

PAUL ROUX

(1:50 and 1:100 Year Floodlines)

Report Prepared for
PHETHOGO CONSULTING

Report Number 477887/1



Report Prepared by

 **srk** consulting

July 2014

Paul Roux

(1:50 and 1:100 Year Floodlines)

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SRK Project Number 477887

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Executive Summary

Phethogo Consulting is planning to undertake a development in Paul Roux, in the Free State province. The proposed development site is situated on the southern side of the N5 highway. The Sand River runs on the eastern side of the proposed development site, with its tributaries joining from the western side, and thus flooding problems are likely to occur within the proposed development site. A need was therefore identified to carry out a detailed floodline study to ensure that future developments are not prone to unacceptable flooding. SRK Consulting was therefore appointed by Phethogo Consulting to undertake a study to determine the 1:50 and 1:100 year floodlines along the watercourse at the vicinity of the proposed development.

Results of a floodline study for the current watercourse conditions are covered in this report.

Summary of principal objectives

The principal objective of this project is to determine the 1:50 and 1:100 year floodlines for existing watercourse conditions along the Sand River and its tributaries which runs on the eastern side of the proposed development site in Paul Roux.

Outline of work programme

The floodlines were determined based on the existing watercourse condition, and survey information supplied by the appointed surveyor. The catchment hydrology was determined by characterising the hydrological and hydraulic parameters of the catchment within which the future developments may take place. The catchment parameters were then used to generate the peak flow data (i.e. 1:50 and 1:100 year flood peaks) using the Rational method. The peak flow data and other relevant information were entered into the backwater model HECRAS to produce the results on the flooding extent along the river banks in the vicinity of the proposed development site.

Conclusions

- The southern portion of Mary Ann. No 712 (North) is slightly affected by the floodlines between chainages S1T1T768 and S1T1T435
- The southern portion of Mary Ann. No 712 (South) is affected by the floodlines between chainages S1T878 and S1T642
- The floodlines are shown in drawing 477887/001.

Recommendations

The following is recommended:

- The floodline information to be used to ensure that no new development is situated within the 1:100 year floodline.

Action Points

- The floodline information be used to determine the final locality and layout of the proposed development such that no development is within the 1:100 year floodline
- The floodlines be revised should watercourse/control structures be modified in the future.

- The floodline data to be used for layout planning and township applications.
- No new development to encroach onto the 1:50-year floodplain

Table of Contents

Executive Summary iii

Disclaimer..... vii

1 Introduction and Scope of Report..... 1

2 Background and Brief 1

 2.1 Background of the project..... 1

 2.2 Program objectives 1

 2.3 Purpose of the Report..... 1

3 Legal and Council Requirements..... 1

4 Description of Study Area 1

5 Topographical Details 4

6 Rainfall Data..... 4

 6.1 Storm Rainfall depths..... 4

7 HECRAS Model Compilation 4

8 Flood Hydrology 5

9 Floodline Determination and Results 5

10 Conclusions 6

11 Recommendations 6

Appendices 8

Appendix A: Hecras Outputs 9

Appendix B: Drawings 12

List of Tables

Table 5-1:	Surveyor Details.....	4
Table 6-1:	Adopted storm rainfall depths (mm).....	4
Table 7-1:	HECRAS Model Main Parameters.....	5
Table 8-1:	Summary of flood peaks (Future Development Conditions).....	5
Table 9-1:	Summary of Average flood depths along floodplains.....	6
Table 9-2:	Summary of Average flow velocity along floodplains.....	6

List of Figures

Figure 4-1:	Paul Roux Study Area.....	2
Figure 4-2:	Paul Roux Catchment Areas.....	3

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by the Phethogo Consulting. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction and Scope of Report

The proposed development site is situated on the southern side of the N5 highway. The Sand River runs on the eastern side of the proposed development site, with its tributaries joining from the western side, and thus flooding problems are likely to occur within the proposed development site. A need was therefore identified to carry out a detailed floodline study to ensure that future developments are not prone to unacceptable flooding. SRK Consulting was hence appointed by Phethogo Consulting to undertake a study to determine the 1:50 and 1:100 year floodlines along the watercourse at the vicinity of the proposed development.

2 Background and Brief

2.1 Background of the project

Phethogo Consulting is planning to undertake a development in Paul Roux, in the Free State Province. The proposed development site is situated on the southern side of the N5 highway. The Sand River runs on the eastern side of the proposed development site, with its tributaries joining from the western side, and thus flooding problems are likely to occur within the proposed development site. In terms of the National Water Act, Act 36 of 1998, the 1:100 year floodlines must be indicated on the layout plans of new townships for information purposes.

2.2 Program objectives

The project objectives are as follows:

- Determination of the detailed 1:50 and 1:100 Year Floodlines for existing watercourse conditions;
- Compile a report and associated floodline drawings.

2.3 Purpose of the Report

This report provides the findings of the study and gives necessary information and recommendations on the flood prone areas due to a 1:50 and 1:100 year flood events.

3 Legal and Council Requirements

The **1:100-year** floodline is required in terms of the National Water Act, Act 36 of 1998, Chapter 14 Part 3 as given below.

144. For the purposes of ensuring that all persons who might be affected have access to information regarding potential flood hazards, no person may establish a township unless the layout plan shows, in a form acceptable to the local authority concerned, lines indicating the maximum level likely to be reached by flood waters on average once in every 100 years.

4 Description of Study Area

The proposed development site is situated on the southern side of the N5 highway. The Sand River runs on the eastern side of the proposed development site, with its tributaries joining from the western side. The study area is shown in Figure 4-1 below.

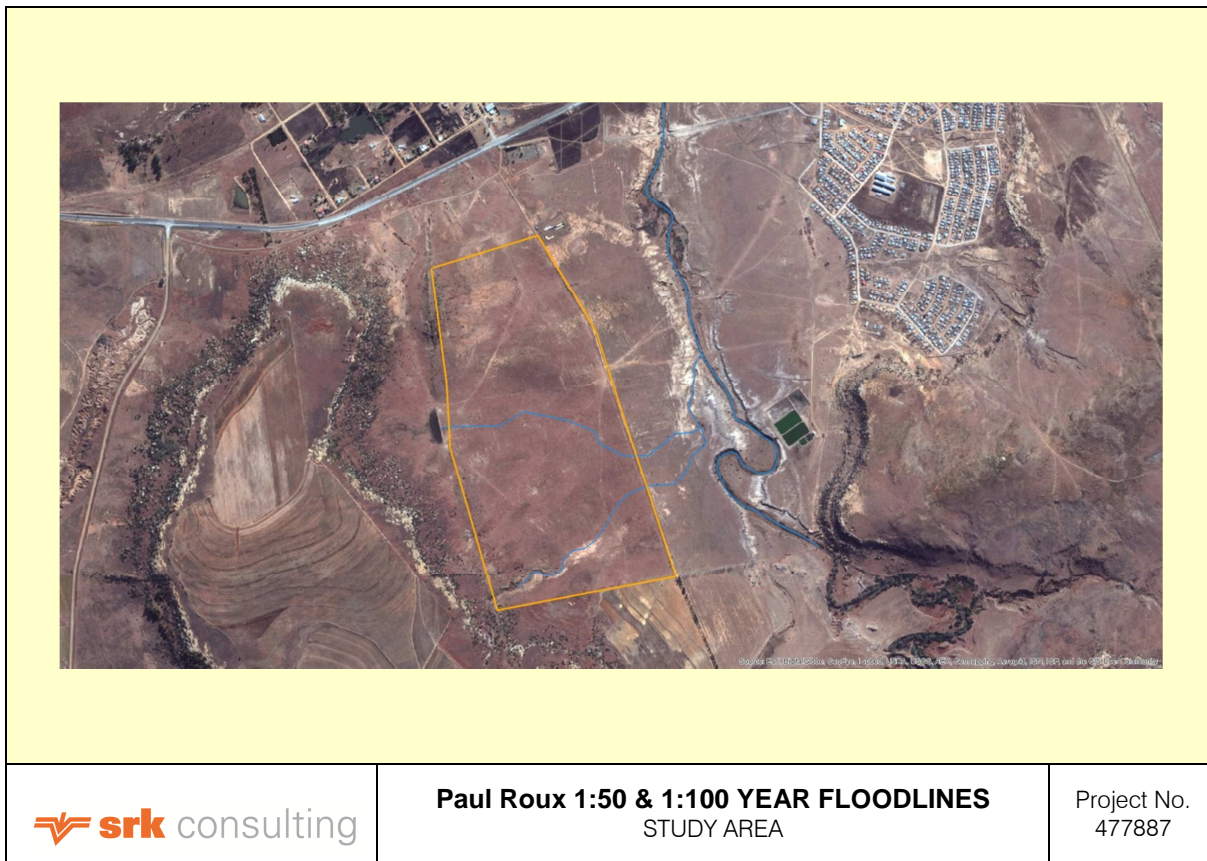


Figure 4-1: Paul Roux Study Area.

The catchment area of all the watercourses that drains into the study area is shown in figure 4-2 below.



Paul Roux 1:50 & 1:100 YEAR FLOODLINES
CATCHMENT AREA

Project No.
477887

Figure 4-2: Paul Roux Catchment Areas.

5 Topographical Details

The general topography was determined using 1:50 000 topographical map. In order to improve the accuracy of the aerial survey (0.5m contours) an additional terrestrial survey was carried out along the watercourses and the road crossings. This survey gave cross sectional data of the watercourse and details of any control structures, the bridge and the culvert. The surveyors' details are given in Table 5.1 below.

Table 5.1: Surveyor Details

Surveyor	Contact Details			
	Name	Tel	Fax	Email
Joynt Landmeters	Eugene Joynt	016973 1839	086532 3690	joyntlandmeters@mweb.co.za

6 Rainfall Data

6.1 Storm Rainfall depths

The rainfall data that was used was extracted from Design Rainfall software for Paul Roux (0330797_W) rainfall station (Smithers and Schulze (2000) - Design Rainfall in South Africa). The software gives that rainfall data for 1:2 year, 1:5 year, 1:10 year, 1:20 year, 1:50 year, 1:100 year and 1:200 year. The program's output is indicated in Table 6-1 below.

Table 6-1: Adopted storm rainfall depths (mm)

Duration	Return Period Rainfall (mm)						
	1:2	1:5	1:10	1:20	1:50	1:100	1:200
1 day	55	76	92	109	134	154	177
2 days	66	92	112	133	163	189	217
3 days	72	101	122	145	177	205	234
7 days	94	134	163	195	240	273	319

7 HECRAS Model Compilation

The survey supplied was converted into a Digital Terrain Model (DTM) which was then entered into the HECRAS (Version 4.0) model. This program employs detailed channel morphology as well as site-specific hydrological data combined to perform one-dimensional hydraulic calculations for a river network. The HECRAS model employs standard backwater techniques to compute the high water level for various steady flow conditions, taking into account structures and controls across the watercourse. The model requires certain boundary river flow conditions as a calculation starting point. The HECRAS model main parameters are summarised in Table 7-1 below.

Table 7-1: HECRAS Model Main Parameters

Parameter	Average Value/Selection	Reason
Manning 'n'	0.040 (main flow channel)	Defined watercourse with vegetation to thick vegetation
	0.035(floodplains)	Moderate vegetation (mainly grass)
Boundary conditions	Normal flow depth	Control structures (Culvert and Bridge) present
Flow regime	Mixed flow	Slope and cross section changes requiring super and sub-critical flow regimes

Further details of the HECRAS model parameter files are given in **Appendix A**.

8 Flood Hydrology

The catchment area was delineated using the 1:50 000 topographical map together with the 5m contours and the data supplied by the surveyor. The hydrological and hydraulic parameters of all the catchments contributing towards the proposed site of development were calculated. The parameters were used as input data for expected future development conditions within the catchment to the RATIONAL method which in turn generated peak flow rates. The peak flow rates were then entered into the HECRAS model to determine relevant flood levels and associated floodlines. The extracted flood peaks together with the catchment area are summarised in Table 8-1 below

Table 8-1: Summary of flood peaks (Future Development Conditions)

River Segment & Chainage	Catchment Area (km ²)	Peak Flow Rate (m ³ /s)	
		1:50	1:100
S1075	113.2	220.3	266.8
S1410	109.9	214.1	259.2
S1T93	2.1	27	31.7
S1T363	0.9	11.2	13.1
S1T1T132	1	13.2	15.5

9 Floodline Determination and Results

The 1:50 and 1:100 year floodlines were determined based on the HECRAS model and peak flow rates as given in Table 8-1 above for existing watercourse conditions. There is a possibility of a road crossing to be constructed at Point A as shown in drawing 477887/001. This road crossings were modelled in order to assess the backwater effect caused by the road crossings. The dimensions of the culvert and bridge were supplied by the surveyor.

Details of the HECRAS model output data are given in Appendix A.

The certified floodlines are shown on drawing 477887/001. From the floodline study, the following was observed:

- a. The coverage of the 1:50 and 1:100 year floodlines are as shown on drawing 477887/001.
- b. The development site is affected by both the 50 and 100 year floodlines .

- c. The 1:50 and the 1:100 year average flood depths and average flood velocities along the floodplains are shown below in Table 9-1 and Table 9-2, respectively.

Details of the HECRAS model output data are given in **Appendix A**.

Table 9-1: Summary of Average flood depths along floodplains

Chainage	Average Flood depths (m)			
	1:50 Year		1:100 Year	
	Hydr depth L	Hydr depth R	Hydr depth L	Hydr depth R
S1075	1.8	1.9	1.9	2.0
S1410	1	0.9	1.1	1
S1T93	0.1	0.3	0.1	0.3
S1T363	0.09	0.06	0.1	0.08
S1T1T132	0.08	0.09	0.09	0.1

Table 9-2: Summary of Average flow velocity along floodplains

Chainage	Average Flow velocity (m/s)			
	1:50 Year		1:100 Year	
	Vel Left	Vel Right	Vel Left	Vel Right
S1075	0.4	0.5	0.5	0.6
S1410	1.1	1.1	1.2	1.3
S1T93	1.4	1.8	1.5	1.9
S1T363	0.8	0.7	0.9	0.7
S1T1T132	0.9	0.8	1	0.9

10 Conclusions

The following is concluded:

- The southern portion of Mary Ann. No 712 (North) is slightly affected by the floodlines between chainages S1T1T768 and S1T1T435
- The southern portion of Mary Ann. No 712 (South) is affected by the floodlines between chainages S1T878 and S1T642
- The floodlines are shown in drawing 477887/001.

11 Recommendations

The following is recommended:

- The floodline information to be used to ensure that no new development is situated within the 1:100 year floodline.

- The floodlines be revised should watercourse/control structures be modified in the future.
- The floodline data to be used for layout planning and township applications.
- No new development to encroach onto the 1:100-year floodplain

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

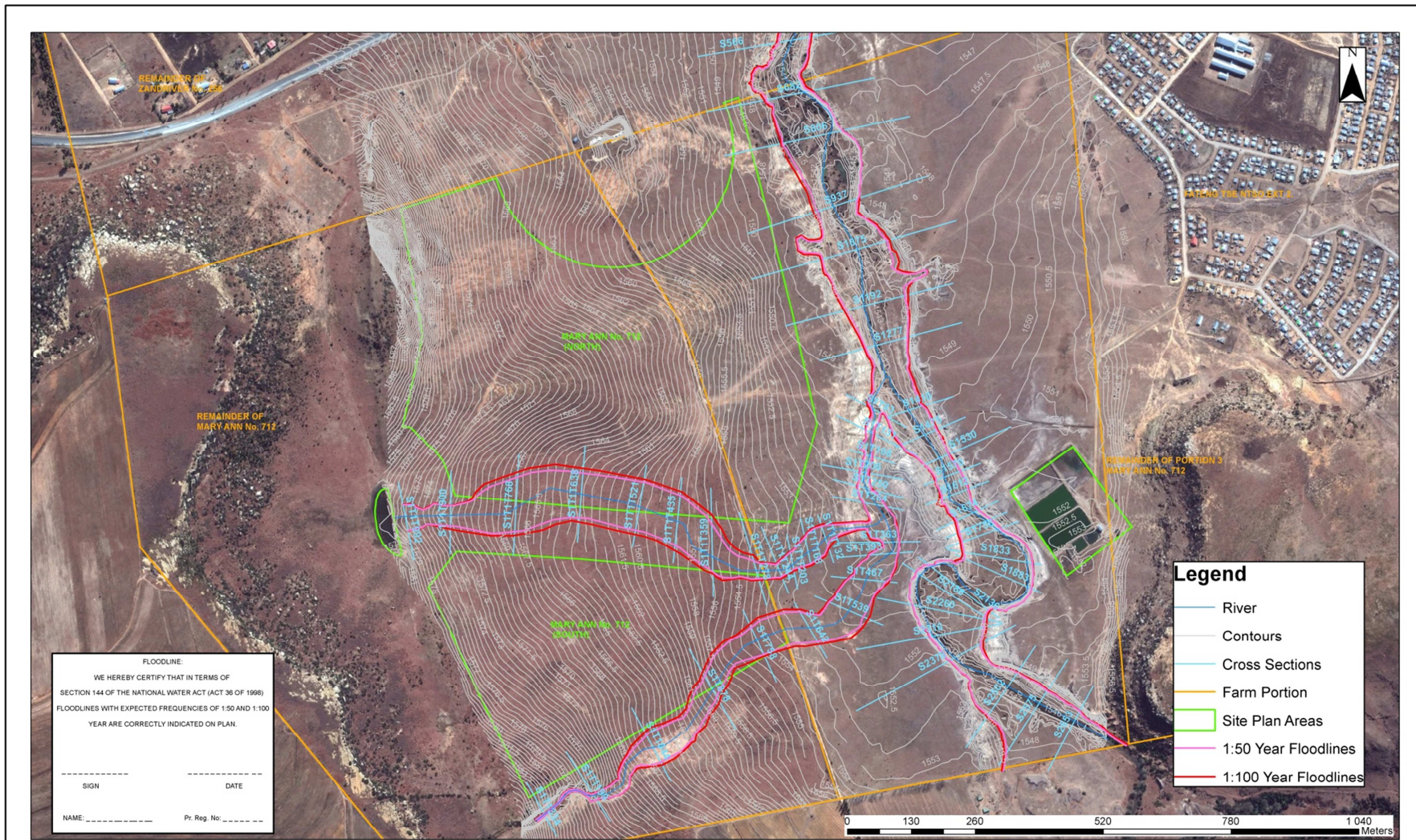
Appendices

Appendix A: Hecras Outputs

Existing HECRAS Output Profile Table																
Node	Profile	Q Total	Min Ch El	W. S. Elev	Crit W. S.	E. G. Elev	E. G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth C	Hydr Depth R	Flow Area	Top Width	Froude # Chl
		(m ³ /s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m)	(m ²)	(m)	
S1334	50yr	11.2	1579.24	1579.49	1579.54	1579.68	0.032003	2	1.28	0.67	0.24	0.15	0.05	6	27.56	1.04
S1334	100yr	13.1	1579.24	1579.52	1579.57	1579.72	0.032034	2.06	1.42	0.83	0.26	0.18	0.07	6.76	28.81	1.07
S1199	50yr	11.2	1573.07	1573.73	1573.76	1573.95	0.021629	0.98	2.15	0.97	0.11	0.45	0.11	5.5	15.69	1.02
S1199	100yr	13.1	1573.07	1573.77	1573.8	1574.02	0.020977	1.09	2.25	1.07	0.14	0.49	0.13	6.21	16.6	1.02
S1044	50yr	11.2	1565.46	1565.62	1565.64	1565.7	0.078422	1.26	1.27	1.33	0.06	0.08	0.07	8.79	118.14	1.46
S1044	100yr	13.1	1565.46	1565.62	1565.65	1565.72	0.087839	1.37	1.4	1.45	0.07	0.08	0.07	9.36	118.9	1.56
S878	50yr	11.2	1557.96	1558.23	1558.26	1558.34	0.032443	0.99	1.56	0.74	0.08	0.2	0.05	8.66	77.75	1.1
S878	100yr	13.1	1557.96	1558.25	1558.28	1558.36	0.031745	1.03	1.62	0.81	0.09	0.22	0.06	9.89	83.45	1.1
S758	50yr	11.2	1553.79	1554.04	1554.05	1554.13	0.033566	0.81	1.34	0.38	0.06	0.16	0.02	8.7	66.86	1.08
S758	100yr	13.1	1553.79	1554.05	1554.07	1554.15	0.03395	0.88	1.43	0.47	0.07	0.17	0.03	9.64	69.77	1.1
S642	50yr	11.2	1552	1552.3		1552.32	0.005072	0.86	0.64	0.36	0.3	0.22	0.08	17.82	94.38	0.44
S642	100yr	13.1	1552	1552.32		1552.34	0.005562	0.92	0.7	0.4	0.32	0.23	0.08	19.18	96.94	0.47
S539	50yr	11.2	1551.34	1551.6		1551.63	0.009305	0.39	0.75	0.37	0.05	0.17	0.05	16.87	152.17	0.57
S539	100yr	13.1	1551.34	1551.62		1551.65	0.008382	0.41	0.76	0.43	0.06	0.19	0.07	19.57	155.11	0.55
S467	50yr	11.2	1550.73	1551.05		1551.09	0.012458	0.35	0.94	0.43	0.04	0.19	0.05	12.96	96.02	0.68
S467	100yr	13.1	1550.73	1551.07		1551.11	0.011382	0.41	0.96	0.52	0.05	0.21	0.07	14.95	98.24	0.66
S393	50yr	11.2	1550.05	1550.64	1550.53	1550.67	0.004097	0.45	0.82	0.37	0.12	0.37	0.09	15.55	66.64	0.43
S393	100yr	13.1	1550.05	1550.67	1550.55	1550.7	0.004012	0.5	0.86	0.4	0.14	0.4	0.11	17.58	69.66	0.43
S363	50yr	11.2	1550	1550.3	1550.3	1550.42	0.023688	0.32	1.52	0.47	0.02	0.25	0.03	7.45	33.99	0.97
S363	100yr	13.1	1550	1550.33	1550.33	1550.45	0.022322	0.46	1.58	0.57	0.04	0.28	0.05	8.45	36.56	0.96
S992	50yr	13.2	1576.04	1576.38	1576.39	1576.49	0.028051	0.93	1.55	1.12	0.09	0.22	0.11	9.25	53.25	1.04
S992	100yr	15.5	1576.04	1576.4	1576.42	1576.52	0.028042	1	1.64	1.19	0.1	0.24	0.12	10.32	55.36	1.06
S900	50yr	13.2	1572.06	1572.31	1572.36	1572.5	0.057189	0.77	1.99	1.09	0.04	0.19	0.06	6.97	45.03	1.45
S900	100yr	15.5	1572.06	1572.32	1572.39	1572.54	0.056845	0.88	2.11	1.18	0.05	0.21	0.07	7.8	47.24	1.47
S768	50yr	13.2	1567.23	1567.44	1567.46	1567.52	0.026288	0.61	1.32	0.68	0.05	0.19	0.06	12.54	140.69	0.98
S768	100yr	15.5	1567.23	1567.46	1567.47	1567.53	0.026438	0.7	1.38	0.73	0.06	0.2	0.06	14.14	142.35	0.99
S638	50yr	13.2	1563.13	1563.33	1563.34	1563.41	0.026526	0.56	1.21	0.58	0.04	0.16	0.02	11.55	108.68	0.96
S638	100yr	15.5	1563.13	1563.35	1563.36	1563.43	0.024696	0.58	1.25	0.55	0.05	0.18	0.03	13.6	124	0.94
S521	50yr	13.2	1559.87	1560.05	1560.08	1560.16	0.054025	0.36	1.44	0.59	0.01	0.12	0.03	9.29	83.51	1.31
S521	100yr	15.5	1559.87	1560.11	1560.1	1560.17	0.019811	0.45	1.12	0.56	0.04	0.18	0.05	14.64	105.86	0.84
S435	50yr	13.2	1557.86	1558.07	1558.07	1558.12	0.019178	1.02	1.11	0.52	0.13	0.18	0.05	14.38	152.16	0.83
S435	100yr	15.5	1557.86	1558.08	1558.08	1558.14	0.019397	1.08	1.16	0.59	0.14	0.19	0.06	16.19	156.31	0.85
S359	50yr	13.2	1556.27	1556.39	1556.4	1556.44	0.043428	1.14	0.88	0.48	0.08	0.07	0.02	12.54	164.96	1.07
S359	100yr	15.5	1556.27	1556.37	1556.41	1556.49	0.094083	1.57	1.17	0.58	0.08	0.06	0.02	10.76	157.4	1.53
S278	50yr	13.2	1553.52	1554.07	1554.07	1554.21	0.019369	0.56	1.68		0.05	0.34		8.23	32.93	0.91
S278	100yr	15.5	1553.52	1554.12	1554.12	1554.26	0.017182	0.66	1.71		0.07	0.39		9.75	37.36	0.88
S244	50yr	13.2	1552.7	1553.24	1553.18	1553.33	0.010393	0.7	1.36		0.12	0.4		10.63	37.79	0.69
S244	100yr	15.5	1552.7	1553.14	1553.22	1553.39	0.041729	0.99	2.25		0.07	0.3		7.23	31.08	1.32
S203	50yr	13.2	1552.25	1552.63	1552.63	1552.75	0.019204	0.89	1.59	1.37	0.11	0.31	0.38	9.05	39.04	0.91
S203	100yr	15.5	1552.25	1552.66	1552.66	1552.79	0.018302	0.97	1.65	1.37	0.13	0.34	0.41	10.29	40.77	0.9
S132	50yr	13.2	1551.38	1551.62	1551.62	1551.69	0.027054	0.6	1.24		0.05	0.17		10.93	73.59	0.97
S132	100yr	15.5	1551.38	1551.63	1551.63	1551.72	0.025788	0.67	1.29		0.06	0.18		12.3	75.17	0.96
S2653	50yr	214.1	1545.5	1548.16	1547.73	1548.49	0.003885	0.99	2.69	1.39	0.42	2.29	0.7	95.93	89.81	0.57
S2653	100yr	259.2	1545.5	1548.3	1547.99	1548.67	0.004243	1.25	2.92	1.58	0.55	2.42	0.79	108.21	90.27	0.6
S2575	50yr	214.1	1545.5	1547.85		1548.1	0.003445	0.95	2.46	1.38	0.42	2.18	0.75	115.74	136.19	0.53

S2575	100yr	259.2	1545.5	1548.1		1548.3	0.002703	1.08	2.34	1.39	0.62	2.42	0.9	150.32	146.58	0.48
S2502	50yr	214.1	1545.31	1547.77		1547.89	0.001703	1.2	1.81	1.08	1.03	2.32	0.88	144.84	105.71	0.38
S2502	100yr	259.2	1545.31	1548		1548.13	0.001574	1.28	1.86	1.14	1.2	2.56	1.02	170.29	110.72	0.37
S2378	50yr	214.1	1544.5	1547.32		1547.6	0.00358	1.16	2.46	1.28	0.6	2.12	0.65	98.76	72.57	0.54
S2378	100yr	259.2	1544.5	1547.55		1547.84	0.00344	1.27	2.58	1.42	0.71	2.35	0.78	115.66	78.11	0.54
S2316	50yr	214.1	1544.5	1547.3		1547.4	0.00168	0.96	1.52	0.96	0.8	1.81	0.74	153.76	112.14	0.36
S2316	100yr	259.2	1544.5	1547.55		1547.66	0.001494	1.01	1.56	1.02	0.95	2.06	0.89	182.37	118.25	0.35
S2260	50yr	214.1	1544.5	1547.24		1547.32	0.001193	0.69	1.33	1.12	0.62	1.92	1.24	172.14	110.68	0.31
S2260	100yr	259.2	1544.5	1547.5		1547.58	0.00107	0.74	1.37	1.2	0.75	2.18	1.5	200.47	111.39	0.3
S2186	50yr	214.1	1544.5	1547.18		1547.25	0.000795	0.67	1.28	1.05	0.83	2.46	1.55	179.08	89.29	0.26
S2186	100yr	259.2	1544.5	1547.43		1547.52	0.000793	0.74	1.36	1.16	0.96	2.71	1.8	201.95	89.91	0.26
S2136	50yr	214.1	1544.39	1547.01		1547.19	0.002203	1.17	1.95	1.81	0.84	2.16	1.65	115.98	65.36	0.42
S2136	100yr	259.2	1544.39	1547.25		1547.45	0.002146	1.32	2.07	1.94	1.04	2.4	1.9	131.89	65.77	0.43
S1883	50yr	214.1	1544	1546.86		1546.91	0.000545	0.95	0.97	0.53	1.74	2.14	0.89	224.37	116.35	0.21
S1883	100yr	259.2	1544	1547.14		1547.19	0.000516	1.01	1.02	0.57	2.01	2.41	1.03	256.24	116.7	0.21
S1833	50yr	214.1	1544	1546.83		1546.88	0.000604	0.99	1.07	0.62	1.74	2.3	0.9	207.46	103.82	0.22
S1833	100yr	259.2	1544	1547.1		1547.16	0.000583	1.07	1.13	0.67	2.02	2.58	1.03	235.91	104.56	0.23
S1756	50yr	214.1	1543.5	1546.75		1546.83	0.000795	1.08	1.35	0.71	1.58	2.69	0.95	174.93	86.67	0.26
S1756	100yr	259.2	1543.5	1547.02		1547.11	0.00078	1.18	1.43	0.78	1.85	2.96	1.12	198.51	87.06	0.26
S1674	50yr	214.1	1543.45	1546.28		1546.64	0.004058	0.99	2.68	1.2	0.41	2.2	0.61	83.24	47.77	0.58
S1674	100yr	259.2	1543.45	1546.5		1546.92	0.004208	1.15	2.91	1.37	0.49	2.43	0.73	94.24	51.8	0.6
S1612	50yr	214.1	1543	1546.19		1546.41	0.002425	1.16	2.15	1.08	0.81	2.33	0.67	104.79	55.52	0.45
S1612	100yr	259.2	1543	1546.41		1546.68	0.002524	1.24	2.34	1.26	0.86	2.55	0.83	117.68	57.62	0.47
S1570	50yr	214.1	1543	1545.87		1546.26	0.004872	1.11	2.79	1.25	0.42	2.04	0.5	80.26	49.69	0.62
S1570	100yr	259.2	1543	1546.05		1546.51	0.005212	1.3	3.06	1.5	0.51	2.22	0.62	89.56	51.86	0.65
S1530	50yr	214.1	1543	1545.66		1546.04	0.00584	1.04	2.77	1.28	0.33	1.75	0.46	79.18	51.4	0.67
S1530	100yr	259.2	1543	1545.81		1546.28	0.006351	1.25	3.06	1.56	0.42	1.91	0.58	87.26	52.42	0.71
S1475	50yr	214.1	1543	1545.36		1545.71	0.005888	1.27	2.67	1.3	0.44	1.65	0.46	86.29	71.32	0.66
S1475	100yr	259.2	1543	1545.53		1545.92	0.005889	1.53	2.85	1.5	0.59	1.82	0.57	98.62	73.48	0.67
S1410	50yr	214.1	1542.2	1544.76	1544.76	1545.29	0.00993	2.16	3.46	1.29	0.66	1.65	0.31	70.43	67.2	0.86
S1410	100yr	259.2	1542.2	1544.93	1544.93	1545.5	0.009526	2.36	3.62	1.51	0.78	1.82	0.4	82.34	71.82	0.86
S1277	50yr	220.3	1542	1544.89	1544.39	1545.12	0.003348	0.61	2.31	1.67	0.22	2.04	1.02	108.51	79.09	0.52
S1277	100yr	266.8	1542	1545.17	1544.57	1545.4	0.002782	0.72	2.29	1.75	0.33	2.32	1.25	131.75	84.69	0.48
S1192	50yr	220.3	1541.6	1544.88		1544.95	0.000731	0.57	1.26	1.01	0.64	2.55	1.5	206.19	131.08	0.25
S1192	100yr	266.8	1541.6	1545.18		1545.25	0.000643	0.63	1.27	1.05	0.82	2.85	1.74	246.41	138.5	0.24
S1075	50yr	220.3	1541.35	1544.81		1544.85	0.000548	0.87	1.15	0.68	1.5	2.77	1.03	237.6	150.01	0.22
S1075	100yr	266.8	1541.35	1545.12		1545.16	0.000476	0.9	1.15	0.71	1.74	3.08	1.22	285.88	159.09	0.21
S937	50yr	220.3	1541.24	1544.72		1544.77	0.00046	0.43	1.04	0.13	0.59	2.71	0.1	217.56	93.34	0.2
S937	100yr	266.8	1541.24	1545.02		1545.08	0.000466	0.46	1.12	0.23	0.65	3.02	0.25	247.15	102.11	0.21
S806	50yr	220.3	1541.1	1544.67		1544.71	0.000333	0.69	1.01	0.74	1.52	3.33	1.74	266.35	134.02	0.18
S806	100yr	266.8	1541.1	1544.98		1545.02	0.000316	0.74	1.05	0.79	1.77	3.64	1.99	308.53	137.85	0.18
S682	50yr	220.3	1541.05	1544.64		1544.67	0.000305	0.58	0.83		1.25	2.65		276.3	120.28	0.16
S682	100yr	266.8	1541.05	1544.95		1544.99	0.000307	0.65	0.88		1.5	2.89		314.06	123.69	0.17
S566	50yr	220.3	1541	1544.34		1544.56	0.001986	0.87	2.17	1.28	0.57	2.75	1.01	113.18	61.83	0.42
S566	100yr	266.8	1541	1544.63		1544.87	0.00195	1	2.3	1.36	0.71	3.04	1.13	131.95	68.19	0.42

Appendix B: Drawings



REV	DR	CH	DATE	DESCRIPTION	REFERENCE DRAWINGS	NOTES	Datum: WGS84	PROJ.:	TITLE:	DATE	CHECKED
					DRAWING_NUMBER DRAWING_DESCRIPTION		Projection: TM		DIHLABENG PAUL ROUX 1:50 & 1:100 YEAR FLOODLINES		
					DRAWING_NUMBER DRAWING_DESCRIPTION		C.M.ZONE LO27				
					DRAWING_NUMBER DRAWING_DESCRIPTION		Copyright:	Suite 47 Rynald Building 320 The Hillside, Lynnwood 0081 Pretoria	CLIENT PHETHOGO CONSULTING		
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