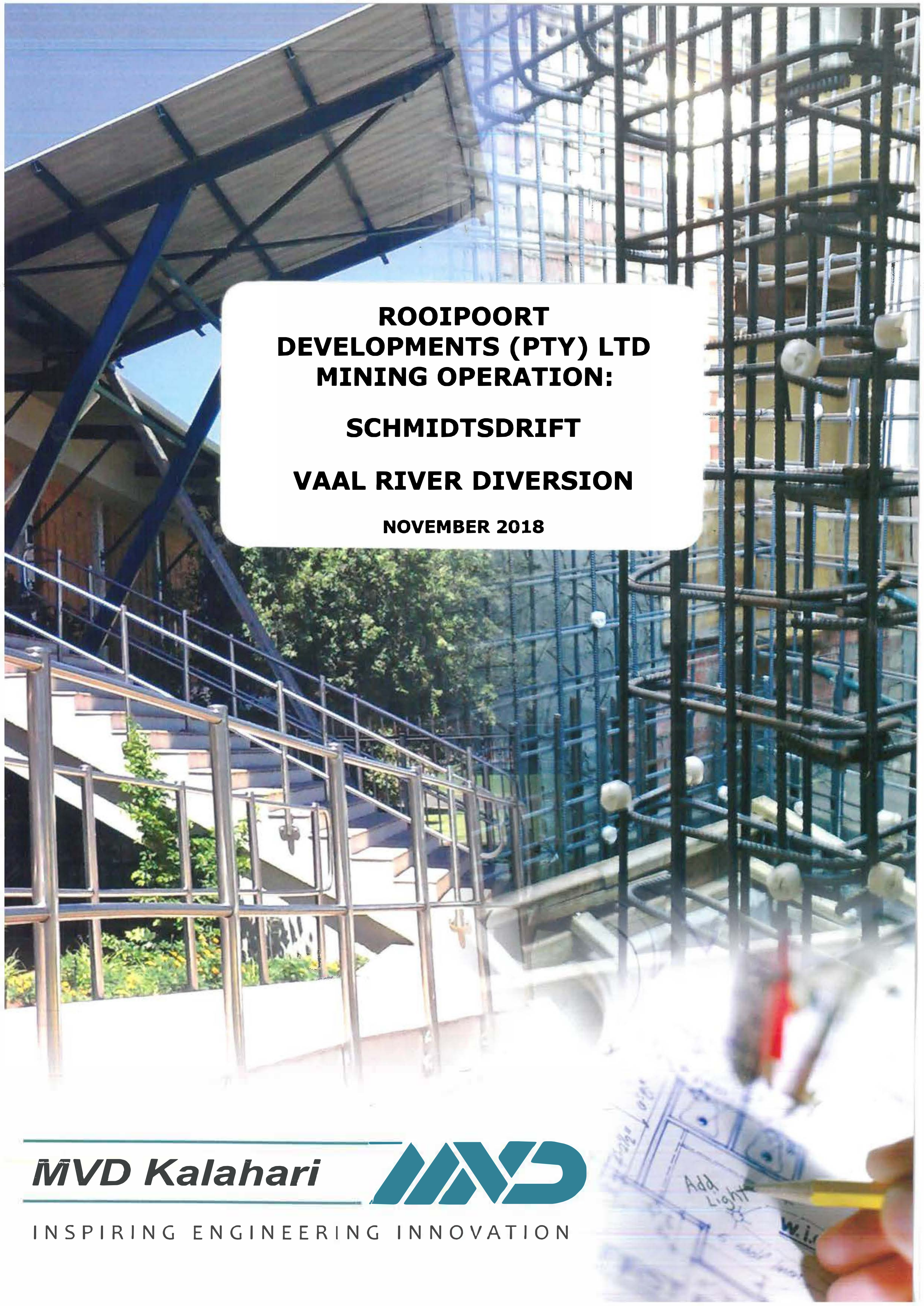

ROOIPOORT DEVELOPMENTS (PTY) LTD MINING OPERATION:

SCHMIDTSDRIFT

VAAL RIVER DIVERSION

NOVEMBER 2018

MVD Kalahari

INSPIRING ENGINEERING INNOVATION

ROOIPOORT DEVELOPMENTS (PTY) LTD MINING OPERATION:

SCHMIDTSDRIFT

VAAL RIVER DIVERSION

NOVEMBER 2018

Report Prepared by	:	P Oosthuizen/B Bensley
On	:	12 November 2018
On behalf of	:	MVD Kalahari
For	:	ROOIPOORT DEVELOPMENTS
Attention	:	Mr P Meyer

PROPOSED RIVER DIVERSION
IN THE VAAL RIVER
FOR
ROOIPOORT DEVELOPMENTS MINING OPERATION: SCHMIDTSDRIFT

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1. INTRODUCTION

MVD Kalahari was requested by Mr Pieter Meyer representing Rooipoort Developments (PTY) Ltd, to submit a report regarding the proposed diversion of the Vaal River that falls within the mining right of the operations of Rooipoort Developments.

The total length of river to be diverted in sections is approximately 27km. It is recommended that the diversion will be done in sections of approximately 1.5km each. Mining will be done within the current river channel and the left flank of the river bank which is within the riparian zone. A site visit to the mining operations took place on 22 August 2018.

2. LOCATION

The Rooipoort Developments mining operation is situated on the outskirts of Schmidtsdrift, bordered in the south by the national route N8 and the Vaal River in the east.

The town of Schmidtsdrift is a town in the Pixley ka Seme District Municipality in the Northern Cape Province and is located along the banks of the Vaal River, approximately 72km west of Kimberley.

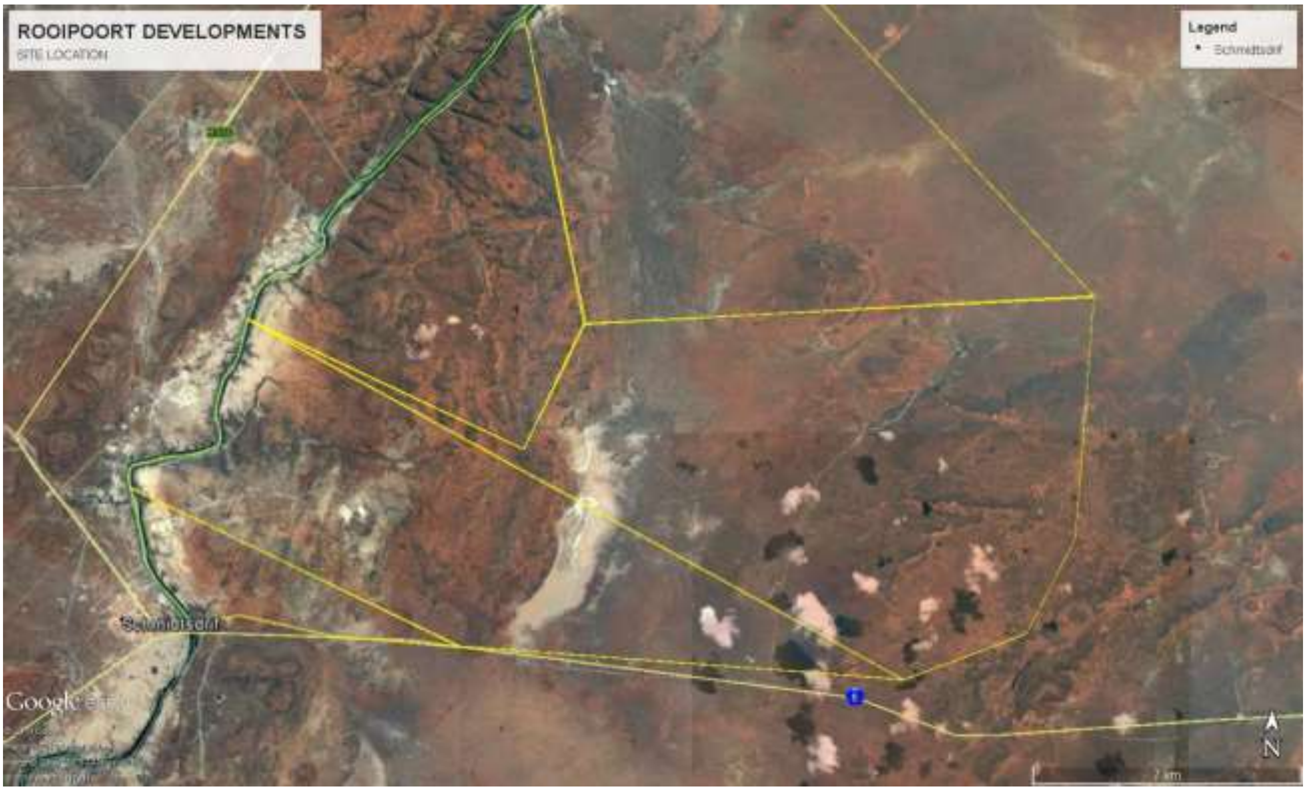

***Figure 1*: Site Location**

3. CLIMATE

The climate of the region is semi-arid with an average annual rainfall below 400mm. Temperatures range from a minimum of 8ºC to a maximum of 41ºC.

Figure 2 indicates average rainfall and average temperatures experienced per month. For the purpose of this report is the rainfall of importance due to the run-off that will be generated that will impact the mining operations when mining commences of the river bed and left flank of this portion of the Vaal River. Stormwater run-off in the catchment including normal river flow is measured in the Vaal River downstream of Schmidtsdrift and the mining site by a multi notched gauging structure, CH024.

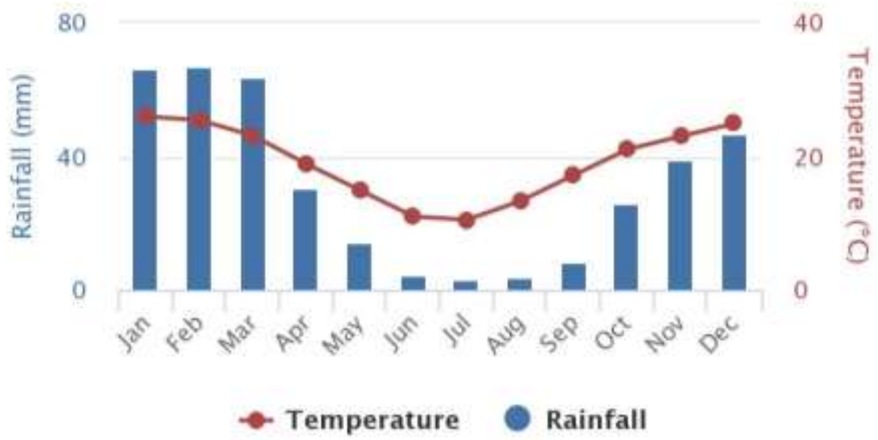

***Figure 2*: Average temperatures and rainfall for the Schmidtsdrift area**

4. HYDROLOGY

4.1 Existing river flow data

River flow data from a gauging structure (C9H024) some 420m downstream of the bridge on the N8 national route crossing the Vaal River has been made available by the Department of Water and Sanitation. Data consist of average daily flows. These flows have been reduced to average monthly flows. The latter will be able to give a clearer picture of the size of flows that can be expected throughout a typical yearly cycle. These results are summarized in *Table 1.*

The accuracy of the data measurement at the gauging structure is not known or has not been determined and is only of importance when measuring low flows. For the purpose of this report we are only interested in the maximum flows per day measured where the effect of the measure of accuracy is minimal. It can also be noted that there are periods within the recorded data where there is no available data. This however will not impact the summarized data significantly as the timeframe of available data is over a fairly long period.

4.2 Flood sizes

The maximum daily flow per month was determined from the hourly recorded data starting from 1996. The maximum monthly flood sizes were during the months of January, February and March which were 2304m³/s, 2506m³/s and 642m³/s respectfully with an average for these months of 344m³/s, 323m³/s and 115m³/s.

By studying the data in *Table 1,* the following is relevant:

- January : 5 x significant flood sizes occurred.
  The maximum flow excluding the 5 x flood sizes is 83.4³/s,
- February : 6 x significant flood sizes occurred.
  The maximum flow excluding the 6 x flood sizes is 21.79m^3/s,
- March : 6 x significant flood sizes occurred.
  The maximum flow excluding the 6 x flood sizes is 27.24m^3/s,
- April : 3 x significant flood sizes occurred.
  The maximum flow excluding the 3 x flood sizes is 36.16m^3/s,
- May : 2 x significant flood sizes occurred.
  The maximum flow excluding the 2 x flood sizes is 32.58m^3/s,
- June : 1 x significant flood sizes occurred.
  The maximum flow excluding the 1 x flood sizes is 30.01m^3/s,
- July : 0 x significant flood sizes occurred.
  The maximum flow over the 23-year period is 49.05m^3/s,
- August : 0 x significant flood sizes occurred.
  The maximum flow over the 23-year period is 23.85m^3/s,
- September : 0 x significant flood sizes occurred.
  The maximum flow over the 23-year period is 15.15m^3/s,
- October : 0 x significant flood sizes occurred.
  The maximum flow over the 23-year period is 15.27m^3/s,
- November : 0 x significant flood sizes occurred.
  The maximum flow over the 23-year period is 15.68m^3/s,
- December : 3 x significant flood sizes occurred.
  The maximum flow excluding the 3 x flood sizes is 17.06m^3/s,

Year	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan
1995	6.78	24.16	36.16	10.03	8.23	7.59	4.26	3.83	4.56	10.6	9.9	6.86
1996	0	0	0	15.76	13.96	11.6	11.31	9.59	10.78	10.05	0	0
1997	0	0	0	0	0	0	9.79	9.94	11.23	13.67	8.44	1227
1998	233.6	238.8	0	17.67	15.99	10.31	23.85	8.95	10.42	12.11	246.5	388.1
1999	9	12.02	13.44	12.71	11.58	11.9	9.04	6.55	15.27	8.98	12.08	0
2000	0	0	0	0	9.96	8.6		12.46	9.2	8.5	0	11.19
2001	12.43	27.24	22.77	32.58	11.66	11.34	11.1	13.73	14.89	282	429	407.4
2002	600	162.7	12.49	11.17	11.68	11.53	15.13	15.15	15.26	12.88	12.56	11.67
2003	16.83	17.52	10.82	10.28	10.29	10.91	9.22	8.5	9.88	14.12	13.34	12.06
2004	9.57	13.25	30.41	9.88	9.31	9.41	8.04	9.08	10.28	7.35	17.06	16.59
2005	21.79	11.29	12.47	9.16	9.12	8.77	7.53	5.49	9.15	8.01	7.62	15.62
2006	15.43	0	0	0	0	0	0	0	0	12.3	8.66	9.17
2007	9.68	10.41	10.5	6.25	6.22	6.19	6.16	7.13	11.54	10.73	14.64	9.97
2008	10.58	11.11	10.17	13.83	11.25	11.63	8.43	6.56	4.21	10.16	11.34	12.57
2009	377.2	252.9	116.6	31.92	9.71	9.85	11.05	7.77	12.75	13.97	10.72	2304
2010	2506	368.9	341.1	103.7	30.01	10.54	11.57	11.3	10.35	8.71	954.3	2628
2011	1526	326.1	402.4	306.1	245.4	49.05	13.96	12.57	12.09	12.28	12.32	9.69
2012	15.66	15.2	15.42	14.07	12.76	9.55	8.84	10.35	13.49	13.23	13.12	13.03
2013	13.54	10.09	12	12.66	11.41	11.34	9.45	8.05	5.87	15.68	15.08	11.8
2014	13.93	8.67	14.04	11.19	11.76	13.4	10.57	8.78	8.79	12.18	12.11	10.98
2015	11.43	11.95	11.53	11.45	13.91	11.01	10.38	9.09	10.3	5.95	7.13	83.49
2016	9.79	12.33	13.5	10.42	8.88	8.99	8.76	8.5	5.16	9.22	8.19	20.1
2017	722.5	642.2	26.16	13.39	11.71	10.09	7.54	6.25	11.5	8.79	9.44	12.03
2018	11.93	13.58	177.1	181.6	11.86	9.19	8.27					
Total Average	**307**	**110**	**68**	**40**	**23**	**12**	**10**	**9**	**10**	**23**	**87**	**344**

<u>Table 1</u>: Summarized yearly flows per month at gauging station C9H024 (Vaal River) for the period 1996 to 2018

4.3 Current channel flow conditions of the Vaal River

The section of the Vaal River that is within the mining right of Rooipoort Developments currently follows the natural water course. Flow during normal or low flow conditions is non-uniform but sub-critical with some sections where flows are critical to super critical where the river section narrows. For purposes of analytical treatment non-uniform flow may be conveniently classified as (a) gradually varied flow and (b) rapidly varied flow. There is no definite dividing line.

Gradually varied flow: As mentioned above, the biggest portion of the river during low flow conditions has gradually varied flow, thus the degree of non-uniformity is slight; the change in flow conditions extends over a considerable distance. The current low flow condition as experienced during the site visit in August 2018 for the majority of the river within the study area is subcritical. River flow will always be non-uniform as uniform flow is an ideal state which is never actually attained. The flow is uniform when the mean velocity from one section to another is constant. This implies a constant cross-section and depth.

The latter can be achieved in a concrete lined channel with a constant cross-section and slope. Uniform flow is thus a balance between the gravity and frictional forces. The flow is non-uniform when the mean velocity varies throughout the length of the river channel.

Rapid varied flow: In rapidly varied flow there is an abrupt or very rapid change in the sectional area of flow within a short distance. Turbulent eddying will accompany such a flow condition. There are short sections of the river that falls within this category.

5. DIVERSION CHANNELS

Each diversion channel will consist of (a) a transition zone where the natural river channel is diverted towards the new constructed diversion channel, (b) the diversion channel with an embankment on right flank to separate the natural river channel from the diversion channel, (c) a transition zone that allows the flow back towards the natural river channel.

5.1 Proposed channel flow conditions for each diversion section

The South African climate oscillates between drought and flood. This leads to extremes in river flow and sediment transport. While storms last for minutes to days, the hydrological critical low flows can last for years during droughts. The strong variation in river flow makes the design of a diversion highly complex in South Africa. It is recommended to achieve the current flow conditions of the Vaal River when constructing the diversion channel. The main reason is to minimize the sediment load, thus not having an increased sediment load within the diversion channel. It is therefore important to make an effort in the construction of the transition zone i.e. the portion of diversion channel connecting the natural watercourse with the newly constructed diversion channel. The width and angle of the transition zone to the diversion channel should be such that subcritical flow conditions should be maintained during normal low flow periods.

The areas in the natural watercourse where the rapidly varied condition exists have to be avoided when the transition zone is constructed. It is recommended that the transition zone be constructed upstream of the area of varied flow to avoid the energy component ($v^2/2g$) which is a significant portion of the total head where this condition exists. These areas will be identified by the Engineer prior to the excavation of the diversion channels. The reason for the above is to avoid unnecessary sedimentation i.e. the higher the velocity within the watercourse the higher the possibility for erosion which will cause sediment to be in suspension and transported downstream; this is classified as contamination which is to be avoided.

5.2 Embankment wall section height between natural river channel and proposed diversion channel and cross- sectional area of the proposed diversion channel.

The following is a requirement to be able to establish the height of each river diversion embankment walls:

- Detailed survey required of each river diversion after excavations is done and before transition section is opened to divert the section of river through the newly excavated diversion channel,

- Calculation of the maximum capacity of the diversion channel which will allow for subcritical flow conditions at the specified flow rate as recommended below.

- It is recommended that the proposed diversion channels have to cater for a minimum flow of $50m^3/s$ for the duration of the mining operations per diversion channel for calendar months April to December. It is also advised that no diversion channels to be operational during the December break.

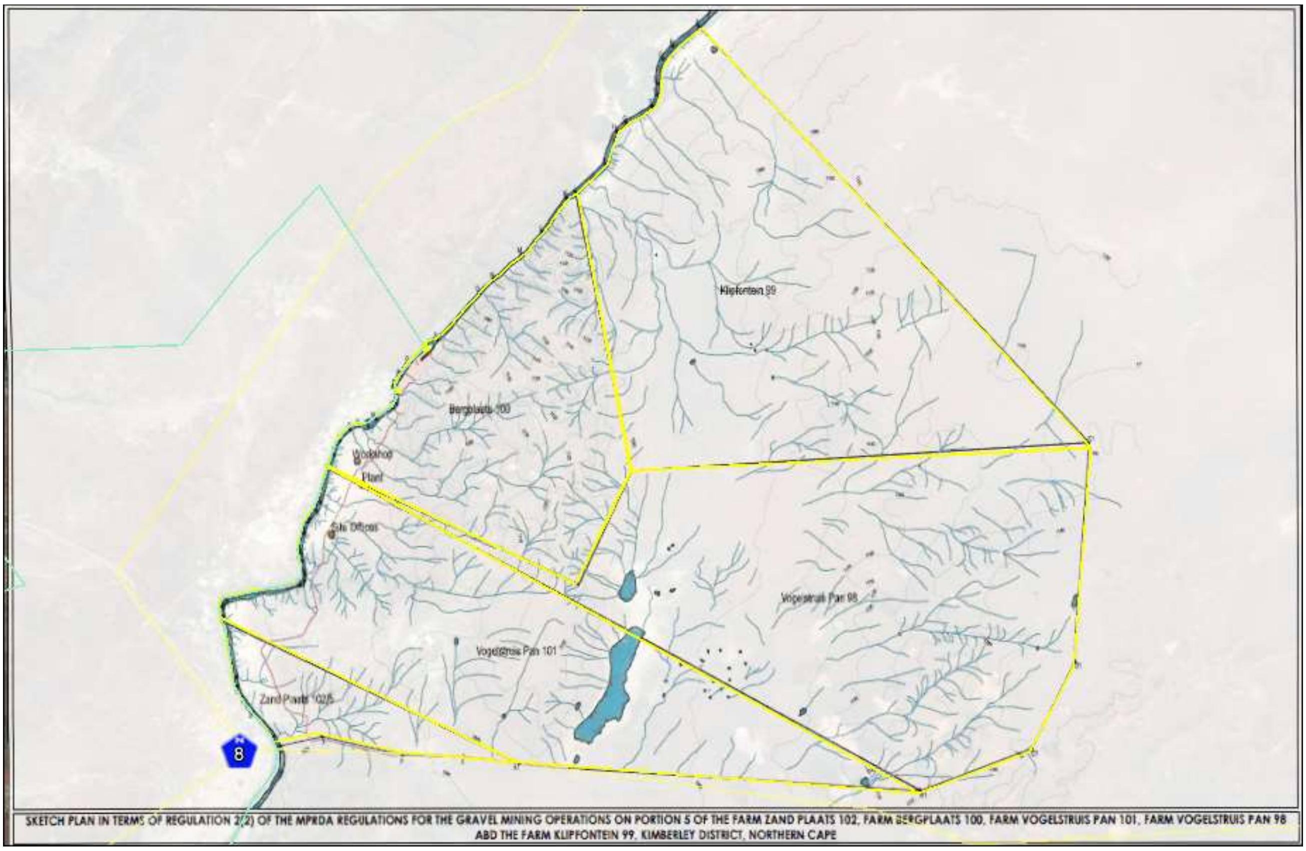

***Figure 3**: Rooipoort Developments mining operations extent.*

5.3 Description of the implementation of a typical diversion section of approximately 1.5km in length.

The complete length of the Vaal River that is covered by the mining right will be mined as indicated in *Figure 3.* The excavation will be done up to the border of the mining right which is situated approximately halfway within the width of the existing Vaal River channel. This line of excavation will be surveyed as per the Surveyor Generals Plan as attached to the title deed of the property by a qualified and registered land surveyor.

Below is a layout, *Figure 4,* indicating the river diversion for a section of the river with length of approximately 1,5km.

A section of the Vaal River has been chosen to illustrate the methodology regarding the construction of the diversion channel to be able to mine the river channel and left bank of the river.

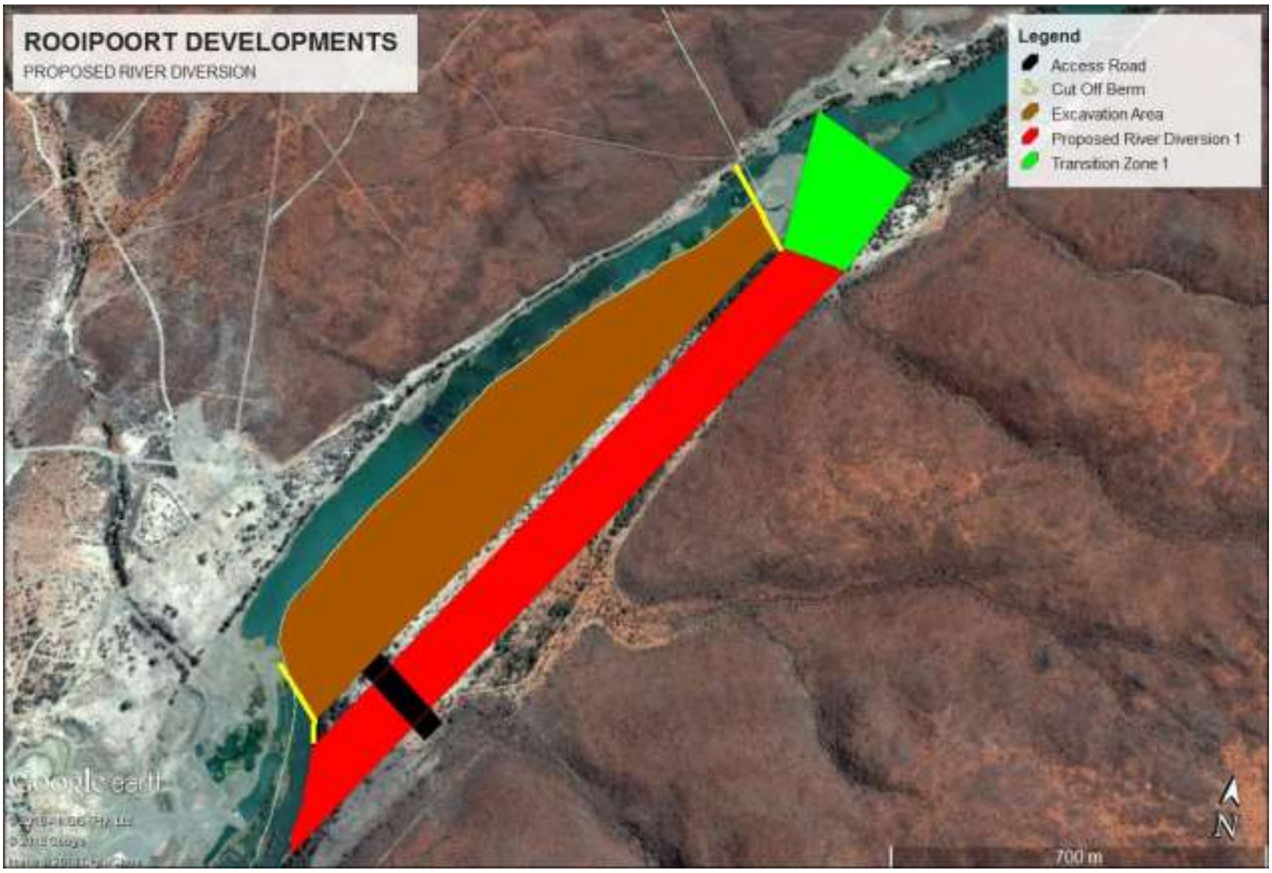

***Figure 4**: Example of the position of a typical river diversion.*

The proposed method statement for the diversion is as follows:

- Excavate proposed diversion (red section) as indicated on drawing
- Excavate intake transition area (green area),
- River crossing with culverts to be constructed prior to completion of the river diversion,
- Transport excavated material to the plant for processing. Construct the cut-off w*all/berm (yellow) upstream of the* diversion.

- A portion of the left bank is to be kept in place to act as a diversion wall between the newly excavated diversion channel(red) and the existing river channel (brown area),

- Construct cut-off wall/berm downstream (yellow).

- The method of end tipping is recommended to be used in the presence of flowing water. This channel is to be closed up after completion of excavation of the natural river channel. The method of end tipping is as explained below:

    - A method frequently used for the closure of rivers is to tip rock/gravel into the river starting from the banks. The crest level of the rock tip embankment thus formed is kept above water level. Rock is end-tipped towards the centre of the river from either or both banks, gradually closing the gap (see *Figure 5* for detail).

    - As the trapezoidal shaped gap is narrowed the flow velocity through it increases. Eventually the stage may be reached where the velocity is sufficient to erode the rock-tip and equilibrium is reached. Further rock tip is washed with the stream to be deposited in a fan downstream. Gradually, the flow may be reduced due to storage or diversion of the river and consequently the gap may be further narrowed. In general, it is found that a larger stone is required to prevent scour of the end-tipped bank during the closure stage than for the submerged embankment.

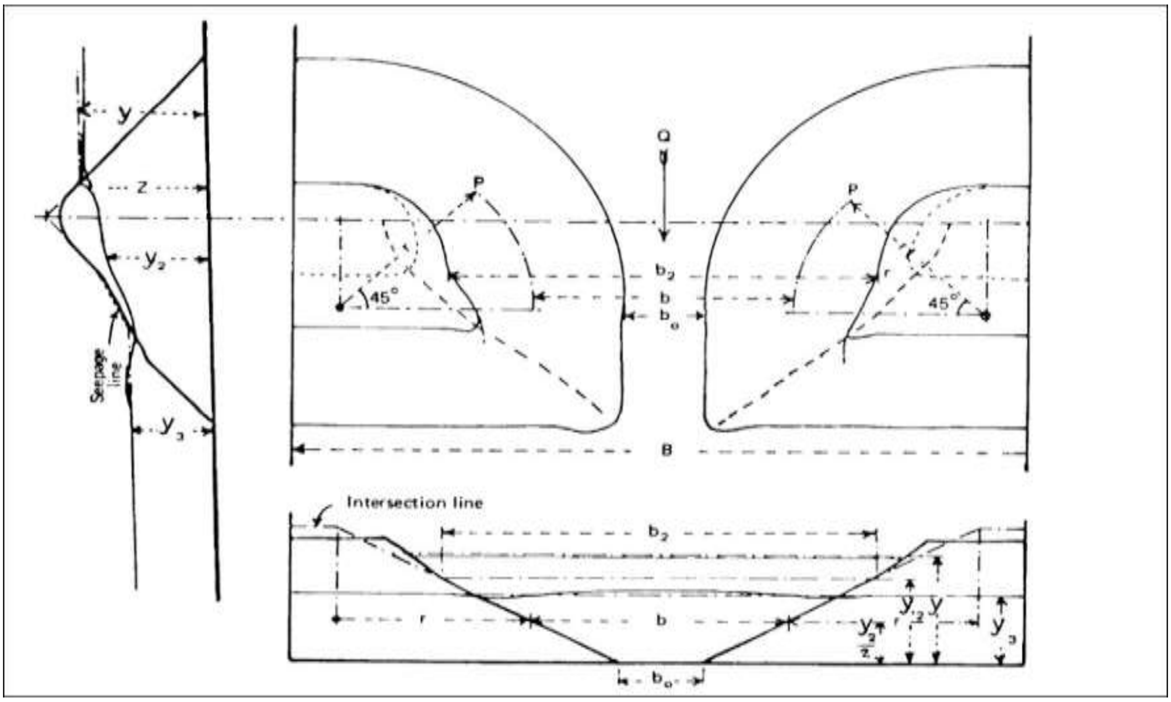

***Figure 5*: End Tipping**

6. STORMWATER CONTROL

Stormwater management will be required at each mining area at the proposed 1,5km diversion sections.

Cut-off drains to be constructed around the proposed mining area to prevent clean water runoff to enter into the mining area. Storm water generated within the mining area will be known as dirty storm water runoff and this dirty water system will be separated from the clean water system as per the GN 704 regulations. These cut-off drains will divert clean storm water runoff during a rainstorm around the proposed mining area following the natural contours into the Vaal River downstream.

7. CONCLUSION AND RECOMMENDATION

7.1 The river diversions are to be installed to adhere to the Government Notice 704: National Water Act 36 of 1998: Regulations on Use of Water for Mining and Related Activities aimed at the Protection of Water;

7.2 All activities to comply with the EMP of Rooipoort Developments mine;

7.3 It is recommended that the proposed diversion channels have to cater for a minimum flow of $50m^3/s$ for the duration of the mining operations per diversion channel for calendar months April to December. There is however a moderate risk of flooding during the months of April and May. The sizing (cross section dimensions) of each diversion has to comply with the conditions as described in paragraph 5.1 – 5.3. It is also advised that no diversion channels are operational during the December break. It is therefore recommended not to construct diversion channels during calendar months January to March as this is the rainy season where extreme flooding may occur;

7.4 It is recommended that only one diversion channel be constructed during any given time. This will minimize the risk of contamination of the river system.

Signatures

Petrus Oosthuizen (Director)

Brian Bensley (Pr Tech Eng)

MVD Kalahari
Consulting Engineers and Town Planners
Level 2 B-BBEE Contributor
/po/8140-QR-Vaal River Diversion

12 November 2018