the required storm water management drainage and storage elements (including channels, pipes, berms and pollution control dams) were defined to ensure appropriate storm water management according to the management principles outlined in the General Notice (GN) 704 of the National Water Act (36 of 1998) and the relevant Best Practice Guidelines (BPGs).

The PCSWMM storm water drainage model (CHI, 2017) was used to size the proposed storm water management infrastructure. PCSWMM is a hydrological rainfall-runoff numerical simulation model suitable for application to both rural and urban environments. PCSWMM can be used to determine the design requirements for various drainage elements as well as to analyse the performance of existing drainage systems. PCSWMM requires a number of input parameters for each of the elements, including:

— Design rainfall;
— Catchment characteristics including catchment area, overland flow length, slope, impervious area, surface cover and soil characteristics.
— Proposed design characteristics of the drainage infrastructure, including the channels, pipes and Pollution Control Dams (PCDs).

The conceptual SWMP was assessed in terms of the 1:50-year recurrence interval storm event (as per the GN704 requirements) to define the required capacity of the storm water infrastructure (i.e. channels, pipes and PCDs). The GN704 states the following regarding capacity requirements of clean and dirty water systems:

— Confine any unpolluted water to a 'clean' water system, away from any 'dirty' areas;
— Design, construct, maintain and operate any 'clean' water system at the mine or activity so that it is not likely to spill into any 'dirty' water system more than once in 50 years;
— Collect the water arising within any 'dirty' area, including water seeping from mining operations, outcrops or any other activity, into a dirty water system;
— Design, construct, maintain and operate any dirty water system at the mine or activity so that it is not likely to spill into any clean water system more than once in 50-years; and
— Design, construct, maintain and operate any dam or tailings dam that forms part of a dirty water system to have a minimum freeboard of 0.8 metres above full supply level, unless otherwise specified in terms of Chapter 12 of the Act.
— Design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years.

The proposed plan includes the use of channels sediment traps and PCDs to manage the runoff from the various contributing catchment areas.

6.2 TOPOGRAPHICAL AND SITE LAYOUT

Aerial imagery and the site layout obtained from the client were used in the numerical modelling. Five meter, readily available contour data was used to define the current topographical surface of the site.

6.3 CLEAN AND DIRTY CATCHMENTS

Three main drainage systems were identified within the Mooiplaats Colliery based on land use, and this is shown in **Figure 11**:

— Plant Area – 'Dirty' water catchments draining to the PCD and Genset Dam;

— Slurry Dam – 'Dirty' water generated on the Slurry Dam; and

— Clean catchments – 'Clean' water generated from the surrounding clean catchments

The plant area was discretised into a total of 20 sub-catchments (SC1-SC19 and the shaft) and this is shown in **Figure 11**. The slurry dam was discretised into a total of 3 sub-catchments (SD1-SD3) and is shown in **Figure 12**. The clean catchment draining towards the site was discretised into three sub catchments (C1-C3) and is shown in **Figure 13**. These catchment characteristics are shown in **Table 7.**

Table 7: PCSWMM catchment details

System	Sub-catchment	Description	Area (ha)	Width (m)	Flow Length (m)	Imperviousness (%)
Plant Area	SC1	Dirty	2.57	170	151.28	25
	SC2	Dirty	1.04	60	173.73	25
	SC3	Dirty	1.35	130	104.02	70
	SC4	Dirty	2.40	110	218.52	70
	SC5	Dirty	1.45	130	111.63	70
	SC6	Dirty	1.84	100	183.93	70
	SC7	Dirty	1.12	100	112.12	70
	SC8	Clean	0.25	500	5.01	70
	SC9	Clean	0.47	45	103.40	40
	SC10	Clean	1.39	55	253.15	50
	SC11	Dirty	0.61	65	94.37	70
	SC12	Dirty	0.19	35	55.37	70
	SC13	Dirty	0.31	55	56.60	70
	SC14	Dirty	0.37	50	74.96	60
	SC15	Dirty	0.47	60	79.15	40
	SC16	Intermediary	0.91	40	228.45	25
	SC17	Intermediary	0.70	40	175.03	25
	SC18	Intermediary	1.87	60	311.65	25
	SC19	Intermediary	2.01	80	251.75	25
	Shaft	Dirty	2.79	80	348.20	25
Slurry Dam	SD1	Dirty	9.34	310	301.24	35
	SD2	Dirty	11.04	250	441.64	35
	SD3	Dirty	10.69	300	356.30	35
Clean Catchments	C1	Clean	10.11	225	449.25	10
	C2	Clean	11.01	150	733.89	10
	C3	Clean	28.56	330	865.35	10

In order to ensure that 'clean' and 'dirty' water generated from the plant is adequately contained and routed, a storm water management plan was developed for the site. The proposed plan includes the use of channels (prefix 'C'), sediment traps and Pollution Control Dams (prefix 'PCD') to manage the runoff from the various contributing catchment areas.

The ROM stockpiles (SC16-SC19) were classified as 'intermediary' as they are currently being rehabilitated and runoff from these areas could be 'clean'. The SWMP treated them as dirty and routed the runoff to the PCD. If the associated storm water runoff meets the relevant water quality standards, discharge into the natural environment can be considered.

MOOIPLAATS COLLIERY

Conceptual SWMP:
Plant Area

Legend

Flow_path
Storage Containment Areas
Junctions

Channels

Clean
Dirty

Subcatchments

Clean
Dirty
Intermediatry

N

0 10 20 30 40 50

Metres

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EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:3,500	DRAWN BY: HASSEN KHAN
DATE: 2019/07/15	REVIEWED BY: THIGESH VATHER
FIGURE NO:	PROJECT NO: 41101537 REV:

MOOIPLAATS COLLIERY

Conceptual SWMP:
Slurry Dam

Legend

Flow_path
Storage Containment Areas
Junctions

Channels

Clean
Dirty

Subcatchments

Clean
Dirty
Intermediatry

N

0 10 20 30 40 50

Metres

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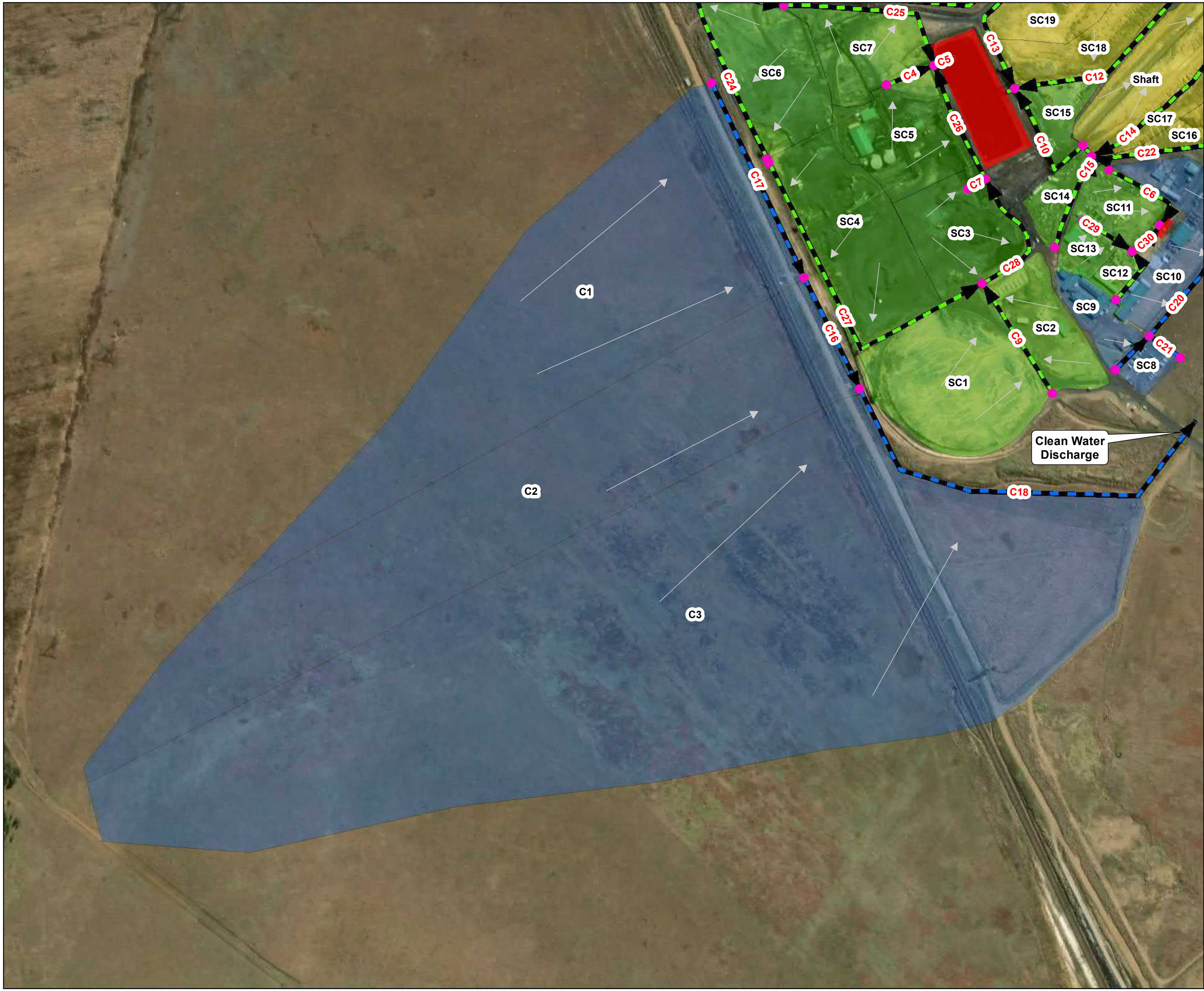
SCALE: 1:3,700	DRAWN BY: HASSEN KHAN
DATE: 2019/07/15	REVIEWED BY: THIGESH VATHER

FIGURE NO:	PROJECT NO: 41101537	REV:



MOOIPLAATS COLLIERY

Conceptual SWMP:
Clean Catchments

Legend

Flow_path
Storage Containment Areas
Junctions

Channels

Clean
Dirty

Subcatchments

Clean
Dirty
Intermediatry

N

0 25 50 75 100 125

Metres

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DATE: 2019/07/15	REVIEWED BY: THIGESH VATHER

FIGURE NO:	PROJECT NO: 41101537	REV:

6.4 NUMERICAL MODELLING

In order to determine the required sizing of the storm water management infrastructure, storm event modelling using the PCSWMM model was undertaken. The numerical modelling was based on the proposed infrastructure and layout of the operations. The results for each infrastructure component is elaborated on in the sections that follow.

6.4.1 DESIGN RAINFALL

The 1:50-year design rainfall was fitted to the SCS-SA type 3 rainfall distribution and applied to the Mooiplaats Colliery to determine the peak flow and volume reporting to the various infrastructure. The rainfall distribution graph is shown below:

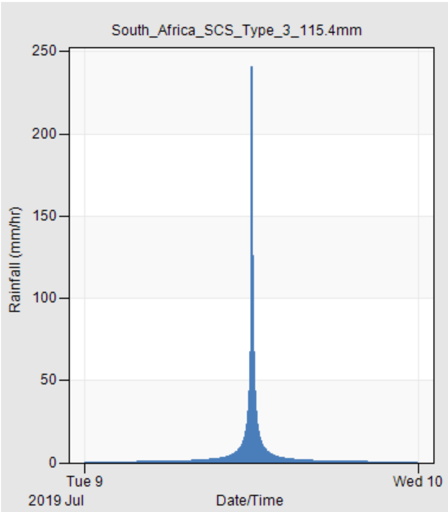

Figure 14: 1:50-year rainfall distribution for the Mooiplaats Colliery

6.4.2 MODELLING OUTPUTS

The sub-catchment characteristics and the flow rates and volumes are shown in **Table 8** and the flow rates and volumes reporting to the channels is shown in **Table 9**.

Table 8: Catchment Details

Name	Discharge Point	Precipitation (mm)	Infiltration (mm)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
SC1	C9	115.39	35.44	80.15	2.06	0.88
SC2	C9	115.39	35.79	79.78	0.83	0.34
SC3	C7	115.39	13.39	102.2	1.38	0.79
SC4	C27	115.39	13.73	101.7	2.44	1.21
SC5	C4	115.39	13.41	102.17	1.48	0.84
SC6	C24	115.39	13.63	101.85	1.87	0.97
SC7	C25	115.39	13.41	102.17	1.15	0.65
SC8	C21	115.39	13.04	102.35	0.26	0.17

Name	Discharge Point	Precipitation (mm)	Infiltration (mm)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
SC9	C19	115.39	27.4	88.22	0.41	0.22
SC10	C20	115.39	23.81	91.68	1.28	0.57
SC11	C6	115.39	13.35	102.24	0.63	0.36
SC12	C31	115.39	13.23	102.37	0.2	0.12
SC13	C29	115.39	13.23	102.37	0.32	0.19
SC14	C15	115.39	17.83	97.79	0.37	0.22
SC15	C10	115.39	27.11	88.53	0.42	0.24
SC16	C22	115.39	62.38	53.17	0.49	0.23
SC17	C14	115.39	60.73	54.86	0.38	0.19
SC18	C12	115.39	64.49	51.04	0.95	0.42
SC19	C13	115.39	63.02	52.53	1.06	0.48
Shaft	Sump	115.39	38.23	77.27	2.15	0.7
SD1	C2	115.39	54.83	60.68	5.67	2.61
SD2	C1	115.39	57.17	58.27	6.43	2.74
SD3	RWD	115.39	55.83	59.65	6.38	2.84
C1	C17	115.39	48.48	67	6.77	1.46
C2	C16	115.39	52.18	63.28	6.97	1.26
C3	C18	115.39	53.61	61.83	17.66	3.03

Table 9: Flow rate and volumes reporting to the channels

Name	Length (m)	Roughness	Contributing Area (ha)	Max. |Flow| (m^3/s)	Max. |Velocity| (m/s)
C1	1111	0.015	11.041	2.246	1.61
C2	998	0.015	9.338	2.164	1.63
C3	122	0.015	31.068	6.172	3.4
C4	58	0.015	1.451	0.836	1.62
C5	27	0.015	11.782	4.839	4.35
C6	103	0.015	0.613	0.356	1.57
C7	22	0.015	1.352	0.79	1.33
C8	8	0.015	1.118	0.656	2.73
C9	146	0.015	3.614	1.201	1.51
C10	143	0.015	2.464	0.642	1.91
C11	17	0.015	6.348	1.399	4.69
C12	416	0.015	1.87	0.386	1.63
C13	421	0.015	2.014	0.449	1.87

C14	328	0.015	0.7	0.165	0.55
C15	112	0.015	0.375	0.211	0.84
C16	139	0.015	21.117	2.661	2.44
C17	241	0.015	10.108	1.444	1.99
C18	475	0.015	49.673	5.58	4.78
C19	53	0.015	0.465	0.217	1.07
C20	207	0.015	2.108	0.924	2.78
C21	43	0.015	0.25	0.16	0.45
C22	364	0.015	0.914	0.195	0.6
C23	15	0.015	1.989	0.485	1.15
C24	377	0.015	1.839	0.893	1.77
C25	209	0.015	2.96	1.447	2.18
C26	140	0.015	7.37	2.76	2.25
C27	385	0.015	2.404	1.16	1.74
C28	161	0.015	6.018	2.177	1.7
C29	64	0.015	0.311	0.192	1.46
C30	44	0.015	0.505	0.305	1.6
C31	73	0.015	0.194	0.119	1.02

6.4.3 STORAGE CONTAINMENT AREAS

The 1:50-year flood event was routed through the Colliery to determine the volume requirements to contain the 1:50-year flood event. The cumulative flood volumes can be seen in the table below:

Table 10: Flow volumes reporting to the storage containment areas

Name	Contributing Area (ha)	Max. Flow (m^3/s)	Total Flow (ML)	Total Flow (m^3)
Plant Area PCD	18	6.23	14.85	14850
Return Water Dam (RWD)	31	6.17	18.41	18410
Genset Dam	1.1	0.65	1.14	1140
Shaft Sump	2.7	0.70	2.15	2150

6.5 RECOMMENDATIONS

Based on observations made during the desktop study, site walkover and development of the SWMP for the Mooiplaats Colliery, the following recommendations are proposed:

— The SWMP should be revisited after any major changes to the current operations.
— To prevent cross-contamination, it must be ensured that there is no handling and disposal of substances that may give rise to pollution within designated ‘clean’ areas.
— It is recommended that gabion ‘sieves’ are placed at the outlet of coal stockpile areas and up-gradient of the pipes/channels. The intention of the gabions will be to prevent large debris from leaving the facilities

during storm events and potentially resulting in a backlog of associated infrastructure. These will need to be actively managed to prevent clogging of the gabion baskets.

- The pipes, channels and PCDs need to be constructed to facilitate routine maintenance (i.e. simple, effectual housekeeping).
- It is recommended that stone pitching channels and concrete pipes are used to transfer runoff. Stone pitching is recommended to reduce high runoff velocities in channels and sulphate-resistant concrete to reduce sulphate content generated in 'dirty' areas with sulphate contaminants.
- To prevent clogging of the grated channel covers and maintain channel capacity, best practice and proper housekeeping practices must be ensured.
- To prevent subsurface contamination migration, hardstanding is proposed for the storage areas.
- All pipes and channels must be checked after any major rainfall events to ensure that there are no blockages and that the water flow will not be restricted in any way.
- Sediment that accumulates within pipes, channels and retention facilities needs to be removed directly after the storm events and appropriately disposed of to ensure design capacity is maintained.
- Erosion protection will be required at the outlet of the 'clean' water pipes discharging to the environment. Erosion protection can take the form of gabions or geotextiles.
- To prevent subsurface contamination, it is recommended that the PCDs be lined. The type of lining to be used will need to consider the quality of effluent contained within the facility and the hydrogeological environmental setting associated with the PCD. It is recommended that the Colliery personnel engage the DWS to establish their requirements in this regard.
- It is recommended that the PCDs be operated empty or at a storage level low enough to accommodate storm water inflows, whilst meeting the required spillage frequency and freeboard requirements.

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7 WATER BALANCE

An annual average static water balance associated with the colliery was calculated showing all the inflows and outflows associated with each component.

7.1 PROCESS FLOW DIAGRAM

The process flow diagram for the Mooiplaats Colliery was based on the water balance diagram received from the client (Water Balance 2017.pdf) (**Figure 15**). The process flow diagram shows that the mine obtains all of its water from groundwater.

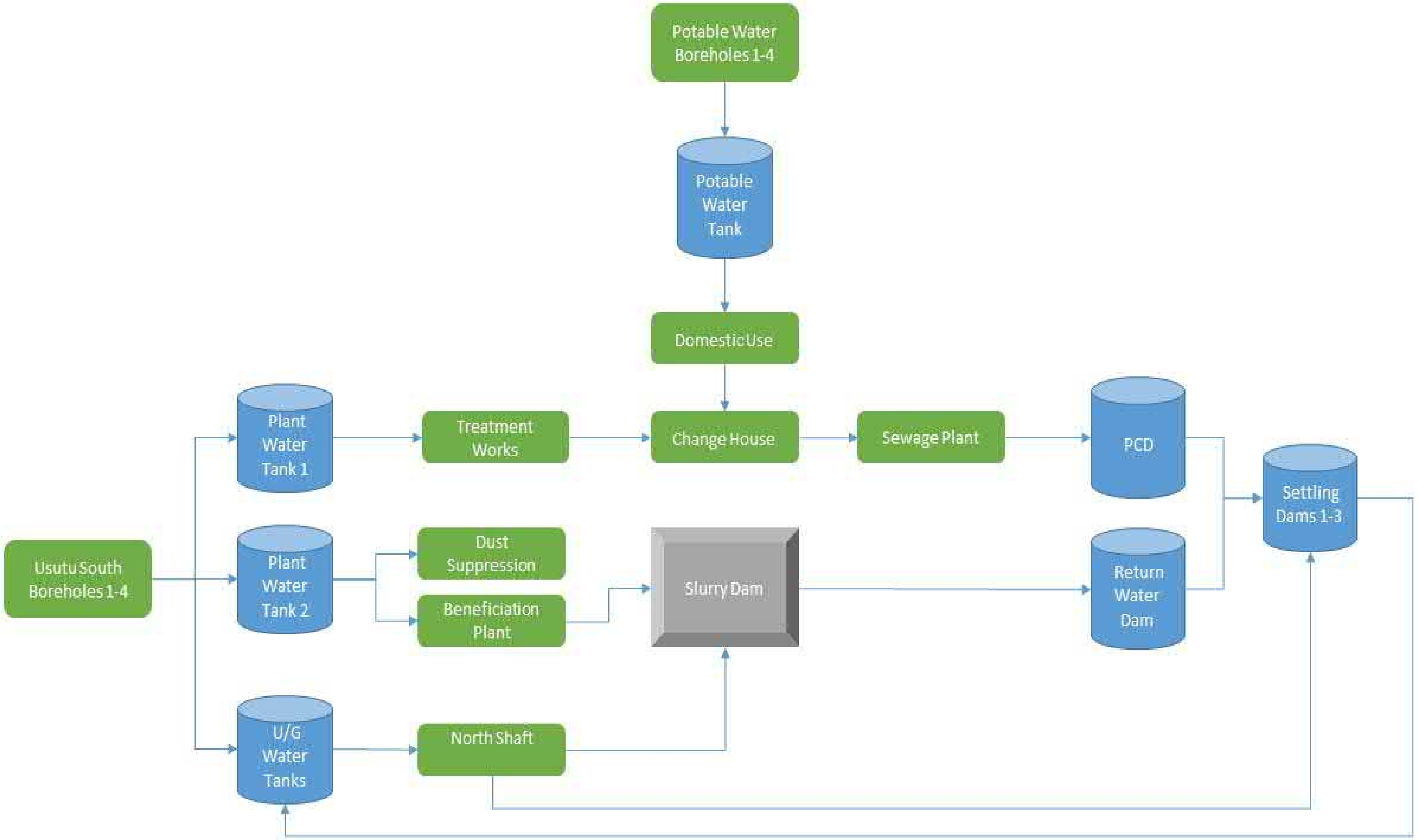
7.2 ASSUMPTIONS

The following assumptions were made during the calculation of the annual average water balance:

- It was assumed that plant water supply is equal to 48l/s. This was based on the water balance diagram received from the client.
- It was assumed that groundwater ingress to the North Shaft is equal to 50l/s. This was based on the water balance diagram from the client.
- Water usage data was obtained for three months only (August-October 2018). These values were extrapolated were possible for an annual average water balance.
- It was assumed that borehole abstraction would be equal to the maximum limit within the water use licence application.
- It was assumed that 40% of the water loss would occur within the change house. This was based on the water balance calculations from the client.

7.3 RESULTS

The annual average salt and water balance was calculated and depicted as stipulated in the DWS BPG G1 (**Figures 16)**. The Mooiplaats Colliery operations use and process an average of 8 million cubic metres of water per annum.



Process Flow Diagram for Mooiplaats

Legend

DATA SOURCE:

PROJECTION: N/A

PROJECT TITLE: EIMS Mooiplaats Hydrological Assessment

PROJECT NO: 41101537

DRAWN BY: H.Khan	DATE:17/07/2019
REVIEWED BY: K.King	FIGURE NO:

Annual Average Water Balance for the Mooiplaats Colliery (m3/annum)

Inflow	Volume	Facility	Outflow	Volume
Groundwater Ingress	1 576 800	North Shaft	U/G Water Tanks	1 576 800
	1 576 800			*1 576 800*
North Shaft	1 576 800	U/G Water Tanks	Beneficiation Plant	1 513 728
PCD	93 349		Evaporation from Settling dams	11 900
RWD	329 867		North Shaft make-up water	144 521
	1 670 149			*1 670 149*
Usutu South Boreholes (1-4)	65 700	Plant Water Tanks	Beneficiation Plant	1 513 728
North Shaft	1 670 149		Processing losses	222 121
	1 735 849			*1 735 849*
U/G Water Tanks	1 513 728	Beneficiation Plant	Slurry Dam	1 286 668
			Loss during processing	227 059
	1 513 728			*1 513 728*
Beneficiation Plant	1 286 668	Slurry Dam	RWD	329 867
			Interstitial Storage	494 801
			Evaporation	462 000
	1 286 668			*1 286 668*
Potable Water Boreholes (1-4)	24 332	Change House / Domestic use	Sewage Plant	14 599
			Loss	9 733
	24 332			*24 332*
Sewage Plant	14 599	PCD	Evaporation	10 080
Dirty Water Runoff	88 830		U/G Water Tanks	93 349
	103 429			*103 429*
TOTAL WATER USAGE	**7 910 954**		**TOTAL WATER USAGE**	**7 910 954**

Annual Water Balance (m^3/annum)

Legend

- Unbalanced
- Balanced
- Previous Water Balance
- Calculated

DATA SOURCE:

PROJECTION: N/A

PROJECT TITLE: EIMS Mooiplaats Hydrological Assessment

PROJECT NO: 41101537

DRAWN BY: H.Khan	DATE:17/07/2019
REVIEWED BY: K.King	FIGURE NO:

8 WATER QUALITY MONITORING PLAN

8.1 SAMPLING LOCATIONS AND FREQUENCY

The Mooiplaats Colliery water monitoring programme consists of monitoring the surface water and groundwater. The Vaal River and its tributaries will be monitored on a monthly basis, whilst the groundwater will be monitored quarterly (four times a year) to biannually (twice a year). The surface water and groundwater sampling locations are summarised in **Table 11** and illustrated in **Figure 17** and **Figure 18**.

Table 11: Surface Water and Groundwater Sampling Locations

Mooiplaats Colliery Water Monitoring Programme			
Surface and Groundwater Monitoring Points			
Locality	**Locality Description**	**Coordinates WGS 84 ddd.ddddd**	**Monitoring Frequency**
Surface Water			
VL-S01	Vaal River 1 Upstream	S26.64616° E30.09890°	Monthly
VL-S02	Vaal River 2 Downstream 1	S26.64804° E30.15098°	Monthly
VL-S03	Vaal River 3 Downstream 2	S26.67879° E30.12411°	Monthly
WT-S01	Witpuntspruit 1 Upstream	S26.71447° E30.06519°	Monthly
WT-S02	Witpuntspruit 2 Midstream	S26.59307° E30.09617°	Monthly
WT-S03	Witpuntspruit Tributary North DS 1	S26.61826° E30.11211°	Monthly
WT-S04	Witpuntspruit 3 Midstream	S26.62014° E30.10781°	Monthly
WT-S05	Witpuntspruit Tributary South DS 2	S26.62294° E30.11463°	Monthly
WT-S06	Witpuntspruit 6 Downstream	S26.62863° E30.11539°	Monthly
MPS-S08	Witpuntspruit 5 MS	S26.62873° E30.12149°	Monthly
MPS-S13	Runoff from Loading Area	S26.64837° E30.09888°	Monthly
MPS-S14	Gen-sub PCD	S26.64616° E30.09890°	Monthly
MPS-S15	Storm water trench @ Security	S26.64837° E30.09888°	Monthly
MPS-S16	DS Area of Erikson's + Settling Dams	S26.64505° E30.10121°	Monthly
MPS-S20	Underground Erickson Dams	S26.64505° E30.10121°	Monthly
MPS-S21	North Shaft RWD	S26.64198° E30.10059°	Monthly
MPS-S25	Clean water Trench DS of Workshop	S26.63826° E30.09506°	Monthly
MPS-S27	Witpuntspruit Tributary entering MP	S26.64716° E30.10336°	Monthly
MPS-S28	Confluence of MPS-S13 and MPS-S15	S26.64808° E30.09925°	Monthly
MPS-S29	Storm water @ Offices. Upstream of MPS-S25	S26.64743° E30.09802	Monthly
MPS-S30	Plant PCD	S26.64508° E30.09674°	Monthly
MPS-S31	Decant water originating from Old Usutu Workings, decanting into Witpuntspruit. Water collected **outside fenced off area** directly **south** of access road.	S26.63689° E30.12933°	Monthly
MPS-S32	Decant water originating from Old Usutu Workings, decanting into Witpuntspruit. Water collected from **sump** directly **north** of access road.	S26.63629° E30.12954°	Quarterly
Groundwater			
GKL-1	Outer perimeter Borehole south of Mooiplaats	S26.69603° E30.07208°	Biannually

GKL-4d	Outer perimeter Borehole south of Mooiplaats	S26.70167° E30.08253°	Biannually
GKL-3m	Outer perimeter Borehole south of Mooiplaats	S26.70178° E30.08269°	Biannually
GKL-2s	Outer perimeter Borehole south of Mooiplaats	S26.70178° E30.08269°	Biannually
GAD-2s	Outer perimeter Borehole south of Mooiplaats	S26.71269° E30.11414°	Biannually
GAD-1	Outer perimeter Borehole south of Mooiplaats	S26.72733° E30.10144°	Biannually
GAD-3s	Outer perimeter Borehole south of Mooiplaats	S26.67772° E30.12374°	Biannually
GAD-4m	Outer perimeter Borehole south of Mooiplaats	S26.67772° E30.12374°	Biannually
GAD-5d	Outer perimeter Borehole south of Mooiplaats	S26.67772° E30.12374°	Biannually
MPG-B1	Down gradient (north) of the co-disposal facility.	S26.63843° E30.09878°	Quarterly
MPG-B2	Down gradient (east) of the lined Settling Dams and co-disposal.	S26.64143° E30.10175°	Quarterly
MPG-B3	Near the security gate.	S26.64816° E30.09905°	Quarterly
MPG-B4	Near the security gate.	S26.64819° E30.09910°	Quarterly
MPG-B5	Up-gradient (south-west) of the plant area next to the railway line.	S26.64457° E30.09363°	Quarterly
MPG-B6	Adjacent to the return water dam.	S26.63719° E30.09540°	Quarterly
MPG-B7	Down gradient (north) of the co-disposal facility.	S26.63832° E30.09870°	Quarterly
MPG-B8	Down gradient (east) of the lined Settling Dams.	S26.64160° E30.10155°	Quarterly
MPG-B9	Down gradient (east) of the plant area.	S26.64403° E30.10107°	Quarterly
MPG-B10	Down gradient (east) of the plant area.	S26.64581° E30.10007°	Quarterly
MPG-B11	Up-gradient (south-west) of the plant area next to the railway line.	S26.64435° E30.09344°	Quarterly
MPG-B13	Outer perimeter Borehole south of Mooiplaats	S26.66689° E30.11329°	Biannually
MPG-B14	Between Usutu/MPN	S26.63716° E30.10992°	Quarterly
MPG-B15	Between Usutu/MPN	S26.63778° E30.10881°	Quarterly
MPG-B16	Between Usutu/MPN Outer perimeter Borehole east of Mooiplaats	S26.64106° E30.11469°	Biannually
MPG-B17	Between Usutu/MPN Outer perimeter Borehole east of Mooiplaats	S26.64095° E30.11259°	Biannually
MPG-B18	Between Usutu/MPN Outer perimeter Borehole east of Mooiplaats	S26.64608° E30.11685°	Biannually
MPG-B19	Between Usutu/MPN Outer perimeter Borehole east of Mooiplaats	S26.64600° E30.11725°	Biannually
MPG-B20	Usutu UG. BH intersecting mine at 90 m	S26.63144° E30.11860°	Quarterly

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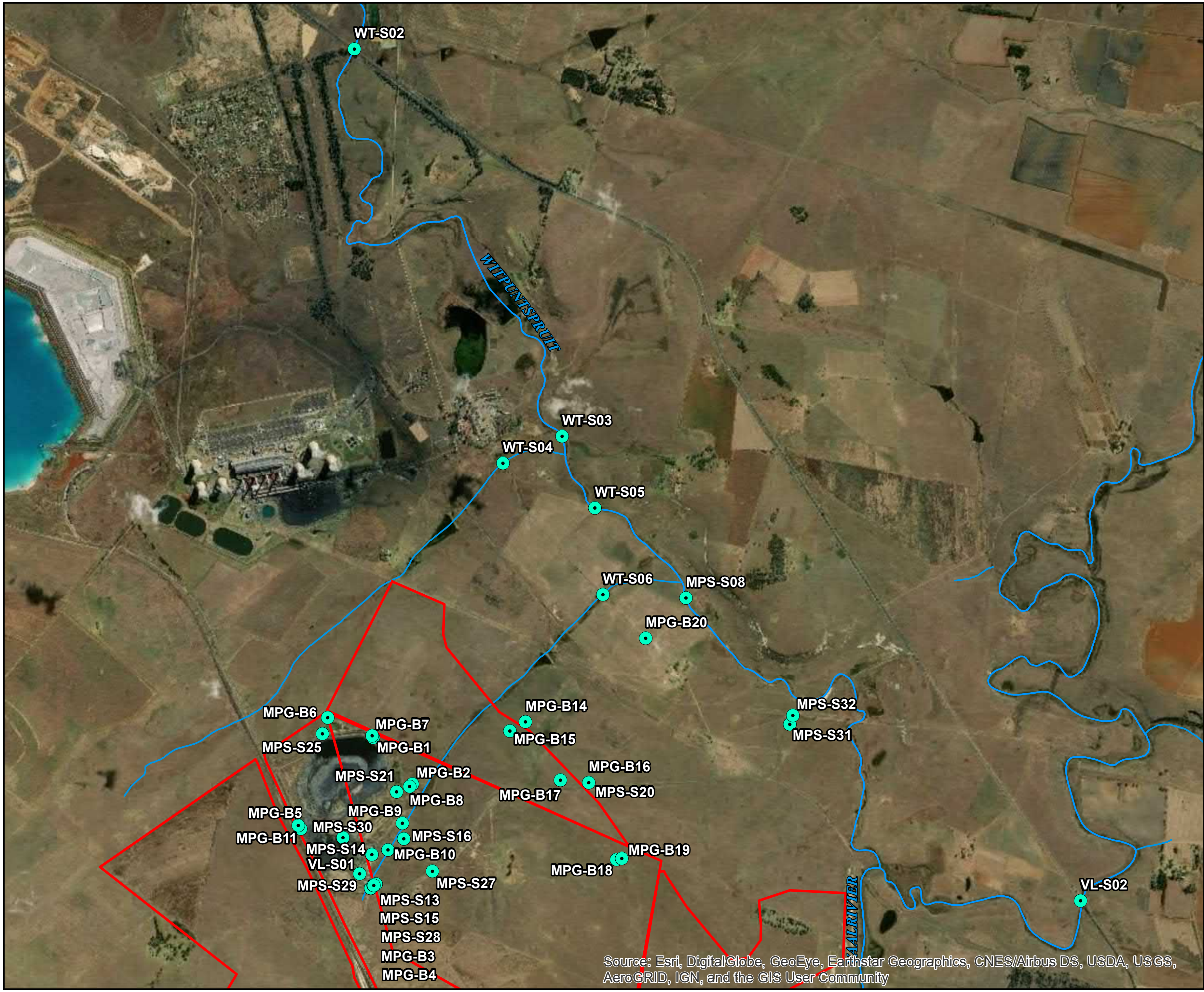
MOOIPLATS WATER QUALITY SAMPLE POINTS



Legend

- Water Quality Sample Points
- Rivers
- Property Boundary

N

0 180 360 540 720 900

Metres

DISCLAIMER

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DATA SOURCE:

SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM-
CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION.

PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:36,000	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/07/16	REVIEWED BY: THIGESH VATHER	
FIGURE NO: 8A	PROJECT NO: 41101537	REV:

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MOOIPLATS WATER QUALITY SAMPLE POINTS

Legend

- Water Quality Sample Points
- Rivers
- Property Boundary

N

0 200 400 600 800 1,000

Metres

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DATA SOURCE:

SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM-
CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION.

PROJECTION: TM_WG31_WGS84

PROJECT TITLE:

EIMS MOOIPLATS HYDROLOGICAL ASSESSMENT

SCALE: 1:38,702	DRAWN BY: SINENHLANHLA RADEBE	
DATE: 2019/07/16	REVIEWED BY: THIGESH VATHER	
FIGURE NO: 8B	PROJECT NO: 41101537	REV:

8.2 SAMPLING METHODOLOGY

The surface water samples were collected directly into laboratory-supplied sample containers. Surface water samples were obtained from at least 10cm below the water surface wherever possible, with the bottle opening facing upstream. Sample containers were kept closed and in a clean condition up to the point of sampling.

Monitoring was undertaken according to DWS Best Practice Guidelines, ensuring that the potential for cross contamination was minimised.

For each sampling point, the temperature, pH and electrical conductivity was measured in-situ using a calibrated multi-parameter probe and recorded. This information, as well as the physical and environmental information of each sampling point (e.g. visual, olfactory observations and flow conditions) were recorded on designated field data sheets.

On each sample, the following must be recorded to ensure proper identification:

— Site Name (e.g. Mooiplaats Colliery);
— Sample Location and Sample Type (e.g. MPCSW01); and
— Sample Date and Time.

Sample containers must be kept closed and in a clean condition up to the point of sampling. Post sampling, all samples must be stored in a temperature controlled cooler box (below 4ºC), which is kept sealed and dust-free, until samples are dispatched to a South African National Accreditation System (SANAS) accredited laboratory for analysis.

8.3 ANALYTICAL PROGRAMME

The water quality parameters (pH, EC, TDS, Alkalinity, Ca, Mg, Na, K, Cl, F, SO_4, NO_3, Al, Fe, Mn) are monitored monthly for surface water and either quarterly or biannually for groundwater. Additional metals (Ag, As, B, Ba, Be, Cd, Co, Cr, Cu, Li, Mo, Ni, Pb, Sb, Se, Si, Sr, Tl, Ti, V, Zn) are monitored biannually for both surface and groundwater sites.

8.4 DATA QUALITY

A factual and interpretive report should be drafted in accordance with the monitoring reporting requirements stipulated by the DWS best practice guidelines. The report should include a description of the methodologies followed, the analytical results obtained and associated interpretation in line with the defined water quality guidelines. The precision of the sampling and analysis must be assessed through a comparison of the original and duplicate sample analytical results. This must be done through a quality assurance/quality control programme (i.e. obtain the percentage variance of the duplicated sample).

9 RISK IMPACT ASSESSMENT

This section describes identified potential surface water impacts that may arise as a result of the proposed project and indicates proposed mitigation measures to manage the identified impacts.

9.1 CONSTRUCTION PHASE

The following section describes the potential impacts associated with the construction phase of the proposed project:

- **Impact**:
  - Water quality degradation as a result of sedimentation, nitrates, phosphates, sulphates, hydrocarbon pollution, hazardous waste and domestic waste.
- **Mitigation Measures**:
  - Undertake construction activities during the dry season;
  - Demarcate sensitive areas, as no go zones;
  - Dust Suppression through the use of water tankers and dust monitoring;
  - Adherence to the relevant Storm Water Management Plan;
  - Erosion control measures should be put in place in order to minimise the transport of sediment;
  - Stabilisation of impacted soils and restricting vehicle movement to designated access roads;
  - Drip trays should be placed under machinery. Oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling;
  - Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes;
  - Provision of adequate sanitation and waste disposal facilities at the basecamp;
  - Toolbox talks with specific consideration to be given to waste disposal.
- **Impact**:
  - Flooding
- **Mitigation Measures**:
  - Construction should occur during the dry season;
  - Avoid the placement of construction equipment and materials within the calculated flood lines;
  - Flood control measures such as the construction of berms and channels should be implemented to minimise the risks of flooding where work within the flood lines is essential.
- **Impact**:
  - Increased Runoff
- **Mitigation measures:**
  - Construction should occur during the dry season;
  - Use existing routes and already disturbed areas;
  - Adherence to the relevant Storm Water Management Plan;
  - Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.

9.2 OPERATIONAL PHASE

The following section describes the potential impacts associated with the operational phase of the proposed project:

- **Impact:**

- Water Quality Degradation as a result of sedimentation, nitrates, phosphates, sulphates, hydrocarbon pollution, hazardous waste and domestic waste.
- **Mitigation Measures**:
  - Adherence to the relevant Storm Water Management Plan;
  - Erosion control measures should be put in place in order to minimise the transport of sediment;
  - Dust Suppression through the use of water tankers and dust monitoring;
  - Restricting vehicle movement to designated access roads;
  - Classification and disposal of waste must be undertaken in accordance with the relevant norms and standards;
  - Drip trays should be placed under machinery. Oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling;
  - Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes;
  - Provision of adequate sanitation and waste disposal facilities at the basecamp;
  - Toolbox talks with specific consideration to be given to waste disposal.
- **Impact**:
  - Flooding
- **Mitigation Measures**
  - Construction should occur during the dry season;
  - Avoid the placement of construction equipment and materials within the calculated flood lines;
  - Flood control measures such as the construction of berms and channels should be implemented to minimise the risks of flooding where work within the flood lines is essential.
- **Impact:**
  - Increased Runoff
- **Mitigation Measures:**
- Adherence to the relevant Storm Water Management Plan;
- Development of vegetation rehabilitation plan. The plan should factor in new drainage patterns and comprise of methods to promote surface water infiltration through the use of vegetation and geotextiles.
- **Impact:**
  - Borehole water extraction resulting in a decrease in base flow
- **Mitigation Measures**
  - Extraction from the borehole should not exceed recharge.

9.3 DECOMMISSIONING PHASE

The following section describes the potential impacts associated with the decommissioning phase of the proposed project:

- **Impact:**
  - Water Quality Degradation as a result of sedimentation, nitrates, phosphates, sulphates, hydrocarbon pollution, hazardous waste and domestic waste.
- **Mitigation Measures**:
  - Dust Suppression through the use of water tankers and dust monitoring;
  - Erosion control measures should be put in place in order to minimise the transport of sediment;
  - Stabilisation of impacted soils and restricting vehicle movement to designated access roads;
  - Drip trays should be placed under machinery. Oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling;
  - Classification and disposal of waste must be undertaken in accordance with the relevant norms and standards;

— Provision of adequate sanitation and waste disposal facilities at the basecamp;
— Toolbox talks with specific consideration to be given to waste disposal;
— Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes.

9.4 SIGNIFICANCE RATINGS

A significance rating for each impact was undertaken using the methodology proposed by EIMS. The significance ratings can be seen in **Table 12 to Table 20**.

Table 12: Significance Rating Results for an Increase in Runoff-Construction Phase

Impact Name	**Increased runoff**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	1
Extent	3	2	Reversibility	2	2
Duration	4	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Construction should occur during the dry season; Use existing routes and already disturbed areas; Adherence to the relevant Storm Water Management Plan; Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.					
Environmental Risk (Post-mitigation)					-3.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.00

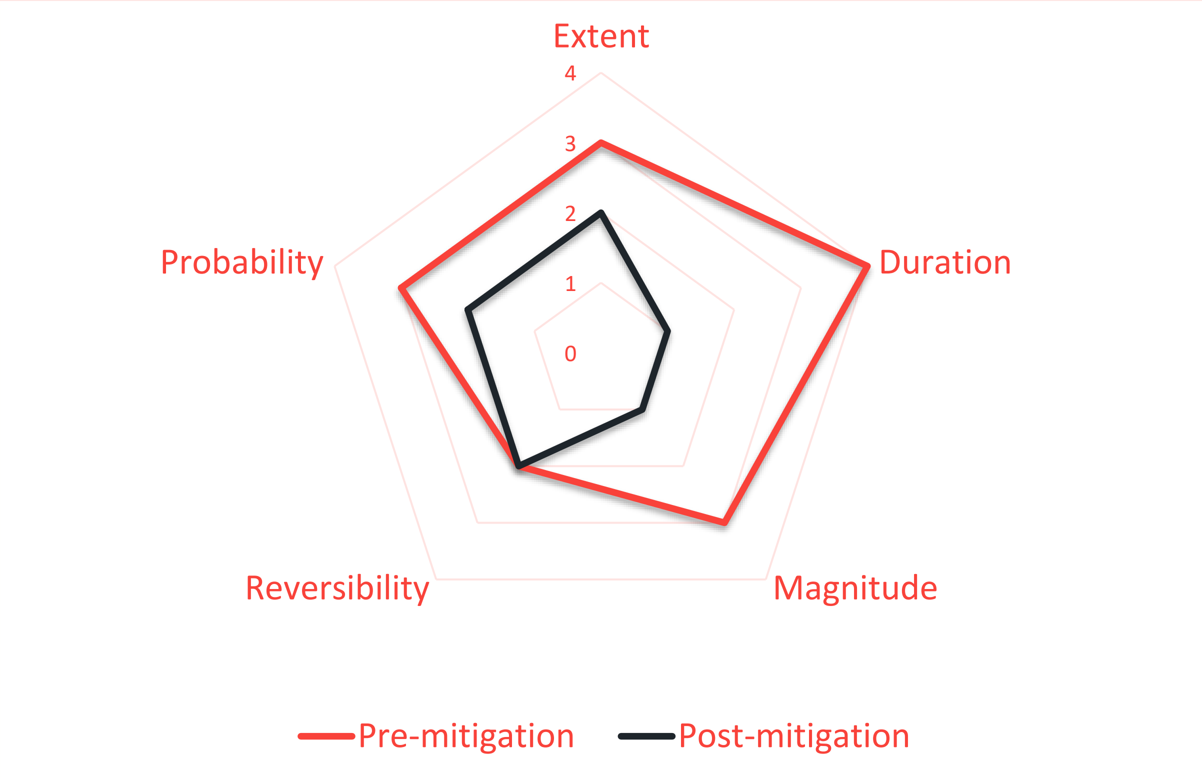

Figure 19 Radar Plot of pre and Post-Mitigation Impacts of Increased Runoff-Construction Phase

Table 13: Significance Rating Results for Hydrocarbon Contamination-Construction Phase

Impact Name	**Hydrocarbon contamination**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	1
Extent	3	1	Reversibility	2	2
Duration	2	1	Probability	3	1
Environmental Risk (Pre-mitigation)					-7.50
Mitigation Measures					
Drip trays should be placed under machinery. oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling; Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes; Provision of adequate sanitation and waste disposal facilities at the basecamp; Toolbox talks with specific consideration to be given to waste disposal.					
Environmental Risk (Post-mitigation)					-1.25
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00

Final Significance	-1.25

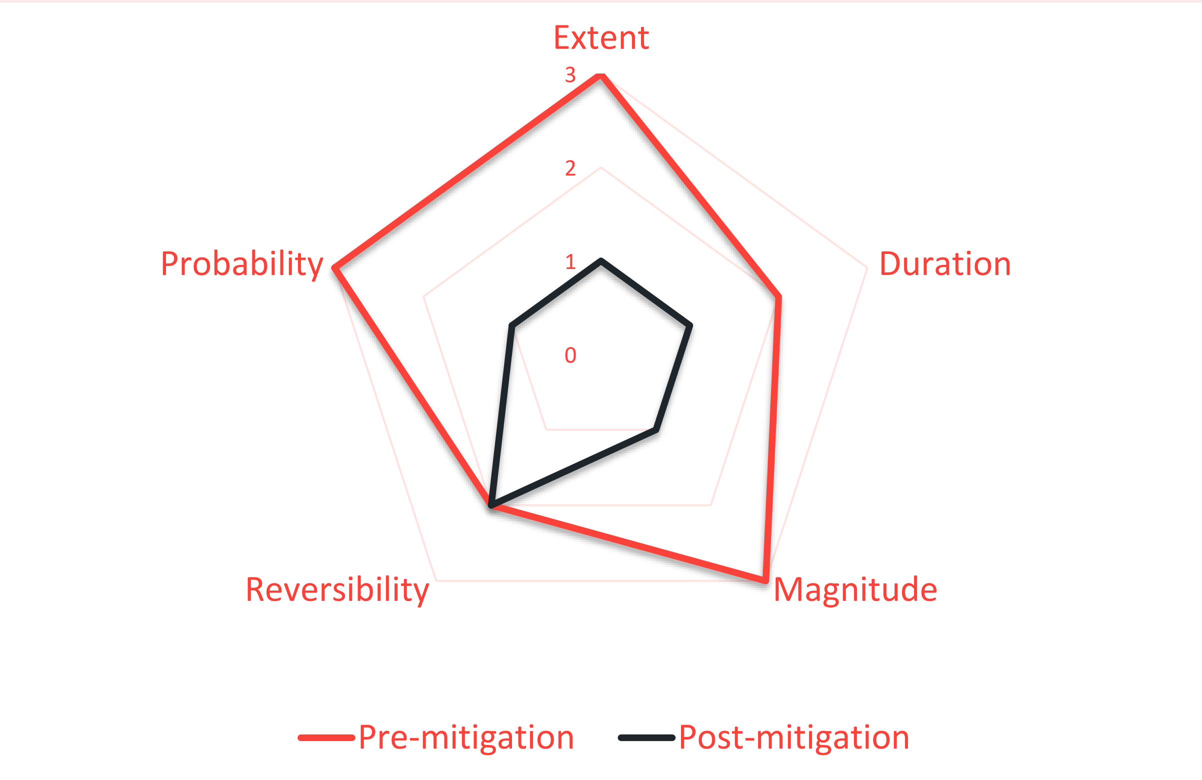

Figure 20: Radar Plot of pre and Post-Mitigation Impacts of Hydrocarbon Contamination-Construction Phase

Table 14: Significance Rating Results for Sedimentation-Construction Phase

Impact Name	**Sedimentation**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	2	Reversibility	2	2
Duration	4	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Undertake construction activities during the dry season; Demarcate sensitive areas, as no go zones; Dust Suppression through the use of water tankers and dust monitoring; Adherence to the relevant Storm Water Management Plan; Erosion control measures should be put in place in order to minimise the transport of sediment; Stabilisation of impacted soils and restricting vehicle movement to designated access roads;.					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1

Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-3.50

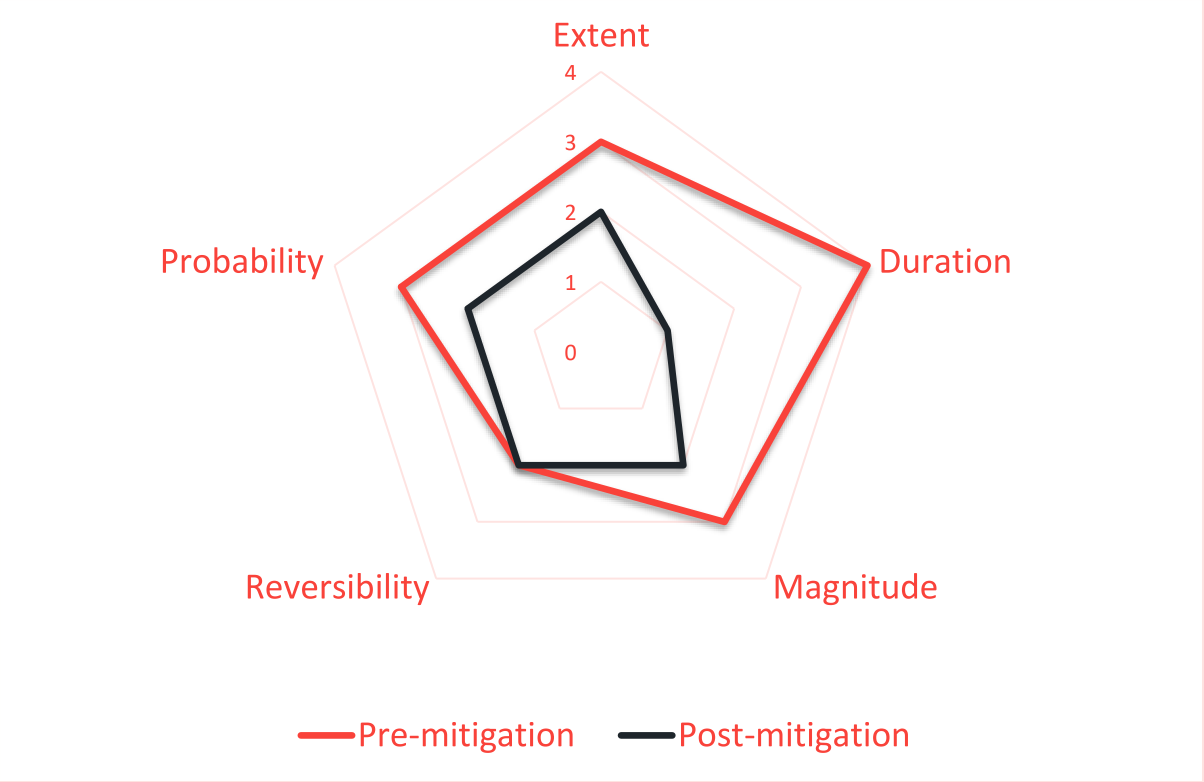

Figure 21: Radar Plot of pre and Post-Mitigation Impacts of Hydrocarbon Contamination-Construction Phase

Table 15: Significance Rating Results for Increased Runoff-Operational Phase

Impact Name	**Increased runoff**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	3
Extent	3	2	Reversibility	4	2
Duration	5	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-12.00
Mitigation Measures					
Adherence to the relevant Storm Water Management Plan; Development of vegetation rehabilitation plan, which should factor in new drainage patterns and comprise of methods to promote surface water infiltration.					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1

Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-4.50

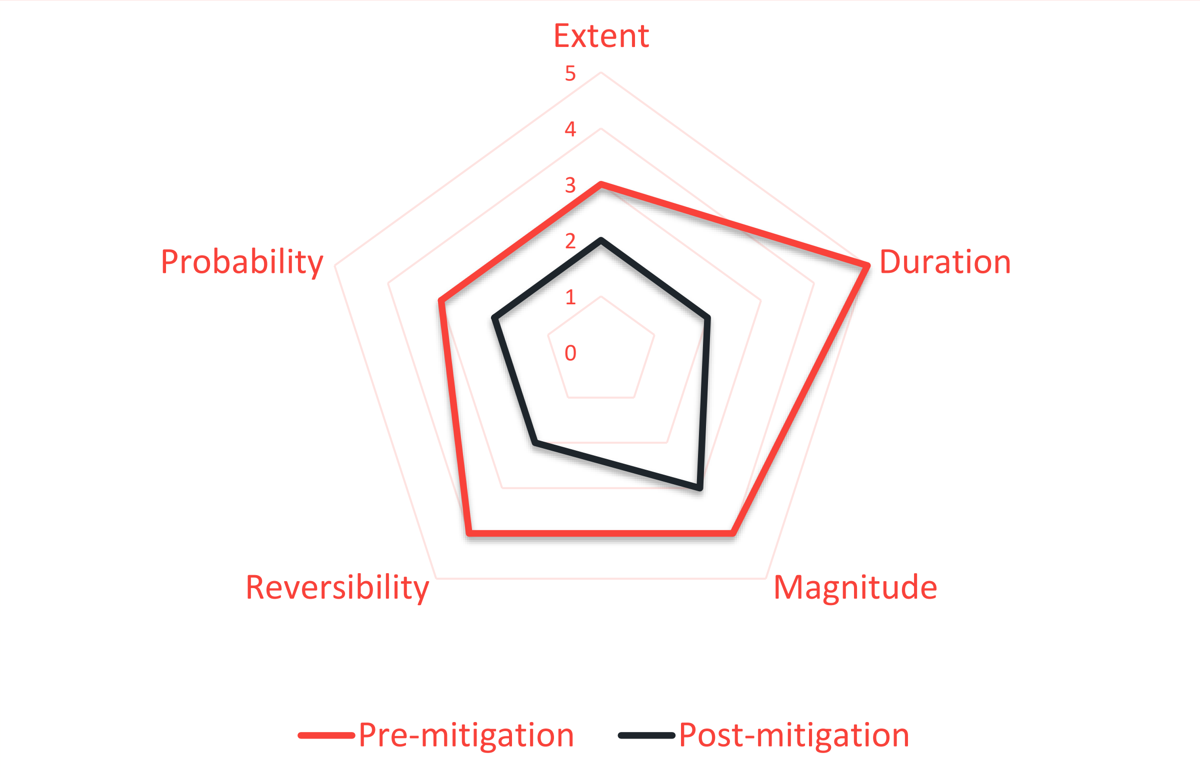

Figure 22: Radar Plot of pre and Post-Mitigation Impacts of Increased Runoff-Operational Phase

Table 16: Significance Rating Results for Change in Flow Regime-Operational Phase

Impact Name	**Change in flow regime**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	4	2	Reversibility	3	2
Duration	5	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-11.25
Mitigation Measures					
The storm water management plan should not change the direction of the natural flow drainage of the catchment and should maximise clean areas and minimize dirty area delineations.					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1

Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-4.00

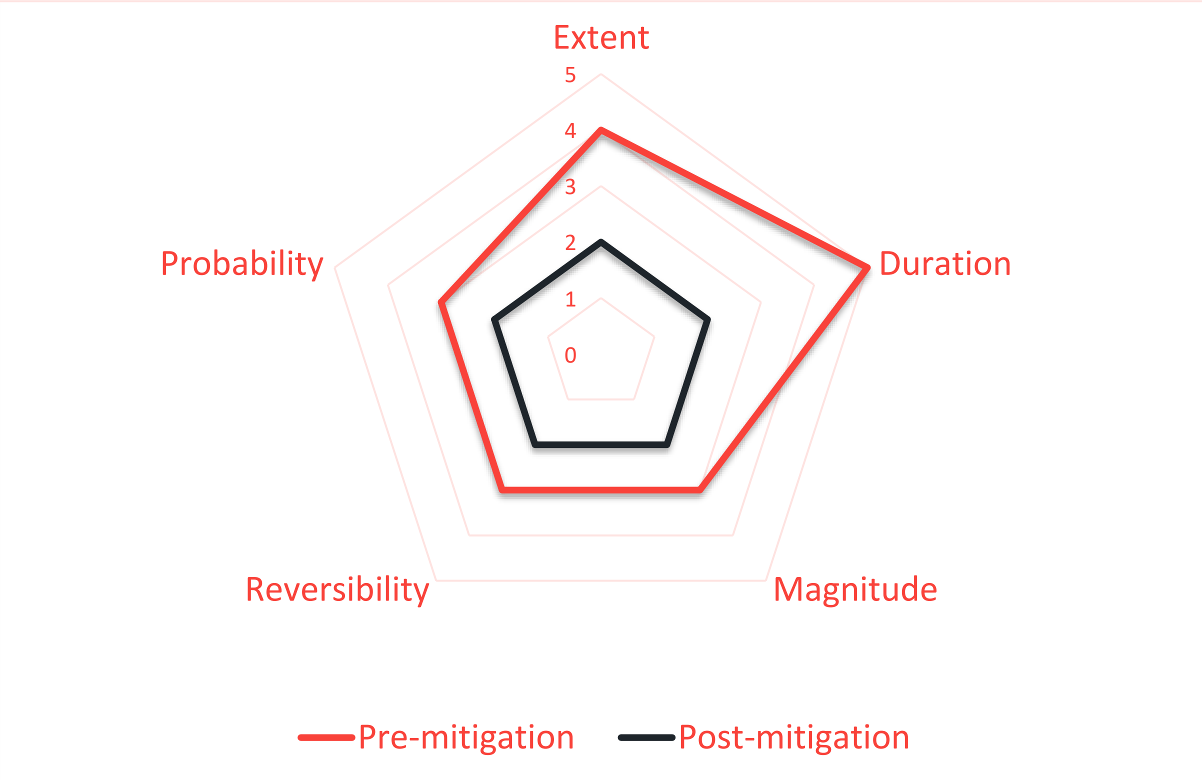

Figure 23: Radar Plot of pre and Post-Mitigation Impacts for the Change in Flow Regime-Operational Phase

Table 17: Significance Rating Results for Surface Water Contamination-Operational Phase

Impact Name	**Surface Water Contamination**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	3
Extent	4	2	Reversibility	4	2
Duration	5	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-17.00
Mitigation Measures					
Drip trays should be placed under machinery; oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling; Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes; Provision of adequate sanitation and waste disposal facilities at the basecamp; Toolbox talks with specific consideration to be given to waste disposal.					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					

Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.17
Final Significance	-5.25

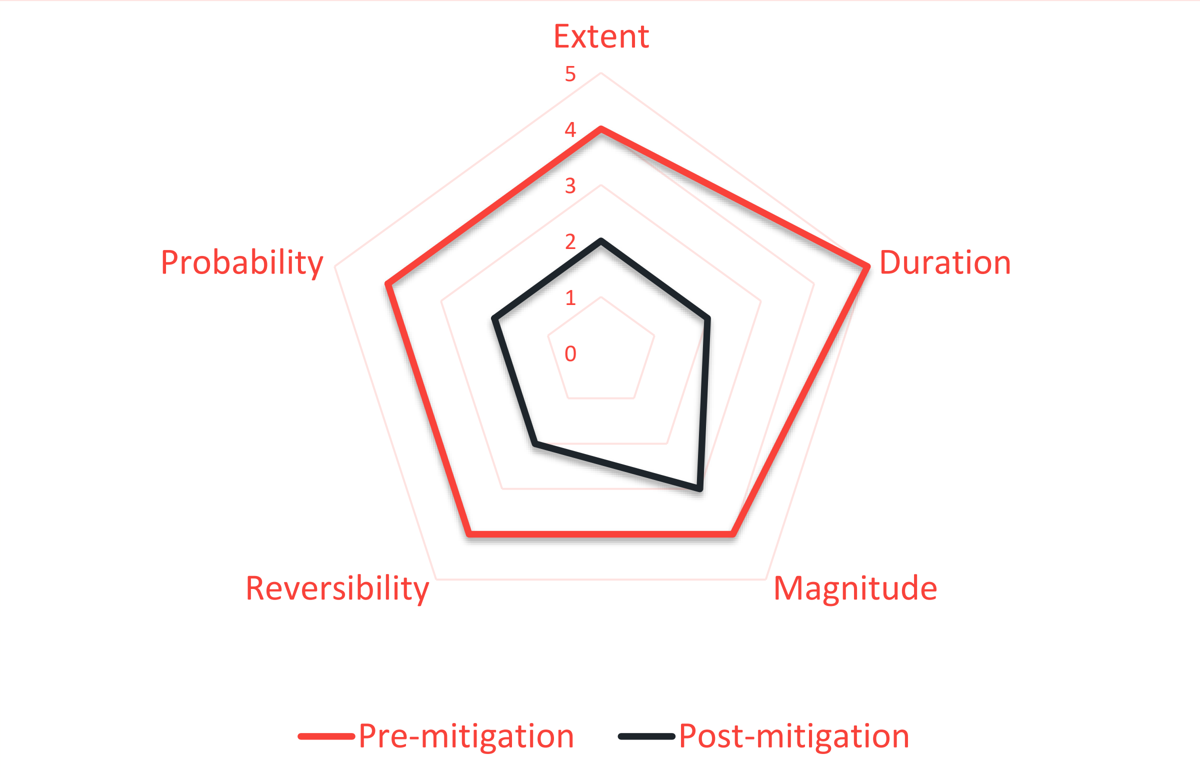

Figure 24: Radar Plot of pre and Post-Mitigation Impacts for the Surface Water Contamination-Operational Phase

Table 18: Significance Rating Results for an Increase in Runoff-Decommissioning Phase

Impact Name	**Increased runoff**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	1
Extent	3	2	Reversibility	2	2
Duration	4	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff; Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths); damage to stabilised areas should be repaired timeously and maintained; the total footprint area to					

be cleared for the development should be kept to a minimum by demarcating the construction areas and restricting removal of vegetation to these areas only.	
Environmental Risk (Post-mitigation)	-3.00
Degree of confidence in impact prediction:	Medium
Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-3.00

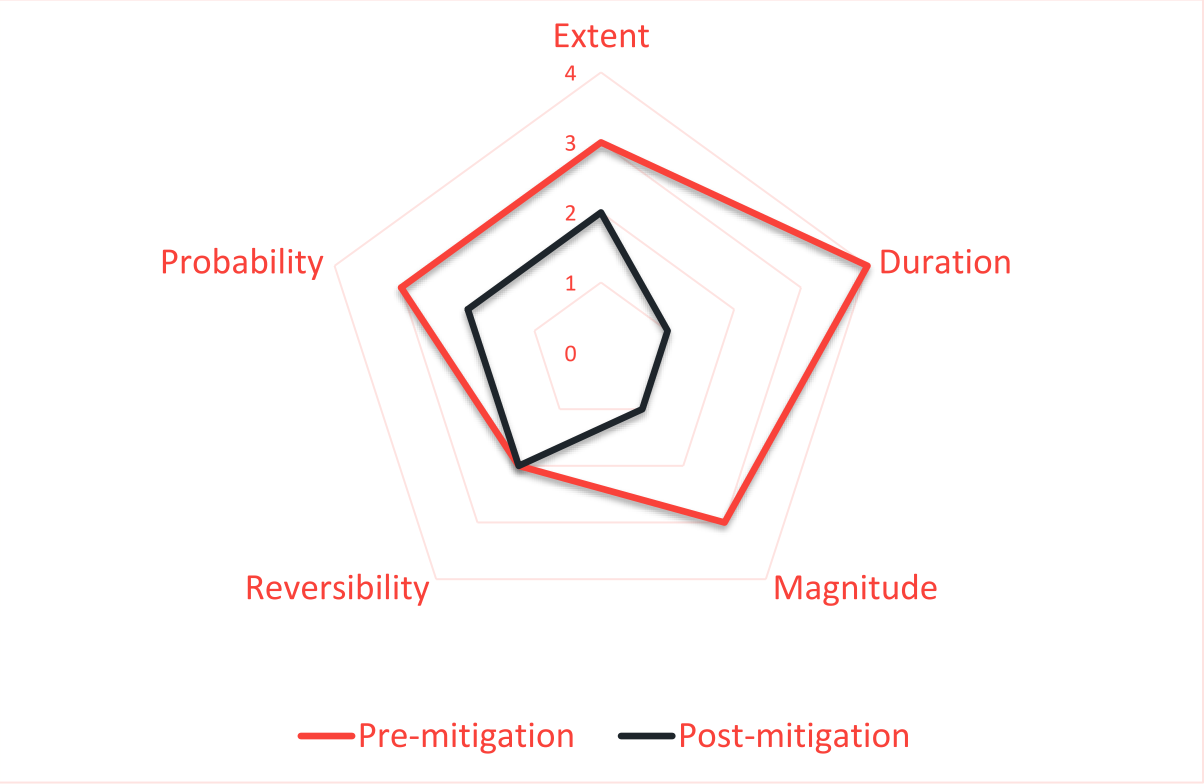

Figure 25: Radar Plot of Pre and Post-Mitigation Impacts of Increased Runoff-Decommissioning Phase

Table 19: Significance Rating Results for Hydrocarbon Contamination-Decommissioning Phase

Impact Name	**Hydrocarbon contamination**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	1
Extent	3	1	Reversibility	2	2
Duration	2	1	Probability	3	1
Environmental Risk (Pre-mitigation)					-7.50

Mitigation Measures	
Drip trays should be placed under machinery; oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling; Classification and disposal of waste must be undertaken in accordance with the relevant norms and standards; Provision of adequate sanitation and waste disposal facilities at the basecamp; Toolbox talks with specific consideration to be given to waste disposal; Continuous surface water and groundwater quality monitoring is essential to keep track of water quality issues that may arise for early detection purposes.	
Environmental Risk (Post-mitigation)	-1.25
Degree of confidence in impact prediction:	Medium
Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.	
Degree of potential irreplaceable loss of resources	1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.	
Prioritisation Factor	1.00
Final Significance	-1.25

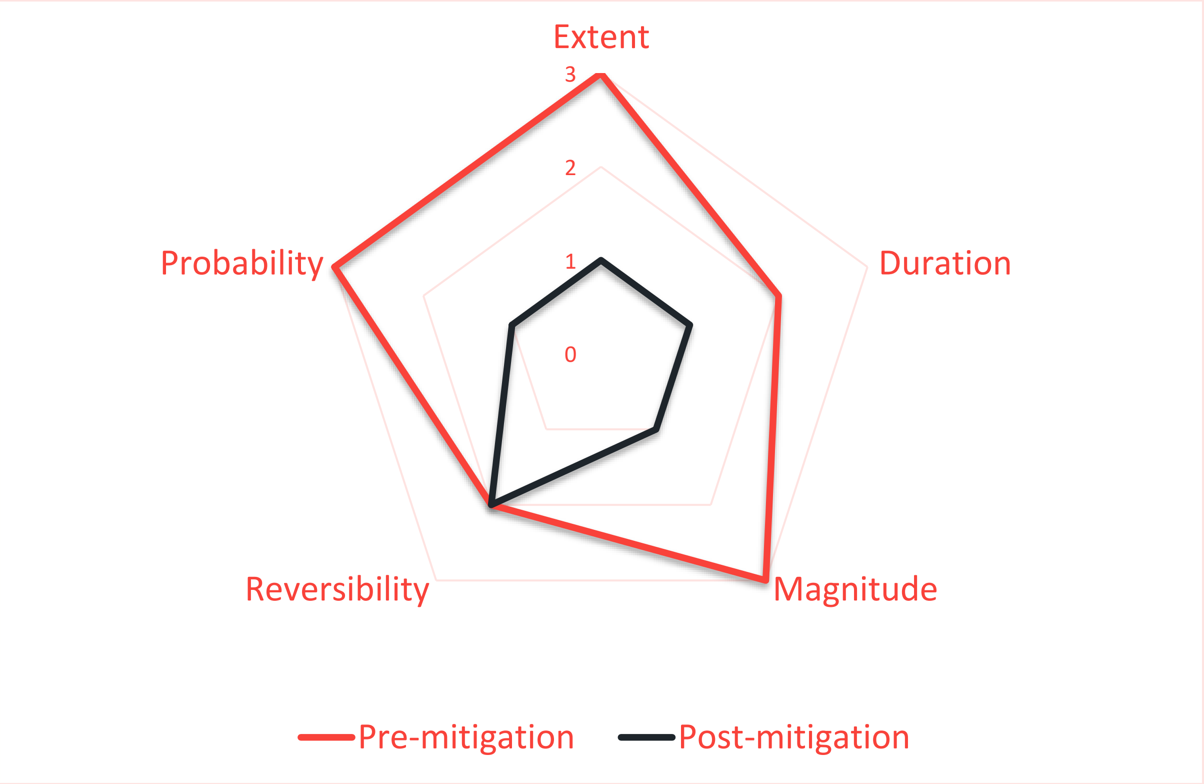

Figure 26: Radar Plot of pre and Post-Mitigation Impacts of Hydrocarbon Contamination-Decommissioning Phase

Table 20: Significance Rating Results for Sedimentation-Decommissioning Phase

Impact Name	**Sedimentation**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**

Nature	-1	-1	Magnitude	3	2
Extent	3	2	Reversibility	2	2
Duration	4	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Dust Suppression through the use of water tankers and dust monitoring; Erosion control measures should be put in place in order to minimise the transport of sediment; Stabilisation of impacted soils and restricting vehicle movement to designated access roads.					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.00
Final Significance					-3.50

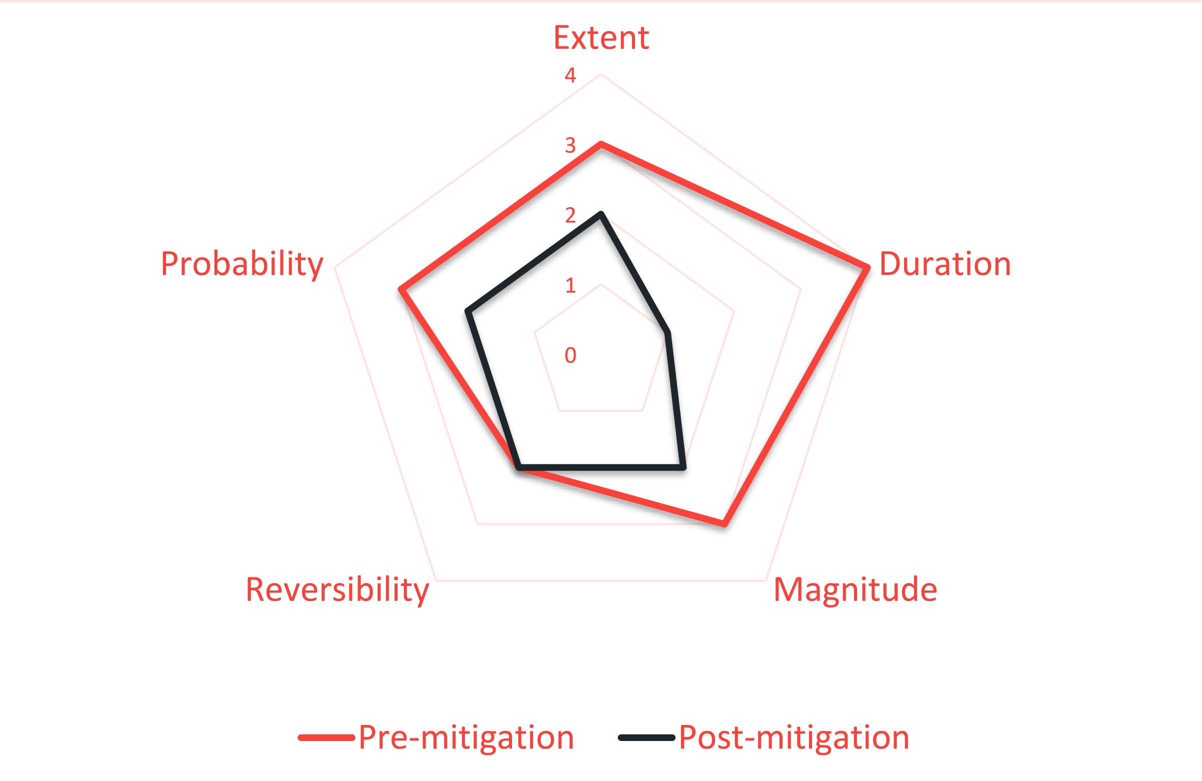

Figure 27: Radar Plot of Pre and Post-Mitigation Impacts of Hydrocarbon Contamination-Decommissioning Phase

The cumulative impacts for the site is predicted to be low as there doesn't seem to be much mining activity within the area. The activity and the footprint of the mine is small in comparison to the catchment area of the Vaal.

10 ACTION PLAN

An action plan provides an overarching framework as well as mechanisms for the management of all identified impacts and mitigation measures within the specific specialist field of study. An action plan suggested for the mitigation measures recommended in Section 9 is presented in **Tables 21 to Table 23**.

Table 21: Construction Phase Suggested Action Plans

No.	Phase	Management action	Timeframe for implementation	Responsible Party for implementation	Responsible party for Monitoring/audit/Review
Increase in Runoff					
1	Construction	Ensure total footprint area is kept to a minimum	Planning and Construction	Contractor	Mine manager/ECO
2	Construction	Traffic and movement of machinery should be minimised and restricted to certain paths.	Construction	Contractor	Mine manager/ECO
3	Construction and ongoing	Progressive rehabilitation of disturbed land should be carried out.	As needed during construction and ongoing	ECO	Mine Manger/ECO
Surface Water Contamination					
4	Construction	Ensure proper collection and storage of oils and grease from construction vehicles and machinery, and facilitate disposal of these by accredited vendors for recycling.	Construction	ECO and Contractor	Mine Manger/ECO
5	Construction	Drip trays should be placed under all standing machinery.	Construction	ECO and Contractor	Mine Manger/ECO
Sedimentation					
6	Construction	Construction should commence during the dry season	Planning and Construction	ECO and Contractor	Mine Manger/ECO
7	Construction	Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths), and damage to stabilised areas should be repaired timeously and maintained.	Planning and Construction	ECO and Contractor	Mine Manger/ECO
8	Construction	Silt traps should be established during this phase to trap sediments from construction. Trapped silt should be dredged and disposed of or used for other purposes such as construction.	Planning and Construction	ECO and Contractor	Mine Manger/ECO

Table 22: Operational Phase Suggested Action Plan

No.	Phase	Management action	Timeframe for implementation	Responsible Party for implementation	Responsible party for Monitoring/Audit/Review
Increase in runoff					
1	Operational	Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff;	Planning, construction and operational	ECO	Mine Manager/ECO
2	Operational	Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths), and damage to stabilised areas should be repaired timeously and maintained;	Planning and construction, operational	ECO	Mine Manager/ECO
3	Operational	Oil recovered from any vehicle or machinery on site should be collected, stored and disposed of by accredited vendors for recycling.	Operational	ECO	Mine Manager/ECO
4	Operational	Compacted surfaces should be kept to a minimum and vegetation rehabilitation must be implemented within the site.	Planning and construction, operational	ECO	Mine Manager/ECO
Surface Water Contamination					
5	Operational	All dirty water generated on site should be captured and stored in a pollution control dam;	Planning and construction, operational	ECO and Contractor	Mine Manager/ECO
6	Operational	A groundwater and surface water quality monitoring plan should be implemented to determine any changes in the water quality.	Planning and construction, operational, decommissioning	ECO and Contractor	Mine Manager/ECO

Table 23: Decommissioning Phase Suggested Action Plan

No.	Phase	Management action	Timeframe for implementation	Responsible Party for implementation	Responsible party for Monitoring/Audit/Review
Increase in Runoff					
1	Decommissioning	Ensure total footprint area is kept to a minimum	Planning and Construction	Contractor	Mine manager/ECO
2	Decommissioning	Traffic and movement of machinery should be minimised and restricted to certain paths.	Construction	Contractor	Mine manager/ECO
3	Decommissioning	Progressive rehabilitation of disturbed land should be carried out.	As needed during construction and ongoing	ECO	Mine Manger/ECO
Surface Water Contamination					
4	Decommissioning	Ensure proper collection and storage of oils and grease from construction vehicles and machinery, and facilitate disposal of these by accredited vendors for recycling.	Construction	ECO and Contractor	Mine Manger/ECO
5	Decommissioning	Drip trays should be placed under all standing machinery.	Construction	ECO and Contractor	Mine Manger/ECO
Sedimentation					
6	Decommissioning	Construction should commence during the dry season;	Planning and Construction	ECO and Contractor	Mine Manger/ECO
7	Decommissioning	Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths), and damage to stabilised areas should be repaired timeously and maintained.	Planning and Construction	ECO and Contractor	Mine Manger/ECO
8	Decommissioning	Silt traps should be established during this phase to trap sediments from construction. Trapped silt should be dredged and disposed of or used for other purposes such as construction.	Planning and Construction	ECO and Contractor	Mine Manger/ECO

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