

STORMWATER CALCULATION PACKAGE

Project: Proposed Dwellings
Address: 71 East Ave Allenby Gardens
Job No: TX12816.00

CONTENTS	PAGES
Section I Box Gutter/ Downpipe Calculations	1 to 1
Section II Stormwater Detention Calculations	2 to 11
Section III Orifice Calculations	12 to 12

NOTES

These calculations are to be read in conjunction with the relevant associated Civil and Structural Drawings, Construction Report and / or details.

All work to comply with relevant SAA Standards

AS/NZS 3500 - Plumbing and Drainage

Australian Rainfall and Runoff

Australian Runoff Quality

Storm Drainage Design in small urban catchments: A handbook for ,
Water Sensitive Urban Design (WSUD) Engineering Procedure: Storm

Revision	By	Date
A	JA	15/03/2018
B	JA	27/03/2018



TRIAXIAL
CONSULTING
COMPLEX PROBLEMS
RESOLVED SIMPLY

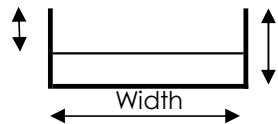
Level 2, 1 King William Road, Unley 5061

PROJECT: TX12816.00
DATE: 6/12/17
DESIGN: FT
PAGE: BG1

BOX GUTTER / DOWNPIPE SPECIFICATIONS:

Design Storm Event = 100 A.R.I
Gutter width = 0.200 m
Gutter depth = 0.100 m
BG Sump depth (below gutter invert) = 0.160 m
Longest gutter run = 15.00 m
Downpipe diameter = 0.090 m

Gutter Freeboard
0.025 m



$A_{\text{pipe}} = 0.0064 \text{ m}^2$
 $A_{\text{box}} = 0.02 \text{ m}^2$
 $n = 0.009$ (roughness co-efficient)
 $k = 2.5$ (fittings loss)
 $s = 0.002$ (gradient)

DETERMINE FLOWS:

$A_{\text{roof}} = 80 \text{ m}^2$ (Worse case roof area to BG sump/downpipe)
 $C = 1.08$ (Runoff co-efficient ($C_{10} \cdot F_y$))
 $I = 185 \text{ mm/hr}$

$Q_{\text{roof}} = C I A_{\text{roof}} / 3600 = 4.44 \text{ L/Sec}$
 $Q_{\text{box}} = A_{\text{box}} R^{2/3} S^{1/2} / n = 7.79 \text{ L/Sec OK! } Q_{\text{box}} > Q_{\text{roof}}$
Where: $R = A_{\text{box}} / P_{\text{box (wetted perimeter)}} = 0.022$

CHECK ENTRY INTO DOWNPIPE AND WATER LEVEL BUILD-UP:

$V = Q_{\text{roof}} / A_{\text{down pipe}} = 0.698 \text{ m/s}$
Velocity head required $= kV^2 / 2g = 0.062 \text{ m}$
Depth required due to length of gutter fall $= 0.030 \text{ m}$
Adopted freeboard $= 0.025 \text{ m}$
Total gutter & sump depth required = 0.117 m
Selected gutter & sump depth = 0.260 m **Therefore box gutter size OK!**

ADOPT:

0.200 m Wide x 0.100 m Deep Box Gutter
0.090 m Diameter Downpipes
0.160 m Deep Box Gutter Sumps

STORMWATER DETENTION CALCULATIONS

Adelaide							
Duration	AVERAGE RETURN INTERVAL (YEARS)						
	1	2	5	10	20	50	100
5	44.00	59.20	81.90	98.50	121.00	155.00	185.00
6	41.00	55.10	76.10	91.50	112.00	144.00	171.00
10	33.10	44.40	60.90	72.90	89.30	114.00	135.00
20	23.50	31.40	42.70	50.90	62.00	78.90	92.80
30	18.80	25.00	33.80	40.20	48.80	61.70	72.70
60	12.40	16.50	22.10	26.10	31.50	39.50	46.40
120	8.14	10.70	14.20	16.60	20.00	24.80	29.00
180	6.36	8.36	11.00	12.80	15.30	18.90	21.90
360	4.15	5.44	7.03	8.10	9.62	11.80	13.60
720	2.66	3.46	4.43	5.08	6.01	7.32	8.42
1440	1.62	2.11	2.69	3.09	3.65	4.44	5.11
2880	0.924	1.21	1.55	1.78	2.12	2.59	2.99
4320	0.652	0.852	1.10	1.26	1.50	1.84	2.12

SITE COVERAGE

Pre Development Coverage



Fy = 1 (Frequency Factor)
C(w) = 0.59 (weighted)

Post Development Coverage

	C	Area (m²)	% Area Undetained
Roof	0.90	451	0.0%
Pavement / Driveways	0.75	317	0.0%
Grass / Open Space	0.35	68	0.0%
Other	0.40	0	0.0%
Total		836	

Fy = 1 (Frequency Factor)
C(w) = 0.80 (weighted)

Summary of Design rates

Detention shown below does not refelct what is ocuring on site, only used to determine critical VOLUME storm for all storm durations										
Page	Design Storm (Pre)	Storm Duration	Design Storm (Post)	Storm Duration		Undetained (L/s)	Tank In (L/s)	Allowable Out (L/s)	Detention (kL)	Post-dev. Flow (L/s)
DC2	5	5	10	5		0.00	12.65	5.00	1.8	5.00
DC3	5	5	10	10		0.00	13.52	11.13	1.1	11.13
DC4	5	5	10	20		0.00	9.44	11.13	0.0	11.13
DC5	5	5	10	30		0.00	7.45	11.13	0.0	11.13
DC6	5	5	100	5		0.00	34.30	11.13	9.3	11.13
DC7	5	5	100	10		0.00	25.03	11.13	11.6	11.13
DC8	5	5	100	20		0.00	17.21	11.13	8.5	11.13
DC9	5	5	100	30		0.00	13.48	11.13	6.0	11.13
DC10	5	5	100	60		0.00	8.60	11.13	54.4	11.13

Based on Spreadsheet on previous Page Critical duration of 10 Year ARI = 5 min

Note: Spreadsheet on previous Page is only used to calculate Critical Storm duration, is not indicative of what will actually occur on site

10 Year ARI, 5 Min storm

First consider only roof area, limit this to 2 L/sec per dwelling \Rightarrow Hence 6 L/sec per site

As per Spreadsheet on next Page need 1300 L of detention for the site \Rightarrow Use 1000 L per dwelling collecting 100% of roof area

\Rightarrow Now we consider only the surface water, set limit to 5 L/sec.

\Rightarrow As per spreadsheet on following pages need 421 L detention \Rightarrow Use 1000 L dual pump system with flow rate of 10 L/sec.



71 East Ave Allenby Gardens

STORMWATER DETENTION CALCULATIONS 10 YEAR ARI, ROOF AREA ONLY

PROJECT:	TX12816.00
DATE:	27/03/2018
DESIGN:	JA
PAGE:	DC1

Adelaide

	AVERAGE RETURN INTERVAL (YEARS)						
Duration	1	2	5	10	20	50	100
5	44.00	59.20	81.90	98.50	121.00	155.00	185.00
6	41.00	55.10	76.10	91.50	112.00	144.00	171.00
10	33.10	44.40	60.90	72.90	89.30	114.00	135.00
20	23.50	31.40	42.70	50.90	62.00	78.90	92.80
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120	8.14	10.70	14.20	16.60	20.00	24.80	29.00
180	6.36	8.36	11.00	12.80	15.30	18.90	21.90
360	4.15	5.44	7.03	8.10	9.62	11.80	13.60
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2880	0.924	1.21	1.55	1.78	2.12	2.59	2.99
4320	0.652	0.852	1.10	1.26	1.50	1.84	2.12

SITE COVERAGE

Pre Development Coverage

Roof	0.90	227
Pavement / Driveways	0.75	180
Grass / Open Space	0.35	429
Other	0.40	0
	Total	836

Fy = **1** (Frequency Factor)
C(w) = **0.59** (weighted)

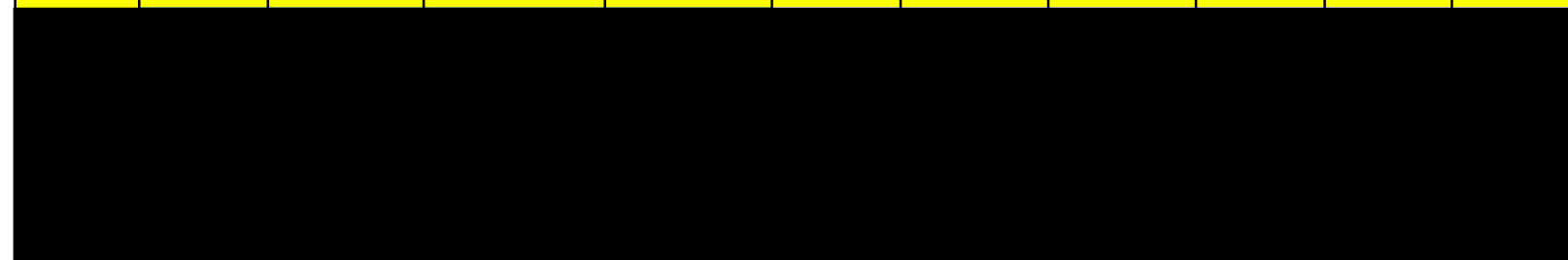
Post Development Coverage

	C	Area (m ²)	% Area Undetained
Roof	0.90	481	0.0%
Pavement / Driveways	0.75	0	0.0%
Grass / Open Space	0.35	0	0.0%
Other	0.40	0	0.0%
	Total	481	

Fy = **1** (Frequency Factor)
C(w) = **0.90** (weighted)

Summary of Design Rates

Page	Design Storm (Pre)	Storm Duration	Design Storm (Post)	Storm Duration	ALLOWABLE Flow (L/s)	Undetained (L/s)	Tank In (L/s)	Allowable Out (L/s)	Detention (kL)	Post-dev. Flow (L/s)
DC2	5	5	10	5	6.00	0.00	11.84	6.00	1.3	6.00



Post

1 in

10

yr ARI

5

minutes

 I =
 98.50
 mm/hr

Max flow:

Q = CIA / 3600 =
 6.00
 L/s
 Total Site Discharge (Pre)

Undetained Flow from Proposed Development (Post):

Q = CIA / 3600 =	Roof	0.00	L/s
	Pavement / Driveways	0.00	L/s
	Grass / Open Space	0.00	L/s
	Other	0.00	L/s
		0.00	L/s

Flow into Proposed Detention (Post):

Q = CIA / 3600 =	Roof	11.84	L/s
	Pavement / Driveways	0.00	L/s
	Grass / Open Space	0.00	L/s
	Other	0.00	L/s
		11.84	L/s

Allowable discharge from detention:
 6.00
 L/s

Estimated time of concentration for post development, TC =
 5
 minutes

Graph Duration vs Flow:

TC	Proposed	Allowable	
(Min.)	Flow	Flow	
	(L/s)	(L/s)	
0	0	0.00	
5	11.84	6.00	
5	11.84	6.00	
10	0.00	6.00	

Therefore,
 Determine Amount of Detention

Intersection & Graph Formulas:

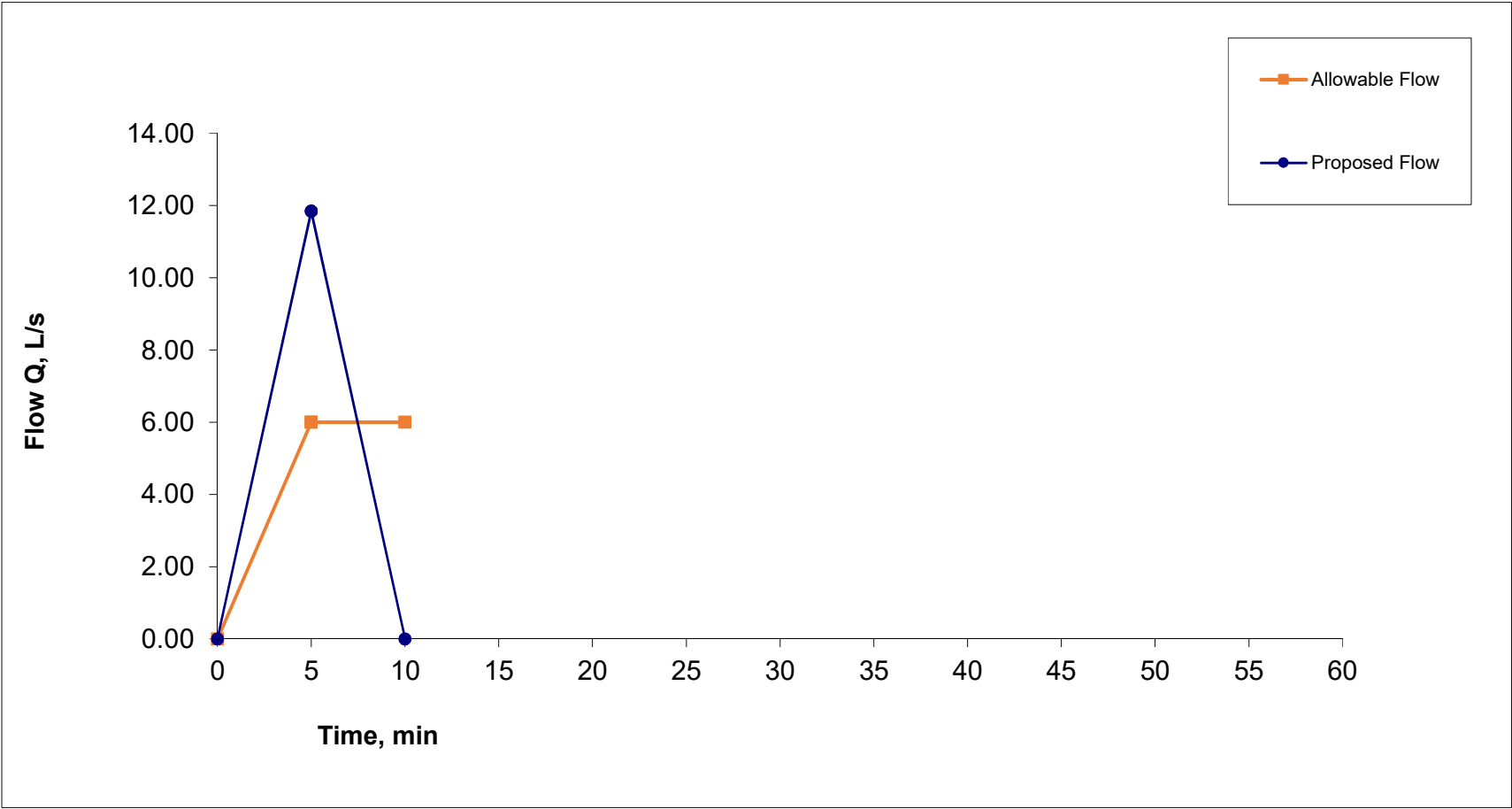
Q rate =
 2.37
 L/sec per min. increase & decrease

Therefore the two graph intersection points (where outflow matches allowable) are:

Int. TC1 =
 2.53
 minutes and
 Int. TC2 =
 7.47

Volume of Water To Be Detained:

Volume =
 1309
 Litres
 =
 1.31
 m³





71 East Ave Allenby Gardens

STORMWATER DETENTION CALCULATIONS

10 YEAR ARI, SURFACE AREA ONLY

PROJECT: TX12816.00

DATE: 27/03/2018

DESIGN: JA

PAGE: DC1

Adelaide

	AVERAGE RETURN INTERVAL (YEARS)						
Duration	1	2	5	10	20	50	100
5	44.00	59.20	81.90	98.50	121.00	155.00	185.00
6	41.00	55.10	76.10	91.50	112.00	144.00	171.00
10	33.10	44.40	60.90	72.90	89.30	114.00	135.00
20	23.50	31.40	42.70	50.90	62.00	78.90	92.80
30	18.80	25.00	33.80	40.20	48.80	61.70	72.70
60	12.40	16.50	22.10	26.10	31.50	39.50	46.40
120	8.14	10.70	14.20	16.60	20.00	24.80	29.00
180	6.36	8.36	11.00	12.80	15.30	18.90	21.90
360	4.15	5.44	7.03	8.10	9.62	11.80	13.60
720	2.66	3.46	4.43	5.08	6.01	7.32	8.42
1440	1.62	2.11	2.69	3.09	3.65	4.44	5.11
2880	0.924	1.21	1.55	1.78	2.12	2.59	2.99
4320	0.652	0.852	1.10	1.26	1.50	1.84	2.12

SITE COVERAGE

Pre Development Coverage

Roof	0.90	227
Pavement / Driveways	0.75	180
Grass / Open Space	0.35	429
Other	0.40	0
	Total	836

Fy = **1** (Frequency Factor)
C(w) = **0.59** (weighted)

Post Development Coverage

	C	Area (m ²)	% Area Undetained
Roof	0.90	0	0.0%
Pavement / Driveways	0.75	317	0.0%
Grass / Open Space	0.35	68	0.0%
Other	0.40	0	0.0%
	Total	385	

Fy = **1** (Frequency Factor)
C(w) = **0.68** (weighted)

Summary of Design Rates

Page	Design Storm (Pre)	Storm Duration	Design Storm (Post)	Storm Duration	ALLOWABLE-Flow (L/s)	Undetained (L/s)	Tank In (L/s)	Allowable Out (L/s)	Detention (kL)	Post-dev. Flow (L/s)
DC2	5	5	10	5	5.00	0.00	7.16	5.00	0.4	5.00

Post

1 in	10	yr ARI	5	minutes
------	----	--------	---	---------

 l = 98.50 mm/hr

Max flow:

Q = CIA / 3600 =

5.00	L/s	Total Site Discharge (Pre)
------	-----	----------------------------

Undetained Flow from Proposed Development (Post):

Q = CIA / 3600 =	Roof	0.00	L/s
	Pavement / Driveways	0.00	L/s
	Grass / Open Space	0.00	L/s
	Other	0.00	L/s
		0.00	L/s

Flow into Proposed Detention (Post):

Q = CIA / 3600 =	Roof	0.00	L/s
	Pavement / Driveways	6.51	L/s
	Grass / Open Space	0.65	L/s
	Other	0.00	L/s
		7.16	L/s

Allowable discharge from detention:

5.00	L/s
------	-----

Estimated time of concentration for post development, TC = 5 minutes

Graph Duration vs Flow:

TC	Proposed Flow	Allowable Flow	
(Min.)	(L/s)	(L/s)	
0	0	0.00	
5	7.16	5.00	
5	7.16	5.00	
10	0.00	5.00	

Therefore,
 Determine Amount of Detention

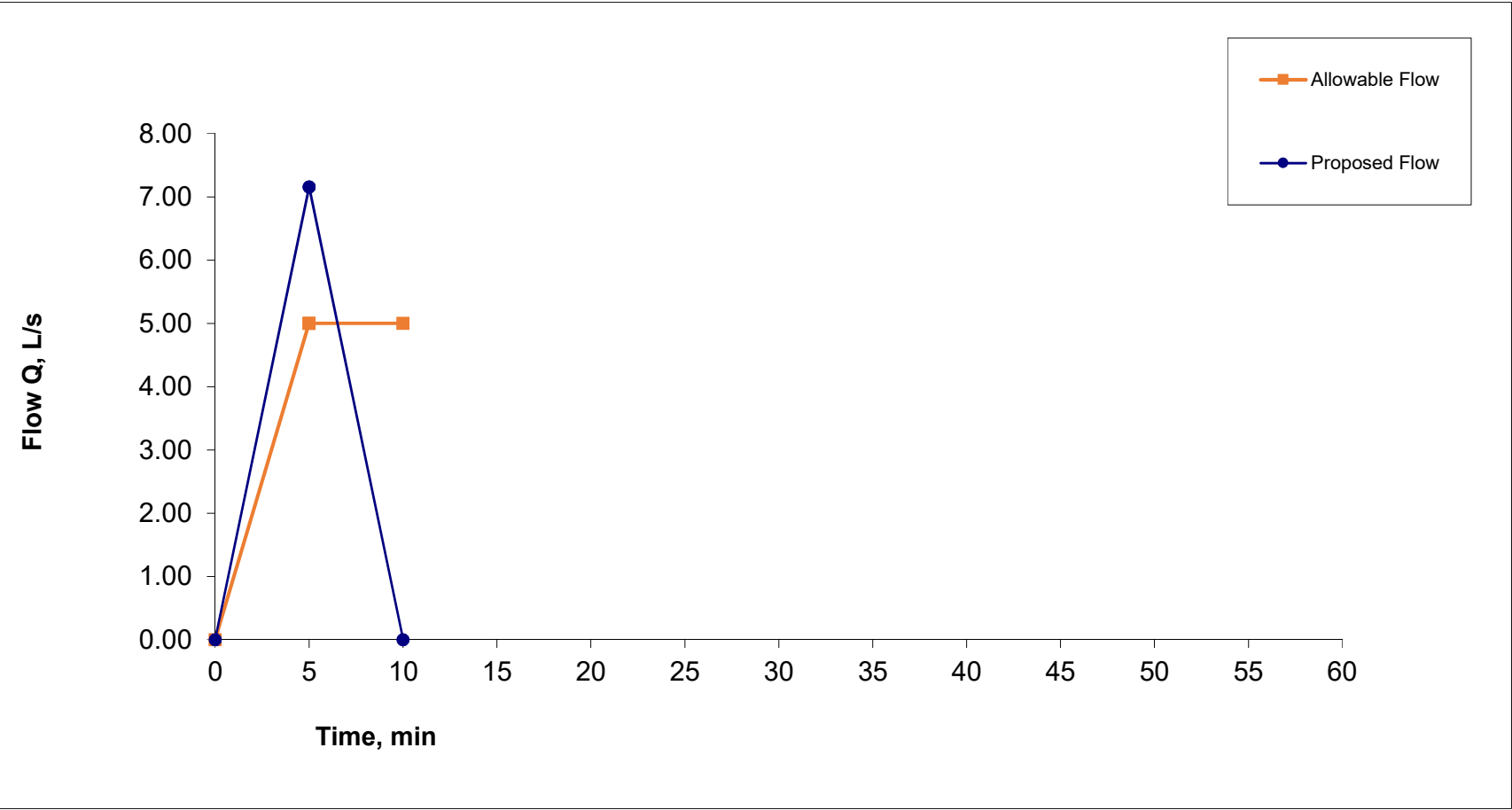
Intersection & Graph Formulas:

Q rate = 1.43 L/sec per min. increase & decrease

Therefore the two graph intersection points (where outflow matches allowable) are:
 Int. TC1 = 3.49 minutes and
 Int. TC2 = 6.51

Volume of Water To Be Detained:

Volume = 421 Litres
 = 0.42 m³



100 yr ARI, Roof only

⇒ Limit roof area to 2 L/sec per dwelling

Note: gutters only capable of holding 20 yr ARI

⇒ As per spreadsheet on following page, Detention = 1700 L
 ⇒ 566 L per dwelling ⇒ okay (Use 1000 L tanks)

100 YR ARI, Surface water & (100 Yr - 20 Yr) Roof

Roof 100 Yr ARI = 16.23 L/sec
 " 20 Yr ARI = 10.74 L/sec

⇒ Roof (100 yr - 20 yr) = 5.49 L/sec

⇒ From Spreadsheet on following pages
 Need 4130 L Detention, okay by using onsite
 ponding, Refer to triaxial civil drawing



71 East Ave Allenby Gardens

STORMWATER DETENTION CALCULATIONS

20 YEAR ARI, ROOF AREA ONLY

PROJECT:	TX12816.00
DATE:	27/03/2018
DESIGN:	JA
PAGE:	DC1

Adelaide

	AVERAGE RETURN INTERVAL (YEARS)						
Duration	1	2	5	10	20	50	100
5	44.00	59.20	81.90	98.50	121.00	155.00	185.00
6	41.00	55.10	76.10	91.50	112.00	144.00	171.00
10	33.10	44.40	60.90	72.90	89.30	114.00	135.00
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30	18.80	25.00	33.80	40.20	48.80	61.70	72.70
60	12.40	16.50	22.10	26.10	31.50	39.50	46.40
120	8.14	10.70	14.20	16.60	20.00	24.80	29.00
180	6.36	8.36	11.00	12.80	15.30	18.90	21.90
360	4.15	5.44	7.03	8.10	9.62	11.80	13.60
720	2.66	3.46	4.43	5.08	6.01	7.32	8.42
1440	1.62	2.11	2.69	3.09	3.65	4.44	5.11
2880	0.924	1.21	1.55	1.78	2.12	2.59	2.99
4320	0.652	0.852	1.10	1.26	1.50	1.84	2.12

SITE COVERAGE

Pre Development Coverage

Roof	0.90	227
Pavement / Driveways	0.75	180
Grass / Open Space	0.35	429
Other	0.40	0
	Total	836

Fy = **1** (Frequency Factor)
C(w) = **0.59** (weighted)

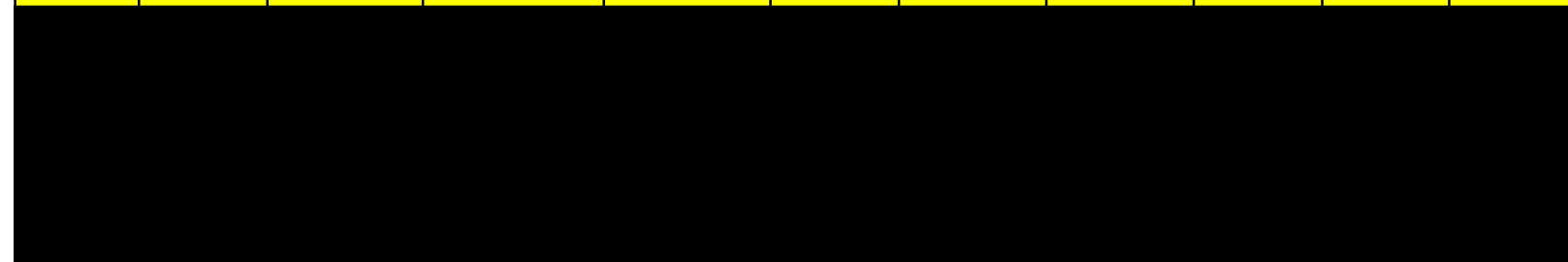
Post Development Coverage

	C	Area (m²)	% Area Undetained
Roof	0.90	481	0.0%
Pavement / Driveways	0.75	0	0.0%
Grass / Open Space	0.35	0	0.0%
Other	0.40	0	0.0%
	Total	481	

Fy = **1** (Frequency Factor)
C(w) = **0.90** (weighted)

Summary of Design Rates

Page	Design Storm (Pre)	Storm Duration	Design Storm (Post)	Storm Duration	ALLOWABLE Flow (L/s)	Undetained (L/s)	Tank In (L/s)	Allowable Out (L/s)	Detention (kl)	Post-dev. Flow (L/s)
DC2	5	5	20	10	6.00	0.00	10.74	6.00	1.7	6.00



Post

1 in	20	yr ARI	10	minutes
------	----	--------	----	---------

 I = 89.30 mm/hr

Max flow:

Q = CIA / 3600 =

6.00	L/s	Total Site Discharge (Pre)
------	-----	----------------------------

Undetained Flow from Proposed Development (Post):

Q = CIA / 3600 =

Roof	0.00	L/s
Pavement / Driveways	0.00	L/s
Grass / Open Space	0.00	L/s
Other	0.00	L/s
	0.00	L/s

Flow into Proposed Detention (Post):

Q = CIA / 3600 =

Roof	10.74	L/s
Pavement / Driveways	0.00	L/s
Grass / Open Space	0.00	L/s
Other	0.00	L/s
	10.74	L/s

Allowable discharge from detention:

6.00	L/s
------	-----

Estimated time of concentration for post development, TC = 5 minutes

Graph Duration vs Flow:

TC	Proposed	Allowable
(Min.)	Flow	Flow
	(L/s)	(L/s)
0	0	0.00
5	10.74	6.00
5	10.74	6.00
10	0.00	6.00

Therefore,
Determine Amount of Detention

Intersection & Graph Formulas:

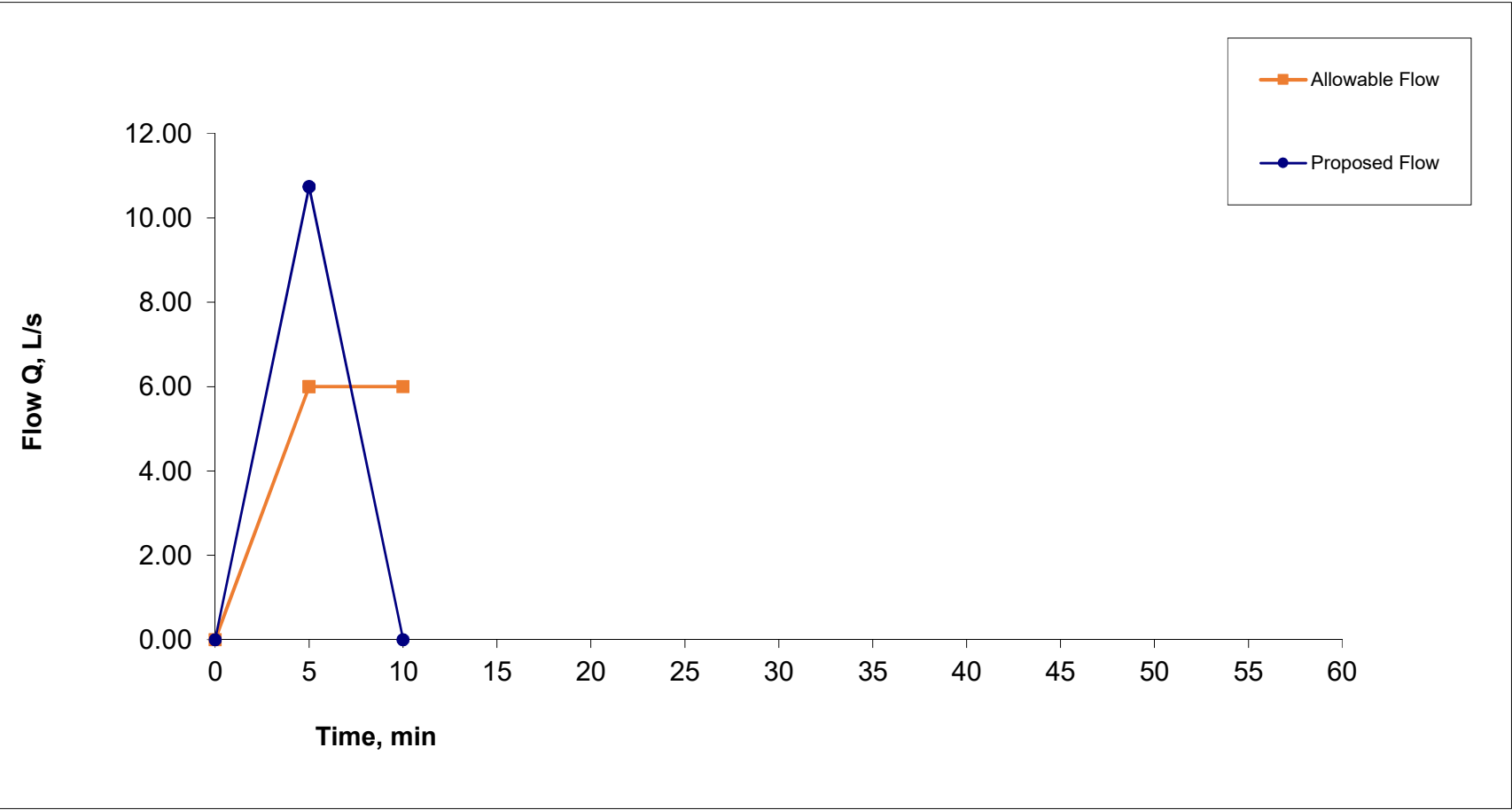
Q rate = 2.15 L/sec per min. increase & decrease

Therefore the two graph intersection points (where outflow matches allowable) are:

Int. TC1 = 2.79 minutes and
Int. TC2 = 12.21

Volume of Water To Be Detained:

Volume = 1735 Litres
= 1.74 m³





71 East Ave Allenby Gardens

STORMWATER DETENTION CALCULATIONS

100 YEAR ARI, SURFACE AREA AND ROOF AREA

PROJECT:	TX12816.00
DATE:	27/03/2018
DESIGN:	JA
PAGE:	DC1

Adelaide

	AVERAGE RETURN INTERVAL (YEARS)						
Duration	1	2	5	10	20	50	100
5	44.00	59.20	81.90	98.50	121.00	155.00	185.00
6	41.00	55.10	76.10	91.50	112.00	144.00	171.00
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30	18.80	25.00	33.80	40.20	48.80	61.70	72.70
60	12.40	16.50	22.10	26.10	31.50	39.50	46.40
120	8.14	10.70	14.20	16.60	20.00	24.80	29.00
180	6.36	8.36	11.00	12.80	15.30	18.90	21.90
360	4.15	5.44	7.03	8.10	9.62	11.80	13.60
720	2.66	3.46	4.43	5.08	6.01	7.32	8.42
1440	1.62	2.11	2.69	3.09	3.65	4.44	5.11
2880	0.924	1.21	1.55	1.78	2.12	2.59	2.99
4320	0.652	0.852	1.10	1.26	1.50	1.84	2.12

SITE COVERAGE

Pre Development Coverage

Roof	0.90	227
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Grass / Open Space	0.35	429
Other	0.40	0
	Total	836

Fy = **1** (Frequency Factor)
C(w) = **0.59** (weighted)

Post Development Coverage

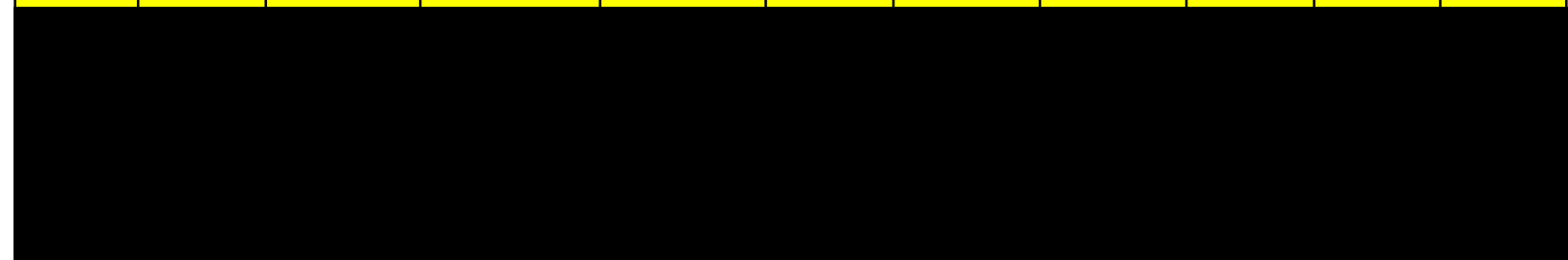
	C	Area (m²)	% Area Undetained
Roof	0.90	0	0.0%
Pavement / Driveways	0.75	317	0.0%
Grass / Open Space	0.35	68	0.0%
Other	0.40	0	0.0%
	Total	385	

(Added manually on next page)

Fy =	1	(Frequency Factor)
C(w) =	0.68	(weighted)

Summary of Design Rates

Page	Design Storm (Pre)	Storm Duration	Design Storm (Post)	Storm Duration	ALLOWABLE Flow (L/s)	Undetained (L/s)	Tank In (L/s)	Allowable Out (L/s)	Detention (kL)	Post-dev. Flow (L/s)
DC2	5	5	100	10	5.00	0.00	15.30	5.00	4.1	5.00



Post

1 in	100	yr ARI	10	minutes
------	-----	--------	----	---------

 I = 135.00 mm/hr

Max flow:

Q = CIA / 3600 =

5.00	L/s	Total Site Discharge (Pre)
------	-----	----------------------------

Undetained Flow from Proposed Development (Post):

Q = CIA / 3600 =

Roof	0.00	L/s
Pavement / Driveways	0.00	L/s
Grass / Open Space	0.00	L/s
Other	0.00	L/s
	0.00	L/s

Flow into Proposed Detention (Post):

Q = CIA / 3600 =

Roof	5.49	L/s
Pavement / Driveways	8.92	L/s
Grass / Open Space	0.89	L/s
Other	0.00	L/s
	15.30	L/s

Allowable discharge from detention:

5.00	L/s
------	-----

Estimated time of concentration for post development, TC = 5 minutes

Graph Duration vs Flow:

TC	Proposed	Allowable
(Min.)	Flow	Flow
	(L/s)	(L/s)
0	0	0.00
5	15.30	5.00
5	15.30	5.00
10	0.00	5.00

Therefore,
Determine Amount of Detention

Intersection & Graph Formulas:

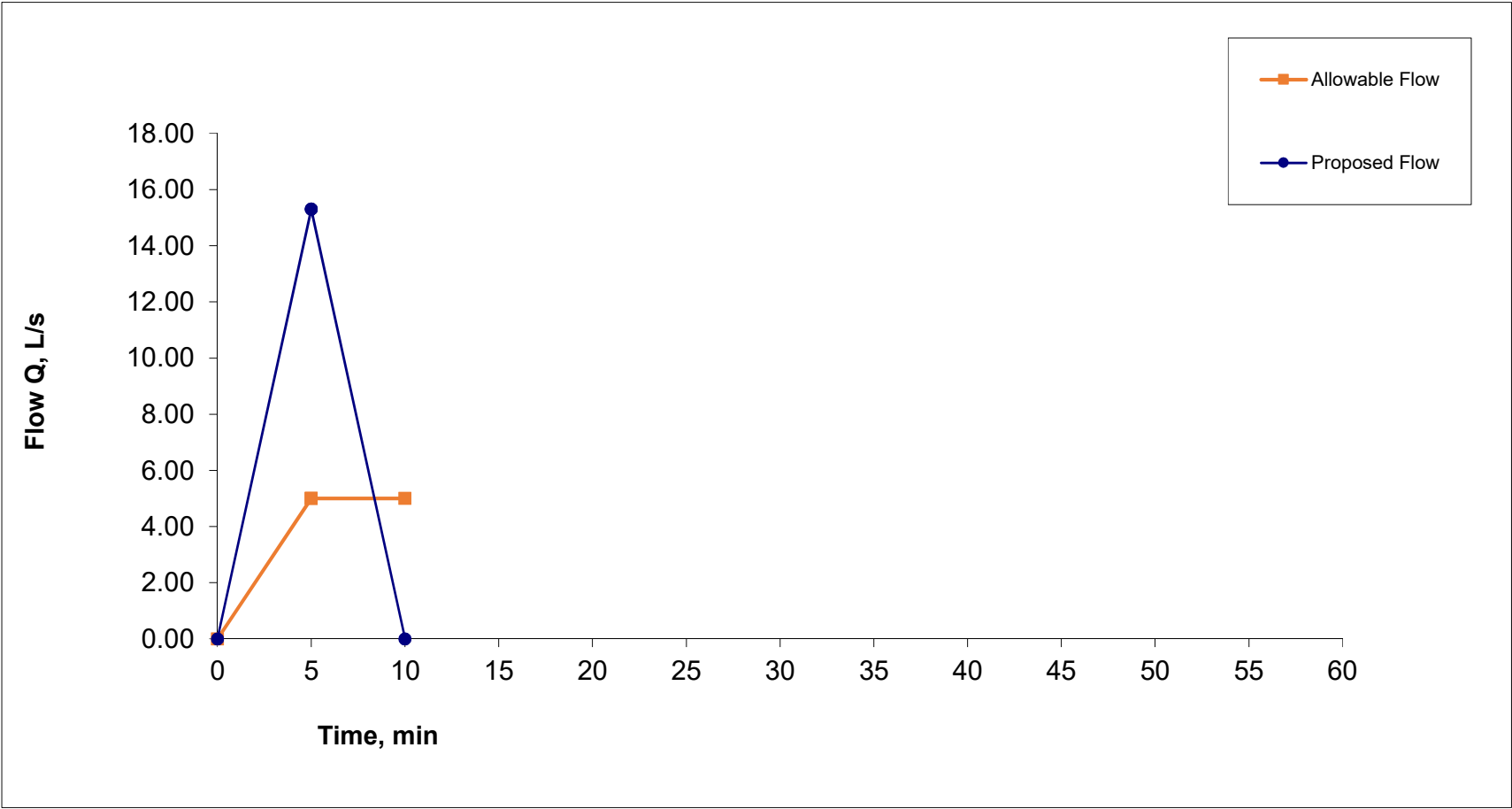
Q rate = 3.06 L/sec per min. increase & decrease

Therefore the two graph intersection points (where outflow matches allowable) are:

Int. TC1 = 1.63 minutes and
Int. TC2 = 13.37

Volume of Water To Be Detained:

Volume = 4129 Litres
= 4.13 m³





TRIAXIAL
CONSULTING

COMPLEX PROBLEMS
RESOLVED SIMPLY

27A King William Road, Unley SA 5034

PROJECT: **TX12816.00**

DATE: **27/03/2018**

DESIGN: **JA**

PAGE: **SW1**

DETENTION TANK ORIFICE SIZING & EMPTY TIME

Note:

Orifice flow rate reduces with decrease in head height. Total empty time base on change in head height for each quarter of tank.

Storage Volume:	1000 L	
Allowable outflow from storage:	2.00 L/SEC	(Per Tank)
Allowable empty time:	24 hrs	
Maximum outlet velocity:	0.10 m/s	

ORIFICE SPECIFICATIONS:

Outlet Coefficient	Cd	0.6	
Orifice diameter	Dia.	20	mm Diameter
Orifice area	$A = \pi * (Dia./2)^2$	0.00031416	
Head	H	2	m (above mid-height of outlet)
Blockage factor	B	1.00	(between 0.10 and 1.00)

ORIFICE FLOW:

4 of 4	$Q_o = C_d * A * \sqrt{2 * g * H} * B$	=	1.2 L/SEC
	=> Time to empty is		4 Minutes
3 of 4	$Q_o = C_d * A * \sqrt{2 * g * H} * B$	=	1.0 L/SEC
	=> Time to empty is		4 Minutes
2 of 4	$Q_o = C_d * A * \sqrt{2 * g * H} * B$	=	0.8 L/SEC
	=> Time to empty is		5 Minutes
1 of 4	$Q_o = C_d * A * \sqrt{2 * g * H} * B$	=	0.6 L/SEC
	=> Time to empty is		7 Minutes

where, g = Gravity (9.81 m/sec^2)
& H reduces by 1/4 for each time step

=> Total time to empty storage is **20 Minutes** or **0 Hours**

=> Orifice size is **OK**

=> Empty time is **OK**