ARCTISMART (PTY) LTD

DEVELOPMENT OF FARM SWAN LAKE 755

INVESTIGATION REPORT REGARDING FLOODLINES FOR THE PROPOSED ESTABLISHEMNT OF AN 'ECO RESIDENTIAL' DEVELOPMENT ON FARM SWAN LAKE 755, IN ASTON BAY

300952 – Document Number

DECEMBER 2018

COMPILED FOR:

Arctismart (Pty) Ltd

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ARCTISMART (PTY) LTD

SYNOPSIS

This report concerns the determination of the floodline for the proposed development of an 'ECO-Residential' development on the remaining portions 1, 4, 5 and 6 of Farm Swan Lake, in Aston Bay. The floodline determination is done by taking into account a possible future development of the Jubilee Golf Estate to the North West of Swan Lake.

The rational method was used to analyse the catchment areas and to determine the peak run-off for a 1:100 year flood. This is based on the area rainfall data with mean annual precipitation of 536mm (SAWB Number 0017723W).

The report concludes with a summary and recommendations of erven to be relocated outside of the 1:100 year flood line.

PROJECT 000/00000/0 – iX engineers FORMAL REPORT TEMPLATE

REV	DESCRIPTION	ORIG	REVIEW	iX engineers APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	GG Author	WH A Reviewer	 WH	DEC 2018	N/A	

CONTENTS

1. INTRODUCTION

This report concerns the determination of the floodlines for the proposed development of an 'ECO-Residential' development on the remaining portions 1, 4, 5 and 6 of Farm Swan Lake, Aston Bay.

1.1 Interpretation of Floodlines

Floodlines are used to indicate the level to which a certain flood magnitude will inundate an area, or which area of land will fall within the flood plain of a particular flood frequency. Flood frequency or the return period (T) is the average period over n-years which an event repeats or exceeds itself; it may be described as the percentage of the annual probability of the occurrence of a flood event.

Common management issues with respect to urban flood plains are rapid urbanisation, flow constriction, inappropriate channelization, flood plain infilling, uncontrolled development, inappropriate land-use, soil-erosion, etc.

With rapid urbanisation experienced over the last decade, it has become increasingly important to manage the flood plains within the urban environment. The effect if urbanisation is dependent on the percentage of surface area that is made impermeable and in the changes in the drainage pattern caused by the stormwater system.

Managing the flood plains and the human activities thereof will, in the long term be financially beneficial in terms of reduced maintenance costs, will preserve the ecological functioning of the habitat adjacent to natural streams and rivers, and will be a measure of safeguarding the public against extreme flood events.

Although flood calculations are executed with great care, the possibility always exists that a more severe flood could or that flooding as a result of non-hydrological events could take place.

2. HYDROLOGY

2.1 Locality

The study area is situated in the Kouga Municipality in the summer rainfall region on the Eastern Cape. There area for the proposed development consists of the remaining portions of Farm Swan Lake 755, in Aston Bay (see Appendix 1: Locality Plan)

Note that there was a proposal that the adjacent farm, Farm Jubilee, be developed into the Jubilee Golf Estate and the stormwater generated from this development will flow through the remainder of Farm Swan Lake at two locations.

2.2 Catchments

The watersheds and catchments were determined using iDAS which is an extension to AutoCAD Civil 3D. The catchment areas that contribute to the 1:100 year peak run-off and the associated floodline is indicated on drawing no. 300952-001 in Appendix 2. The table below indicates the different catchment area characteristics (See Appendix 3 for calculations).

CATCHMENTS	AREA [km²]	LONGEST WATERCOURSE [km]	AVERAGE SLOPE [%]	TIME OF CONCENTRATION [min]	RUNOFF COEFFICIENT
Catchment 1	1.496	2.663	1.503	42.534	0.271
Catchment 2	0.232	0.87	1.679	17.234	0.289
Catchment 3	0.396	1.29	2.209	20.992	0.274
Catchment 4	0.019	0.09	8.666	1.645	0.336
Catchment 5	0.118	0.17	3.789	3.592	0.304

Using the above characteristics the 1:100 year peak run-off can be calculated using the rational method as described in the Drainage Manual 6th edition, 2013. The peak run-off volumes are indicated in the table below:

CATCHMENTS	PEAK RUN-OFF [m³/s]
Catchment 1	8.10
Catchment 2	2.01
Catchment 3	3.10
Catchment 4	0.15
Catchment 5	0.63

The total run-off in the stream is calculated to be 13.99m³/s.

3. FLOODLINES

The 1:100 floodlines for the present conditions were investigated for the flood plain, and the following assumptions were made:

- The 100 year floodline for the study area was determined by plotting 50m interval cross-sections from the surveyed section of the flood plain
- A Manning roughness coefficient value of 0.05 was assumed for the natural stream, as well as for floodplains.
- An average slope of 0.5% was used for the determination of the stream flow.
- The influence of the proposed Jubilee Golf Estate on the expected floodlines was investigated for the study are. For relatively low-density developments, such as the Jubilee Golf Estate, the run-off contribution from the development is relatively low.

A drawing indicating the floodline and cross sections are attached in Appendix 2.

4. SUMMARY AND RECOMMENDATIONS

- The floodlines represent the calculated conditions possible during a 1:100 year return period flood, as it assumed that the storm will occur over the full catchment and the stream will convey a peak flood.
- It is recommended that the development be constructed above the expected 1:100 year flood levels. As such it is recommended that plots numbered, 16, 17, 18, 19, 23, 24 and 25 be moved away from the floodline.
- If any disturbance to the vegetation or soil conditions, below the 1:100 year floodline occurs during the construction works, it is recommended that the area be re-vegetated and protected against possible erosion.
- It must also be noted that dam-safety evaluations were not performed during this investigation, and dam-break scenarios were not considered in the determination of the floodlines. The risk is assumed as the dams have been formed by depressions rather than build up dam walls.

5. CONCLUSION

The 1:100 year floodline indicated on drawing no. 300592-002 in Appendix 2 is reasonably conservative and problems should not be encountered if all building activities are located above the floodline.

Any queries with regards to flood levels can be referred directly to iXengineers (Pty) Ltd.

It is trusted that the investigation and recommendations contained in this report will be to the satisfaction of Arctismart.

iXengineers

Appendix 1 – Locality Plan

N

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL A4 PLAN

FOR DISCUSSION

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

CLIENT

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PROJECT

SWAN LAKE ECO ESTATE

DRAWING DESCRIPTION

PROPOSED SWAN LAKE DEVELOPMENT : LOCALITY PLAN

DESIGNED	DRAWN	CHECKED
WH	ACB	WH

DATE	SCALE
2018/08/02	N.T.S.

DRAWING NUMBER	REV
300952/01	00

P:\Jobs\JBAY\300952 - ASTON BAY EIA SWAN Lake Eco Estate\DRW\Swanlake Aerial Survey\300952-01_A4 Swanlake Eco Estate_Locality Plan.dwg

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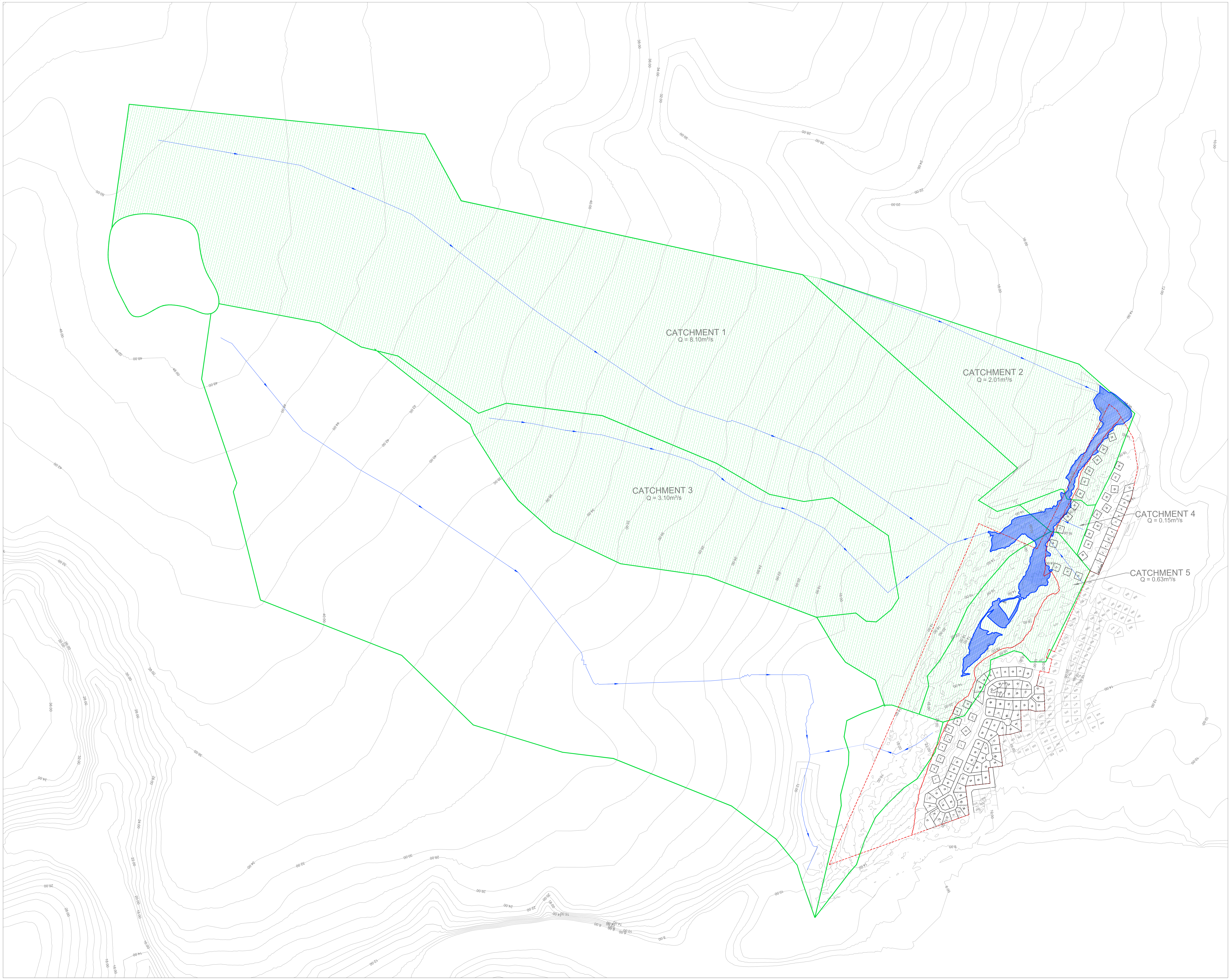
Appendix 2 – Drawings

- 300952-001 – Catchment Areas
- 300952-002 – 1:100 year Floodline



SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL PLAN

All dimensions must be verified on site before the works commence.
Refer any discrepancies to the Engineer.

NOTES

- NO-GO AREA
- WATERSHED
- WATER COARSE
- WATER COARSE
- FLOOD PLAIN

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

FOR INFORMATION

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CLIENT

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PROJECT

SWANLAKE ECO ESTATE

DRAWING DESCRIPTION

CATCHMENT AREAS

DATE	SCALE	ORIGINAL SIZE
2017/01/01	AS SHOWN	A1

DRAWING NUMBER	REV
300952-001	00

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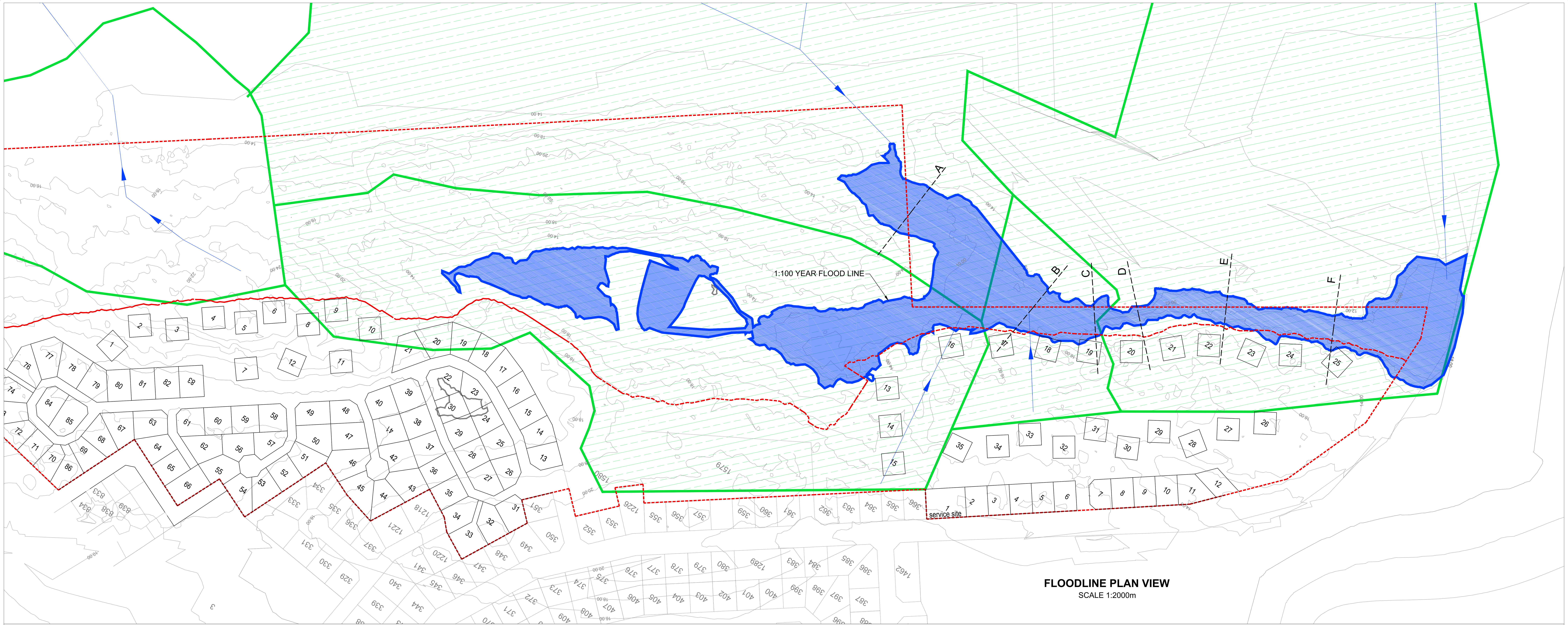
FLOODLINE PLAN VIEW



FLOODLINE PLAN VIEW
SCALE 1:2000m

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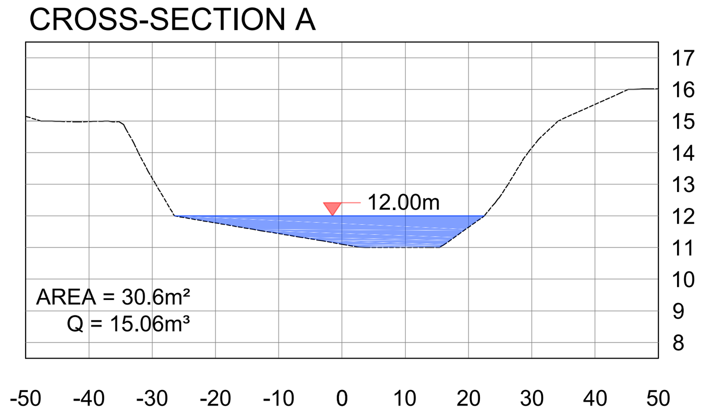
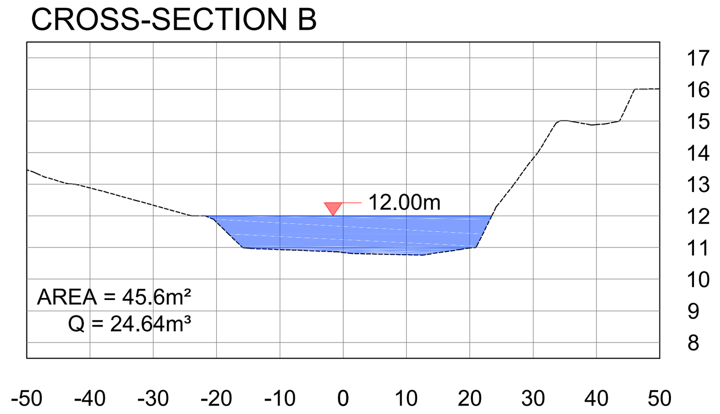


CROSS-SECTION B



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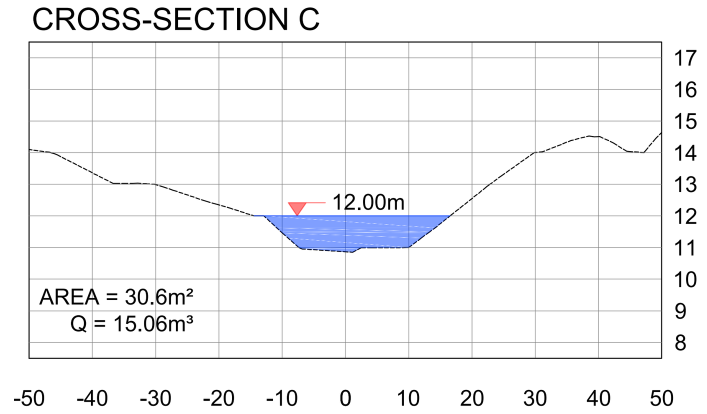
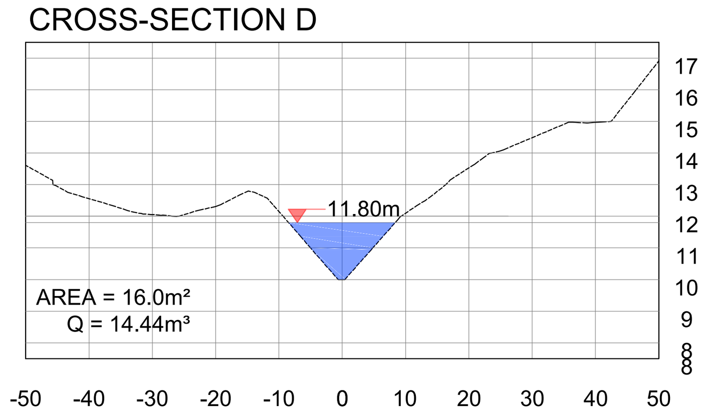


CROSS-SECTION D



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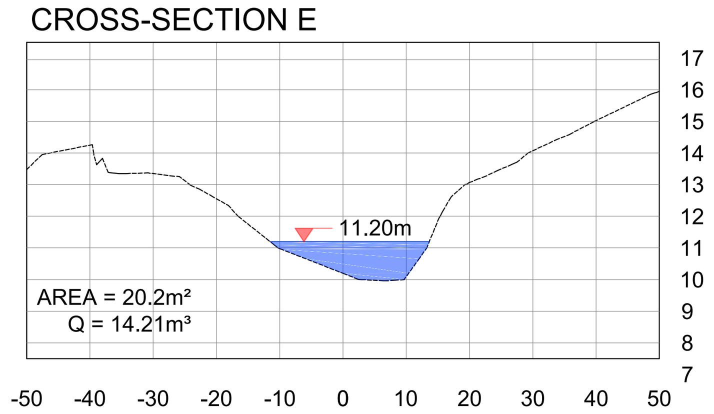
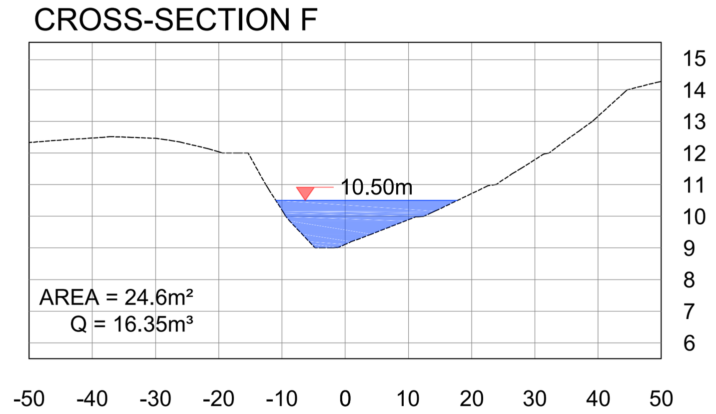


CROSS-SECTION F



CROSS SECTIONS
SCALE HOR : 1 : 1000m
VERT 1 : 200m

SCALE FOR REDUCED PLAN

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

NOTES

- NO-GO AREA
- WATERSHED
- LONGEST WATER COURSE
- 1:100 YEAR FLOOD LINE
- WATER COARSE
- FLOOD PLAIN

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

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PROJECT

SWANLAKE ECO ESTATE

DRAWING DESCRIPTION

1:100 YEAR FLOOD LINE

DATE	SCALE	ORIGINAL SIZE
2017/01/01	AS SHOWN	A1

DRAWING NUMBER	REV
300952-002	00

Appendix 3 – Catchment Calculation Sheets

RATIONAL METHOD

Description of the catchment	**CATCHMENT AREA 1**		
River details			
Calculated by		Date	13 December 2018

Physical characteristics

Size of the catchment (A)	1.497	km^2	
Longest watercourse (L)	2.663	km	
Average slope (S_{av})	0.01503	m/m	
Dolomite area ($D_{\%}$)	0	%	
Mean annual rainfall (MAP)	536	mm	

Rainfall region	Coastal
Area distribution factors	
Rural (α)	1
Urban (β)	0
Lakes (γ)	0

Rural

Surface slope	%	Factor	C_s
Vleis and pans	10	0.01	0.10
Flat areas	90	0.06	5.40
Hilly	0	0.12	0.00
Steep areas	0	0.22	0.00
Total	100		**0.055**

Permeanbility	%	Factor	C_p
Very permeable	30	0.03	0.90
Permeable	40	0.06	2.40
Semi-permeable	20	0.12	2.40
Impermeable	10	0.21	2.10
Total	100		**0.078**

Vegetation	%	Factor	C_v
Thick bush & plantation	5	0.03	0.15
Light busch and farmlands	25	0.07	1.75
Grasslands	70	0.17	11.90
No vegetation	0	0.26	0.00
Total	100		**0.138**

Urban

Description	%	Factor	C_s
Lawns	Low (0)	0.5	High(1)
Sandy, flat (<2%)			
Sandy, steep (>7%)			
Heavy soil, flat (<2%)			
Heavy soil,steep (>7%)			
Residential area	Low (0)	0.5	High(1)
Houses			
Flats			
Industry	Low (0)	0.5	High(1)
Light industry			
Heavy industry			
Business	Low (0)	0.5	High(1)
City centre			
Suburban			
Streets			
Maximum flood			
Total			

Time of concentration (T_c)

Overland flow

$$Tc = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$$

Tc = 1.840 hours

Defined watercourse

$$Tc = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$$

Tc = 0.71 hours

Notes

Run-off coefficient

Return period (years), T	2	5	10	20	50	100	Max
Run-off coefficient C_1 ($C_1 = C_s + C_p + C_v$)	0.271	0.271	0.271	0.271	0.271	0.271	0.271
Adjusted for dolomitec areas, C_{1D} ($=C_1 (1 - D_{\%}) + C1\ D_{\%}(\sum(D_{factor} \times C_{S\%}))$)	0.271	0.271	0.271	0.271	0.271	0.271	0.271
Adjustment factor for initial saturation, F_t	0.625	0.675	0.725	0.785	0.89	1	1.000
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)	0.169	0.183	0.196	0.213	0.241	0.271	0.271
Combined run-off coefficient C_t ($= \alpha C_{1T} + \beta_{C2} + \gamma_{C3}$)	0.169	0.183	0.196	0.213	0.241	0.271	0.271

Rainfall

Return period (years), T	2	5	10	20	50	100	Max
Point rainfall (mm), P_T	14.00	20.00	25.00	31.00	40.00	51.00	51.00
Point intensity (mm/hour), P_{iT} (= P_T / T_C)	19.72	28.18	35.22	43.68	56.36	71.85	71.85
Area reduction factor (%), ARF_T	1	1	1	1	1	1	1
Average intensity (mm/hour), I_T (= $P_{iT} \times ARF_T$)	19.72	28.18	35.22	43.68	56.36	71.85	71.85

Peak flow

Return period (years), T	2	5	10	20	50	100	Max
Peak flow (m3/s) $Q_T = \frac{C_T I_T A}{3.6}$	**1.4**	**2.1**	**2.9**	**3.9**	**5.7**	**8.1**	**8.10**

RATIONAL METHOD

Description of the catchment	**CATCHMENT AREA 2**		
River details			
Calculated by		Date	13 December 2018

Physical characteristics

Size of the catchment (A)	0.232171	km^2
Longest watercourse (L)	0.871	km
Average slope (S_{av})	0.01679	m/m
Dolomite area ($D_{\%}$)	0	%
Mean annual rainfall (MAP)	536	mm

Rainfall region	Coastal
Area distribution factors	
Rural (α)	1
Urban (β)	0
Lakes (γ)	0

Rural

Surface slope	%	Factor	C_s
Vleis and pans	10	0.01	0.10
Flat areas	80	0.06	4.80
Hilly	10	0.12	1.20
Steep areas	0	0.22	0.00
Total	100		**0.061**
Permeanbility	%	Factor	C_p
Very permeable	10	0.03	0.30
Permeable	50	0.06	3.00
Semi-permeable	30	0.12	3.60
Impermeable	10	0.21	2.10
Total	100		**0.090**
Vegetation	%	Factor	C_v
Thick bush & plantation	5	0.03	0.15
Light busch and farmlands	25	0.07	1.75
Grasslands	70	0.17	11.90
No vegetation	0	0.26	0.00
Total	100		**0.138**

Urban

Description	%	Factor	C_s
Lawns	Low (0)	0.5	High(1)
Sandy, flat (<2%)			
Sandy, steep (>7%)			
Heavy soil, flat (<2%)			
Heavy soil,steep (>7%)			
Residential area	Low (0)	0.5	High(1)
Houses			
Flats			
Industry	Low (0)	0.5	High(1)
Light industry			
Heavy industry			
Business	Low (0)	0.5	High(1)
City centre			
Suburban			
Streets			
Maximum flood			
Total			

Time of concentration (T_c)

Overland flow			**Defined watercourse**	
$Tc = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$			$Tc = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$	
Tc =	1.064	hours	Tc = 0.29	hours

Notes

Run-off coefficient

Return period (years), T	2	5	10	20	50	100	Max
Run-off coefficient C_1 ($C_1 = C_s + C_p + C_v$)	0.289	0.289	0.289	0.289	0.289	0.289	0.289
Adjusted for dolomitec areas, C_{1D} ($=C_1 (1 - D_{\%}) + C1\ D_{\%}(\sum(D_{factor} \times C_{S\%}))$)	0.289	0.289	0.289	0.289	0.289	0.289	0.289
Adjustment factor for initial saturation, F_t	0.625	0.675	0.725	0.785	0.89	1	1.000
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)	0.181	0.195	0.210	0.227	0.257	0.289	0.289
Combined run-off coefficient C_t ($= \alpha C_{1T} + \beta_{C2} + \gamma_{C3}$)	0.181	0.195	0.210	0.227	0.257	0.289	0.289

Rainfall

Return period (years), T	2	5	10	20	50	100	Max
Point rainfall (mm), P_T	8.00	12.00	15.00	18.00	26.00	31.00	31.00
Point intensity (mm/hour), P_{iT} ($= P_T / T_C$)	27.81	41.72	52.14	62.57	90.38	107.76	107.76
Area reduction factor (%), ARF_T	1	1	1	1	1	1	1
Average intensity (mm/hour), I_T ($= P_{iT} x ARF_T$)	27.81	41.72	52.14	62.57	90.38	107.76	107.76

Peak flow

Return period (years), T	2	5	10	20	50	100	Max
Peak flow (m3/s) $Q_T = \frac{C_T I_T A}{3.6}$	**0.3**	**0.5**	**0.7**	**0.9**	**1.5**	**2.0**	**2.01**

RATIONAL METHOD

Description of the catchment	**CATCHMENT AREA 3**		
River details			
Calculated by		Date	13 December 2018

Physical characteristics

Size of the catchment (A)	0.39601	km^2	Rainfall region	Coastal
Longest watercourse (L)	1.29	km	**Area distribution factors**	
Average slope (S_{av})	0.02209	m/m	Rural (α)	1
Dolomite area ($D_{\%}$)	0	%	Urban (β)	0
Mean annual rainfall (MAP)	536	mm	Lakes (γ)	0

Rural

Surface slope	%	Factor	C_s
Vleis and pans	10	0.01	0.10
Flat areas	85	0.06	5.10
Hilly	5	0.12	0.60
Steep areas	0	0.22	0.00
Total	100		**0.058**
Permeanbility	%	Factor	C_p
Very permeable	30	0.03	0.90
Permeable	40	0.06	2.40
Semi-permeable	20	0.12	2.40
Impermeable	10	0.21	2.10
Total	100		**0.078**
Vegetation	%	Factor	C_v
Thick bush & plantation	5	0.03	0.15
Light busch and farmlands	25	0.07	1.75
Grasslands	70	0.17	11.90
No vegetation	0	0.26	0.00
Total	100		**0.138**

Urban

Description	%	Factor	C_s
Lawns	Low (0)	0.5	High(1)
Sandy, flat (<2%)			
Sandy, steep (>7%)			
Heavy soil, flat (<2%)			
Heavy soil,steep (>7%)			
Residential area	Low (0)	0.5	High(1)
Houses			
Flats			
Industry	Low (0)	0.5	High(1)
Light industry			
Heavy industry			
Business	Low (0)	0.5	High(1)
City centre			
Suburban			
Streets			
Maximum flood			
Total			

Time of concentration (T_c)

Overland flow			**Defined watercourse**		
$Tc = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$			$Tc = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$		
Tc =	1.199	hours	Tc =	0.35	hours

Notes

Run-off coefficient

Return period (years), T	2	5	10	20	50	100	Max
Run-off coefficient C_1 ($C_1 = C_s + C_p + C_v$)	0.274	0.274	0.274	0.274	0.274	0.274	0.274
Adjusted for dolomitec areas, C_{1D} ($=C_1 (1 - D_{\%}) + C1\ D_{\%}(\sum(D_{factor} \times C_{S\%}))$)	0.274	0.274	0.274	0.274	0.274	0.274	0.274
Adjustment factor for initial saturation, F_t	0.625	0.675	0.725	0.785	0.89	1	1.000
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)	0.171	0.185	0.199	0.215	0.244	0.274	0.274
Combined run-off coefficient C_t ($= \alpha C_{1T} + \beta_{C2} + \gamma_{C3}$)	0.171	0.185	0.199	0.215	0.244	0.274	0.274

Rainfall

Return period (years), T	2	5	10	20	50	100	Max
Point rainfall (mm), P_T	9.00	14.00	16.00	21.00	28.00	36.00	36.00
Point intensity (mm/hour), P_{iT} (= P_T / T_C)	25.70	39.97	45.68	59.96	79.95	102.79	102.79
Area reduction factor (%), ARF_T	1	1	1	1	1	1	1
Average intensity (mm/hour), I_T (= $P_{iT} \times ARF_T$)	25.70	39.97	45.68	59.96	79.95	102.79	102.79

Peak flow

Return period (years), T	2	5	10	20	50	100	Max
Peak flow (m3/s) $Q_T = \frac{C_T I_T A}{3.6}$	**0.5**	**0.8**	**1.0**	**1.4**	**2.1**	**3.1**	**3.10**

RATIONAL METHOD

Description of the catchment	**CATCHMENT AREA 4**		
River details			
Calculated by		Date	13 December 2018

Physical characteristics

Size of the catchment (A)	0.019082	km^2	Rainfall region	Coastal
Longest watercourse (L)	0.093	km	**Area distribution factors**	
Average slope (S_{av})	0.0866	m/m	Rural (α)	1
Dolomite area ($D_{\%}$)	0	%	Urban (β)	0
Mean annual rainfall (MAP)	536	mm	Lakes (γ)	0

Rural

Surface slope	%	Factor	C_s
Vleis and pans	10	0.01	0.10
Flat areas	30	0.06	1.80
Hilly	40	0.12	4.80
Steep areas	20	0.22	4.40
Total	100		**0.111**
Permeanbility	%	Factor	C_p
Very permeable	0	0.03	0.00
Permeable	0.35	0.06	0.02
Semi-permeable	0.45	0.12	0.05
Impermeable	0.15	0.21	0.03
Total	1		**0.107**
Vegetation	%	Factor	C_v
Thick bush & plantation	5	0.03	0.15
Light busch and farmlands	45	0.07	3.15
Grasslands	50	0.17	8.50
No vegetation	0	0.26	0.00
Total	100		**0.118**

Urban

Description	%	Factor	C_s
Lawns	Low (0)	0.5	High(1)
Sandy, flat (<2%)			
Sandy, steep (>7%)			
Heavy soil, flat (<2%)			
Heavy soil,steep (>7%)			
Residential area	Low (0)	0.5	High(1)
Houses			
Flats			
Industry	Low (0)	0.5	High(1)
Light industry			
Heavy industry			
Business	Low (0)	0.5	High(1)
City centre			
Suburban			
Streets			
Maximum flood			
Total			

Time of concentration (T_c)

Overland flow			**Defined watercourse**	
$Tc = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$			$Tc = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$	
Tc =	0.255	hours	Tc =	0.03	hours

Notes

Run-off coefficient

Return period (years), T	2	5	10	20	50	100	Max
Run-off coefficient C_1 ($C_1 = C_s + C_p + C_v$)	0.336	0.336	0.336	0.336	0.336	0.336	0.336
Adjusted for dolomitec areas, C_{1D} ($=C_1 (1 - D_{\%}) + C1\ D_{\%}(\sum(D_{factor} \times C_{S\%}))$)	0.336	0.336	0.336	0.336	0.336	0.336	0.336
Adjustment factor for initial saturation, F_t	0.625	0.675	0.725	0.785	0.89	1	1.000
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)	0.210	0.226	0.243	0.263	0.299	0.336	0.336
Combined run-off coefficient C_t ($= \alpha C_{1T} + \beta_{C2} + \gamma_{C3}$)	0.210	0.226	0.243	0.263	0.299	0.336	0.336

Rainfall

Return period (years), T	2	5	10	20	50	100	Max
Point rainfall (mm), P_T	6.00	8.00	10.00	12.00	18.00	21.00	21.00
Point intensity (mm/hour), P_{iT} (= P_T / T_C)	24.00	32.00	40.00	48.00	72.00	84.00	84.00
Area reduction factor (%), ARF_T	1	1	1	1	1	1	1
Average intensity (mm/hour), I_T (= P_{iT}xARF_T)	24.00	32.00	40.00	48.00	72.00	84.00	84.00

Peak flow

Return period (years), T	2	5	10	20	50	100	Max
Peak flow (m3/s) $Q_T = \frac{C_T I_T A}{3.6}$	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.15**

RATIONAL METHOD

Description of the catchment	**CATCHMENT AREA 5**		
River details			
Calculated by		Date	13 December 2018

Physical characteristics

Size of the catchment (A)	0.11768	km^2	Rainfall region	Coastal
Longest watercourse (L)	0.170324	km	**Area distribution factors**	
Average slope (S_{av})	0.03789	m/m	Rural (α)	1
Dolomite area ($D_{\%}$)	0	%	Urban (β)	0
Mean annual rainfall (MAP)	536	mm	Lakes (γ)	0

Rural

Surface slope	%	Factor	C_s
Vleis and pans	10	0.01	0.10
Flat areas	50	0.06	3.00
Hilly	40	0.12	4.80
Steep areas	0	0.22	0.00
Total	100		**0.079**
Permeanbility	%	Factor	C_p
Very permeable	0	0.03	0.00
Permeable	0.35	0.06	0.02
Semi-permeable	0.45	0.12	0.05
Impermeable	0.15	0.21	0.03
Total	1		**0.107**
Vegetation	%	Factor	C_v
Thick bush & plantation	5	0.03	0.15
Light busch and farmlands	45	0.07	3.15
Grasslands	50	0.17	8.50
No vegetation	0	0.26	0.00
Total	100		**0.118**

Urban

Description	%	Factor	C_s
Lawns	Low (0)	0.5	High(1)
Sandy, flat (<2%)			
Sandy, steep (>7%)			
Heavy soil, flat (<2%)			
Heavy soil,steep (>7%)			
Residential area	Low (0)	0.5	High(1)
Houses			
Flats			
Industry	Low (0)	0.5	High(1)
Light industry			
Heavy industry			
Business	Low (0)	0.5	High(1)
City centre			
Suburban			
Streets			
Maximum flood			
Total			

Time of concentration (T_c)

Overland flow

$$Tc = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$$

Tc = 0.411 hours

Defined watercourse

$$Tc = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$$

Tc = 0.06 hours

Notes

Run-off coefficient

Return period (years), T	2	5	10	20	50	100	Max
Run-off coefficient C_1 ($C_1 = C_s + C_p + C_v$)	0.304	0.304	0.304	0.304	0.304	0.304	0.304
Adjusted for dolomitec areas, C_{1D} (=C_1 (1 - $D_{\%}$) + C1 $D_{\%}$(∑(D_{factor} x $C_{S\%}$))	0.304	0.304	0.304	0.304	0.304	0.304	0.304
Adjustment factor for initial saturation, F_t	0.625	0.675	0.725	0.785	0.89	1	1.000
Adjusted run-off coefficient, C_{1T} (= C_{1D} x F_t)	0.190	0.205	0.220	0.238	0.270	0.304	0.304
Combined run-off coefficient C_t (= $\alpha C_{1T} + \beta_{C2} + \gamma_{C3}$)	0.190	0.205	0.220	0.238	0.270	0.304	0.304

Rainfall

Return period (years), T	2	5	10	20	50	100	Max
Point rainfall (mm), P_T	5.00	6.00	7.00	9.00	14.00	16.00	16.00
Point intensity (mm/hour), P_{iT} (= P_T / T_C)	20.00	24.00	28.00	36.00	56.00	64.00	64.00
Area reduction factor (%), ARF_T	1	1	1	1	1	1	1
Average intensity (mm/hour), I_T (= P_{iT}xARF_T)	20.00	24.00	28.00	36.00	56.00	64.00	64.00

Peak flow

Return period (years), T	2	5	10	20	50	100	Max
Peak flow (m3/s) $Q_T = \frac{C_T I_T A}{3.6}$	**0.1**	**0.2**	**0.2**	**0.3**	**0.5**	**0.6**	**0.63**