PJ WRIGHT
& ASSOCIATES PTY LTD
Hydraulic & Fire Design Consultants
ABN 96 994 944 009 ACN 008 928 096

AHSCA
The Association of Hydraulic Services Consultants Australia

Suite 1 / 101 Scarborough Beach Road Mount Hawthorn Western Australia 6016
PO Box 335 Mount Hawthorn Western Australia 6915
telephone (08) 9443 3466 email email@pjwrightandassociates.com.au

Karratha Apartments

Lot 14 Ridely Street Bulgarra

Stormwater Management Report

Issue Date: Thursday, March 5, 2026
Revision: 01 Building Permit

1 PREAMBLE.

PJ Wright and Associates Pty Ltd (**PJWAA**) have been engaged by Developed Pty Ltd (**Project Managers**) to prepare a stormwater management plan for three proposed residential development sites in Bulgarra.

This Stormwater Management Plan (SMP) outlines the requirements for Lot 17 Ridely Street Bulgarra.

The SMP was submitted in May 2025 and Development Approval was granted.

Since DA the project has been adjusted with emergency vehicle travel paths reducing the area along the western and eastern boundaries for the utilization of box culverts to divert the offsite flows through to Ridely street.

The offsite drainage systems are now piped with a series on manholes to manage discharges to surcharge sump along Ridely street .

PJWAA have issued drawings 1804-3 P.01 and 1804-3 P.03 which relate to site and stormwater drainage.

Coordination with Civil engineering has also been undertaken to ensure hardstand areas are graded correctly.

2 SITES AND CONDITIONS.

The proposed site is Lot 17 Ridley Street, Bulgarra (**The Site**). Refer to Figure 1.

The proposed development consists of:

- 5,100 square metres site.
- 32 residential units.
- Zoning: R40

Figure 1: Location Plan

3 FLOOD DATA.

PJWAA have reviewed the City of Karratha *500-year Storm Surge Risk Policy* and confirm the proposed development is located between Ridley Street and Millstream Road.

The site located approximately 300m south of the Storm Surge Zone, which is located near Hunt Way of Sheet 6 of 6 of the Storm Surge Risk Policy.

3.1 RAINFALL DATA.

PJWAA have the 1%AEP storm events based upon current Bureau of Meteorology (**BOM**) rainfall data for Karratha (refer to Figure 2 below).

Australian Government
Bureau of Meteorology

Location

Label: Not provided

Latitude: -20.7337 [Nearest grid cell: 20.7375 (S)]

Longitude:-116.844 [Nearest grid cell: 116.8375 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 12 May 2025

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Unit: mm/h

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	80.5	93.8	137	167	197	238	271
2 min	63.9	74.2	107	129	152	182	206
3 min	60.8	70.8	102	124	146	176	200
4 min	59.1	68.9	99.9	122	144	173	197
5 min	57.5	67.0	97.6	119	141	170	193
10 min	49.5	57.8	84.4	103	122	147	168
15 min	42.9	49.9	72.8	88.9	105	127	144
20 min	37.7	43.9	63.9	77.9	91.9	111	126
25 min	33.6	39.1	56.9	69.4	81.8	98.8	112
30 min	30.4	35.4	51.4	62.6	73.9	89.2	101
45 min	23.7	27.6	40.2	49.0	57.9	69.9	79.4
1 hour	19.6	22.9	33.4	40.8	48.3	58.4	66.4
1.5 hour	14.8	17.4	25.6	31.4	37.3	45.3	51.7
2 hour	12.1	14.3	21.2	26.2	31.1	38.0	43.5
3 hour	9.11	10.8	16.4	20.4	24.4	30.1	34.6
4.5 hour	6.88	8.25	12.8	16.1	19.4	24.2	28.0
6 hour	5.67	6.85	10.8	13.7	16.7	20.9	24.3
9 hour	4.34	5.31	8.58	11.0	13.5	17.1	20.0
12 hour	3.61	4.45	7.31	9.43	11.7	14.8	17.4
18 hour	2.79	3.48	5.81	7.57	9.44	12.1	14.2
24 hour	2.32	2.91	4.91	6.42	8.03	10.3	12.1
30 hour	2.01	2.52	4.28	5.61	7.02	8.97	10.6
36 hour	1.78	2.24	3.80	4.99	6.25	7.96	9.36
48 hour	1.45	1.83	3.12	4.08	5.11	6.49	7.60
72 hour	1.07	1.35	2.28	2.98	3.71	4.67	5.44
96 hour	0.846	1.06	1.79	2.32	2.88	3.60	4.18
120 hour	0.694	0.870	1.46	1.89	2.34	2.91	3.37
144 hour	0.585	0.731	1.23	1.59	1.96	2.43	2.81
168 hour	0.503	0.627	1.05	1.36	1.68	2.09	2.41

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

Figure 2:BOM Annual Exceedance Period (AEP) data.

The data utilised for this Management report are in accordance with the Stormwater Guidelines for Residential developments. [3]

The relevant intensities area as follows:

a) 20% AEP (1:50 year) for five minute duration 97.6 mm/hr.
b) 1% AEP (1:100 year) for five minute duration 194 mm/hr.

3.2 COEFFICIENT OF RUNOFF.

The offsite catchments are based upon *Coefficient of Runoff* (**CoR**) of 0.65 as the land is un-developed.

All internal site catchments are based upon CoR of 0.8.

3.3 TIME OF CONCENTRATION.

PJWAA have undertaken the *Time of Concentration* (**TOC**) calculation based upon travel distance for each off site catchment area.

The TOC was calculated using an *Empirical version of the Rational Method* as appropriate to the scale of the development being a single property based upon Table 9.6.3 Book 9 of the ARR.

4 FLOOD CALCULATIONS.

PJWAA have utilised the survey and architectural drawings to calculate the catchment areas for each stormwater travel path.

4.1 OFF SITE INFLOWS.

An un-development area of land is located to the West of the site located east of the existing Exmouth Golf Club.

This land is elevated and has a natural slope towards the western boundary of the site.

The land has been broken into two areas based upon existing topographic information provided on the site survey. Refer to Figure 3.

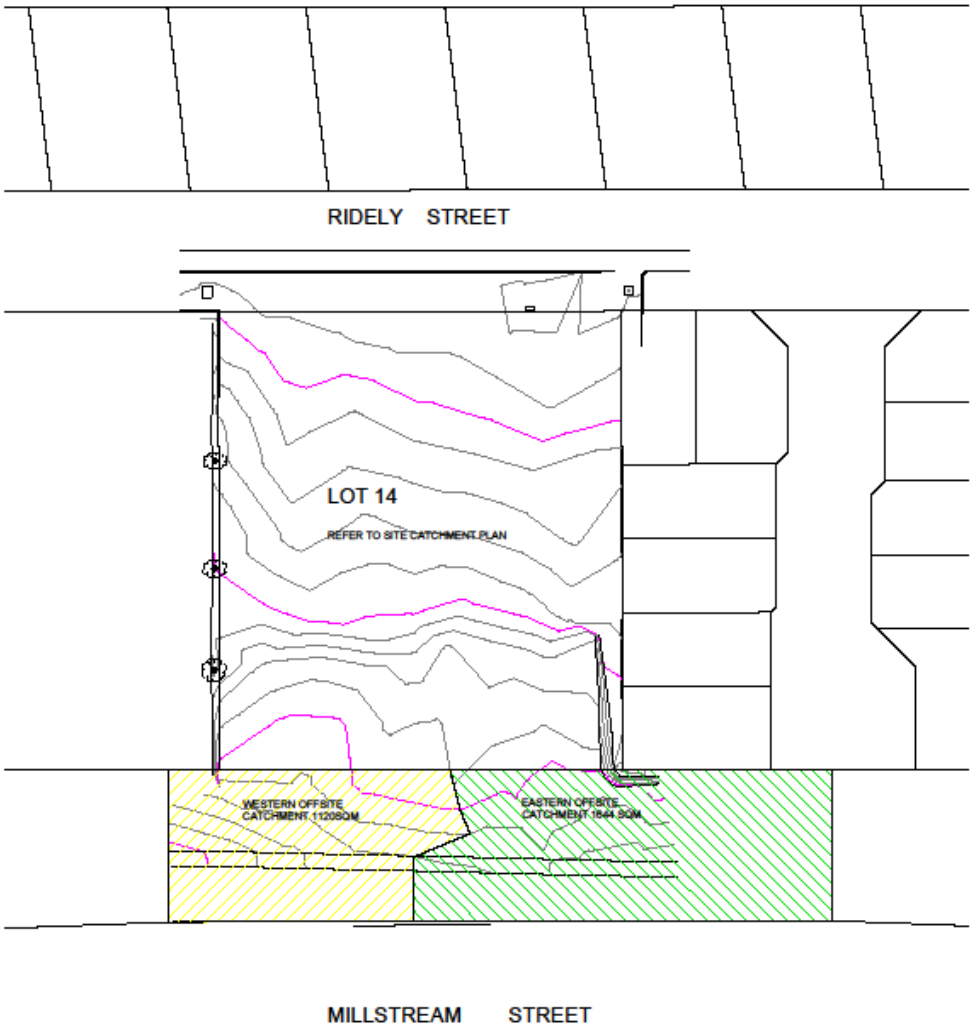

Figure 3 : Offsite Inflow Catchments

PJWAA have taken into account the predevelopment flows from this land and provided drainage channel to collect and diver the 1 % AEP flows around the development.

4.1.1 West Offsite Catchment

a) Catchment: 1,120 square meters.
b) Time of concentration: 8.66 mins.

The catchment has an estimated predevelopment 1% AEP design flow of 0.034m^3/sec.

The existing flow path will require redirection to divert flow towards the west boundary.

The new flow path will be directed via a grated manhole with a pipe 150mm pvc drain run down the western driveway to a surcharge manhole located in the southern verge of Ridely street.

The drainage system will also receive the Catchment C discharge which has been calculated at 0. 043m3/sec, providing a total design flow of 0.078m^3/sec

The surcharge outlet is 1.894 metres lower than the grated manhole at the head of line and 1.41 metres below the central courtyard collection swale.

4.1.2 East Offsite Catchment

a) Catchment: 1,644 square meters.
b) Time of concentration: 9.46 mins.

The catchment has an estimated predevelopment 1% AEP design flow of 0.0502m3/sec.

The current flow path currently flows through a shallow gully on the eastern side of lot 14 and will remain in this configuration.

The flow will be directed via a grated manhole with a pipe 225mm pvc drain run down the eastern driveway to a surcharge manhole located in the southern verge of Ridely street.

The surcharge outlet is 1.169 metres lower than the grated manhole at the head of line.

4.2 SITE FLOWS.

Lot 14 has a high point located at the rear boundary with natural falls towards Ridely Street.
The site has been broken into 4 main catchment areas. Refer to Figure 4.

a) Catchment A : Western side of the site.
b) Catchment B : Eastern side of the site.
c) Catchment C : Central Common area.
d) Catchment D : Ridely Street frontage.

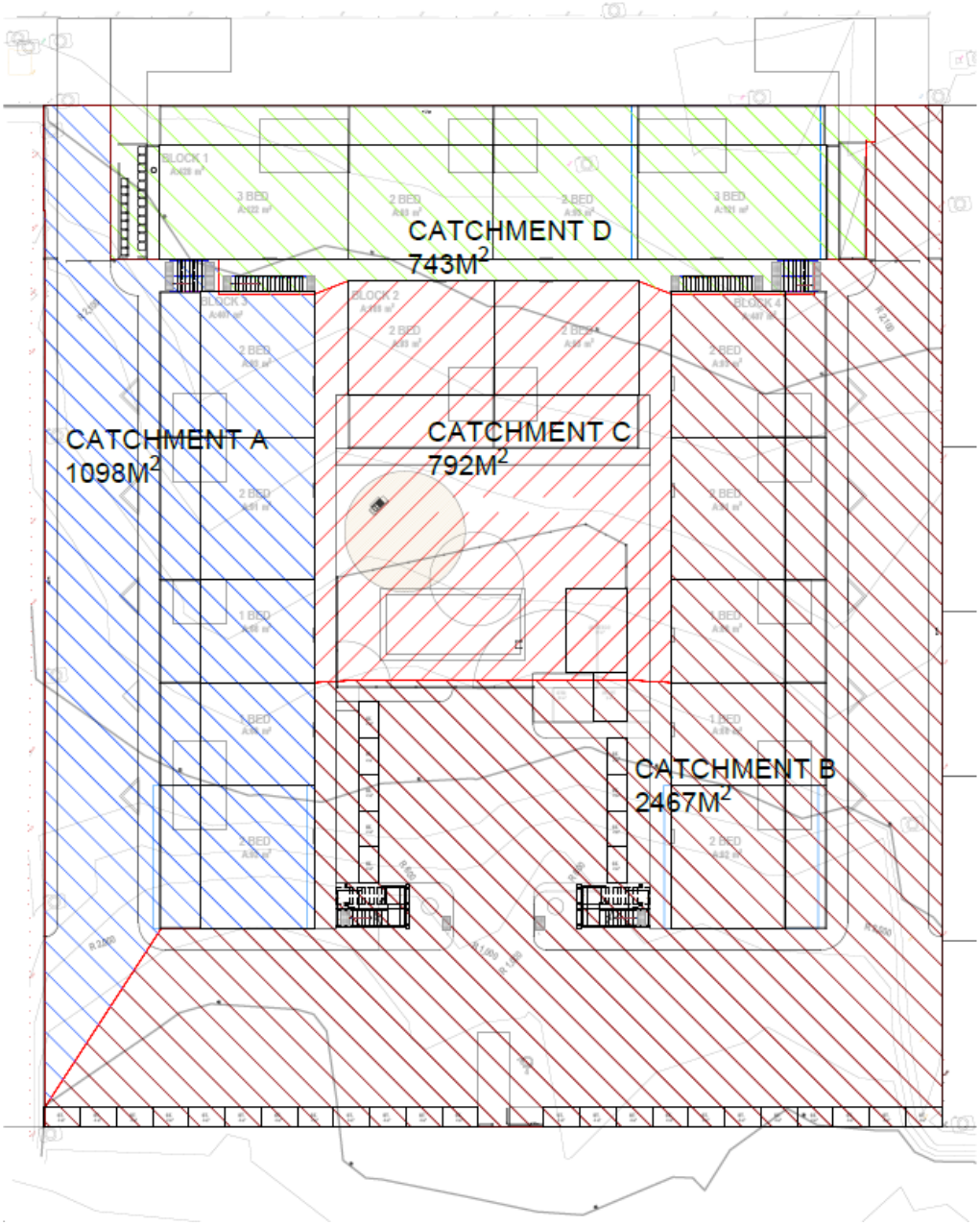

Figure 4: Site Catchment Areas.

The flows from Catchment A and B have been directed to flow down the centre of the roadways to discharge via crossovers onto Ridley Street.

Catchment C will be piped to the western offsite drainage diversion.

Catchment D will discharge via overland from towards Ridely Street.

4.3 CATCHMENT A

Catchment A is 1098 square meters in area. The storm flow path will run down the centre of the driveway.

The parking bays will be graded towards the driveway and the driveway will fall to allow discharge to Ridely Street.

The 20% AEP (5 year ARI) design stormwater flow has been calculated at 23.81L/second and the anticipated flow path has been indicated on drawing P.01.

The 1% AEP (100 year ARI) design stormwater flow has been calculated at 59.17 l/second and has been designed for crossover width of 6000 at the point of discharge onto Ridely street.

The flow characteristics at ridley street has been calculated as follows:

a) 20% AEP (Refer to Chart 3 in Appendix B)
    i. Volume:0.024 m3/sec
    ii. Slope : 3.8% (1:26 crossover)
    iii. Depth of 20% AEP flow: 6 mm across roadway
b) 1% AEP (refer to Chart 4 in Appendix B)
    i. Volume:0.059 m3/sec
    ii. Slope : 3.8% (1:26 crossover)
    iii. Depth of 1% AEP flow: 13 mm across roadway

4.4 CATCHMENT B

Catchment B is 2468 square meters in area. The storm flow path will run down the centre of the driveway.

The parking bays will be graded towards the driveway and the driveway will fall to allow discharge to Ridely Street.

The 20% AEP (5 year ARI) design stormwater flow has been calculated at 53.53 L/second and the anticipated flow path has been indicated on drawing P.01.

The 1% AEP (100year ARI) design stormwater flow has been calculated at 130.73 l/second and has been designed for crossover width of 6000 at the point of discharge onto Ridely street.

The flow characteristics at the crossover has been calculated as follows:

c) 20% AEP (Refer to Chart 5 in Appendix B)
    i. Volume:0.054 m3/sec
    ii. Slope : 2.2% (1:22)
    iii. Depth of 20% AEP flow: 14 mm across roadway
d) 1% AEP (Refer to Chart 6 in Appendix B)
    i. Volume:0.130 m3/sec
    ii. Slope : 2.2% (1:22)
    iii. Depth of 5% AEP flow: 24 mm across roadway

4.5 CATCHMENT C

Catchment C is the central common area and is 792 square meters in area. The storm water will be overland flow collected by a 1300 wide rock swale located south of the main access path.

The swale will discharge to a grated manhole with a pipe 150mm pvc drain run below the building and connecting into the western offsite drainage system.

The 20% AEP (5 year ARI) design stormwater flow has been calculated at 17.17 L/second.

The 1% AEP (100year ARI) design stormwater flow has been calculated at 42.68 l/second.

The depth of flow in the swale has been calculated as follows:

a) 20% AEP.(Refer to Chart 7 in Appendix B)
    i. Volume:0.017 m3/sec
    ii. Slope : 1.0%
    iii. Depth of 20% AEP flow: 60 mm
b) 1% AEP. (Refer to Chart 8 in Appendix B)
    i. Volume:0.043 m3/sec
    ii. Slope : 1.0%
    iii. Depth of 1% AEP flow: 107 mm

4.6 CATCHMENT D

Catchment D are the north apartments facing Ridley street.

The total area of the catchment is 743 square meters.

The storm water will be overland flow collected into four 1000 wide x 50mm deep gravel lined channels which will discharge towards Ridely Street as shown on drawing P.01.

Each channel has a catchment of 186 square metres.

The 20% AEP (5 year ARI) design stormwater flow for each channel has been calculated at 4.03 L/second.

The 1% AEP (100year ARI) design stormwater flow has been calculated at 8.01 l/second.

The depth of flow in each channel has been calculated as follows:

a) 20% AEP. (Refer to Chart 9 in Appendix B)
    i. Volume:0.004 m3/sec
    ii. Slope : 3.03%
    iii. Depth of 20% AEP flow: 31 mm
b) 1% AEP. (Refer to Chart 10 in Appendix B)
    i. Volume:0.009 m3/sec
    ii. Slope : 3.03%
    iii. Depth of 1% AEP flow: 49mm.

5 BUILDING FINISHED FLOOR LEVELS

Final design drawings have been fully coordinated during the design phase with architectural and civil design drawings.

If you require further information or clarification, please do not hesitate to contact this office.

Anthony R Serek
Senior Hydraulic Service Engineer
Dip.Hyd.Serv.Design;
Dip. Eng. (Const.Hyd.);
Cert.Arch.Draft;
LCIBSE,Eng.Tech(UK); SoPHE
LMAHSCA; MIPA.

6 APPENDIX A

References

1 Stormwater Management Manual of Western Australia, Department of Water; Chapter 9 Structural Controls. 2007.

2 Policy DP 19Karratha 500 year Storm Surge Risk Policy 2012, City of Karratha

3 Stormwater Design Guidelines for Residential Developments dated June 2011, City of Karratha.

4 Australian Rainfall and Runoff Book 9 – A Guide to Flood Estimation, Commonwealth of Australia (Geoscience Australia), 2016 ; Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M , Testoni I.

5 Stormwater and site grading Plan drawing C3301 for Lot 17 ridley Street Bulgara prepared by Edge Consulting Engineers, project No AU25819

7 APPENDIX B. SHEETS AND CHARTS.

DRAINAGE CALCULATIONS

Address	17 Ridley Street Bulgarra Eastern Offsite	Date	08.05.25

PRE DEVELOPMENT

Site Area	1120	m^2
Pervious Area	1120	m^2
Impervious Area	0	m^2
$^{1}I_{10}$	70.6	mm/hr
F_i	0	
F_y	1	
C_{10}	0.5	
$C_y = F_y C_{10}$	0.65	

Time of concentration

$t = \frac{(107nL^{0.333})}{s^{0.2}}$ where

t =	9.46 mins	t =	time (mins)
		n = (bare soil)	0.0275
$^{10}I_{10}$	104 mm/hr	L = (m)	52
		s = (%)	2.1
		F = (m)	1.09

Flow

$Q_o = CIA/3600$ where

Q_o =	34.18 L/s	Q_o =	?
	0.0342 m^3/s	C =	0.65
		I =	169
		A =	1120.0

AEP	Fy	C10	Cy
100%	0.8	0.65	0.52
50%	0.85	0.65	0.5525
20%	0.95	0.65	0.6175
10%	1	0.65	0.65
5%	1.05	0.65	0.6825
2%	1.15	0.65	0.7475
1%	1.2	0.65	0.78

PRE DEVELOPMENT FLOWS			
AEP	Cy	Iy	Qy
63.20%	0.52	49.90	8.07 L/s
50%	0.5525	58.20	10.00 L/s
20%	0.6175	84.9	16.31 L/s
10%	0.65	**104**	**21.03** L/s
5%	0.6825	123	26.12 L/s
2%	0.7475	148	34.42 L/s
1%	0.78	169	41.01 L/s

Spreadsheet based upon RAMWADE flow calculator.

Chart 1 Predevelopment West Off Site inflow.

DRAINAGE CALCULATIONS

Address	17 Ridley Street Bulgarra Western Offsite	Date	08.05.25

PRE DEVELOPMENT

Site Area	1120	m^2
Pervious Area	1120	m^2
Impervious Area	0	m^2
$^{1}I_{10}$	27.5	mm/hr
F_i	0	
F_y	1	
C_{10}	0.5	
$C_y = F_y C_{10}$	0.5	

Time of concentration

$t = \frac{(107nL^{0.333})}{s^{0.2}}$ where

t =	8.66 mins	t =	time (mins)
		n = (bare soil)	0.0275
$^{15}I_{10}$	104 mm/hr	L = (m)	51.2
		s = (%)	3.2
		F = (m)	1.63

Flow

$Q_o = CIA/3600$ where

Q_o =	26.29 L/s	Q_o =	?
	0.0263 m^3/s	C =	0.5
		I =	169
		A =	1120.0

AEP	Fy	C10	Cy
100%	0.8	0.5	0.4
50%	0.85	0.5	0.425
20%	0.95	0.5	0.475
10%	1	0.5	0.5
5%	1.05	0.5	0.525
2%	1.15	0.5	0.575
1%	1.2	0.5	0.6

PRE DEVELOPMENT FLOWS			
AEP	Cy	Iy	Qy
63.20%	0.4	49.90	6.21 L/s
50%	0.425	58.20	7.70 L/s
20%	0.475	84.9	12.55 L/s
10%	0.5	**104**	**16.18** L/s
5%	0.525	123	20.09 L/s
2%	0.575	148	26.48 L/s
1%	0.6	169	31.55 L/s

Spreadsheet based upon RAMWADE flow calculator.

Chart 2 Predevelopment East Off Site inflow

Flow Volume: 17.801L/s

Flow Velocity: 0.494m/s

Flow Depth: 6mm

Flow Depth: 6%

Maximum Flow Volume: 1896.441L/s

Maximum Flow Velocity: 3.161m/s

Input

Invert Width (mm)

6000

Width at top (mm)

6000

Depth of Channel (mm)

100

Surface Type (Manning's n)

Concrete, trowel finished

Roughness (n)

0.013

Slope of Invert (%)

3.8

Design Flow Rate (L/s)

17.17

Submit

Chart 3: Catchment A 20% AEP Crossover Flow

Flow Volume: 64.479L/s

Flow Velocity: 0.827m/s

Flow Depth: 13mm

Flow Depth: 13%

Maximum Flow Volume: 1896.441L/s

Maximum Flow Velocity: 3.161m/s

Input

Invert Width (mm)

6000

Width at top (mm)

6000

Depth of Channel (mm)

100

Surface Type (Manning's n)

Concrete, trowel finished

Roughness (n)

0.013

Slope of Invert (%)

3.8

Design Flow Rate (L/s)

59.17

Submit

Chart 4 : Catchment A 1% AEP Crossover flow

Flow Volume: 55.499L/s

Flow Velocity: 0.661m/s

Flow Depth: 14mm

Flow Depth: 14%

Maximum Flow Volume: 1442.975L/s

Maximum Flow Velocity: 2.405m/s

Input

Invert Width (mm)
6000

Width at top (mm)
6000

Depth of Channel (mm)
100

Surface Type (Manning's n)
Concrete, trowel finished

Roughness (n)
0.013

Slope of Invert (%)
2.2

Design Flow Rate (L/s)
53.53

Submit

Chart 5 : Catchment B 20% AEP Crossover flow.

Flow Volume: 135.977L/s

Flow Velocity: 0.944m/s

Flow Depth: 24mm

Flow Depth: 24%

Maximum Flow Volume: 1442.975L/s

Maximum Flow Velocity: 2.405m/s

Input

Invert Width (mm)
6000

Width at top (mm)
6000

Depth of Channel (mm)
100

Surface Type (Manning's n)
Concrete, trowel finished

Roughness (n)
0.013

Slope of Invert (%)
2.2

Design Flow Rate (L/s)
130.73

Submit

Chart 6 : Catchment B 1% AEP Crossover flow.

Flow Volume: 17.361L/s

Flow Velocity: 0.539m/s

Flow Depth: 58.8mm

Flow Depth: 49%

Maximum Flow Volume: 51.526L/s

Maximum Flow Velocity: 0.784m/s

Input

Invert Width (mm) 500

Width at top (mm) 1300

Depth of Channel (mm) 120

Surface Type (Manning's n) Gravel

Roughness (n) 0.025

Slope of Invert (%) 1

Design Flow Rate (L/s) 17.17

Submit

Chart 7 : Catchment C 20% AEP Swale Flow

Flow Volume: 43.362L/s

Flow Velocity: 0.741m/s

Flow Depth: 106.8mm

Flow Depth: 89%

Maximum Flow Volume: 51.526L/s

Maximum Flow Velocity: 0.784m/s

Input

Invert Width (mm) 500

Width at top (mm) 1300

Depth of Channel (mm) 120

Surface Type (Manning's n) Gravel

Roughness (n) 0.025

Slope of Invert (%) 1

Design Flow Rate (L/s) 42.68

Submit

Chart 8 : Catchment C 1% AEP Swale Flow

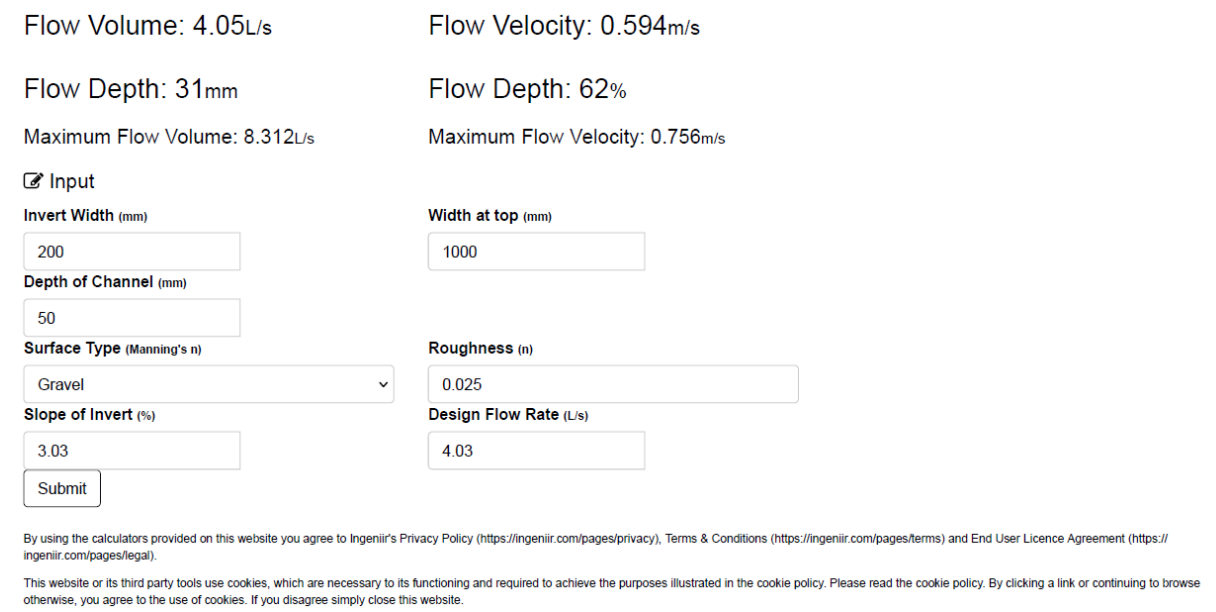

Chart 9 : Catchment D (Channel) 5% AEP Flow

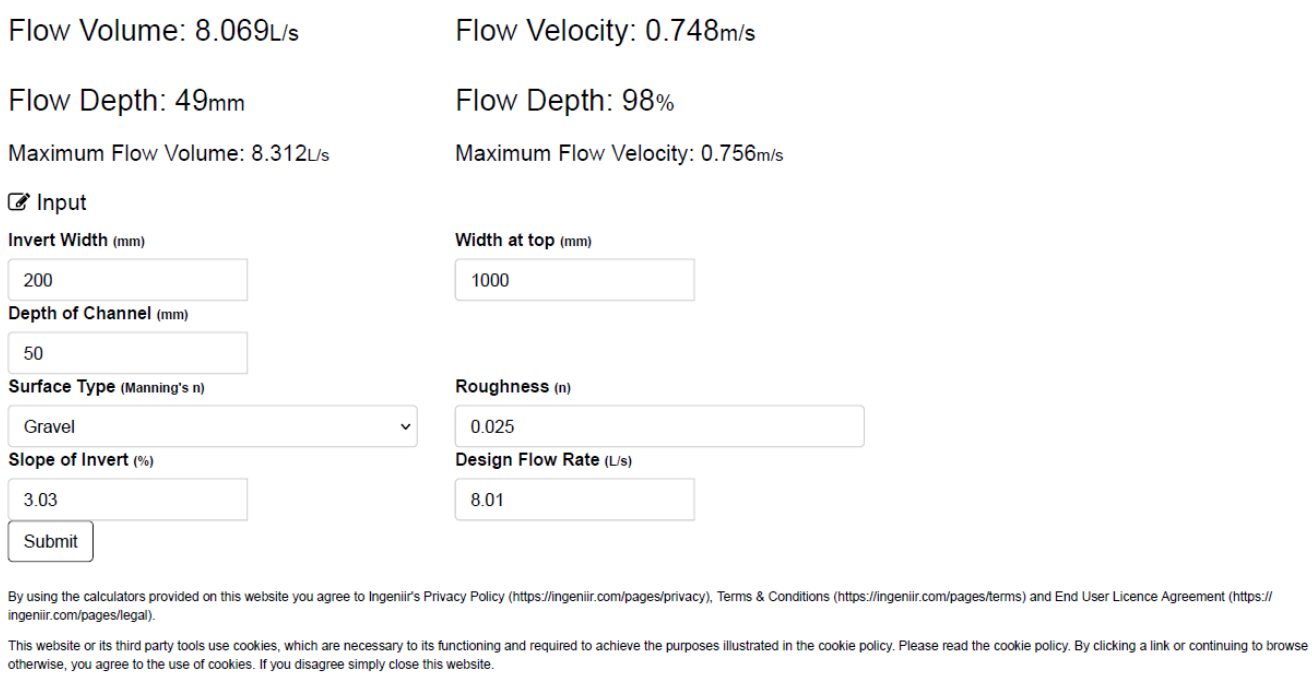

Chart 10 : Catchment D 1% AEP Flow