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PLATREEF RESOURCES (PTY) LTD

Platreef Project Pre-Feasibility Study: Draft Hydrology Report for Draft EIA

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REPORT

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Golder Associates

Executive Summary

Platreef Resources (Pty) Ltd (Platreef) are currently undertaking a study to assess the feasibility of developing an underground platinum mine on the farms Turfspruit 241KR, Macalacaskop 243KR, Rietfontein 2KS and Uitloop 3 in the Limpopo Province. The scoping phase of the ESIA has commenced and is being undertaken by Digby Wells and Associates. This baseline report, describes the prevailing surface water situation over the prospecting area, has been prepared as a supporting document to the main ESIA.

The available climate and rainfall data were analysed to describe the baseline conditions on the site. The 24 hour rainfall depths for different recurrence intervals were generated for use in infrastructure design. A daily rainfall and average monthly evaporation records were produced for use in the feasibility studies. The hourly wind data measured at the Mokopane Weather Station were assessed and wind roses produced for the area. The Weather Station is still operational although a number of the rain gauges close to the site have been closed. The Mokopane Weather Station is located about 13 km south east of the project area. The data collected at this station will not be fully representative of conditions on site particularly on Rietfontein 2KS to the north where a tailings storage facility is planned. It is recommended that Platreef set up a weather station on site to measure local conditions.

A monitoring programme has been set up to collect flow and water quality data on the project area. A first round of water quality sampling and flow measurements was carried out in September 2011. The rivers were largely dry during this time. Throughout the monitoring process the rivers were mainly dry with the exception of the Dorsp River which experienced low flow. This low flow was due to discharges from the maturation ponds treating sewage effluent. The water quality and flow data collected by Department of Water Affairs (DWA) was sourced and assessed. There is doubt as to the accuracy of the flow station on the Nyl River. The available water quality data were patchy and limited water quality variables were measured. The water quality results from the Platreef monitoring programme are presented in the report. The results show that the water has undesirable standards of Total Dissolved Solids (TDS) for drinking water with the exception of the upper most region of the site. The water quality results also show high concentrations of dissolved manganese, aluminium and iron, which could be due to geological influences. The Rooisloot and Dorpsrivier show a eutrophic system enriched with nutrients due to sewage effluent coming from the surrounding towns and from the sewage treatment plants. There are also high chloride levels in the Mogalakwena River due to anthropogenic sources.

The 50 year and 100 year flood peaks and flood lines have been determined for the rivers crossing the project area and the Mogalakwena River flowing to the west of the site. The analysis shows that the current mine infrastructure is located within the floodlines of one of the tributaries.

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1.0 INTRODUCTION

Platreef Resources (Pty) Ltd (Platreef) are currently undertaking a study to assess the feasibility of developing an underground platinum mine on the farms Turfspruit 241KR, Macalacaskop 243KR, Rietfontein 2KS and Uitloop 3 in the Limpopo Province. Platreef hold prospecting rights for the farms which are situated some 5 – 10km North West of Mokopane, as shown in Figure 1.

The scoping phase of the ESIA has commenced and is being undertaken by Digby Wells and Associates. This baseline report, describing the prevailing surface water situation over the prospecting area, has been prepared as a supporting document to the main ESIA. This report uses information available at the time of preparation. A baseline flow and water quality monitoring programme had been set up and the results appear in the report below and the available climate information has been analysed.

2.0 STUDY OBJECTIVES

The overriding objective of the baseline assessment is to provide a reference point against which impacts to the surface water system can be measured. The baseline assessment will therefore characterise and describe the prevailing surface water environment and provide the context for the subsequent impact assessment.

The baseline assessment will involve the collection, discussion and interpretation of existing and new data useful to describe the pre-mining surface water situation on the four farms comprising the exploration concession, namely Turfspruit 241KR, Macalacaskop 243KR, Rietfontein 2KS and Uitloop 3.

The primary objectives of the hydrological baseline study are:

- To use the available climate data to describe the climate on site;
- To collect baseline information to characterise the flow and water quality in the streams crossing or adjacent to the project area;
- To generate rainfall and evaporation records for use in the design of mine infrastructure; and
- Propose a monitoring programme for further baseline data collection and for the operational phase once the project description becomes available.

3.0 GENERAL DESCRIPTION OF THE STUDY AREA

The project area is located north west of the town of Mokopane in the Limpopo Province. The study area falls in the Limpopo Water Management Area (WMA). The two quaternary catchments in which the project falls are A61F and A61G (See Figure 1). A61F is drained by the Rooisloot River and A61G by the Mogalakwena River. The Nyl River is the headwaters of the Mogalakwena River. The Nyl River flows in a north easterly direction from Modimolle located in the headwaters of the Nyl River, towards Mokopane. At Mokopane, the Nyl River becomes the Mogalakwena River and turns to flow in a north westerly direction passed Mokopane and the project area. The Mogalakwena River flows to the west of the project area and ultimately flows into the Limpopo River. The Mogalakwena River is characterised by the presence of vleis and wetlands along its drainage course on both the Turfspruit and Macalacaskop farms. The Sterk River is a major tributary of the Mogalakwena River and joins the Mogalakwena River from the west some 30 km below the project area. The Doorndraai Dam is located on the Sterk River. The Doorndraai Dam is the main water supply dam for Mokopane.

There are four main water courses that drain across or adjacent to the project area (See Figure 2). The Dithokeng, Ngwaditse, Rooisloot and the Dorps Rivers flow in a westerly direction across the project area into the Mogalakwena River. The Dithokeng stream crosses the corner of the mine property in the north before joining the Mogalakwena River. A dam has been constructed on this stream upstream of the town to the north east of Turfspruit. The dam is used for domestic water supply.

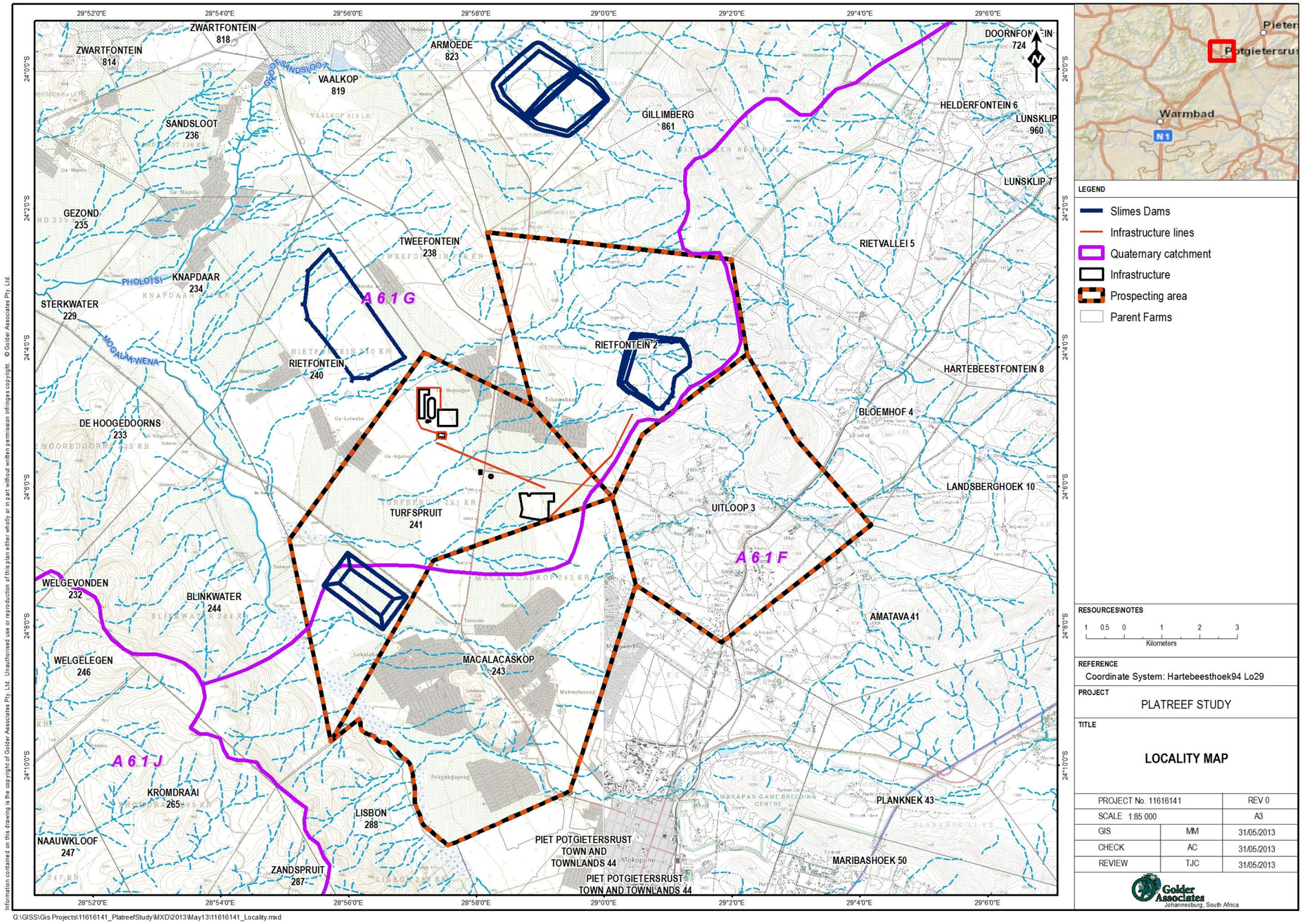


Figure 1: Location of project area

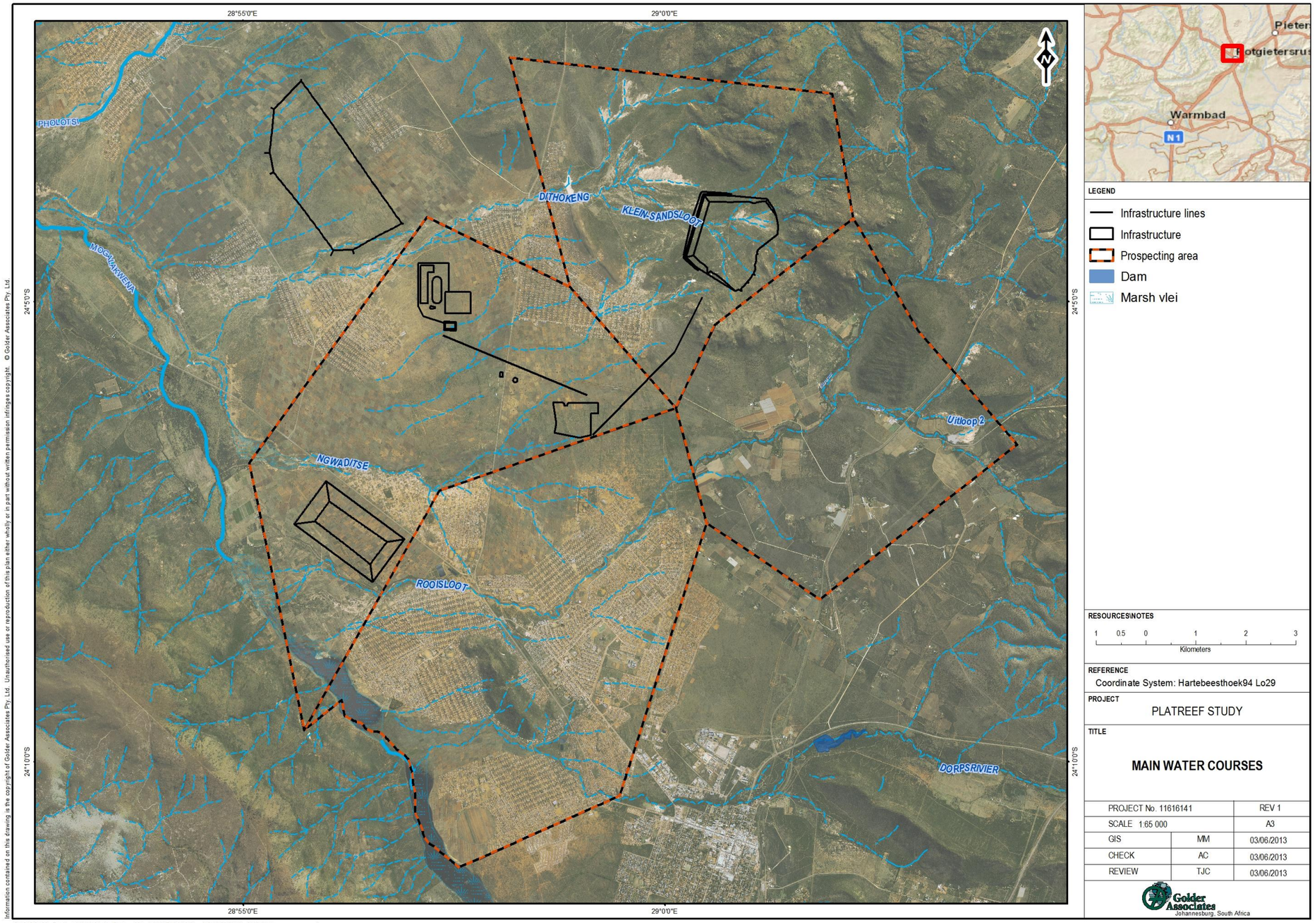


Figure 2: Location of streams crossing the project area

Extensive portions of the exploration rights area are developed with urban areas. The village of Ga-Magongwe is located in the northern boundary area on Turfspruit with Ga-Kgabadi in the west. Large parts of Macalacaskop are built up with the communities of Lekwlakala, Madika and Maroelereng. Recent expansion of the villages is evident. The streams close to these urban developments are used by the communities for clothes washing and stock watering.

4.0 ASSESSMENT OF CLIMATE DATA

4.1 Hydrological and meteorological description

The Platreef study area is situated in the Central Bushveld bioregion (SANBI, 2006) in the Limpopo province, immediately north-west of Mokopane (previously known as Potgietersrus). The altitude of the area is approximately 1 100 m above mean sea level. The area is generally warm and frost seldom occurs. Rain falls mainly in the summer months from October to April. The climate stations near the study area are listed in Table 2 and their locations are indicated in Figure 3.

The available information indicates that the majority of the rainfall, evaporation and weather stations in the area were closed between 1989 and 1992. The weather station 0634011 5 closed in 1992. This station was replaced with the station 0633852 for a short period of time from 1992 to 1995. This station was replaced with the current station 06338827 which started in 1995 and is still operating. The Mokopane rainfall station (0633882W) and the A6E001 evaporation station at Doorndraai Dam remain open. The Mokopane rainfall station has only 10.5 years of record. The A6E001 evaporation station is located 23 km from site and therefore will not provide site specific information for the project area.

4.2 Temperature

The annual average minimum and maximum temperatures measured at 063411 5 Potgietersrus Tabak Ko-Op weather station were 13.0 ºC and 26.3 ºC respectively while the average temperature was 19.7 ºC.

Monthly average temperatures, average of the monthly maximums, average of the monthly minimums as well as the minimum and maximum daily temperatures in each month are presented in Table 1. The average monthly temperatures are shown plotted in Figure 4.

Table 1: Monthly temperature statistics for the Mokopane area

Month	Average of Minimum (°C)	Mean (°C)	Average of Maximum (°C)	Minimum recorded (°C)	Maximum recorded (°C)
Oct	15.1	21.6	28.2	6.5	36.7
Nov	16.4	22.4	28.4	7.5	38.5
Dec	17.3	23.2	29.1	8.8	37.1
Jan	18.1	24.0	29.9	11.8	37.8
Feb	17.6	23.4	29.1	11.8	39.4
Mar	16.3	22.1	28.0	8	36.4
Apr	13.2	19.6	26.0	5.3	35
May	9.13	16.5	23.8	2.1	32.6
Jun	5.93	13.5	21.1	-1.3	28.2
Jul	6.07	13.8	21.5	0.6	28
Aug	8.78	16.3	23.9	0.1	32.1
Sep	12.5	19.8	27.0	1	36.2

Table 2: Climate stations near the study area (Refer to Figure 3)

Station number	Station Name	Elements	Altitude (mamsl)	Years of data	Data period	Latitude (Decimal °)	Longitude (Decimal °)	Distance (km) from site	Direction from site	Station Type
0633881 AW	Potgietersrus (POL)	Rainfall	1143	96	01-Sep-1903 to 31-Aug-00	-24.1833	29.0	13	ESE	Rainfall station
0633881 W	Potgietersrus (SKL)	Rainfall	1115	96	01-Sep-1903 to 31-Aug-00	-24.1833	29.0166	11.5	SE	Rainfall station
0633882 W	Mokopane	Rainfall		10.5	02-Jan-00 to 25-Aug-11	-24.205	29.011	14	SE	Rainfall station
0634011 A	Potgietersrus	Rainfall	1143	91	01-Sep-1903 to 31-Aug-00	-24.1833	29.0166	13	ESE	Rainfall station
0634011 W	Potgietersrus Tabak Ko-Op	Rainfall	1143	96	01-Sep-1903 to 31-Aug-00	-24.1833	29.0166	13	ESE	Rainfall station
0634011 5	Potgietersrus Tabak Ko-Op	Temperature, Wind, Relative Humidity	1143	27	01-Jan-66 to 30-Jun-92	-24.1833	29.0166	13	ESE	Meteorological station
A6E001	Doorndraai @ Doorndraai Dam	Evaporation (S-Pan), Rainfall		58	01-Jul-55 to 30-Jan-13	-24.28388	28.77444	23	SW	Evaporation station
A6E002	Potgietersrus	Evaporation (A-Pan), Rainfall		23	01-Jun-57 to 29-Sep-80	-24.18388	29.016388	13	ESE	Evaporation station
A6E007	Piet Potgietersrust @ Gert Combrink Dam	Evaporation (S-Pan), Rainfall		6	01-Jan-83 to 27-Feb-89	-24.16722	29.049444	15.5	E	Evaporation station

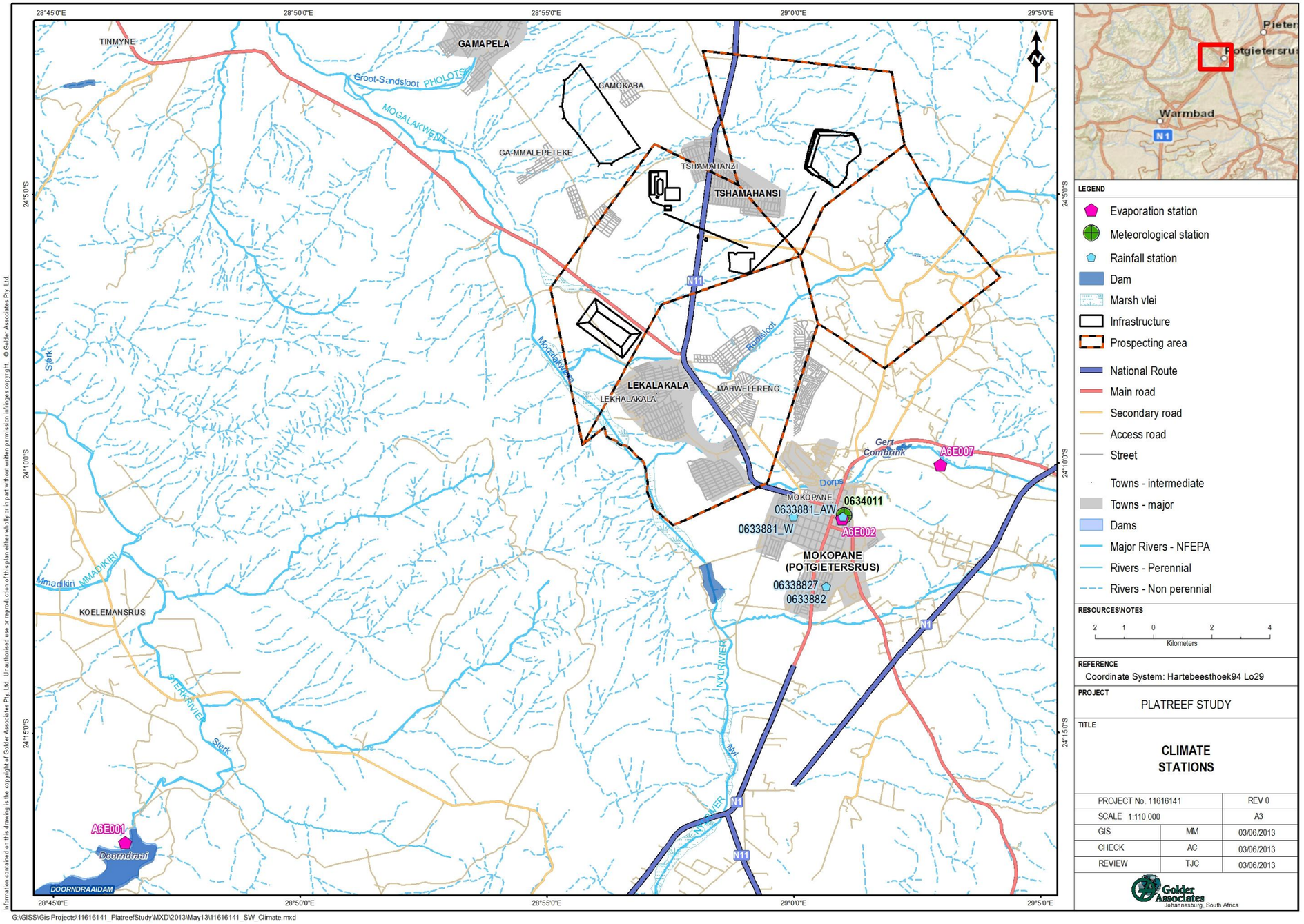
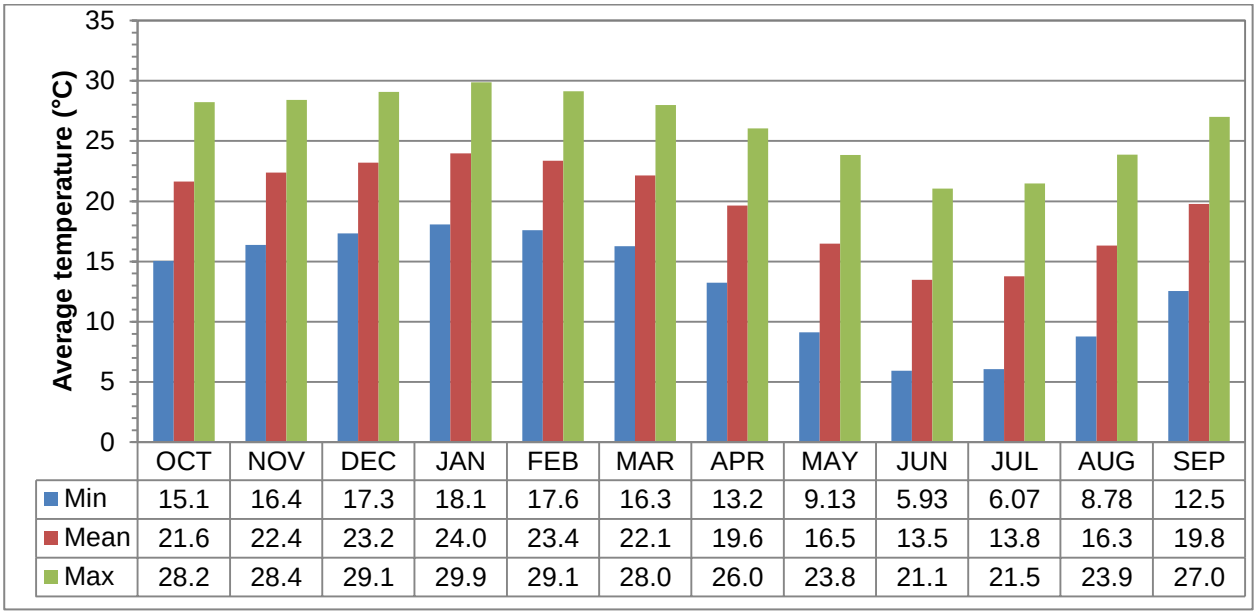


Figure 3: Location of rain gauges, weather station and evaporation stations



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Min	15.1	16.4	17.3	18.1	17.6	16.3	13.2	9.13	5.93	6.07	8.78	12.5
Mean	21.6	22.4	23.2	24.0	23.4	22.1	19.6	16.5	13.5	13.8	16.3	19.8
Max	28.2	28.4	29.1	29.9	29.1	28.0	26.0	23.8	21.1	21.5	23.9	27.0

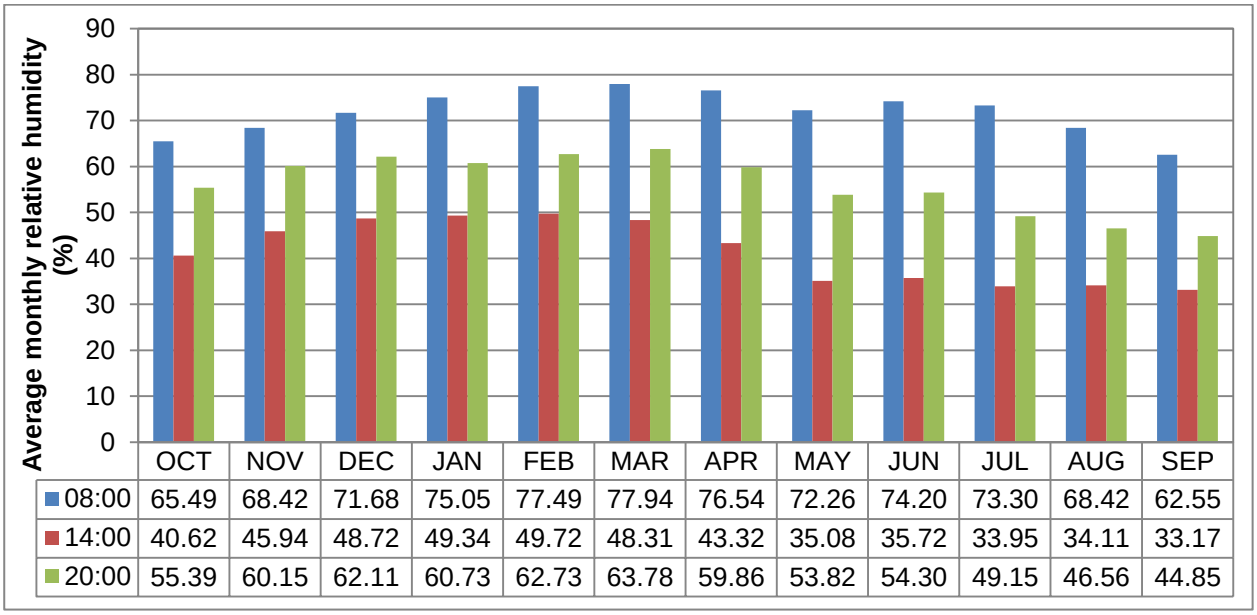
Figure 4: Plot of mean, minimum and maximum monthly temperatures

4.3 Relative humidity

The average relative humidity readings for the data period are measured at 8h00, 14h00 and 20h00. The average relative humidity as well as the minimum and maximum humidity is shown in Table 3 while the average monthly relative humidity at 8h00, 14h00 and 20h00 are shown in Figure 5.

Table 3: Average relative humidity readings for January 1978 to June 1992

08h00	14h00	20h00	Minimum	Maximum
72.1 %	41.4 %	56.3 %	5 %	100 %



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
08:00	65.49	68.42	71.68	75.05	77.49	77.94	76.54	72.26	74.20	73.30	68.42	62.55
14:00	40.62	45.94	48.72	49.34	49.72	48.31	43.32	35.08	35.72	33.95	34.11	33.17
20:00	55.39	60.15	62.11	60.73	62.73	63.78	59.86	53.82	54.30	49.15	46.56	44.85

Figure 5: Average monthly relative humidity

4.4 Wind speed and direction

Wind roses summarise the occurrence of winds at a location, representing their strength, direction and frequency. Calm conditions are wind speeds less than 1 m/s which are represented as a percentage of the total winds in the centre circle. Each directional branch on a wind rose represents wind originating from that direction. Each directional branch is divided into segments of different colours which represent different wind speeds. For the current wind roses, each dotted circle represents a 5% frequency of occurrence. Wind speed is represented in categories, 1 – 2 m/s in blue, 2 – 4 m/s in yellow, 4 – 6 m/s in orange and > 6 m/s in red. The wind roses depicted below are generated from the Mokopane station data.

4.4.1 Annual wind rose

At Mokopane winds originate from the north (17.5 % of the time) and from the north-north-west (14.5 % of the time) (Figure 6). Wind speeds are low to moderate, with a low percentage (19.46%) of calm conditions (<1m/s).

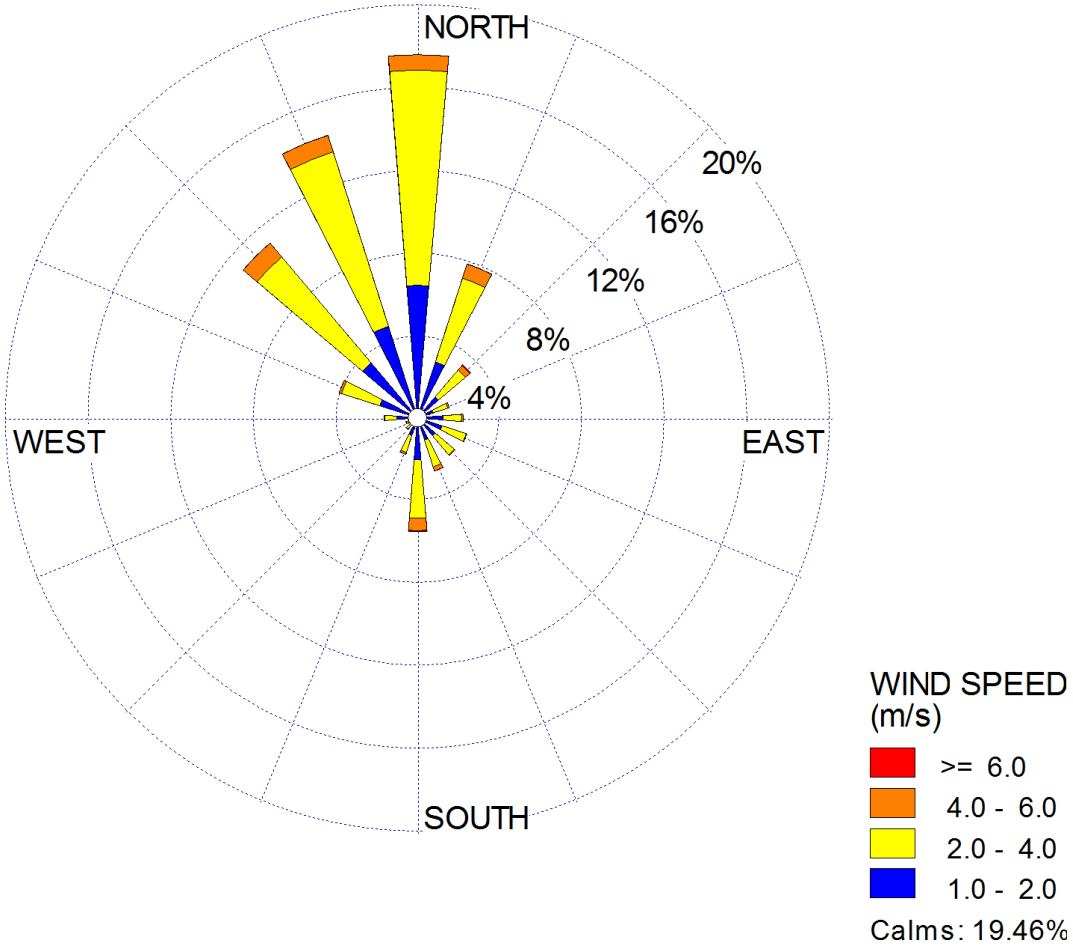


Figure 6: Mokopane annual wind rose for 2004 to 2008

4.4.2 Diurnal wind roses

A slight diurnal variation in wind is observed during the monitoring period at Mokopane (Figure 7).

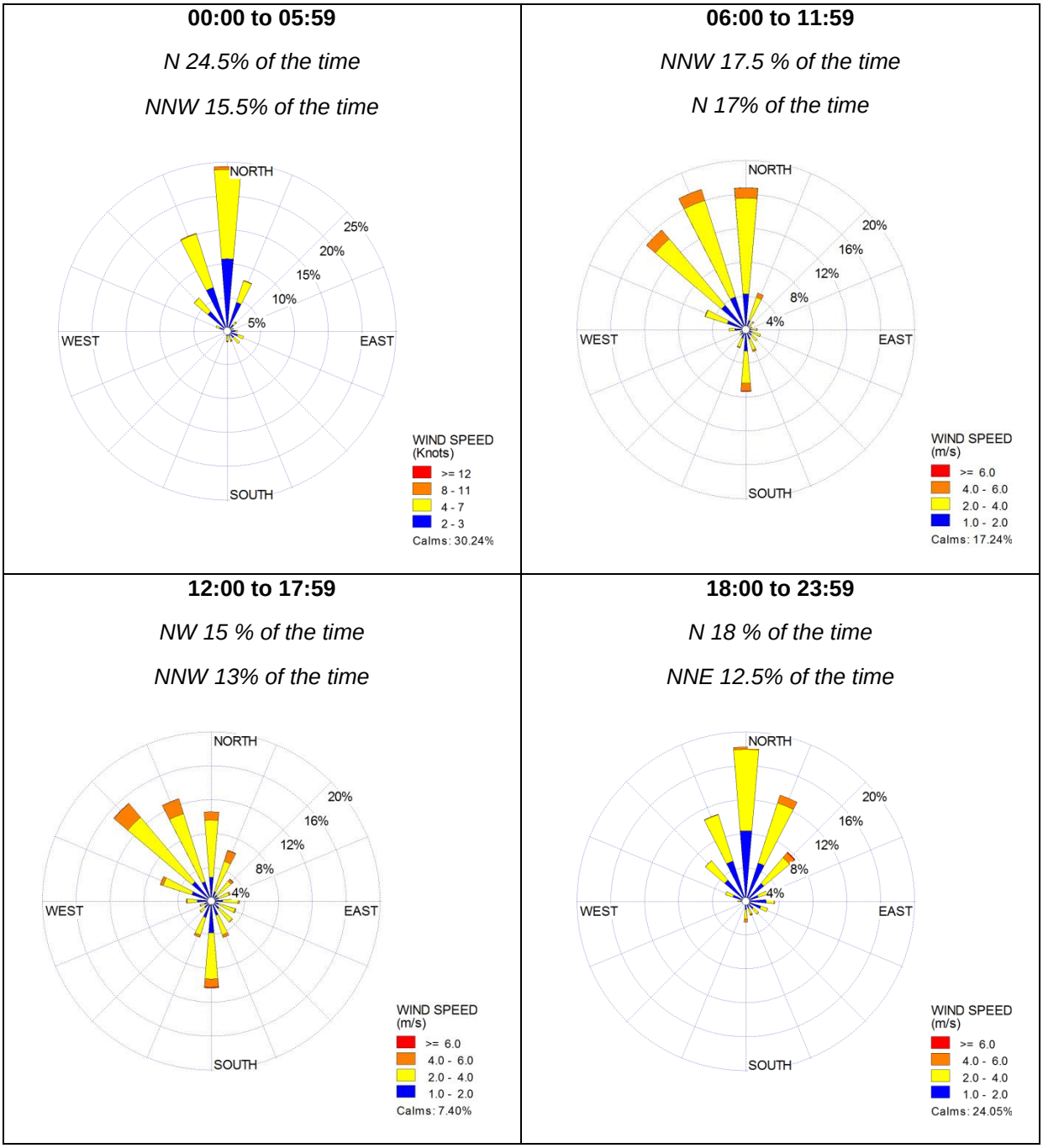


Figure 7: Diurnal Mokopane wind roses with predominant wind directions

4.4.3 Seasonal wind roses

No seasonal variation in wind is observed during the monitoring period at Mokopane (Figure 8).

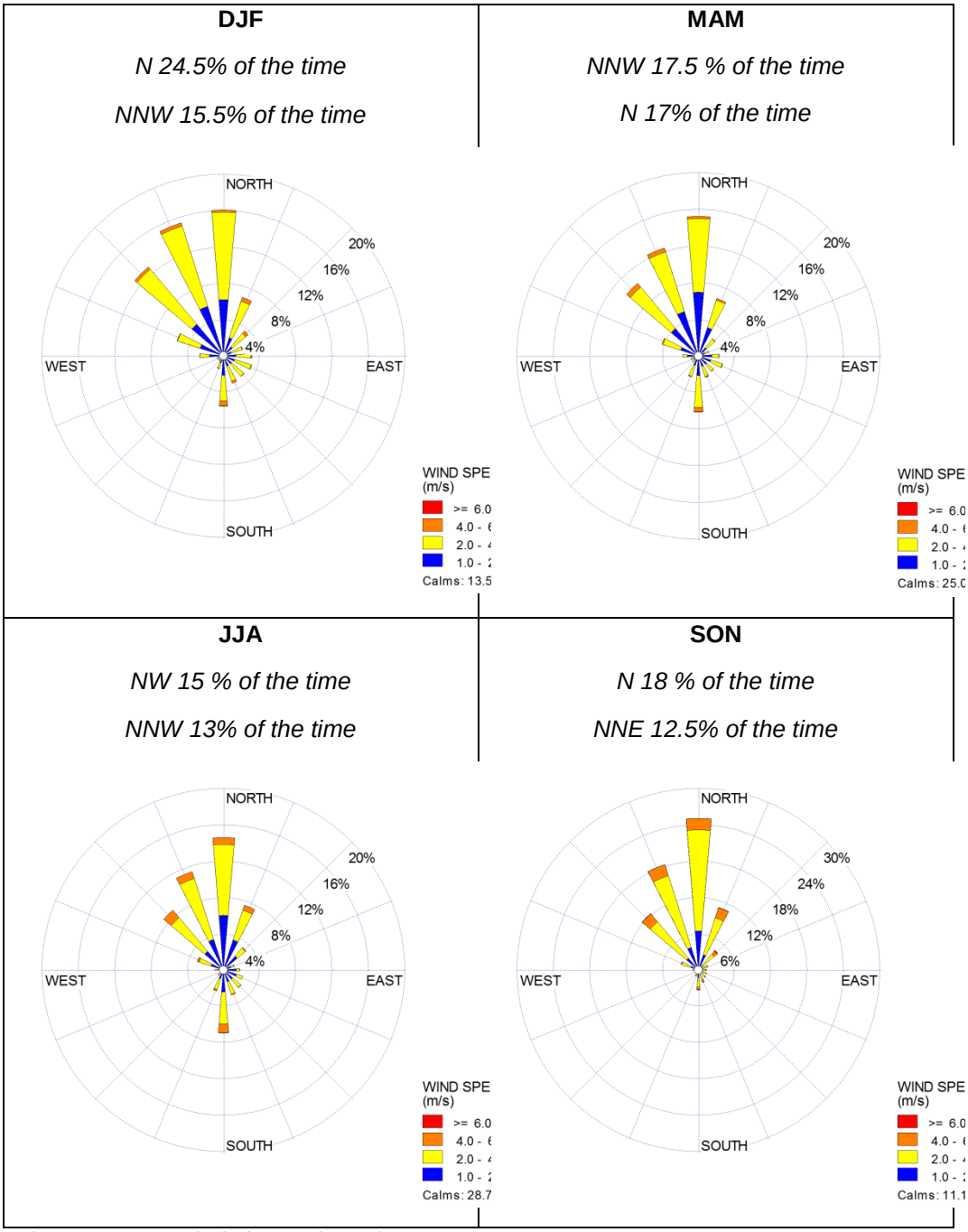


Figure 8: Seasonal wind roses for Mokopane

Notes:

DJF - December, January, February represents summer
MAM – March, April, May represents autumn
JJA – June, July, August represents winter
SON – September October, November represents spring

4.5 Potential Evaporation

The study area falls in evaporation zone 1C (Midgley, Pitman, & Middleton, Surface Water Resources of South Africa 1990. Volume I: Appendices, 1994). The mean annual S-pan evaporation depth in the area is between 1 700 and 2 000 mm/a while the A-pan evaporation is between 2 000 and 2 200 mm/a. Table 4 summarises the average monthly evaporation values measured at the three evaporation stations in the vicinity of the site. The monthly average evaporation depths for the three stations are shown in Figure 9.

Since Station A6E002 was measured in A-Pan, it has been converted to S-Pan data for direct comparison with the other two evaporation stations.

Table 4: Average monthly evaporation (mm)

Month	A6E001 S-Pan	A6E002 A-Pan	A6E002 S-Pan	A6E007 S-Pan
Oct	192.45	210.38	168.75	208.22
Nov	277.03	173.49	136.32	212.92
Dec	287.11	176.57	139.02	187.68
Jan	283.48	138.52	105.57	197.40
Feb	249.83	124.38	93.13	178.16
Mar	156.27	102.25	73.67	175.40
Apr	121.37	122.71	91.66	144.92
May	101.36	170.37	133.57	134.57
Jun	80.33	228.05	184.29	104.52
Jul	87.60	263.50	215.46	108.35
Aug	122.56	229.17	185.28	145.57
Sep	161.96	218.13	175.56	181.83
Annual Evaporation (mm)	**2121**	**2158**	**1702**	**1980**

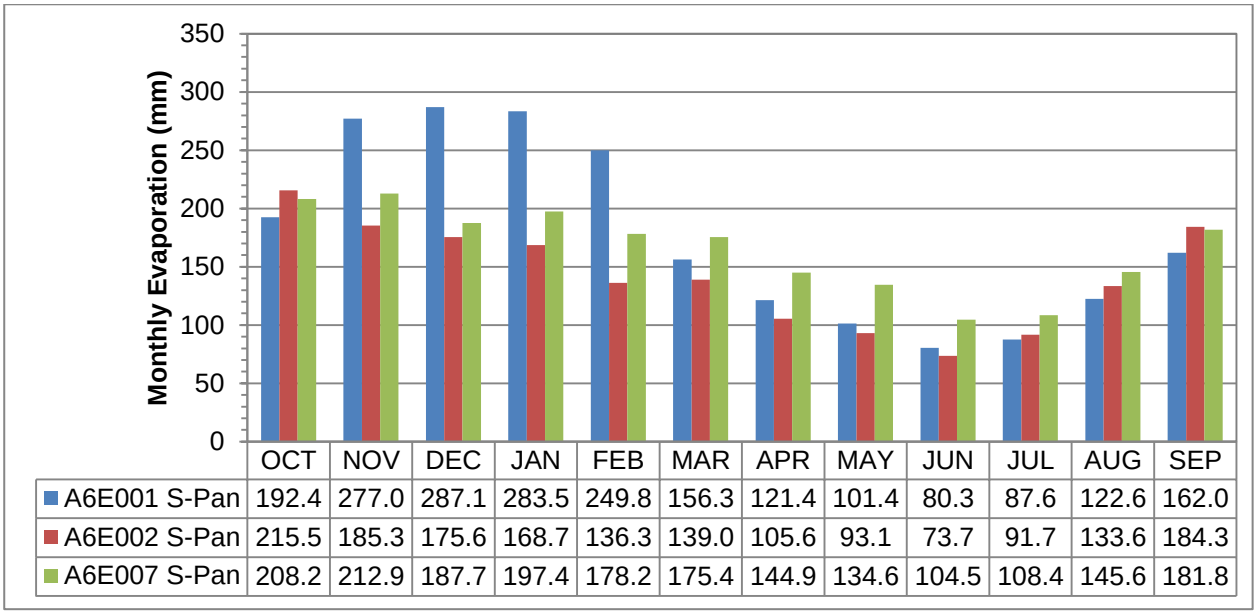


Figure 9: Average monthly evaporation values for stations A6E002 (A-pan), A6E007 (S-pan) and A6E001 (S-pan)

4.6 Rainfall

Rainfall data was extracted using the Daily Rainfall Data Extraction Utility (Kunz, 2004) for various rainfall stations in the area namely, Potgietersrus (POL) (0633881 AW), Potgietersrus (SKL) (0633881 W), Mokopane (0633882 W), Potgietersrus (0634011 A) and Potgietersrus Tabak Ko-Op (0634011 W) (refer to Table 2). However, the Mokopane station was not used in the analysis since there is insufficient data (11 years) to develop extreme event statistics and long term averages as this station is only in operation from January 2000 to August 2011. For the other stations the actual data period ends in March 1997 for station

Potgietersrus (POL), January 1992 for station Potgietersrus (SKL), July 1992 for station Potgietersrus Tabak Ko-Op and December 1971 for station Potgietersrus however, patched data was available until August 2000. The patched data were included in the analysis and the plots to follow.

The maximum recorded rainfall and the number of rainfall days when the rainfall was more than 50 mm is given in Table 5.

Table 5: High rainfall events

Rainfall station	Maximum recorded daily rainfall (mm)	Date of maximum rainfall	Number of days with > 50 mm
0633881 AW Potgietersrus (POL)	111.8	14 Jan 1923	113
0633881 W Potgietersrus (SKL)	109.2	05 Jan 1928	99
0634011 A Potgietersrus	93.5	09 Feb 1964	24
0634011 W Potgietersrus Tabak Ko-Op	126.9	23 Nov 1977	36

The cumulative rainfall data measured at the Potgietersrus (POL), Potgietersrus (SKL), Potgietersrus and Potgietersrus Tabak Ko-Op stations are shown plotted in Figure 10. The cumulative plots do not show any unusual trends or anomalies in the data. The daily rainfall data for the rainfall stations are shown in Figure 11.

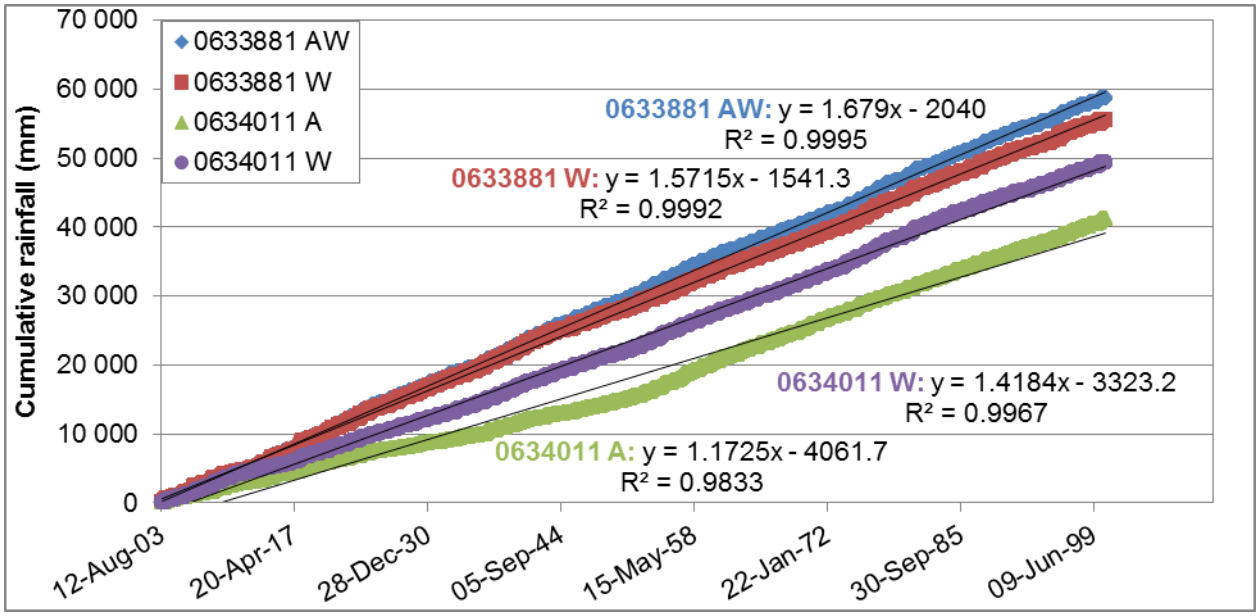


Figure 10: Cumulative plot for rainfall stations in the Mokopane area

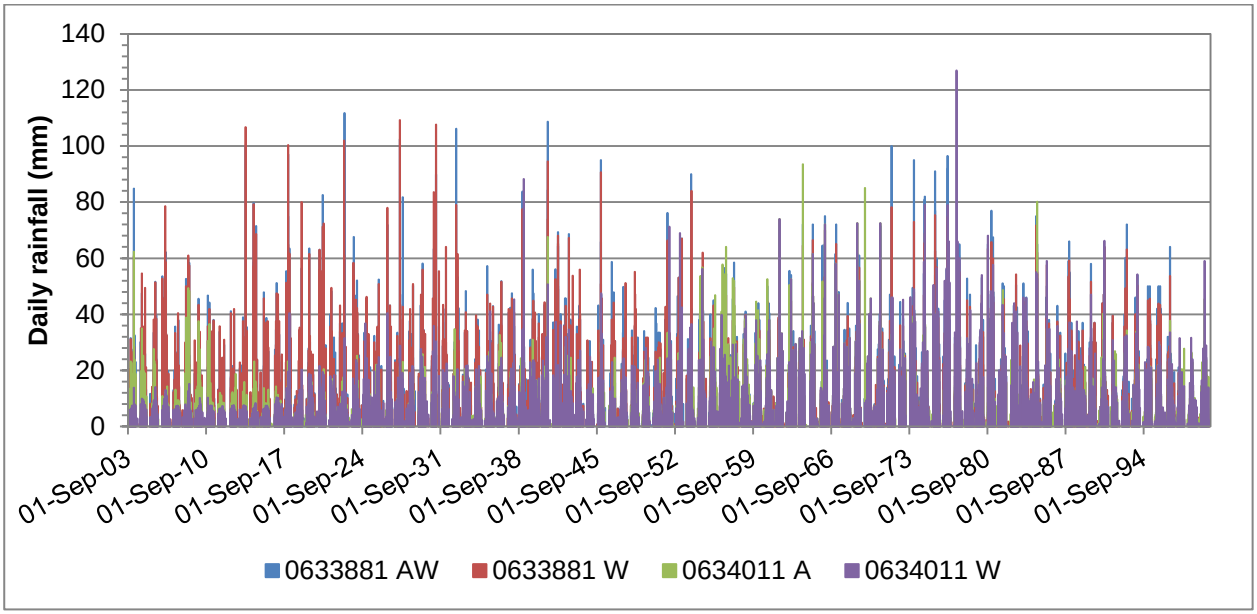
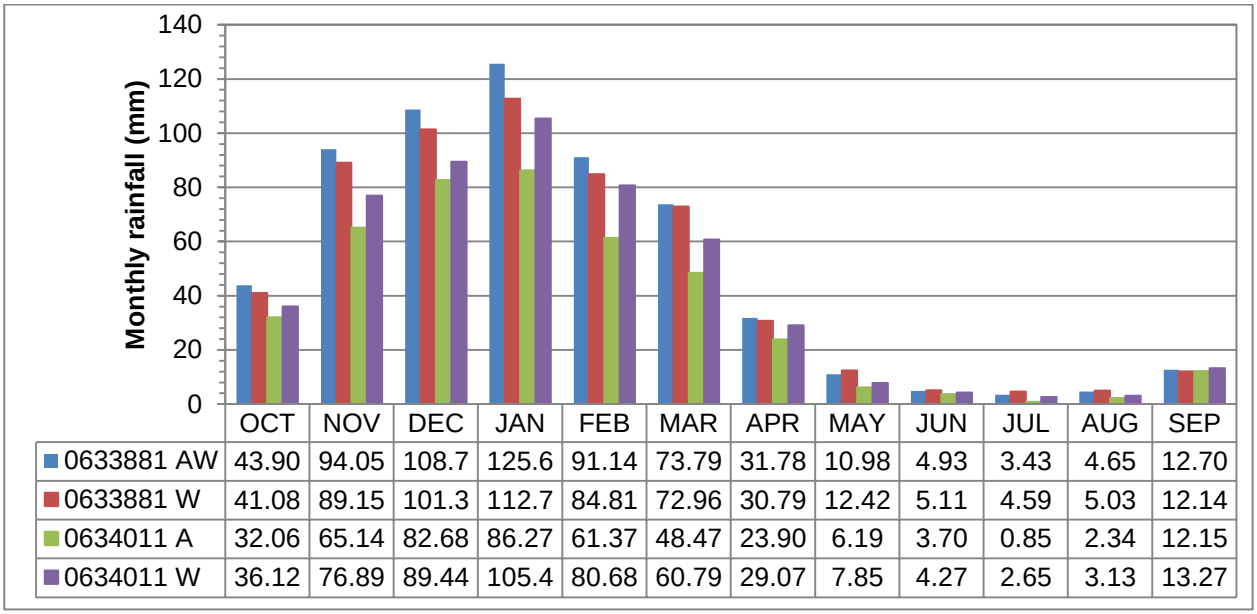


Figure 11: Daily rainfall for rainfall stations in the Mokopane area

The average monthly rainfall for the rainfall stations are given in Table 6 and plotted in Figure 12.

Table 6: Average monthly rainfall (mm)

Month	0633881 AW	0633881 W	0634011 A	0634011 W
Oct	43.90	41.08	32.06	36.12
Nov	94.05	89.15	65.14	76.89
Dec	108.72	101.39	82.68	89.44
Jan	125.61	112.76	86.27	105.46
Feb	91.14	84.81	61.37	80.68
Mar	73.79	72.96	48.47	60.79
Apr	31.78	30.79	23.90	29.07
May	10.98	12.42	6.19	7.85
Jun	4.93	5.11	3.70	4.27
Jul	3.43	4.59	0.85	2.65
Aug	4.65	5.03	2.34	3.13
Sep	12.70	12.14	12.15	13.27
YEAR (MAP)	**605.71**	**572.23**	**425.11**	**509.60**



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
0633881 AW	43.90	94.05	108.7	125.6	91.14	73.79	31.78	10.98	4.93	3.43	4.65	12.70
0633881 W	41.08	89.15	101.3	112.7	84.81	72.96	30.79	12.42	5.11	4.59	5.03	12.14
0634011 A	32.06	65.14	82.68	86.27	61.37	48.47	23.90	6.19	3.70	0.85	2.34	12.15
0634011 W	36.12	76.89	89.44	105.4	80.68	60.79	29.07	7.85	4.27	2.65	3.13	13.27

Figure 12: Average monthly rainfall for rainfall stations in Mokopane area

The 24 hour storm rainfall gridded data for the 1:2, 1:5, 1:10, 1:20, 1:50, 1:100 and 1:200-year recurrence intervals was abstracted from the database using the Design Rainfall Estimation Programme (Smithers & Schulze, 2002) from the five closest rainfall stations. The depths are presented in Table 7.

Table 7: Computed 24 Hour Storm Rainfall Depths (mm)

Return Period (years)	1:2	1:5	1:10	1:20	1:50	1:100	1:200
Rainfall Depth (mm)	66.9	91.2	108.6	126.4	151.2	171.2	192.3

5.0 FLOW AND WATER QUALITY BASELINE MONITORING

5.1 Setup of monitoring programme

There is limited flow information available on the site. There is a Department of Water Affairs (DWA) flow gauging station A6H033 located on the Nyl River upstream of Mokopane that has been measuring flow since December 1990 and there was a DWA flow gauging station A6H032 located in the Dorps River that measured flow between 1978 and 1980 (See Figure 16).

Table 8 indicates the monthly average flow and the minimum and maximum flows recorded in each month. The measured average daily flows are shown graphically in Figure 13 and Figure 14 for A6H032 and A6H033 respectively.

The available data indicates possible problems with the A6H033 station as the Nyl River is unlikely to consistently dry up, particularly in the summer months when the minimum recorded flow is reported to be 0 m^3/s. The figure shown in Figure 14 also highlights an unlikely flow pattern in the Nyl River particularly as the catchment area exceeds 3000 km^2. The flow data could also indicate extensive upstream use of water resulting in the frequent periods of low flow.

Additional flow monitoring sites were added on the tributaries flowing across the project area and on the Mogalakwena River downstream of the project area. The monitoring programme was set up during a site visit undertaken by Angelina Jordanova and Eugeshin Naidoo of Golder Associates Africa (Pty) Ltd over the period 21st to 23rd September 2011. The Golder staff were accompanied on the site visit by Elias Kekana of Platreef Resources. The cross sections and details of the sites selected are given in APPENDIX A. The key information is summarised in this section.

Table 8: Monthly average, maximum and minimum flows in m^3/s

Month	A6H032			A6H033		
	Min	Average	Max	Min	Average	Max
Oct	0.0	0.00008	0.001	0.0	0.0	0.0
Nov	0.0	0.00030	0.001	0.0	0.0	0.0
Dec	0.0	0.00023	0.002	0.0	0.00003	0.001
Jan	0.0	0.00013	0.001	0.0	0.16403	6.8
Feb	0.0	0.00053	0.004	0.0	0.10836	3.202
Mar	0.0	0.0	0.0	0.0	0.18012	4.393
Apr	0.0	0.00015	0.003	0.0	1.17732	24.165
May	0.0	0.0	0.0	0.0	0.62941	15.168
Jun	0.0	0.00017	0.001	0.0	0.11320	1.842
Jul	0.0	0.00022	0.001	0.0	0.00325	0.117
Aug	0.0	0.00015	0.001	0.0	0.00005	0.013
Sep	0.0	0.00019	0.002	0.0	0.0	0.0

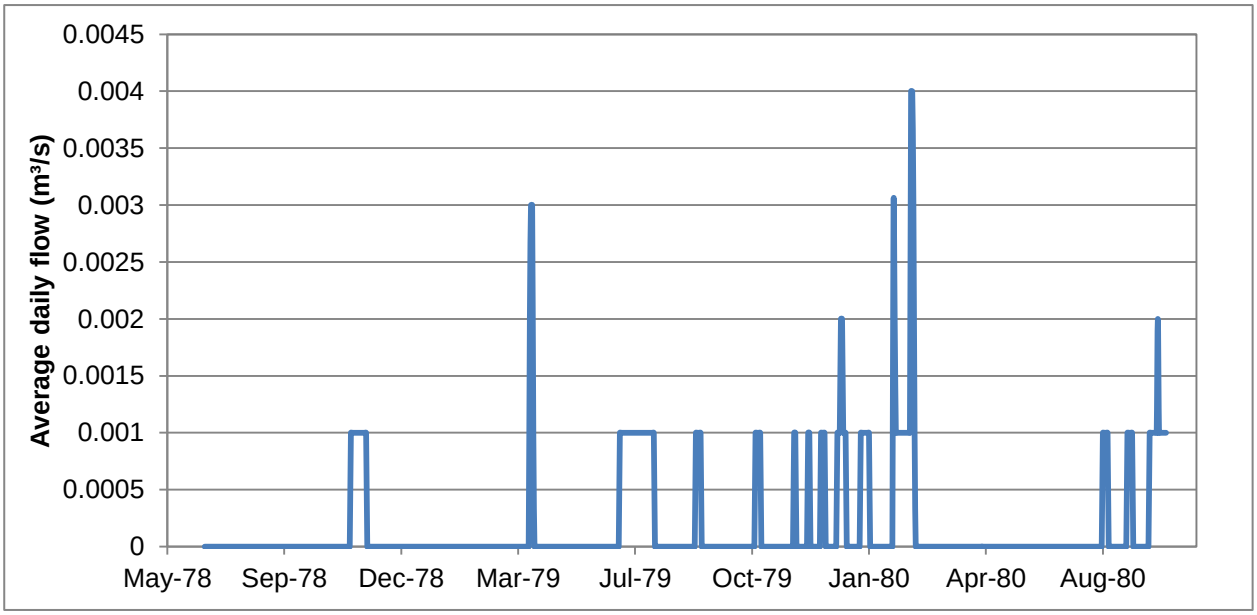


Figure 13: Average daily flow recorded at A6H032

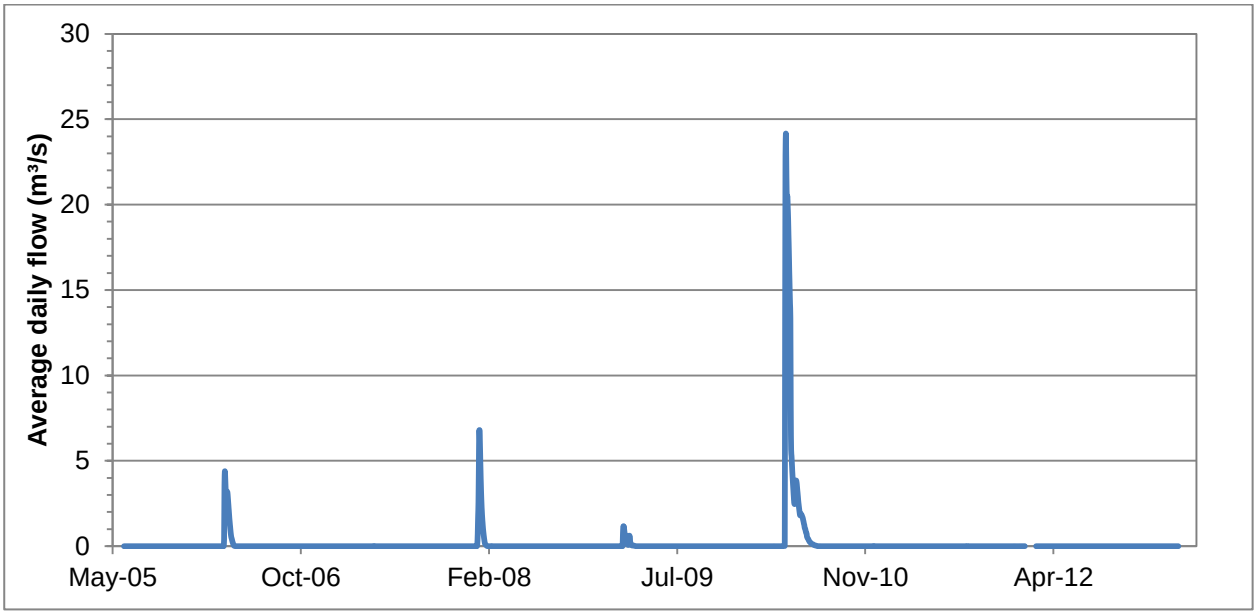


Figure 14: Average daily flow recorded at A6H033

The location of the water quality and flow sampling points selected are shown in Figure 16. The principle adopted in selecting the points is to have one flow sampling point on each of the rivers crossing the project area and a water quality sampling point up and downstream of the project area where practically possible. In some instances, the flow (FM) and water quality (WQ) sampling points are in the same location. The co-ordinates, site description and type are summarised in Table 9.

Table 9: Summary of locations, names and type of sampling point

River	Monitoring Site	Type	Latitude	Longitude
Dithokeng	Dithokeng Upstream (Dam)	WQ	-24.06189	28.98018°
	Dithokeng Downstream	WQ & FM	-24.07383	28.95178°
Rooisloot	Rooisloot Upstream	WQ	-24.11638	29.00169°
	Rooisloot Downstream	WQ & FM	-24.13525	28.96082°
Dorpsrivier	Dorpsrivier	WQ & FM	-24.16499	28.97358°
Mogalakwena	Mogalakwena	WQ & FM	-24.13918	28.92083°
	Mogalakwena Deep Pool	WQ	-24.15193	28.93875°

At each flow station a steel rod was hammered into the bank to act as a bench mark. The cross section of the river was surveyed. The flow rate was calculated using an OTT velocity meter and the measured cross section area. The approach used is standard approach as described in DWA (2011) and Gordon et al. (2004).

The discharge was measured on the Dorps River Downstream monitoring site using an OTT flow meter. As the site visit occurred during the dry season, the Dithokeng, Rooisloot and Mogalakwena streams were not flowing. The Dithokeng was dry while there were stagnant pools of water on the Rooisloot and Mogalakwena Rivers. As a result the flow measurements at these sites were not performed. During the monitoring period it was found that most rivers were dry with the exception of the Dorps River and twice the Rooisloot. As a result the flow information is not conclusive enough to make any flow predictions from the data. Table 10 shows the flow measurements taken for the Dorps River and the Rooisloot while Figure 15 shows the flow that was measured in the Dorps River.

Table 10: Flow measurements taken at the Dorps and Rooisloot Rivers

Date	Dorps River		Rooisloot River	
	Water Depth (m)	Flow (m³/s)	Water Depth (m)	Flow (m³/s)
08-Dec-11	0	0.006		
16-Jan-12	0.145	0.01	0.215	0.063
07-Feb-12	0.122	0.012		
01-Mar-12	0.124	0.014	0.198	0.008
26-Mar-12	0.123	0.016		
24-Apr-12	0.098	0.015		
22-May-12	0.188	0.018		
21-Jun-12	0.135	0.006		
26-Jul-12	0.129	0.007		
21-Aug-12	0.133	0.006		
26-Sep-12	0.104	0.012		
24-Oct-12	0.105	0.009		
10-Dec-12	0.129	0.022		
22-Jan-13	0.144	0.029		
18-Feb-13	0.115	0.008		
19-Mar-13	0.127	0.044		
23-Apr-13	0.1666	0.058		
14-May-13	0.152	0.055		

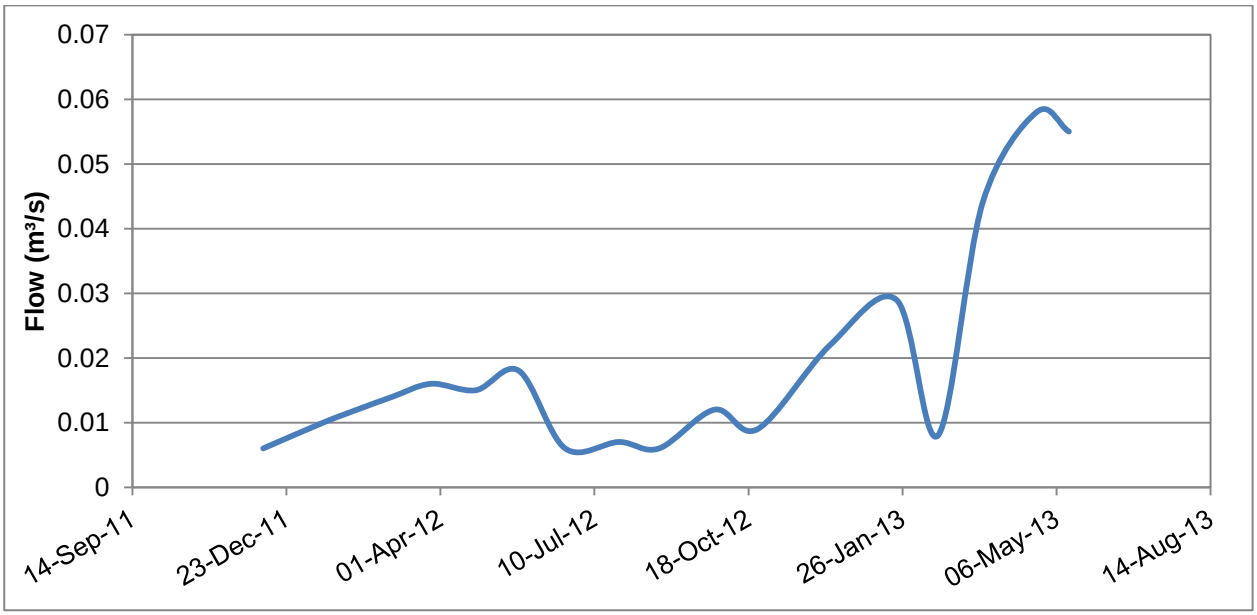


Figure 15: Measured flow in the Dorps River

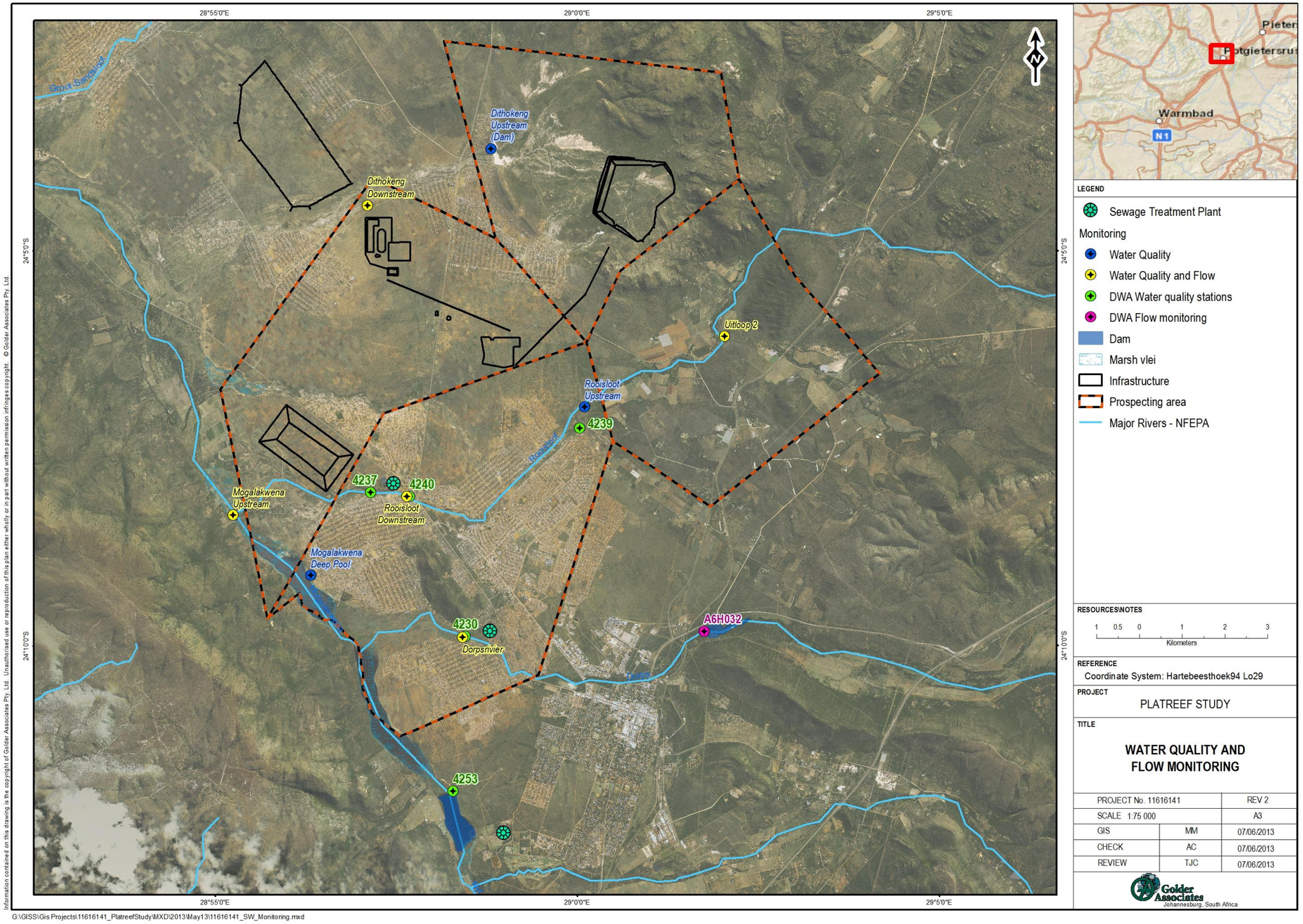


Figure 16: Map showing locations of DWA water quality and flow sampling sites and water quality and flow sampling sites setup by Golder

5.2 Water Quality

5.2.1 DWA water quality database

Water quality data was obtained from the DWA WMS database (Department of Water Affairs, 2011). The five water quality monitoring sites that were available on the DWA database are listed in Table 11 and their locations are shown in Figure 16.

Table 11: DWA water quality monitoring sites

Number	Name	Description	Sampling period	No of readings
WMS A61_1000004230 (4230 in Figure 16)	Macalacaskop 243 KR R33 Bridge downstream of Sekgakgapeng Oxidation Ponds on Dorps River	Upstream end within study area of Dorps River	21 Jan 2009 to 25 Apr 2012	41
WMS A61_1000004237 (4237 in Figure 16)	Lekalakala Township Macalacaskop 243 KR downstream of Masehlaleng Oxidation Ponds	Within study area downstream of Lekalakala Township	21 Jan 2009 to 25 Apr 2012	51
WMS A61_1000004239 (4239 in Figure 16)	Madiba Macalacaskop 243 KR downstream of Mahwelereng STW on Rooisloot River	Upstream of Rooisloot River area	17 Mar 2005 to 16 Mar 2010	29
WMS A61_1000004240 (4240 in Figure 16)	Lekalakala Township Macalacaskop 243 KR upstream of Masehlaleng Oxidation Ponds	Within study area upstream of Lekalakala Township	17 Mar 2005 to 7 Jul 2009	27
WMS A62_1000004253 (4253 in Figure 16)	Mokopane Potgietersrus Town 44KS Bridge downstream of Mokopane STW near Dam on Mogalakwena River	Upstream of entire study area	17 Mat 2005 to 12 Aug 2008	10

The number of readings given in Table 11 is the maximum number of samples that were analysed over the data period. However, not all the parameters were analysed for all the samples. Due to the small number of samples, only the minimum and maximum values are presented in Table 12. The values were compared to the 2011 SANS 241 standards for drinking water, Class 1 (SANS 241-1:2011). Values that exceed these standards are highlighted in red in Table 12.

Results indicate that the **upstream** water quality sometimes exceeds the standards for pH, Sodium, Fluoride and Ammonium. **Within the study area**, pH, Fluoride and Ammonium were sometimes measured above the limit. At the **downstream** monitoring sites values that exceeded the standard were recorded for Sodium and Fluoride.

5.2.2 Platreef water quality data

The first round of water quality sampling took place on the 26 of September 2009 and the monthly water quality monitoring programme was setup and started from the 9th of December 2011 until the current 14th of May 2013. Results of the monitoring programme set up for the project are presented in Table 13. The measured concentrations are compared to the SANS 241 (class 1) drinking water standards and where these limits are exceeded they are shown in red.

Table 12: DWA water quality data

	Unit	SANS 241 Standards (Class 1)	WMS A61_1000004230		WMS A61_1000004237		WMS A61_1000004239		WMS A61_1000004240		WMS A62_1000004253	
			Dorpsrivier		Rooisloot River						Mogalakwena River	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Calcium	mg/l	150	21	54	32	42	21.99	44	11.06	45.20	9	23.29
Chloride	mg/l		0.025	100	46	66	6.52	70.96	16.44	112	8.3	175
Total Dissolved Solids (TDS)	mg/l	1000	294	294			191	568	160	1394	647	1054
Electrical Conductivity (EC)	mS/m	150	30.7	146.0	61.1	97.1	25.7	94.2	22.2	177.0	18.2	144.0
Fluoride	mg/l	1	0.2	0.41	0.2	0.86	0.2	0.79	0.33	3.5	0.94	2.6
Potassium	mg/l	50	0.62	8	2	5	1	17.05	0.6	23.30	8	20.97
Magnesium	mg/l	70	10	89	34	67	7.97	64	6.02	172	6	35.6
Sodium	mg/l	400	23	133	10	73	6.3	62	19.7	139	128	229
Nitrate_Nitrite as N	mg/l	10	0.05	26	0.05	15	0.02	0.21	0.02	7.19	0.07	0.52
Ammonia	mg/l	1	0.2	18	0.2	9.7	0.04	20.16	0.04	15	0.04	0.45
pH		9.5	7.3	8.3	7.4	8.8	7.7	8.8	7.8	9.0	8.0	9.2
Phosphate as P	mg/l		0.2	3.2	0.2	95	0.006	4.21	0.006	0.999	0.038	0.22
Silicon	mg/l		0	0	0	0	1.76	12.70	4.81	17.21	0.4	1.88
Sulphate	mg/l	400	34	108	5.8	20	8.25	23.53	5	147	4.83	44
Total Alkalinity	mg/l		111	622	480	511	100	445	66	742	301	460

Table 13: Results of Water Quality Sampling programme

Water Quality Variable	River		Dithokeng			Rooisloot						Dorps			Mogalakwena					
	Site	SANS 241 Standards (Class 1)	Dithokeng Upstream (Dam)			Rooisloot Upstream			Rooisloot Downstream			Dorpsrivier			Mogalakwena			Mogalakwena Deep Pool		
	Unit	No Of Samples taken	18			16			15			18			8			18		
		Percentile	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th
pH	-	5 - 9.5	6.9	7.8	8.6	7.2	8.1	8.5	7.2	8.3	8.7	7.2	7.8	8.2	7.9	8.5	8.9	8.2	9.0	9.5
Conductivity	mS/m	<150	2.0	25.3	50.9	18.8	55.7	80.0	38.2	73.5	95.3	86.7	124.3	143.6	91.6	122.8	150.1	110.0	133.8	163.9
Total Dissolved Solids	mg/l	<1 000	106	323	675	293	409	499	333	498	671	646	862	1365	468	681	868	534	883	1285
Total Suspended Solids Dried at 105°C	mg/l	-		140									170						320	
Total Alkalinity as $CaCO_3$	mg/l	-	73	109	163	155	363	470	205	424	542	399	601	714	376	491	560	463	584	735
Chloride	mg/l	<200	4.16	6.57	8.73	12.76	37.82	54.25	15.81	52.98	97.60	46.78	106	176	77.95	203	273	139	227	312
Sulphate	mg/l	<400	2.60	4.27	6.44	3.09	16.67	30.00	4.86	21.89	35.80	16.22	79.25	164.6	6.81	14.88	26.30	12.40	30.24	52.35
Fluoride	mg/l	<1	0.440	0.746	1.160	0.680	0.950	1.325	0.442	0.672	1.200	0.025	0.239	0.378	0.748	0.870	1.000	0.025	0.667	1.015
Nitrite as N	mg/l	<10	0.05	0.23	0.29	0.20	1.74	7.73	0.25	5.42	27.40	0.22	3.91	21.65	0.05	0.23	0.41	0.05	0.35	0.75
Nitrate as N	mg/l	<10	0.05	0.30	0.90	0.09	1.47	4.33	0.43	16.07	36.30	0.05	17.69	46.30	0.05	0.54	1.81	0.05	0.27	0.86
Orthophosphate as P	mg/l	-	0.010	0.041	0.137	0.010	0.026	0.047	0.019	0.052	0.102	0.113	2.433	9.315	0.010	0.031	0.086	0.010	0.025	0.049
Dissolved																				
Calcium	mg/l	<150	9.30	12.62	17.15	20.00	36.50	43.75	23.50	37.47	44.30	44.40	53.78	69.95	12.35	15.13	21.85	13.55	21.50	31.30
Sodium	mg/l	<200	15.9	24.7	33.6	25.8	38.5	46.5	27.2	50.1	69.8	74.6	105.2	134.3	96.8	119.8	158.5	93.5	125.6	164.1
Magnesium	mg/l	<70	4.0	5.1	6.6	10.5	41.3	59.0	17.7	50.7	78.0	47.8	74.3	95.3	47.8	71.9	100.4	65.0	87.7	122.5
Potassium	mg/l	<50	2.13	2.93	3.52	2.15	2.86	3.83	2.70	5.51	14.44	2.27	5.44	11.45	10.35	13.63	17.30	8.96	12.84	17.15
Iron	mg/l	<0.2	0.184	1.165	3.190	0.068	0.217	0.553	0.068	0.812	3.410	0.055	0.380	0.983	0.058	0.273	0.597	0.025	0.248	0.881
Manganese	mg/l	<0.1	0.043	0.178	0.286	0.023	0.463	0.925	0.036	0.539	1.272	0.213	1.137	3.000	0.022	0.474	1.238	0.026	0.777	1.909
Aluminium	mg/l	<0.3	0.443	2.627	7.940	0.010	0.174	0.583	0.045	0.972	4.070	0.010	0.289	0.779	0.014	0.293	1.089	0.010	0.321	1.370
Nickel	mg/l	<0.15	0.002	0.007	0.014	0.002	0.008	0.015	0.002	0.013	0.041	0.002	0.007	0.016	0.002	0.008	0.014	0.002	0.012	0.026
Copper	mg/l	<1	0.009	0.011	0.022	0.008	0.078	0.283	0.007	0.012	0.022	0.009	0.009	0.010	0.004	0.009	0.010	0.009	0.011	0.013
Phosphorus as P	mg/l		0.015	0.158	0.418	0.015	0.076	0.130	0.042	0.194	0.650	0.338	1.330	3.170	0.084	0.123	0.165	0.015	0.107	0.187
Total																				
Calcium	mg/l		9.30	12.62	17.15	20.00	36.50	43.75	23.50	37.47	44.30	44.40	53.78	69.95	12.35	15.13	21.85	13.55	21.50	31.30
Sodium	mg/l		15.9	24. 7	33.6	25.8	38.5	46.5	27.2	50.1	69.8	74.6	105.2	134.3	96.8	119.8	158.5	93.5	125.6	164.1
Magnesium	mg/l		4.0	5.1	6.6	10.5	41.3	59.0	17.7	50.7	78.0	47.8	74.3	95.3	47.8	71.9	100.4	65.0	87.7	122.5
Potassium	mg/l		2.13	2.93	3.52	2.15	2.86	3.83	2.70	5.51	14.44	2.27	5.44	11.45	10.35	13.63	17.30	8.96	12.84	17.15
Iron	mg/l		0.184	1.165	3.190	0.068	0.217	0.553	0.068	0.812	3.410	0.055	0.380	0.983	0.058	0.273	0.597	0.025	0.248	0.881
Manganese	mg/l		0.043	0.178	0.286	0.023	0.463	0.925	0.036	0.539	1.272	0.213	1.137	3.000	0.022	0.474	1.238	0.026	0.777	1.909
Aluminium	mg/l		0.443	2.627	7.940	0.010	0.174	0.583	0.045	0.972	4.070	0.010	0.289	0.779	0.014	0.293	1.089	0.010	0.321	1.370
Nickel	mg/l		0.002	0.007	0.014	0.002	0.008	0.015	0.002	0.013	0.041	0.002	0.007	0.016	0.002	0.008	0.014	0.002	0.012	0.026
Copper	mg/l		0.009	0.011	0.022	0.008	0.078	0.283	0.007	0.012	0.022	0.009	0.009	0.010	0.004	0.009	0.010	0.009	0.011	0.013
Phosphorus as P	mg/l		0.015	0.076	0.285	0.015	0.030	0.054	0.025	0.191	0.776	0.334	1.447	4.045	0.045	0.084	0.125	0.029	0.074	0.125
Orthophosphate (Total Reactive Phosphorous or PO_4)	mg/l		0.018	0.039	0.080	0.017	0.036	0.076	0.023	0.277	1.165	0.994	6.799	27.360	0.032	0.050	0.069	0.017	0.031	0.050
Orthophosphate as P	mg/l		0.010	0.041	0.137	0.010	0.026	0.047	0.019	0.052	0.102	0.113	2.433	9.315	0.010	0.031	0.086	0.010	0.025	0.049

All rivers in the area show high concentrations of iron, manganese and aluminium, this suggests that there is some geological influence for the high concentrations of these metals in the area. The Total Dissolved Solids (TDS) are not of desirable standards for drinking water, while most sites remain under the limit of 1000 mg/l the ideal limit for drinking water is 450 mg/l which, with the exception of Dithokeng Upstream (US) (Dam) and Rooisloot Upstream (US) most sites fail to meet. The Rooisloot River shows low concentrations of nitrates US of the town of Madiba but high concentrations of nitrates downstream (DS) of the town. This could be due to leaking sewers in the town and animals defecating in the rivers. The Dorps River shows a eutrophic system enriched with nutrients due to sewage effluent coming from the sewage treatment plant and urban runoff. The Mogalakwena River shows high levels of chloride and high conductivity readings. The chloride in the river could be due to anthropogenic sources and the conductivity readings could be due to the high metal contents in the rivers in the area. The conductivity could also be coming from groundwater sources feeding the river.

6.0 FLOOD LINE DETERMINATION

The floodlines for the Platreef mine operation were done in two stages. The first set of floodlines were done for the rivers on the Turfspruit 241KR, Macalacaskop 243KR and Rietfontein 2KS farms and the second set of floodlines were expanded to include the Uitloop 3 farm.

6.1 Methodology used to determine floodlines

The approach adopted in the study to determine the floodlines can be summarised as follows:

- The site was visited to assess the site specific hydrological conditions;
- The catchment areas of the Platreef area were delineated based on the 1 in 30 000 scale topographical maps;
- A flood peak analysis was undertaken to determine the different recurrence interval flood peaks for the watercourses within the Platreef mine boundary using the Rational Method;
- The flood peaks and the survey data of the study area were used as inputs to the HEC-RAS backwater programme to determine the surface water elevations for the 1: 50 and 1:100 year floods peaks;
- The floodlines were plotted on the available mapping.

6.2 Limitations and assumptions

The following limitations and assumptions have been made in this specialist study:

- No flow and rainfall data against which the runoff calculations might be calibrated were available. The runoff volumes were therefore calculated theoretically;
- Since no flow data was available for estimation of the roughness coefficients, the Manning's *n* coefficients were estimated by comparing the vegetation and nature of the channel surfaces to published data (Hicks & Mason, 1991; Webber, 1971).

6.3 Sub-catchments

The total drainage area of the Platreef exploration area was divided into 9 sub-catchments based on the topography of the area and the river reaches where flood lines were required. The catchment boundaries are shown in Figure 17 (shown in purple). For the floodlines on the Uitloop farm, the smaller study area had to be divided into sub-catchments (see green sub-catchments in Figure 17). The catchment of Nyl River was used in the calculations of the flood peaks for the original floodlines and is shown in Figure 17.

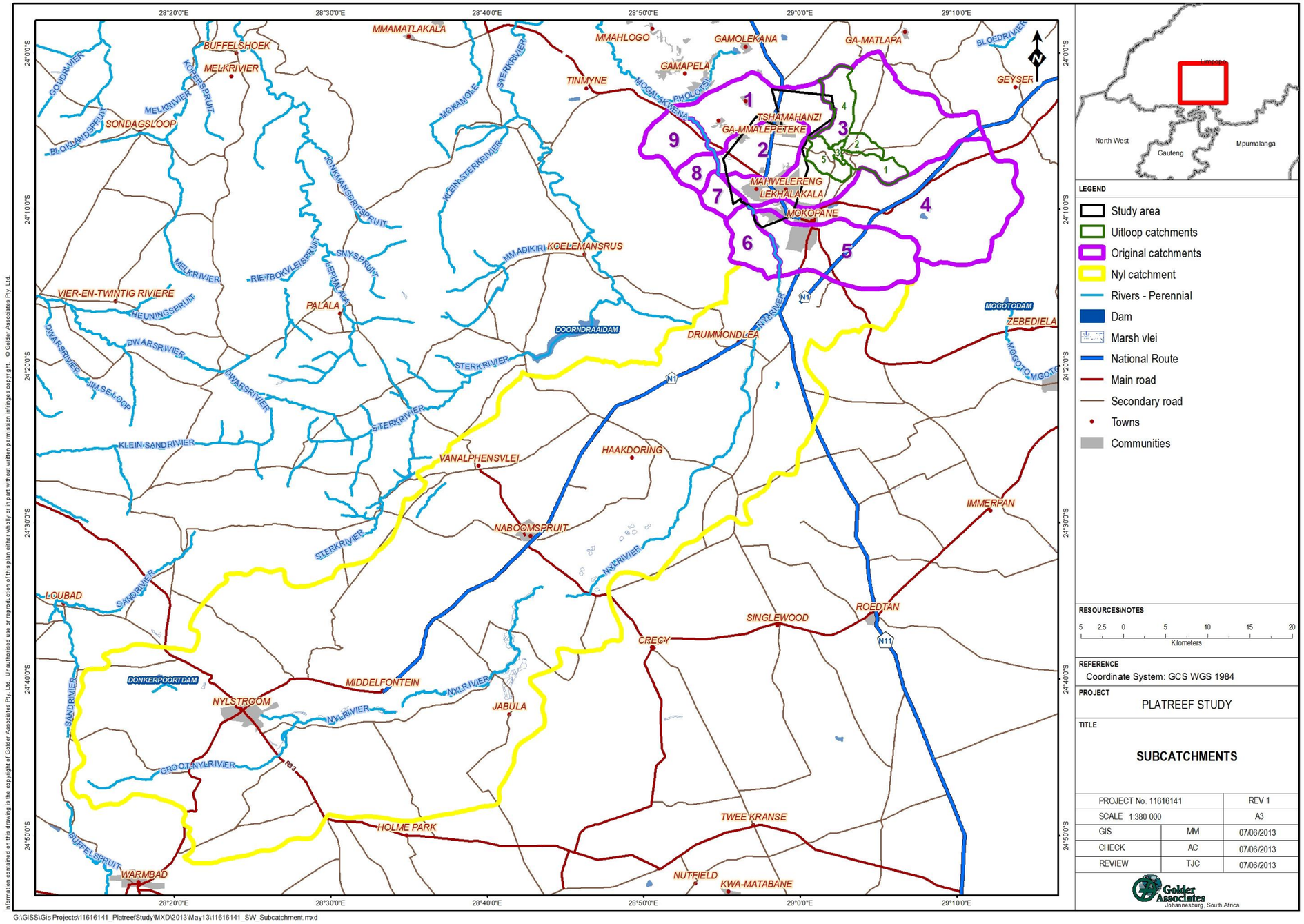


Figure 17: Location and extent of sub-catchments used to calculate the flood peaks

6.4 Flood peak calculation

The rational method was applied to the Platreef mine area sub-catchments. The sub-catchment characteristics used in applying the Rational Method are shown in Table 14 for the first set of floodlines and in Table 15 for the Uitloop set of floodlines.

Table 14: Sub-catchment characteristics used in the Rational Method for original floodlines

Stream Name	Catchment	Area (km^2)	River Length (m)	10-85 Slope (m/m)	Time of Concentration (h)
Dithokeng	1	80.2	20 667	0.013	3.64
Tshama	2	52.1	10 939	0.012	2.29
Rooisloot	3	213.2	34 058	0.014	5.21
Dorpsrivier	4	195.6	36 317	0.014	5.47
Mogalakwena	1 to 9 + Nyl	3 175.0	153 969	0.001	42.49

Table 15: Sub-catchment characteristics used in the Rational Method for Uitloop floodlines

Stream Name	Catchment	Area (km^2)	River Length (m)	10-85 Slope (m/m)	Time of Concentration (h)
Rooisloot – Main	1	14.16	8013.1	0.028	1.30
Rooisloot – Trib 1	2	7.92	5525.6	0.032	0.93
Rooisloot – Main 2	3	22.07	8013.1	0.028	1.30
Rooisloot – Trib 2	4	129.31	19656.8	0.019	2.99
Rooisloot – Main 1	5	153.44	19656.8	0.019	2.99

The 50 year and 100 year flood peaks computed using the Rational Method are presented in Table 16.

Table 16: Computed 50 year and 100 year flood peaks

Original		Peak Flow (m^3/s)		Uitloop		Peak Flow (m^3/s)	
River	Reach	1 in 50 yr	1 in 100 yr	River	Reach	1 in 50 yr	1 in 100 yr
Ditho	Trib	202.8	306.9	Rooisloot	Main	65.1	102.6
Tshama	Trib	189.0	279.5	Rooisloot	Main2	101.5	159.9
Rooi	Trib	357	533.8	Rooisloot	Main1	278.9	415.6
Mogala	Main	1 340.7	1 828.9	Rooisloot	Trib1	46.3	72.9
Dorp	Trib	354.4	519.6	Rooisloot	Trib2	235.0	350.2

6.5 Floodline Modelling

Cross-sectional data was obtained from the topographical map provided by the client. The Manning's n resistance coefficients for the stream channel and the stream banks were estimated by comparing the vegetation and nature of the channel surface with published data (Hicks & Mason, 1991; Webber, 1971). Since no flow data was available for estimation of the roughness coefficients, slightly conservative estimations were adopted. The Manning's n coefficient of 0.065 and 0.07 has been estimated for the river bed and river banks for the wetland region (mainly along the Mogalakwena and Tshama streams), and 0.04 and 0.035 has been estimated for the river bed and river banks for the grassland regions respectively.

The HEC-RAS back-water programme was used to compute the water surface elevations for the 50 year and 100 year flood peaks. The river crossings were measured in the field and input into the HEC-RAS programme and their locations are shown in Figure 18. The properties of the river crossings used in the determination of the floodlines are presented in Table 17. The photos of these river crossings can be viewed in APPENDIX B. APPENDIX C shows the HEC-RAS output files for the original floodlines while APPENDIX D contains the HEC-RAS output for the Uitloop floodlines.

The flood lines were plotted on the available mapping provided by the client. The flood lines are shown on Figure 19.

Table 17: Properties of the river crossings for original floodlines

Name	Type	Number of Barrels	Diameter (m)	Height (m)	Width (m)	Barrel Length (m)	Deck Length (m)	Deck Thickness (m)	Slope
Dithokeng C1	Box	3		3.80	4.30	8.20	14.19	0.50	0.003
Dithokeng C2	Box	16		0.75	1.80	5.00	31.68	0.25	0.001
Dithokeng C4	Arch	5	4.70			15.00	34.57	0.70	0.002
Tshama C1	Box	4		2.00	2.20	10.00	12.94	0.50	0.002
Dorpsrivier C8	Box	2		4.00	10.00	10.00	22.00	0.50	0.002
Dorpsrivier C9	Box	2		2.00	3.50	4.60	7.70	0.20	0.002
Dorpsrivier C10	Box	2		3.00	4.00	10.00	8.80	0.70	0.002
Rooisloot C3	Box	4		1.50	2.50	8.00	11.00	0.30	0.003
Rooisloot C4	Box	6		4.40	5.00	10.00	33.00	0.50	0.002
Rooisloot C5	Box	7		1.70	3.00	5.60	23.10	0.25	0.001

Table 18: Properties of the river crossings for Uitloop floodlines

Name	Type	Number of Barrels	Diameter (m)	Height (m)	Width (m)	Barrel Length (m)	Deck Length (m)	Deck Thickness (m)
Road bridge 1	Box	1		0.84	24.91	14.37	24.91	0.5
Rail bridge 1	Box	1		1.98	19.98	9.95	19.98	0.5
Culvert	Round	1	1.5			10.38	36.63	0.5
Road bridge 2	Box	1		1.6	24.85	18.41	24.85	0.5
Rail bridge 2	Box	1		2.55	29.86	13.03	29.86	0.5

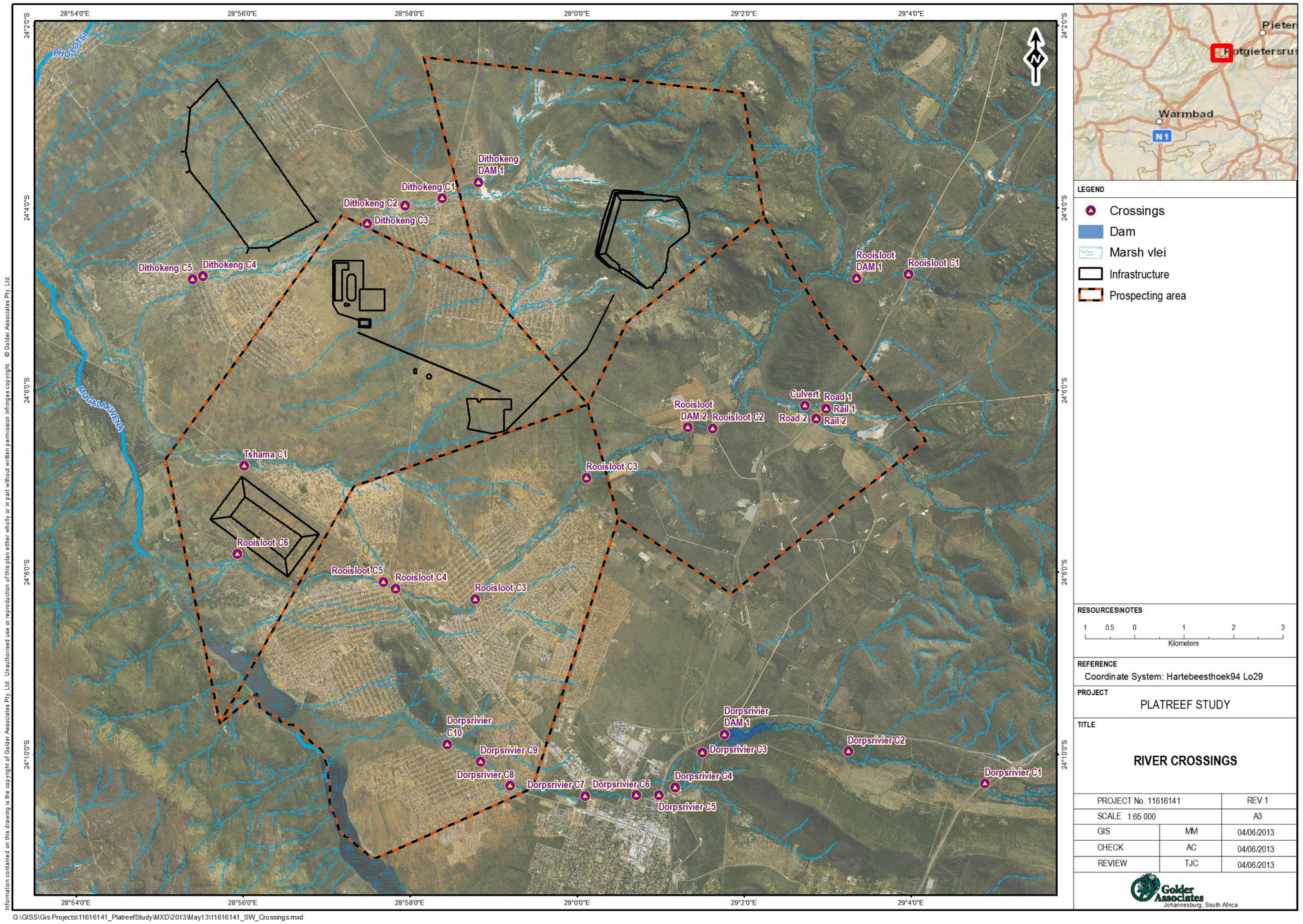


Figure 18: Locations of river crossing measured for input to HEC-RAS backwater model

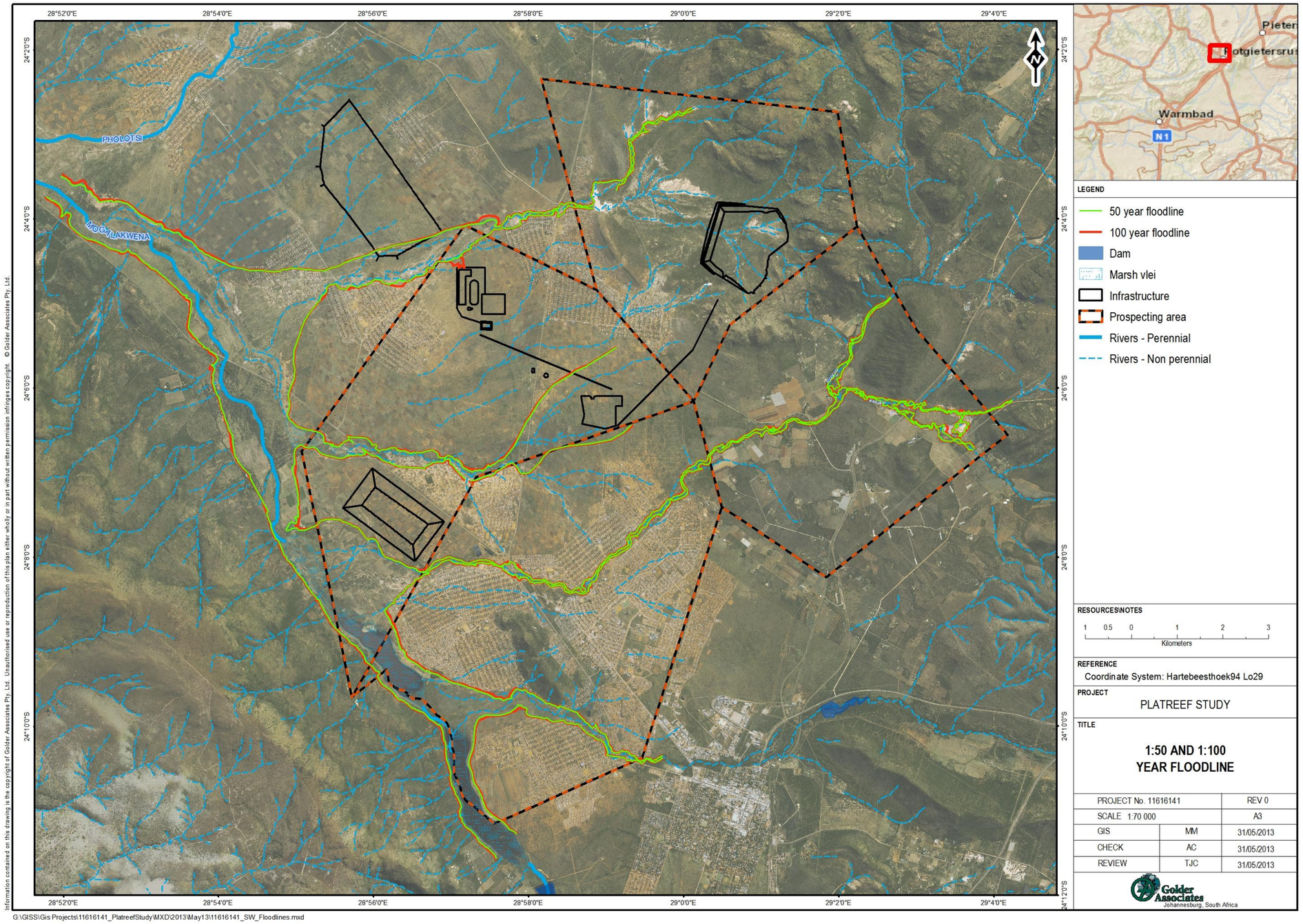


Figure 19: 50 year and 100 year flood lines for the project area

7.0 CONCLUSIONS

The following conclusions can be made as a result of this study:-

- The available climate and rainfall data was analysed to describe the baseline conditions on the site. The 24 hour rainfall depths for different recurrence intervals were generated for use in infrastructure design. A daily rainfall and average monthly evaporation records were produced for use in the feasibility studies.
- The Mokopane weather station is still operational although a number of the rain gauges close to the site have been closed. The Mokopane Weather Station is located about 13 km south east of the project area. The data collected at this station will not be fully representative of conditions on site particularly on Rietfontein 2KS to the north where a tailings storage facility is planned.
- A monitoring programme has been set up to collect flow and water quality data on the project area. A first round of water quality sampling and flow measurements was carried out in September 2011. Throughout the monitoring process the rivers were mainly dry with the exception of the Dorsp River which experienced low flow. This low flow was due to discharges from the maturation ponds treating sewage effluent.
- The water quality and flow data collected by DWA was sourced and assessed. There is doubt as to the accuracy of the flow station on the Nyl River. The available water quality data was patchy and limited water quality variables were measured.
- The water quality results from the Platreef monitoring programme are presented in the report. The results show that the water has undesirable standards of TDS for drinking water with the exception of the upper most region of the site. The water quality results also show high concentrations of dissolved manganese, aluminium and iron, which could be due to geological influences. The Rooisloot and Dorpsrivier show a eutrophic system enriched with nutrients due to sewage effluent coming from the surrounding towns and from the sewage treatment plants. There are also high chloride levels in the Mogalakwena River due to anthropogenic sources.
- The 50 year and 100 year flood peaks and flood lines have been determined for the rivers crossing the project area and the Mogalakwena River flowing to the west of the site. The analysis shows that the current mine infrastructure is located within the floodlines of one of the tributaries.

8.0 REFERENCES

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APPENDIX A

Flow and Water Quality Monitoring Programme Setup

APPENDIX B

River Crossings

COORDINATES OF RIVER CROSSINGS

The coordinates of the various river crossings used in the original floodlines are given in the table below:

Name	Coordinates	
	Latitude	Longitude
Dithokeng C1	24° 3' 53.92"	28° 58' 22.96"
Dithokeng C2	24° 3' 58.77"	28° 57' 56.61"
Dithokeng C4	24° 4' 10.74"	28° 57' 29.03"
Dorpsrivier C8	24° 10' 20.94"	28° 59' 11.75"
Dorpsrivier C9	24° 10' 5.01"	28° 58' 50.68"
Dorpsrivier C10	24° 9' 53.61"	28° 58' 26.46"
Rooisloot C3	24° 8' 16.00"	28° 58' 46.00"
Rooisloot C4	24° 8' 11.14"	28° 57' 49.56"
Rooisloot C5	24° 8' 6.66"	28° 57' 40.77"

PHOTOS:

DITHOKENG C1:

UPSTREAM

DITHOKENG C1: DOWNSTREAM

DITHOKENG C2: UPSTREAM

DITHOKENG C2: DOWNSTREAM

DITHOKENG C4: UPSTREAM

DORPSRIVIER C8:

UPSTREAM

DORPSRIVIER C8:

DOWNSTREAM

DORPSRIVIER C9:

UPSTREAM

DORPSRIVIER C9:

DOWNSTREAM

DORPSRIVIER C10:

UPSTREAM

DORPSRIVIER C10:

DOWNSTREAM

ROOISLOOT C3:

UPSTREAM

ROOISLOOT C3:

DOWNSTREAM

ROOISLOOT C4:

UPSTREAM

ROOISLOOT C4:

DOWNSTREAM

ROOISLOOT C5:

UPSTREAM

ROOISLOOT C5:

DOWNSTREAM

APPENDIX C

HEC-RAS Output

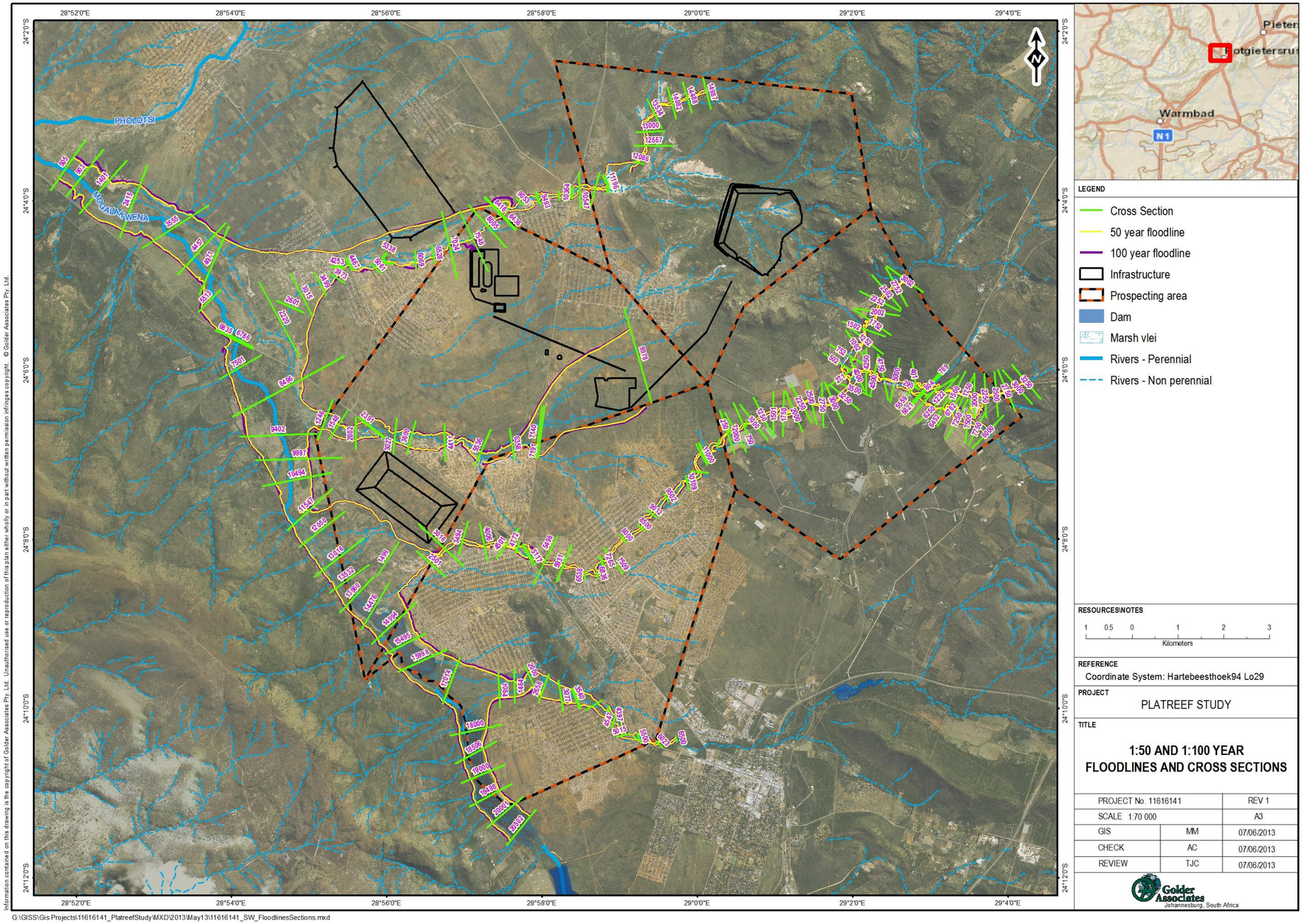

Figure E5: Location and numbering of cross-sections for the original floodlines

DITHOKENG PROFILE OUTPUT TABLE:

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
14987	1 in 50-600mm	202.78	1247.84	1249.73	1249.84	1250.48	0.013	3.87	53.07	46.74
14987	1 in 100-600mm	306.9	1247.84	1250.06	1250.28	1251.07	0.013	4.51	69.7	52.65
14488	1 in 50-600mm	202.78	1225.12	1225.98	1226.93	1232.2	0.296	11.11	18.49	34.77
14488	1 in 100-600mm	306.9	1225.12	1226.18	1227.29	1233.41	0.239	12.09	26.02	40.06
14082	1 in 50-600mm	202.78	1209.04	1210.69	1210.94	1211.6	0.018	4.25	48.57	49.62
14082	1 in 100-600mm	306.9	1209.04	1210.95	1211.34	1212.22	0.020	5.07	62.12	55.36
13534	1 in 50-600mm	202.78	1194.09	1195.67	1196.23	1197.46	0.039	5.96	34.33	35.24
13534	1 in 100-600mm	306.9	1194.09	1196.01	1196.7	1198.19	0.034	6.59	46.99	39.86
13000	1 in 50-600mm	202.78	1186.76	1188.12	1188.17	1188.65	0.009	3.09	63.32	71.12
13000	1 in 100-600mm	306.9	1186.76	1188.35	1188.49	1189.11	0.010	3.64	79.99	76.49
12557	1 in 50-600mm	202.78	1180.39	1181.78	1182.15	1182.96	0.024	4.93	42.46	50.39
12557	1 in 100-600mm	306.9	1180.39	1182.09	1182.52	1183.47	0.021	5.34	59.26	58.88
12086	1 in 50-600mm	202.78	1169.87	1171.14	1171.51	1172.31	0.022	4.63	42.4	55.51
12086	1 in 100-600mm	306.9	1169.87	1171.33	1171.86	1173.01	0.025	5.46	53.67	60.56

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
11233	1 in 50-600mm	202.78	1154.83	1155.43	1155.52	1155.74	0.018	1.91	83.94	315.3
11233	1 in 100-600mm	306.9	1154.83	1155.52	1155.62	1155.88	0.017	2.17	117.1	377.07
11196	1 in 50-600mm	202.78	1151.57	1152.51	1153.05	1154.47	0.062	6.27	32.7	54.55
11196	1 in 100-600mm	306.9	1151.57	1152.78	1153.39	1154.79	0.042	6.25	48.92	63.81
11000	1 in 50-600mm	202.78	1145.34	1147.05	1147.39	1148.14	0.019	4.68	44.2	41.59
11000	1 in 100-600mm	306.9	1145.34	1147.3	1147.83	1148.89	0.022	5.69	55.35	46.63
10547	1 in 50-600mm	202.78	1139.59	1142.31	1141.22	1142.41	0.001	1.44	145.18	88.57
10547	1 in 100-600mm	306.9	1139.59	1142.55	1141.59	1142.72	0.001	1.9	167.29	96.44
10364	1 in 50-600mm	202.78	1137.83	1142.35	1139.76	1142.36	0.000	0.56	416.61	247.74
10364	1 in 100-600mm	306.9	1137.83	1142.62	1140.21	1142.64	0.000	0.7	485.36	254.03
10350		Culvert								
10317	1 in 50-600mm	202.78	1137.7	1139.48	1139.48	1140.11	0.010	3.56	57.49	45.55
10317	1 in 100-600mm	306.9	1137.7	1139.91	1139.91	1140.69	0.009	3.94	78.68	52.31
10006	1 in 50-600mm	202.78	1132.11	1133.43	1133.85	1134.78	0.036	5.23	39.91	53.89
10006	1 in 100-600mm	306.9	1132.11	1133.62	1134.19	1135.53	0.040	6.27	50.9	61.1

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
9493	1 in 50-600mm	202.78	1126.95	1128.8	1128.29	1128.95	0.002	1.78	121.17	119.42
9493	1 in 100-600mm	306.9	1126.95	1129.16	1128.61	1129.33	0.002	1.97	173.09	169.95
9475		Culvert								
9468	1 in 50-600mm	202.78	1126.69	1127.87	1127.87	1128.3	0.010	2.96	70.3	83.93
9468	1 in 100-600mm	306.9	1126.69	1128.18	1128.18	1128.67	0.008	3.19	99.65	102
9053	1 in 50-600mm	202.78	1120.02	1121.57	1121.96	1122.74	0.019	4.82	42.49	49.43
9053	1 in 100-600mm	306.9	1120.02	1121.79	1122.32	1123.43	0.022	5.68	54.43	56.38
8436	1 in 50-600mm	202.78	1113.6	1114.81	1114.81	1114.82	0.000	0.17	593.63	577.54
8436	1 in 100-600mm	306.9	1113.6	1114.81	1114.81	1114.83	0.000	0.25	593.63	577.54
8416	1 in 50-600mm	202.78	1113.07	1114.17	1114.36	1114.76	0.023	3.77	61.36	174.45
8416	1 in 100-600mm	306.9	1113.07	1114.45	1114.54	1114.79	0.009	2.83	120	249.47
8005	1 in 50-600mm	202.78	1105.87	1107.32	1107.42	1107.91	0.013	3.45	60.32	68.28
8005	1 in 100-600mm	306.9	1105.87	1107.32	1107.78	1108.68	0.029	5.25	60.06	68.13
7548	1 in 50-600mm	202.78	1099.97	1101.67	1101.86	1102.36	0.012	3.86	55.78	64.06

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
7548	1 in 100-600mm	306.9	1099.97	1102.01	1102.17	1102.46	0.007	3.56	129.14	393
7024	1 in 50-600mm	202.78	1089.78	1090.74	1091.09	1091.84	0.042	4.79	44.33	87.69
7024	1 in 100-600mm	306.9	1089.78	1090.76	1091.37	1093.07	0.086	6.95	46.28	89.93
6528	1 in 50-600mm	202.78	1081.97	1083.4	1083.42	1083.83	0.008	2.98	70	84.9
6528	1 in 100-600mm	306.9	1081.97	1083.71	1083.72	1084.2	0.007	3.19	99.48	104.36
6069	1 in 50-600mm	202.78	1075.93	1077.16	1077.6	1077.98	0.022	4.08	51.39	72.43
6069	1 in 100-600mm	306.9	1075.93	1077.33	1077.73	1078.53	0.027	4.99	64.4	84.29
5364	1 in 50-600mm	202.78	1068.31	1069.67	1069.59	1070	0.007	2.55	80.38	93.32
5364	1 in 100-600mm	306.9	1068.31	1069.89	1069.89	1070.36	0.008	3.08	101.9	109.21
5338	1 in 50-600mm	202.78	1067.97	1069.52	1069.52	1069.8	0.006	2.57	87.31	149.54
5338	1 in 100-600mm	306.9	1067.97	1069.59	1069.7	1070.1	0.010	3.39	97.79	152.77
5061	1 in 50-600mm	202.78	1062.89	1063.81	1064.34	1065.69	0.071	6.19	33.66	59.69
5061	1 in 100-600mm	306.9	1062.89	1064.18	1064.72	1065.58	0.031	5.4	58.88	79.5
4494	1 in 50-600mm	202.78	1055.08	1058.72	1056.39	1058.73	0.000	0.3	647.64	329.78
4494	1 in 100-600mm	306.9	1055.08	1059.09	1056.71	1059.09	0.000	0.36	767.84	329.78

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
4480		Culvert								
4467	1 in 50-600mm	202.78	1054.97	1056.4	1056.4	1056.86	0.011	3.01	67.92	76.72
4467	1 in 100-600mm	306.9	1054.97	1056.8	1056.8	1057.09	0.005	2.55	135.43	209.58
4273	1 in 50-600mm	202.78	1051.84	1052.76	1052.44	1052.83	0.001	0.71	182.81	228.46
4273	1 in 100-600mm	306.9	1051.84	1052.11	1052.56	1054.3	0.047	2.08	53.7	145.39
4253	1 in 50-600mm	202.78	1051.25	1052.48	1052.48	1052.77	0.007	2.49	85.83	147.34
4253	1 in 100-600mm	306.9	1051.25	1052.43	1052.66	1053.22	0.020	4.15	79.18	145.86
3973	1 in 50-600mm	202.78	1047.32	1049.11	1049.38	1050.04	0.019	4.31	47.72	47.91
3973	1 in 100-600mm	306.9	1047.32	1049.83	1049.83	1050.43	0.007	3.58	92.57	84.76
3499	1 in 50-600mm	202.78	1039.82	1042.12	1042.17	1042.75	0.013	3.51	57.93	52.71
3499	1 in 100-600mm	306.9	1039.82	1042	1042.59	1043.8	0.042	5.95	51.54	50.01
3015	1 in 50-600mm	202.78	1035.17	1037.13	1037.2	1037.77	0.010	3.59	57.74	52.18
3015	1 in 100-600mm	306.9	1035.17	1037.63	1037.63	1038.28	0.007	3.68	87.67	69.26
2601	1 in 50-600mm	202.78	1029.96	1030.74	1030.87	1031.23	0.026	3.11	65.67	129.95

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
2601	1 in 100-600mm	306.9	1029.96	1030.75	1031.11	1031.81	0.055	4.57	67.65	131.58
2220	1 in 50-600mm	202.78	1027.88	1029	1028.68	1029.07	0.002	1.22	176.22	306.33
2220	1 in 100-600mm	306.9	1027.88	1029.17	1028.91	1029.26	0.002	1.37	236.56	389.89

TSHAMA PROFILE OUTPUT TABLE:

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
9978	1 in 50-600mm	189.03	1132.11	1132.64	1132.61	1132.76	0.044	1.66	129.29	451.33
9978	1 in 100-600mm	279.49	1132.11	1132.71	1132.71	1132.87	0.050	1.97	161.67	473.99
7191	1 in 50-600mm	189.03	1077.97	1078.67	1078.5	1078.72	0.011	1.05	204.75	492.39
7191	1 in 100-600mm	279.49	1077.97	1078.83	1078.59	1078.89	0.009	1.1	287.19	522.78
7140	1 in 50-600mm	189.03	1076.91	1078.32		1078.35	0.003	0.92	281.46	462.03
7140	1 in 100-600mm	279.49	1076.91	1078.48		1078.52	0.003	1.03	358.65	469.41
6358	1 in 50-600mm	189.03	1070.8	1071.65	1071.65	1071.9	0.044	2.44	90.76	185.78
6358	1 in 100-600mm	279.49	1070.8	1071.84	1071.8	1072.12	0.037	2.61	129.05	220.15
5536	1 in 50-600mm	189.03	1062.65	1064.51	1063.75	1064.57	0.004	1.22	189.21	183.1
5536	1 in 100-600mm	279.49	1062.65	1064.84		1064.91	0.004	1.4	256.79	234.43
4411	1 in 50-600mm	189.03	1054.17	1055.63	1055.63	1055.84	0.030	2.21	108.82	262.84
4411	1 in 100-600mm	279.49	1054.17	1055.78	1055.78	1056	0.030	2.42	147.91	288.43
3600	1 in 50-600mm	189.03	1046	1047.54	1047.12	1047.58	0.004	1.06	224.83	312.17
3600	1 in 100-600mm	279.49	1046	1047.77	1047.25	1047.82	0.004	1.18	300.17	349.08

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
3027	1 in 50-600mm	189.03	1041.08	1042.72	1042.72	1042.95	0.026	2.51	103.34	194.78
3027	1 in 100-600mm	279.49	1041.08	1042.87	1042.87	1043.15	0.029	2.88	132.14	207.69
2418	1 in 50-600mm	189.03	1037.92	1040.31	1038.54	1040.31	0.000	0.26	899.14	660.65
2418	1 in 100-600mm	279.49	1037.92	1040.42	1038.69	1040.43	0.000	0.35	978.18	671.18
2400		Culvert								
2391	1 in 50-600mm	189.03	1037.1	1038.82	1038.82	1039.09	0.029	2.64	92.09	167.38
2391	1 in 100-600mm	279.49	1037.1	1039.02	1039.02	1039.31	0.026	2.82	133.42	225.81
2002	1 in 50-600mm	189.03	1035	1036.07	1035.52	1036.1	0.003	0.85	252.3	322.32
2002	1 in 100-600mm	279.49	1035	1036.28	1035.65	1036.32	0.003	0.98	322.67	341.42
1548	1 in 50-600mm	189.03	1032.02	1032.92		1033.06	0.021	1.82	122.86	228.97
1548	1 in 100-600mm	279.49	1032.02	1033.11		1033.27	0.019	1.99	170.16	266.1
1246	1 in 50-600mm	189.03	1030.48	1031.59	1031.01	1031.61	0.002	0.67	313.05	374.66
1246	1 in 100-600mm	279.49	1030.48	1031.83	1031.11	1031.85	0.002	0.76	403.31	392.25

ROOISLOOT PROFILE OUTPUT TABLE:

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
12500	1 in 50-600mm	357	1133.38	1136.81	1136.39	1137.64	0.006495	4.13	109.44	51.39
12500	1 in 100-600mm	533.79	1133.38	1137.59	1137.15	1138.68	0.006379	4.78	152.38	59.04
12000	1 in 50-600mm	357	1128.6	1132.22	1132.22	1133.58	0.010177	5.41	97.28	44.46
12000	1 in 100-600mm	533.79	1128.6	1133.11	1133.11	1134.8	0.009342	6.12	140.32	51.89
11488	1 in 50-600mm	357	1125.97	1129.55	1128.65	1130	0.003461	3.02	145.21	68.4
11488	1 in 100-600mm	533.79	1125.97	1130.2	1129.29	1130.84	0.003858	3.64	192.63	77.6
11058	1 in 50-600mm	357	1124.4	1126.62	1126.62	1127.47	0.011624	4.23	119.94	92.59
11058	1 in 100-600mm	533.79	1124.4	1127.18	1127.18	1128.22	0.010668	4.78	175.85	110.4
11048	1 in 50-600mm	357	1123.38	1125.24	1125.82	1127.17	0.037985	6.18	62.47	54.12
11048	1 in 100-600mm	533.79	1123.38	1125.79	1126.43	1127.94	0.027989	6.59	95.38	66.52
11000	1 in 50-600mm	357	1120.32	1122.56	1123.34	1125.16	0.04218	7.17	52.28	36.8
11000	1 in 100-600mm	533.79	1120.32	1123.11	1124.08	1126.31	0.035667	7.98	74.16	42.55
10501	1 in 50-600mm	357	1117	1119.91	1119.76	1120.85	0.009001	4.42	108.34	60.19
10501	1 in 100-600mm	533.79	1117	1120.77	1120.44	1121.84	0.007187	4.8	165.65	73.38

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
10109	1 in 50-600mm	357	1113.08	1116.63	1116.36	1117.63	0.007471	4.77	131.38	63.59
10109	1 in 100-600mm	533.79	1113.08	1117.25	1117.18	1118.7	0.008825	5.82	174.01	73.77
9502	1 in 50-600mm	357	1108.02	1111.13	1111.13	1112.3	0.010391	5.21	127.07	72.27
9502	1 in 100-600mm	533.79	1108.02	1111.99	1111.99	1113.31	0.008786	5.69	199.82	95.24
9012	1 in 50-600mm	357	1103.72	1106.51	1106.18	1107.07	0.004737	3.2	107.6	59.46
9012	1 in 100-600mm	533.79	1103.72	1106.33	1106.73	1107.87	0.014387	5.31	97.45	57.3
8500	1 in 50-600mm	357	1100.22	1103.17	1103.17	1104.04	0.0075	4.02	86.45	50.33
8500	1 in 100-600mm	533.79	1100.22	1103.77	1103.77	1104.8	0.006401	4.28	119.18	58.26
8000	1 in 50-600mm	357	1096.34	1099.11	1099.14	1099.97	0.008887	4.15	87.26	53.48
8000	1 in 100-600mm	533.79	1096.34	1099.48	1099.76	1100.73	0.010677	5.01	108.05	61.03
7509	1 in 50-600mm	357	1091.66	1093.73	1093.96	1094.79	0.012559	4.2	79.61	59.07
7509	1 in 100-600mm	533.79	1091.66	1094.19	1094.47	1095.48	0.010678	4.5	108.8	66.06
7265	1 in 50-600mm	357	1089.95	1093.9	1091.98	1093.96	0.000373	1.15	311.9	154.3
7265	1 in 100-600mm	533.79	1089.95	1094.69	1092.49	1094.76	0.000289	1.15	443.02	175.21
7250		Culvert								

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
7247	1 in 50-600mm	357	1089.54	1093.86		1093.91	0.000196	0.87	368.55	158.28
7247	1 in 100-600mm	533.79	1089.54	1094.66		1094.72	0.000175	0.93	503.69	180.83
6836	1 in 50-600mm	357	1089.37	1092.66	1092.66	1093.59	0.006839	4.1	83.94	45.52
6836	1 in 100-600mm	533.79	1089.37	1093.29	1093.29	1094.4	0.006067	4.41	114.56	52.72
6538	1 in 50-600mm	357	1085.97	1088.19	1088.82	1090.21	0.020406	5.57	58.61	40.37
6538	1 in 100-600mm	533.79	1085.97	1088.61	1089.46	1091.26	0.01983	6.27	76.84	44.55
5931	1 in 50-600mm	357	1081.1	1084.25	1083.9	1084.84	0.004783	3.3	105.95	55.9
5931	1 in 100-600mm	533.79	1081.1	1084.69	1084.5	1085.54	0.005603	3.95	131.53	62.1
5498	1 in 50-600mm	357	1079.22	1081.48	1081.48	1082.24	0.007636	3.52	94.07	63.69
5498	1 in 100-600mm	533.79	1079.22	1081.98	1081.98	1082.91	0.006565	3.78	128.07	70.95
5117	1 in 50-600mm	357	1077.15	1081.4	1078.98	1081.41	0.000081	0.55	690.93	434.83
5117	1 in 100-600mm	533.79	1077.15	1082.25	1079.44	1082.26	0.000045	0.47	1072.26	462.23
5100		Culvert								
5080	1 in 50-600mm	357	1077.04	1079.07	1079.07	1079.89	0.012391	4.01	89.41	56.47

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
5080	1 in 100-600mm	533.79	1077.04	1080.14	1080.14	1080.51	0.003504	2.93	217.63	251.91
4786	1 in 50-600mm	357	1073.75	1076.84	1075.92	1077.02	0.001391	1.89	193.47	125.62
4786	1 in 100-600mm	533.79	1073.75	1077.35	1076.4	1077.55	0.001328	2.06	264.16	154.81
4780		Culvert								
4772	1 in 50-600mm	357	1073.05	1075.27	1075.27	1076.08	0.011925	4.01	89.91	56.4
4772	1 in 100-600mm	533.79	1073.05	1075.9	1075.9	1076.75	0.008689	4.18	132.27	80.04
4501	1 in 50-600mm	357	1064.31	1066.4	1067.42	1069.9	0.051999	8.11	43.26	34.03
4501	1 in 100-600mm	533.79	1064.31	1066.74	1068.06	1071.54	0.054833	9.39	55.28	37.61
4006	1 in 50-600mm	357	1058.86	1062.45	1061.89	1063	0.004116	3.31	108.67	49.05
4006	1 in 100-600mm	533.79	1058.86	1062.96	1062.54	1063.75	0.00474	3.95	135.07	53.83
3494	1 in 50-600mm	357	1056.93	1059.53	1059.53	1060.38	0.00635	3.58	89.27	54.13
3494	1 in 100-600mm	533.79	1056.93	1060.1	1060.1	1061.11	0.005526	3.85	122.12	61.4
3016	1 in 50-600mm	357	1054.56	1058.01	1057.39	1058.36	0.002608	2.6	136.41	76.07
3016	1 in 100-600mm	533.79	1054.56	1058.4	1057.92	1058.92	0.003191	3.13	167.17	83.8

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
2501	1 in 50-600mm	357	1052.24	1055.09	1055.09	1056.02	0.009342	4.3	83.71	45.71
2501	1 in 100-600mm	533.79	1052.24	1056.09	1055.72	1056.89	0.004903	3.94	135.27	57.5
1499	1 in 50-600mm	357	1047.9	1049.86	1049.17	1050.04	0.002004	1.7	196.42	128.47
1499	1 in 100-600mm	533.79	1047.9	1049.51	1049.51	1050.16	0.009662	3.26	153.54	118.36

DORPSRIVIER PROFILE OUTPUT TABLE:

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
6500	1 in 50-600mm	354.37	1093.59	1096.66	1097.16	1098.68	0.014003	6.52	90.46	54.9
6500	1 in 100-600mm	519.59	1093.59	1097.31	1098.01	1099.93	0.014004	7.53	129.97	68.23
6023	1 in 50-600mm	354.37	1087.08	1089.81	1090.2	1091.53	0.015723	5.81	64.81	38.72
6023	1 in 100-600mm	519.59	1087.08	1090.32	1090.92	1092.67	0.016242	6.83	85.86	44.55
5500	1 in 50-600mm	354.37	1082.62	1085.76	1085.24	1086.21	0.003215	3.11	242.01	215.48
5500	1 in 100-600mm	519.59	1082.62	1086.08	1085.78	1086.77	0.00441	3.93	315.64	243.25
5405	1 in 50-600mm	354.37	1081.36	1085.88	1083.78	1086	0.000577	1.62	339.19	150
5405	1 in 100-600mm	519.59	1081.36	1086.26	1084.28	1086.47	0.000868	2.13	396.26	150
5400		Culvert								
5397	1 in 50-600mm	354.37	1081.31	1083.96		1084.57	0.006815	3.46	102.61	60.65
5397	1 in 100-600mm	519.59	1081.31	1084.35	1084.21	1085.22	0.007702	4.14	133.52	120.49
5015	1 in 50-600mm	354.37	1078.13	1080.75	1080.75	1081.64	0.008565	4.27	118.25	111.93
5015	1 in 100-600mm	519.59	1078.13	1081.35	1081.35	1082.37	0.00723	4.65	202.67	164.73
4547	1 in 50-600mm	354.37	1074.98	1076.71	1076.54	1077.19	0.006807	3.16	165.45	153.51

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
4547	1 in 100-600mm	519.59	1074.98	1076.72	1076.92	1077.74	0.014387	4.6	166.62	153.91
4397	1 in 50-600mm	354.37	1073.93	1076.91	1075.1	1076.95	0.000259	0.88	584.81	348.7
4397	1 in 100-600mm	519.59	1073.93	1077.12	1075.35	1077.19	0.00043	1.19	658.88	370.7
4390		Culvert								
4369	1 in 50-600mm	354.37	1073.72	1074.96	1074.84	1075.31	0.008197	2.67	162.07	197.34
4369	1 in 100-600mm	519.59	1073.72	1075.19	1075.11	1075.69	0.0089	3.18	209.85	216.13
3999	1 in 50-600mm	354.37	1069.93	1071.18	1071.18	1071.61	0.012447	2.92	124.51	165.32
3999	1 in 100-600mm	519.59	1069.93	1071.43	1071.43	1071.99	0.011315	3.31	171.33	200.22
3564	1 in 50-600mm	354.37	1066	1070.12	1067.47	1070.14	0.000148	0.83	1025.74	380.83
3564	1 in 100-600mm	519.59	1066	1070.34	1067.75	1070.39	0.000258	1.14	1110.5	388.04
3550		Culvert								
3540	1 in 50-600mm	354.37	1065.99	1067.9	1067.72	1068.37	0.01098	4.09	304.88	252.52
3540	1 in 100-600mm	519.59	1065.99	1068.26	1068.12	1068.91	0.011463	4.8	407.42	296.79
3077	1 in 50-600mm	354.37	1062.61	1063.87	1063.73	1064.18	0.00793	2.69	287.34	350.88

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
3077	1 in 100-600mm	519.59	1062.61	1064.12	1063.99	1064.53	0.008291	3.15	377.16	378.53
2658	1 in 50-600mm	354.37	1059.5	1061.05	1060.71	1061.23	0.006149	2.54	472.51	456.42
2658	1 in 100-600mm	519.59	1059.5	1061.37	1060.94	1061.6	0.005776	2.88	622.11	474.2
2000	1 in 50-600mm	354.37	1055.04	1057.73	1057.46	1058.02	0.004532	2.49	260.95	335.44
2000	1 in 100-600mm	519.59	1055.04	1058.05	1057.74	1058.43	0.004728	2.9	386.93	449.64
1484	1 in 50-600mm	354.37	1052.52	1054.25	1054.25	1054.71	0.009765	3.13	209.99	354.22
1484	1 in 100-600mm	519.59	1052.52	1054.53	1054.53	1055.08	0.00938	3.53	313.49	392.26
1084	1 in 50-600mm	354.37	1050.5	1052.64	1051.89	1052.77	0.002001	1.92	571.62	474.01
1084	1 in 100-600mm	519.59	1050.5	1053.05	1052.21	1053.21	0.002001	2.2	778.72	532.26

MOGALAKWENA PROFILE OUTPUT TABLE:

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)
20502	1 in 50-600mm	1094.2	1042.78	1047.9	1044.24	1047.91	0.000135	0.47	2582.97	698.49
20502	1 in 100-600mm	1492.7	1042.78	1048.66	1044.46	1048.67	0.000141	0.53	3130.64	736.19
20001	1 in 50-600mm	1094.2	1042.23	1047.84		1047.85	0.000112	0.46	2671.86	664.51
20001	1 in 100-600mm	1492.7	1042.23	1048.6		1048.61	0.000123	0.53	3188.19	695.52
19498	1 in 50-600mm	1094.2	1042.16	1047.77		1047.78	0.000149	0.53	2337.5	591.15
19498	1 in 100-600mm	1492.7	1042.16	1048.52		1048.54	0.000163	0.61	2793.47	621.67
19000	1 in 50-600mm	1094.2	1043.63	1047.62		1047.65	0.000574	0.81	1428.43	475.82
19000	1 in 100-600mm	1492.7	1043.63	1048.36		1048.4	0.000543	0.89	1797.55	516.89
18506	1 in 50-600mm	1094.2	1043.54	1047.33		1047.36	0.000597	0.81	1444.59	489.29
18506	1 in 100-600mm	1492.7	1043.54	1048.09		1048.13	0.000548	0.89	1831.5	524.83
18000	1 in 50-600mm	1094.2	1042.9	1047.13		1047.14	0.000309	0.63	1905.51	602.5
18000	1 in 100-600mm	1492.7	1042.9	1047.9		1047.92	0.000294	0.69	2391.51	647.5
17014	1 in 50-600mm	1176.5	1043.04	1046.68		1046.69	0.000184	0.45	2794.73	930.87
17014	1 in 100-600mm	1605	1043.04	1047.49		1047.5	0.000161	0.48	3557.14	965.41

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
15998	1 in 50-600mm	1176.5	1037.92	1046.65		1046.65	0.000017	0.24	5554.04	885.82
15998	1 in 100-600mm	1605	1037.92	1047.45		1047.45	0.000022	0.29	6284.31	949.82
15495	1 in 50-600mm	1176.5	1039.05	1046.63		1046.64	0.000053	0.38	3575.98	733.33
15495	1 in 100-600mm	1605	1039.05	1047.42		1047.43	0.000064	0.45	4172.92	777.93
14994	1 in 50-600mm	1176.5	1039.9	1046.61		1046.61	0.000039	0.31	4243.74	877.79
14994	1 in 100-600mm	1605	1039.9	1047.4		1047.4	0.000047	0.36	4958.54	941.48
14476	1 in 50-600mm	1176.5	1040.36	1046.59		1046.59	0.000058	0.35	3981.93	1044.4
14476	1 in 100-600mm	1605	1040.36	1047.37		1047.38	0.000062	0.39	4824.79	1103.91
13960	1 in 50-600mm	1176.5	1040.65	1046.55		1046.55	0.000091	0.42	3309.66	905.35
13960	1 in 100-600mm	1605	1040.65	1047.33		1047.34	0.000093	0.47	4029.69	930.9
13532	1 in 50-600mm	1176.5	1040.86	1046.47		1046.49	0.000298	0.69	2095.87	813.03
13532	1 in 100-600mm	1605	1040.86	1047.25		1047.27	0.000269	0.73	2780.94	923.05
13016	1 in 50-600mm	1264.8	1040.92	1044.42		1044.52	0.003001	1.52	968.39	584.18
13016	1 in 100-600mm	1725.5	1040.92	1044.84		1044.96	0.003031	1.68	1235.5	682.26
12050	1 in 50-600mm	1264.8	1037.21	1042.57		1042.63	0.001373	1.32	1479.93	791.35

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)
12050	1 in 100-600mm	1725.5	1037.21	1043.08		1043.14	0.001271	1.38	1886.2	801.54
11547	1 in 50-600mm	1264.8	1036.2	1041.11	1040.07	1041.36	0.005922	2.75	981.72	498.58
11547	1 in 100-600mm	1725.5	1036.2	1041.68	1040.47	1041.94	0.00583	2.98	1272.83	537.41
10494	1 in 50-600mm	1264.8	1032.95	1036.9	1035.37	1037.03	0.002991	1.8	1228.72	759.74
10494	1 in 100-600mm	1725.5	1032.95	1037.34	1035.77	1037.5	0.00317	2	1577.9	785.17
9997	1 in 50-600mm	1264.8	1031.63	1035.5		1035.58	0.002807	1.53	1619.65	978.32
9997	1 in 100-600mm	1725.5	1031.63	1036.03		1036.1	0.002429	1.59	2141.22	988.58
9402	1 in 50-600mm	1264.8	1029.13	1034.95	1032.53	1034.96	0.000511	0.85	3506.87	1349.1
9402	1 in 100-600mm	1725.5	1029.13	1035.47		1035.49	0.000547	0.95	4217.3	1353.51
8496	1 in 50-600mm	1285.1	1026.9	1030.24		1030.27	0.002045	1.19	1651.86	1464.54
8496	1 in 100-600mm	1753.1	1026.9	1030.56		1030.6	0.001744	1.19	2131.11	1512.36
7501	1 in 50-600mm	1285.1	1025.99	1028.74		1028.78	0.001159	0.91	1599.79	834.6
7501	1 in 100-600mm	1753.1	1025.99	1029.15		1029.19	0.001165	1	1941.72	845.39
6835	1 in 50-600mm	1285.1	1021.93	1027.3		1027.44	0.004459	1.9	888.83	613.46
6835	1 in 100-600mm	1753.1	1021.93	1027.92		1028.03	0.002982	1.77	1337.43	817.65

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
6786	1 in 50-600mm	1285.1	1021.71	1027.2		1027.28	0.00214	1.57	1271.14	897.6
6786	1 in 100-600mm	1753.1	1021.71	1027.88		1027.93	0.001255	1.34	1874.96	897.6
5513	1 in 50-600mm	1285.1	1020.27	1026.61	1022.98	1026.62	0.000218	0.65	2308.49	618.59
5513	1 in 100-600mm	1753.1	1020.27	1027.31	1023.22	1027.33	0.000243	0.74	2752.79	652.06
4971	1 in 50-600mm	1340.7	1019.67	1021.19		1021.23	0.001866	0.75	1477.53	976.24
4971	1 in 100-600mm	1828.9	1019.67	1021.54		1021.59	0.001865	0.88	1839.93	1116.95
4457	1 in 50-600mm	1340.7	1017.95	1020.44		1020.48	0.001226	0.78	1692.66	972.86
4457	1 in 100-600mm	1828.9	1017.95	1020.71		1020.76	0.001484	0.93	1956.66	1005.69
3555	1 in 50-600mm	1340.7	1016.85	1018.23		1018.31	0.006741	1.35	1052.03	1043.78
3555	1 in 100-600mm	1828.9	1016.85	1018.75		1018.82	0.003383	1.21	1616.12	1111.28
2415	1 in 50-600mm	1340.7	1013.99	1017.54		1017.55	0.000226	0.47	2979.64	1043.43
2415	1 in 100-600mm	1828.9	1013.99	1018.11		1018.13	0.000235	0.53	3582.3	1071.22
1401	1 in 50-600mm	1340.7	1012.89	1017.21		1017.23	0.000478	0.77	2090.62	828.69
1401	1 in 100-600mm	1828.9	1012.89	1017.77		1017.79	0.000488	0.86	2564.26	867.8

River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface. Elevation	Critical Water Surface	Energy Gradient. Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)
903	1 in 50-600mm	1340.7	1011.03	1016.7		1016.8	0.00198	1.61	1121.15	575.06
903	1 in 100-600mm	1828.9	1011.03	1017.24		1017.35	0.002025	1.77	1474.14	744.09
505	1 in 50-600mm	1340.7	1010.82	1015.91	1014.35	1016	0.002002	1.58	1111.68	534.17
505	1 in 100-600mm	1828.9	1010.82	1016.44	1014.69	1016.55	0.002004	1.72	1414.18	605.35

APPENDIX D

Uitloop Floodlines

Flow station setup

At the flow monitoring site steel rods were inserted into the soil on the left and right banks. The rods were used as benchmarks (BM). The river was not flowing during the site visit. The cross-sectional profile was surveyed using a dumpy level instrument. The dumpy level was setup on the right bank of the stream and the cross section was surveyed from the left bank (LB). A photograph of the surveyed cross-section is presented in Figure F1. Steel rods were inserted into the soil to be used as benchmarks as seen in Figure F2. The cross section is located at angle of 70° from the reference point; in this case the reference point is an electric pole as seen in Figure F3. The surveyed cross-section together with the left and right bank BMs is shown in Figure F4.

Figure F1: Photograph of surveyed Uitloop cross-section

Figure F2: Steel rod was inserted at LB into the soil to be used as BM

Figure F3: Uitloop cross-section reference point looking downstream from cross-section

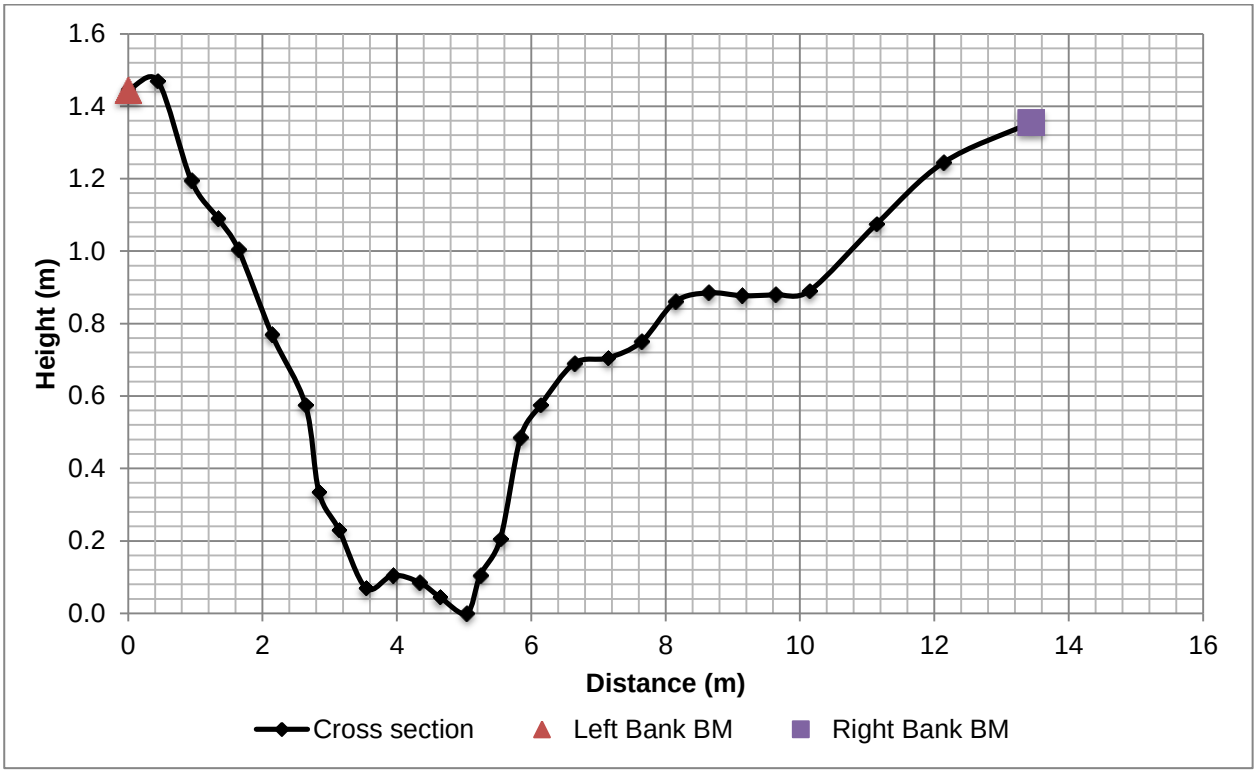

Figure F4: Surveyed cross-sectional profile of the Uitloop monitoring site

Due to the river being dry, neither flow measurements nor water quality measurements were taken during this site visit. The locations of the cross-sections are shown in Figure F5.

The following pages show the outputs from HEC-RAS.

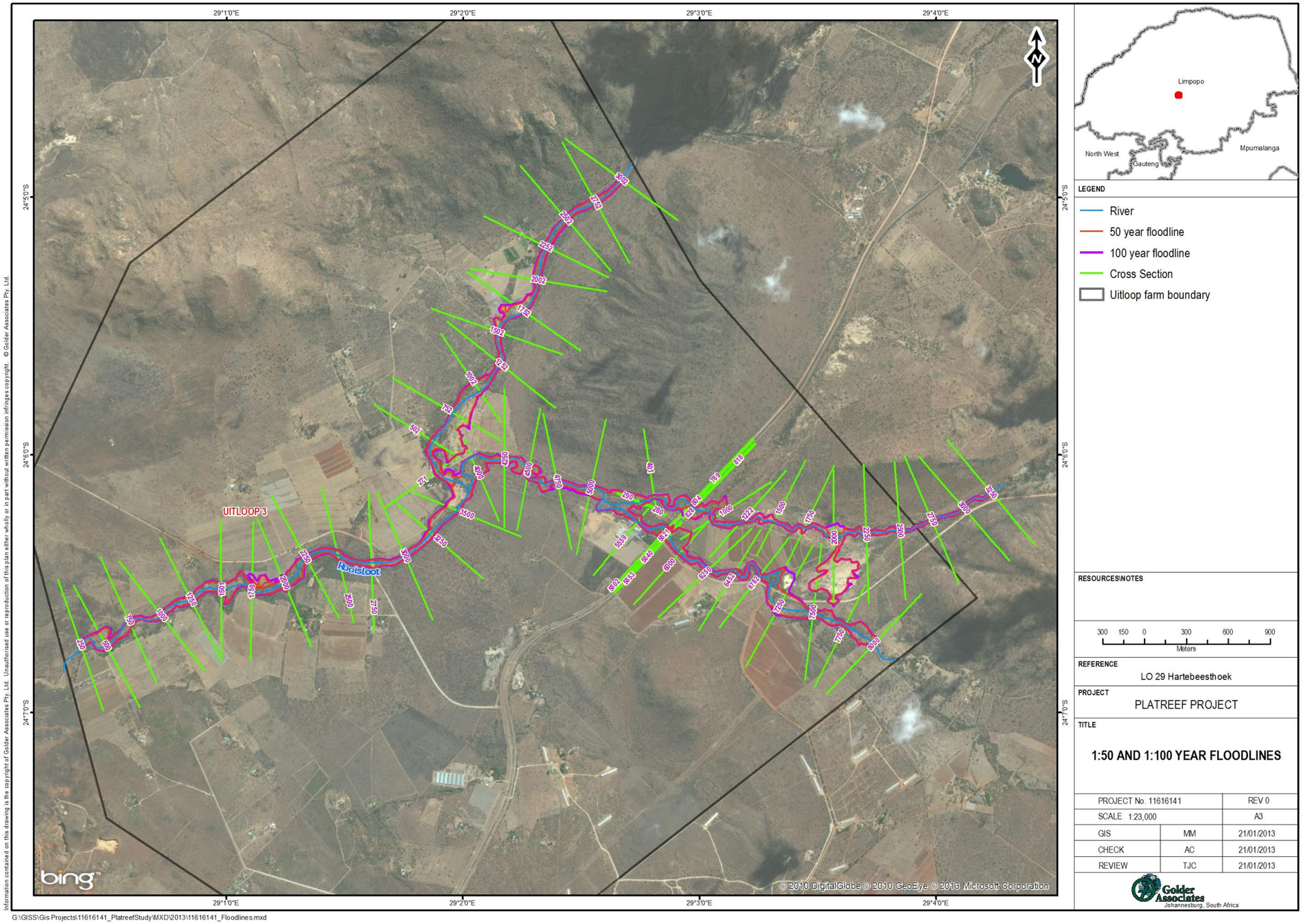

Figure F5: Location and numbering of cross-sections for Uitloop floodlines

ROOISLOOT – MAIN PROFILE OUTPUT TABLE

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Main	8000	1 in 50	65.12	1216.3	1217.23	1217.46	1217.99	0.01401	2.8	17.4	27.29	0.93
Main	8000	1 in100	102.59	1216.3	1217.45	1217.76	1218.45	0.01401	3.23	23.76	30.74	0.97
Main	7750	1 in 50	65.12	1211.9	1213.05	1213.36	1214.02	0.017987	3.62	15.23	21.52	1.09
Main	7750	1 in100	102.59	1211.9	1213.3	1213.71	1214.55	0.017304	4.07	21.15	25	1.11
Main	7500	1 in 50	65.12	1207.87	1208.83	1209.1	1209.67	0.017059	2.99	16.64	28.62	1.02
Main	7500	1 in100	102.59	1207.87	1209.02	1209.39	1210.17	0.018056	3.5	22.28	31.98	1.08
Main	7250	1 in 50	65.12	1205.91	1206.38	1206.43	1206.63	0.008109	1.34	30.22	87.3	0.63
Main	7250	1 in100	102.59	1205.91	1206.48	1206.57	1206.84	0.008828	1.6	39.54	92.27	0.68
Main	6782	1 in 50	65.12	1198.1	1199.12	1199.58	1200.66	0.028235	3.69	12.75	20.82	1.3
Main	6782	1 in100	102.59	1198.1	1199.39	1199.91	1201.08	0.022712	4	18.91	24.51	1.22
Main	6452	1 in 50	65.12	1193.82	1195.23	1195.39	1195.91	0.009692	3.03	18.26	21.15	0.83
Main	6452	1 in100	102.59	1193.82	1195.48	1195.77	1196.46	0.010964	3.61	23.96	23.89	0.91
Main	6250	1 in 50	65.12	1190.11	1191.23	1191.68	1192.71	0.02856	4.33	12.53	17.87	1.36
Main	6250	1 in100	102.59	1190.11	1191.52	1192.06	1193.24	0.023808	4.66	18.19	20.96	1.29

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Main	6000	1 in 50	65.12	1185.52	1189.47	1187.19	1189.5	0.000073	0.51	100.61	46.46	0.08
Main	6000	1 in100	102.59	1185.52	1189.67	1187.56	1189.72	0.000144	0.74	110.25	49.73	0.12
Main	5853	1 in 50	65.12	1185.09	1189.47	1186.78	1189.48	0.000042	0.41	135.16	66.25	0.07
Main	5853	1 in100	102.59	1185.09	1189.67	1187.16	1189.7	0.000087	0.61	149.21	74.23	0.09

ROOISLOOT – MAIN1 PROFILE OUTPUT TABLE

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Main1	3500	1 in 50	278.93	1157.92	1160.73	1160.14	1160.93	0.001038	1.58	143.45	99.67	0.3
Main1	3500	1 in 100	415.57	1157.92	1161.32	1160.47	1161.53	0.000799	1.58	205.86	112.19	0.28
Main1	3250	1 in 50	278.93	1156.52	1159.62	1159.62	1160.42	0.00398	3.16	72.21	45.36	0.6
Main1	3250	1 in 100	415.57	1156.52	1160.18	1160.18	1161.1	0.003668	3.42	100.34	54.8	0.59
Main1	3000	1 in 50	278.93	1151.67	1153.75	1154.86	1157.86	0.032574	6.83	32.24	26.68	1.6
Main1	3000	1 in 100	415.57	1151.67	1154.2	1155.48	1158.74	0.027249	7.23	45.45	31.14	1.51
Main1	2750	1 in 50	278.93	1149.35	1151.66	1152.05	1152.94	0.009427	4.2	56.08	45.41	0.89
Main1	2750	1 in 100	415.57	1149.35	1151.97	1152.54	1153.74	0.010891	4.91	71.1	51.28	0.98
Main1	2500	1 in 50	278.93	1148.67	1150.57	1150.6	1151.17	0.004452	2.5	82.1	72.7	0.59
Main1	2500	1 in 100	415.57	1148.67	1150.85	1150.97	1151.7	0.004934	2.89	103.38	77.2	0.63
Main1	2250	1 in 50	278.93	1145.47	1147.49	1148.06	1149.3	0.012746	4.5	47.66	37.29	1.01
Main1	2250	1 in 100	415.57	1145.47	1148.02	1148.61	1149.92	0.009609	4.58	69.24	43.18	0.91
Main1	2000	1 in 50	278.93	1144.69	1146.34	1146.42	1146.89	0.005658	2.58	85.5	97.84	0.65
Main1	2000	1 in 100	415.57	1144.69	1146.47	1146.73	1147.4	0.008426	3.31	98.17	103.08	0.8

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Main1	1750	1 in 50	278.93	1142.39	1144.5	1144.71	1145.34	0.006504	3.15	70.41	65.18	0.72
Main1	1750	1 in 100	415.57	1142.39	1145.06	1145.23	1145.73	0.004914	3.23	124.89	138.21	0.65
Main1	1501	1 in 50	278.93	1140.08	1142.87	1142.46	1143.18	0.001666	2	113.18	76.83	0.39
Main1	1501	1 in 100	415.57	1140.08	1142.37	1142.84	1143.89	0.011953	4.68	76.49	68.63	1
Main1	1250	1 in 50	278.93	1139.38	1141.77	1141.77	1142.5	0.00408	2.81	74.85	51.69	0.59
Main1	1250	1 in 100	415.57	1139.38	1142.25	1142.25	1143.13	0.003782	3.06	101.56	58.37	0.58
Main1	1000	1 in 50	278.93	1134.41	1135.94	1136.89	1139.79	0.044106	6.81	32.69	36.65	1.79
Main1	1000	1 in 100	415.57	1134.41	1136.28	1137.4	1140.63	0.036302	7.08	45.74	41.21	1.68
Main1	750	1 in 50	278.93	1130.11	1131.41	1131.98	1133.28	0.014843	3.6	47.46	44.47	1.01
Main1	750	1 in 100	415.57	1130.11	1131.68	1132.46	1134.28	0.016307	4.28	59.88	47.07	1.1
Main1	500	1 in 50	278.93	1127.79	1131.82	1130.21	1131.89	0.000244	0.96	245.42	132.67	0.16
Main1	500	1 in 100	415.57	1127.79	1132.7	1130.56	1132.76	0.000158	0.88	366.15	142.64	0.13
Main1	250	1 in 50	278.93	1126.87	1131.07	1130.53	1131.71	0.002001	2.75	81.11	33.76	0.45
Main1	250	1 in 100	415.57	1126.87	1131.81	1131.24	1132.6	0.002	3.09	107.88	38.64	0.46

ROOISLOOT – MAIN2 PROFILE OUTPUT TABLE

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Main2	5000	1 in 50	101.52	1173.76	1175.51	1175.6	1175.95	0.00802	3.07	35.35	61.12	0.77
Main2	5000	1 in 100	159.94	1173.76	1175.71	1175.83	1176.28	0.007942	3.3	48.22	66.36	0.78
Main2	4750	1 in 50	101.52	1169.79	1171.37	1171.98	1172.85	0.021374	3.7	20.03	23.15	0.99
Main2	4750	1 in 100	159.94	1169.79	1171.73	1172.27	1173.39	0.01822	3.97	29.45	29	0.95
Main2	4500	1 in 50	101.52	1167.25	1168.42	1168.54	1168.87	0.010256	2.48	36.27	84.65	0.8
Main2	4500	1 in 100	159.94	1167.25	1168.52	1168.72	1169.2	0.012798	2.97	45.4	86.57	0.91
Main2	4250	1 in 50	101.52	1163.52	1164.56	1164.9	1165.57	0.019745	3.45	23.36	40.56	1.12
Main2	4250	1 in 100	159.94	1163.52	1164.84	1165.17	1165.88	0.015397	3.6	36.3	53.31	1.03
Main2	4000	1 in 50	101.52	1162.09	1163.15	1163.15	1163.51	0.004439	1.72	39.28	51.66	0.54
Main2	4000	1 in 100	159.94	1162.09	1163.39	1163.41	1163.9	0.004556	2	51.88	53.17	0.56

ROOISLOOT – TRIB1 PROFILE OUTPUT TABLE

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)	
Trib	3250	1 in 50	46.29	1243.72	1244.94	1245.16	1245.69	0.014013	3.19	12.43	16.48	0.96
Trib	3250	1 in 100	72.92	1243.72	1245.2	1245.51	1246.21	0.014013	3.66	16.85	18.54	1
Trib	3000	1 in 50	46.29	1236.92	1237.77	1238.27	1239.53	0.05318	5.15	8.04	13.99	1.79
Trib	3000	1 in 100	72.92	1236.92	1237.99	1238.61	1240.24	0.047921	5.68	11.21	15.83	1.76
Trib	2750	1 in 50	46.29	1230.31	1231.53	1231.83	1232.47	0.016951	3.2	11.51	16.48	1.03
Trib	2750	1 in 100	72.92	1230.31	1231.75	1232.15	1233.04	0.018421	3.81	15.32	18.64	1.11
Trib	2500	1 in 50	46.29	1224.33	1225.32	1225.74	1226.67	0.034446	4.51	9.17	14.06	1.47
Trib	2500	1 in 100	72.92	1224.33	1225.57	1226.1	1227.27	0.03035	4.94	12.91	15.98	1.43
Trib	2250	1 in 50	46.29	1219.11	1220.27	1220.52	1221.07	0.014992	3.1	12.27	17.56	0.98
Trib	2250	1 in 100	72.92	1219.11	1220.48	1220.84	1221.61	0.016661	3.7	16.12	19.58	1.06
Trib	2000	1 in 50	46.29	1214.73	1215.38	1215.65	1216.22	0.026387	3.03	11.71	27.01	1.2
Trib	2000	1 in 100	72.92	1214.73	1215.54	1215.89	1216.62	0.024577	3.39	16.27	30.22	1.21
Trib	1750	1 in 50	46.29	1206.31	1206.68	1206.9	1207.52	0.050868	2.83	11.78	51.23	1.52
Trib	1750	1 in 100	72.92	1206.31	1206.74	1207.05	1207.96	0.055111	3.31	15.33	53.1	1.62

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Trib	1500	1 in 50	46.29	1199.89	1200.89	1201.08	1201.52	0.014184	2.9	13.41	22.08	0.94
Trib	1500	1 in 100	72.92	1199.89	1201.11	1201.35	1201.91	0.013576	3.26	18.71	25.86	0.96
Trib	1222	1 in 50	46.29	1193.18	1193.89	1194.26	1195.19	0.048119	4.12	9.37	22.91	1.63
Trib	1222	1 in 100	72.92	1193.18	1194.03	1194.5	1195.74	0.048368	4.71	12.85	26.49	1.69
Trib	1000	1 in 50	46.29	1191.82	1192.85	1192.85	1193.14	0.005591	1.82	20.09	34.38	0.59
Trib	1000	1 in 100	72.92	1191.82	1193.08	1193.08	1193.43	0.00507	1.99	28.62	40.14	0.58
Trib	828	1 in 50	46.29	1188.93	1189.89	1190.28	1191.18	0.030772	3.96	9.65	16.03	1.36
Trib	828	1 in 100	72.92	1188.93	1190.14	1190.62	1191.66	0.025795	4.29	13.91	18.49	1.3
Trib	823		Bridge									
Trib	818	1 in 50	46.29	1188.86	1189.74	1190.09	1190.85	0.029635	3.89	10.17	18.05	1.34
Trib	818	1 in 100	72.92	1188.86	1189.95	1190.39	1191.36	0.027815	4.35	14.14	20.72	1.34
Trib	804	1 in 50	46.29	1188.46	1190.05	1189.63	1190.09	0.000805	0.94	49.62	91	0.24
Trib	804	1 in 100	72.92	1188.46	1190.46	1189.82	1190.49	0.000354	0.73	93.01	113.21	0.17
Trib	796		Bridge									

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m^3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m^2)	(m)	
Trib	789	1 in 50	46.29	1188.15	1189.53	1189.53	1189.89	0.005088	1.92	18.52	24.84	0.58
Trib	789	1 in 100	72.92	1188.15	1189.58	1189.62	1190.35	0.010624	2.85	19.73	25.7	0.84
Trib	401	1 in 50	46.29	1181.63	1182.32	1182.87	1185.19	0.095658	5.14	6.73	16.51	2.23
Trib	401	1 in 100	72.92	1181.63	1182.65	1183.15	1184.42	0.034835	4.27	13.11	21.68	1.46
Trib	290	1 in 50	46.29	1179.36	1182.76	1180.96	1182.76	0.000004	0.11	350.85	213.02	0.02
Trib	290	1 in 100	72.92	1179.36	1182.86	1181.19	1182.86	0.000008	0.15	372.97	214	0.03
Trib	285		Culvert									

ROOISLOOT – TRIB2 PROFILE OUTPUT TABLE

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Trib	3002	1 in 50	235.07	1181.22	1183.39	1184.03	1185.36	0.014012	4.63	39.07	30.6	1.05
Trib	3002	1 in 100	350.22	1181.22	1183.78	1184.58	1186.23	0.014024	5.22	51.86	34.77	1.09
Trib	2752	1 in 50	235.07	1179.18	1181.63	1181.92	1182.69	0.007124	3.56	54.31	45.99	0.77
Trib	2752	1 in 100	350.22	1179.18	1181.93	1182.35	1183.36	0.008032	4.12	69.06	50.51	0.83
Trib	2502	1 in 50	235.07	1176.52	1178.86	1179.35	1180.42	0.011721	4.47	43.21	34.35	0.98
Trib	2502	1 in 100	350.22	1176.52	1179.31	1179.88	1181.09	0.01023	4.76	60.21	40.15	0.94
Trib	2252	1 in 50	235.07	1172.79	1175.21	1175.89	1177.22	0.013845	4.93	39.06	30.18	1.07
Trib	2252	1 in 100	350.22	1172.79	1175.62	1176.43	1178.08	0.013977	5.55	52.56	36.52	1.1
Trib	2002	1 in 50	235.07	1171.47	1173.43	1173.67	1174.39	0.007403	3.2	54.96	47.72	0.76
Trib	2002	1 in 100	350.22	1171.47	1173.72	1174.12	1175.06	0.008266	3.74	69.57	52	0.82
Trib	1752	1 in 50	235.07	1169.79	1171.95	1172.11	1172.6	0.00665	3.26	69.34	86.55	0.73
Trib	1752	1 in 100	350.22	1169.79	1172.16	1172.4	1173.02	0.007427	3.68	88.26	93.82	0.79
Trib	1502	1 in 50	235.07	1166.19	1168.32	1168.92	1170.18	0.013729	4.46	40.26	33.15	1.04
Trib	1502	1 in 100	350.22	1166.19	1168.83	1169.44	1170.74	0.010442	4.56	58.83	39.24	0.94

Reach	River Station	Profile	Q Total	Minimum Channel Elevation	Water Surface Elevation	Critical Water Surface	Energy Gradient Elevation	Energy Gradient Slope	Velocity Channel	Flow Area	Top Width	Froude No Channel
			(m³/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m²)	(m)	
Trib	1252	1 in 50	235.07	1164.88	1167.07	1166.81	1167.52	0.002364	2.04	81.3	55.57	0.44
Trib	1252	1 in 100	350.22	1164.88	1166.85	1167.23	1168.21	0.008585	3.62	68.93	52.86	0.83
Trib	1002	1 in 50	235.07	1164.32	1166.3	1166.3	1166.76	0.004328	2.45	79.2	84.02	0.58
Trib	1002	1 in 100	350.22	1164.32	1166.6	1166.6	1167.14	0.004465	2.76	108.31	105.05	0.6
Trib	752	1 in 50	235.07	1163.68	1164.55	1164.75	1165.28	0.008352	2	63.48	83.75	0.71
Trib	752	1 in 100	350.22	1163.68	1164.8	1165.04	1165.7	0.00734	2.25	85.32	87.65	0.69
Trib	502	1 in 50	235.07	1162.34	1164.49	1164.49	1164.6	0.001196	1.44	164.37	210.68	0.31
Trib	502	1 in 100	350.22	1162.34	1164.49	1164.49	1164.73	0.002654	2.15	164.37	210.68	0.47
Trib	271	1 in 50	235.07	1159.59	1161.25	1161.96	1163.68	0.029089	5.84	34.37	39.24	1.47
Trib	271	1 in 100	350.22	1159.59	1161.82	1162.38	1163.53	0.013517	4.87	60.94	53.4	1.06

APPENDIX E

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DOCUMENT LIMITATIONS

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