APPENDIX A

COMMUNITY CONSULTATION

PENRITH CITY COUNCIL

Friday, 13 November 2015

NEWS IS HERE

Approvals needed (please sign in box):

A.Wilkinson	CS	BM	AS	KM

Call for community input into flood studies

Council is asking residents and business owners in two areas of the City to share their local flood knowledge and experiences to help us prepare overland flow flood studies.

One study is focusing on the **Little Creek catchment**, which includes the suburbs of St Marys, North St Marys, Oxley Park and Colyton.

The other study area is the **College, Orth and Werrington Creeks catchment** which includes Werrington, Werrington County, Cambridge Park, Kingswood and Caddens as well as the University of Western Sydney Kingswood campus.

Council is investing more than $450,000 in these flood studies as part of our Floodplain Risk Management Program, in addition to financial support from the State Government under its Floodplain Management Program. The studies will update Council's existing flood information, helping us plan, predict and manage the risk of flooding across the catchment. Future studies will focus on other areas, but these catchments were identified as a priority in a City-wide scoping study.

"Potential personal danger and property damage from flooding is a concern for many residents, and many have lived through previous floods. We're being proactive so Council and the community can be as prepared as possible for future flood events," Penrith City Mayor Karen McKeown said.

"Historical observations and photos of flooding behaviour from the community are a valuable source of information which will help develop computer models of the extent and nature of potential flooding" she said.

The studies are concerned with flash flooding and overland flow, which occurs when intense rainfall exceeds the capacity of the stormwater network or creek channel, running down roads, through parks and potentially through property. In urbanised areas, overland flow has the potential to cause major damage to property and risk to life.

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601 High Street, Penrith
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e: cspears@penrithcity.nsw.gov.au
w: penrithcity.nsw.gov.au

Tel: (02) 4732 7632
Fax: (02) 4732 7958

A letter and questionnaire has been distributed to residents and businesses in the two study areas. Residents are encouraged to provide information relating to their experiences of flooding by **Friday 27 November**.

For more information see Council's website.

COLLEGE, ORTH & WERRINGTON CREEKS CATCHMENT OVERLAND FLOW FLOOD STUDY

INFORMATION SHEET

INTRODUCTION

Council is in the initial stages of preparing an overland flow flood study for the College, Orth and Werrington Creeks catchment. The extent of the catchment is shown in the map below and includes the suburbs of Werrington, Werrington County, Cambridge Park, Kingswood and Caddens.

During most rainfall events across the catchment, runoff is carried by the stormwater system into College, Orth or Werrington Creek. But during heavy rainfall there is potential for the capacity of the stormwater system to be exceeded, leading to overland flooding. There is also potential for water to overtop the banks of the creeks and inundate the adjoining floodplain.

The study will be overseen by the Penrith Floodplain Risk Management Committee, and will receive financial support from the State Government under the Floodplain Management Program.

Extent of the College, Orth and Werrington Creeks catchment

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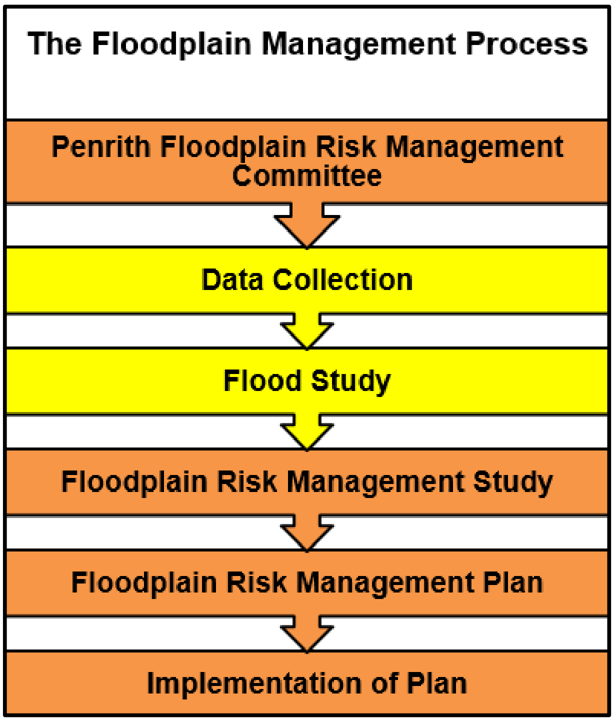
WHY DO WE NEED TO PREPARE A FLOOD STUDY?

Flooding is the most costly natural disaster in Australia, causing over $300million worth of damage each year. Over 2,000 people have lost their lives due to floods in Australia.

Under the NSW Government Flood Prone Land Policy, management of the flood prone land is, primarily, the responsibility of Councils. The Policy specifies a staged process involving data collection, a flood study, a floodplain risk management study and plan, and implementation of the plan (see flowchart).

Council will follow this process to manage the floodplain in your area. We are in the initial stages of undertaking the “Data Collection” and “Flood Study” stages of the process.

The preparation of a flood study will help Council to understand the existing flooding problem within the catchment. It will also help to identify where flood risk reduction measures may be best implemented to reduce the cost of flooding to the community, assist with emergency management and guide future development.



WHAT IS INVOLVED IN PREPARING A FLOOD STUDY?

The primary objective of the flood study is to identify the nature and extent of the existing flooding problem. A considerable amount of work is involved in preparing a flood study, including:

- collect and review all available flood-related information for the area.
- develop a computer flood model to simulate how floodwaters are distributed across the catchment.
- calibrate the computer model to reproduce historic floods.
- use the computer model to simulate a range of hypothetical floods from relatively frequent storms right up to the largest flood that could possibly occur.
- prepare a flood study report and maps summarising the outcomes of all stages of the investigation.

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HOW YOU CAN BE INVOLVED...

Council recognises that the community holds important information about past floods that will help identify flooding ‘trouble spots’ and calibrate the computer flood model.

The study team will consult with the community at various stages throughout the flood study to obtain this information:

- a **questionnaire** is included with this information sheet and also available online – we encourage you to complete it to share your past flooding experiences.
- once the computer model is developed, we will ‘door knock’ with local residents and business owners who have experienced flooding problems to verify the model is replicating these past experiences.
- once the draft flood study report is prepared, a **community workshop** will be held to give you an opportunity to review the report and associated mapping and ask questions about any component of the study. Any comments from the workshop will be reviewed and addressed as part of the final report.

WEBSITE

A website has been established for the study. The flood study website is www.werrington.floodstudy.com.au. The website will provide the latest available information on the study including details of the above community consultations. An online version of the questionnaire is also available on the website.

FURTHER INFORMATION

For more information on the College, Orth and Werrington Creeks Overland Flow Flood Study or to submit any information you think may be relevant to the study, please contact:

Catchment Simulation Solutions

David Tetley

Suite 2.01, 210 George Street

Sydney NSW 2000

Phone: 9247 4882

Email: dtetley@csse.com.au

Penrith City Council

Ratnam Thilliyar

PO Box 60

Penrith NSW 2751

Phone: 4732 7777

COLLEGE, ORTH AND WERRINGTON CREEKS CATCHMENT OVERLAND FLOW FLOOD STUDY

COMMUNITY QUESTIONNAIRE

Penrith City Council has engaged Catchment Simulation Solutions Consultant to undertake a detailed overland flow flood study for the College, Orth and Werrington Creeks catchment, which includes the suburbs of Werrington, Werrington County, Cambridge Park, Kingswood and Caddens.

Council encourages you to complete and return this questionnaire to share your experiences and records of flooding in the catchment. This valuable community input will help us prepare an overland flow flood study for the catchment – see the “Information Sheet” for more information.

The questionnaire should only take about 10 minutes to complete. Please try to answer as many questions as you can and give as much detail as possible (attach additional pages if necessary). Please return the completed questionnaire via email (dtetley@csse.com.au) or mail (no postage stamp required) by **Friday 27 November 2015**. Alternatively, you can also complete the questionnaire online at:

WWW.WERRINGTON.FLOODSTUDY.COM.AU

If you have any questions or require further information please contact:

Ratnam Thilliyar from Penrith City Council on 4732 7777

CONTACT DETAILS - OPTIONAL

Providing contact details is optional, but useful if we wish to contact you for additional information, otherwise just providing the name of your street will help. If you choose to provide contact details, this information will remain confidential at all times and will not be published.

Name: ____

Address: ____

____

Phone number: _____________________________________

Email: ____

1) WHAT TYPE OF PROPERTY DO YOU LIVE IN/OWN?

☐ Residential

☐ Commercial

☐ Industrial

☐ Vacant land

☐ Other (please specify) ______________________________

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2) WHAT IS THE OCCUPIER STATUS OF THIS PROPERTY?

- ☐ Owner occupied
- ☐ Rental property
- ☐ Business
- ☐ Other (please specify) ______________________________

3) HOW LONG HAVE YOU LIVED / WORKED IN THE AREA?

(a) At this address? ______________________________

(b) In the general area? ______________________________

4) HAVE YOU EVER BEEN AFFECTED BY FLOODING?

- ☐ Yes
- ☐ No (if No, please go to Question 11)

5) HOW WERE YOU AFFECTED BY FLOODING?

- ☐ Roadway was cut by water
- ☐ My front / back yard was flooded
- ☐ My garage was flooded
- ☐ My house was flooded
- ☐ Sewer or water was turned off at my property
- ☐ Other (please specify) ______________________________

6) CAN YOU PROVIDE ADDITIONAL INFORMATION ON THESE PAST FLOODS?

Date of flood(s)		
Flood depth / height		
Location of depth / height (e.g. on fence, building wall)		
How confident are you of the height / depth of the flood?	☐ High (exact) ☐ Medium (within 10cm) ☐ Low (within 50cm)	☐ High (exact) ☐ Medium (within 10cm) ☐ Low (within 50cm)

7) COULD WE COME AND SPEAK WITH YOU AT A LATER DATE TO CONFIRM OUR FLOOD MODEL IS REPRODUCING YOUR PAST FLOOD EXPERIENCES?

- ☐ Yes
- ☐ No

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8) DO YOU HAVE ANY PHOTOGRAPHS OR VIDEOS OF THESE FLOODS?

☐ Yes

☐ No

If 'Yes', a copy of these photos/videos would assist our study. Please note below if you would like these returned to you.

☐ Yes, please return these to me after the study is completed.

9) WAS YOUR PROPERTY DAMAGED BY FLOODWATERS?

☐ Yes

☐ No

If 'yes', please provide details____

____

____

10) IN YOUR OPINION, WHAT WAS THE MAIN CAUSE OF FLOODING?

☐ Insufficient creek capacity

☐ Insufficient storm capacity

☐ Blockage of creeks, stormwater inlets, bridges or drains

☐ Overland flow impediments (e.g. fences, buildings)

☐ Other (please specify) ______________________________________

11) DO YOU HAVE ANY OTHER COMMENTS, INFORMATION OR SUGGESTIONS YOU THINK MAY ASSIST THE STUDY?

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Thank you for taking the time to complete this questionnaire

It can be returned without a postage stamp or scanned and emailled to: dtetley@csse.com.au by Friday 27th November 2015. Flood photos and videos can also be sent to this email address or posted to:

Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW 2000

Catchment Simulation Solutions will analyse the community responses and report back to Council. If you would like to have items returned please note this in Question 8 and the items will be returned at the conclusion of the study.

Fold here

How to send back this questionnaire...

Please fold this questionnaire using the 'Fold Here' lines as a guide to form a business sized evelope with the address on the front and this text box on the back. Seal the folded pages with tape on all sides to help maintain privacy (please do not use staples) and then post it back.

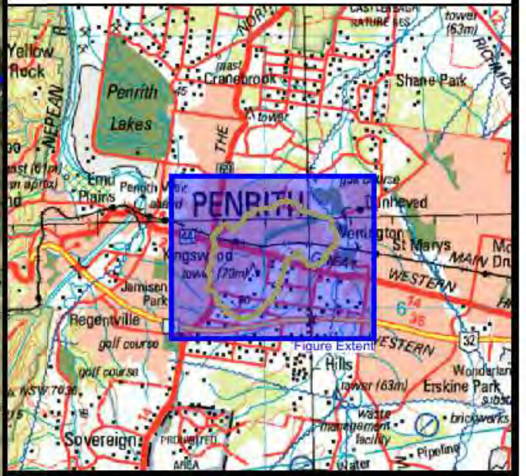
Fold here

No stamp required
if posted in Australia

Delivery Address:
PO Box 60
PENRITH NSW 2751

Penrith City Council
Engineering Services
Reply Paid 60
PENRITH NSW 2751

PENRITH CITY COUNCIL



LEGEND

- College, Orth and Werrington Creeks Catchment
- Watercourse
- Railway

Questionnaire Response Locations
Has flooding been experienced?
- No
- Yes

Notes:
Aerial photograph date: 2014

N W E S

Scale 1:16,000 (at A3)
0 0.5 1.0
Km

Figure A1:
Spatial Distribution of Questionnaire Responses

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig A1 - Community Consultation Responses.wor

Community Questionnaire Responses - College, Orth and Werrington Creeks Catchment Overland Flow Flood Study

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
1	Residential	Owner Occupied	50	Years		Years											No	No		No				
2	Residential	Owner Occupied	47	Years		Years	Y	x	x				The park/paddock next to our property gets flooded each time we get heavy rain				Yes	No		No		Insufficient storm capacity	The land next to the property is low lying and feeds into a catchment drain so flooding occurs when heavy. Prior to installation of catchment drain and pipes, the entire paddock, road and front yard of our property would flood. Since the installation, minor flooding occurs in the paddock and the front of our property.	
3	Residential	Owner Occupied	6	Years	8	Years	Y	x	x	x	x			9/02/2012	2m	Low	Yes	Yes		Yes	Water entered home through laundry door and it covered the laundry, kitchen, dining room etc to approx. 15cm in depth. Water tank was moved when floodwaters undermined footings, backyard and garden completely submerged.	Insufficient creek capacity	Poor planning of stormwater evacuation, insufficient maintenance of creeks & drains. The streets around the area have gum leaves from the trees in Samuel Foster Park clogging the drains as they are never cleaned up.	
4	Residential	Owner Occupied	20	Years	25	Years	Y	x		x				13/02/2015	Waist height on property boundary	Medium	Yes	Yes		Yes	Garage was flooded with items on the ground being water affected. Front yard was flooded.	Build up of land where a nursing home now sits		
5	Commercial	Business	55	Years		Years	Y		x				Club premise was flooded	10/02/2012	30cm on the whole club property	High	Yes	Yes		Yes		Insufficient storm capacity		Attached a snapshot of a report detailing the hazard of water entering onto the sports ground, as well as recommendations for the sports club to investigate the use of flood barriers to protect main electrical room.
6				Years		Years											No	No						
7	Residential	Owner Occupied	25	Years	35	Years														No				
8	Residential	Owner Occupied	>4	Years	7	Years																		
9	Residential	Rental Property	7	Years		Years							Basement was flooded	After heavy storms for the past 6 years	Varies depending on volume of water		Yes	No		Yes	Water and mud flowed through the back wall of our unit in basement entry/storage level. Basement carpark also floods regularly.	Possibly a combination of overland and insufficient storm capacity and blockages		
10	Residential	Rental Property	1	Years		Years											No			No				
11	Vacant Land	Business	1	Years		Years											No	No		No			It is a vacant block of land that we rarely attend to so we are unsure if it is affected by floods at any stage.	
12	Residential	Owner Occupied	3.5	Years		Years																	We have not been affected by Werrington Lake, but we do get run off from other properties after long heavy torrential rain whereby our backyard turns into a stream and runs down the side of the house as well as under our house.	
13	Residential	Owner Occupied	23	Years	23	Years	Y	x	x	x	x			Around 2006-2008; 10/02/2012	18cm; 56cm	High	Yes	Yes		Yes	Fan in the airconditioner had to be replaced and there was a lot of debris left after the flood water receded that smelt and was dirty.	Build up of land in the area, insufficient storm capacity, insufficient creek capacity	I would also like to add that during the 2012 flood my family and I were forced to evacuate our home as the water depth was rapidly increasing , within 5-10 mins of the flood starting the water was one brick away from coming inside the house. We evacuated to two doors up where the water only came up to the fence/ driveway. It also took about 4hours for the water to recede.	
14	Residential	Owner Occupied	24	Years	50	Years											No			No		Insufficient storm capacity	Although our own property was not affected by flooding, our street banks up with storm water during heavy rain possibly due to blocked drains. The trees on our street are very messy.	
15	Residential	Owner Occupied	1	Years	31	Years							My house has not been affected but the creeks around the area swell, those leading in and out of Werrington lakes-Orth Creek and Werrington Creek. The Kingsway bridge at St Marys was cut off by flooding of South Creek, that flooding affects the flood plains around the Colonial Golf Course and Christie St Bridge.				Yes	No		No		Insufficient storm capacity	Generally these creeks are satisfactory to contain the water however in periods of prolonged heavy downpour, flooding does occur into the flood plains between South Creek and Werrington Rd.	
16	Residential	Owner Occupied	27	Years		Years											No			No				
17	Residential	Owner Occupied	9	Years		Years																		
18	Residential	Owner Occupied	3	Years	3	Years	Y	x	x	x				2/01/2012	Different at different locations		No	No		No		Insufficient storm capacity		
19	Residential	Rental Property		Years		Years																		
20	Residential	Owner Occupied	41	Years	41	Years	Y	x	x		x			1978; 2012	> 1m; >1m	Medium	Yes	No		No		Insufficient storm capacity		
21	Residential	Rental Property		Years		Years											Yes	No						
22	Residential	Rental Property	17	Years	25	Years																	Given the increasing level of hard surfaces; new roads, medium density development etc there will be significantly increased run off. The development plans need to allow for drainage basins to manage the flow from exceptionally heavy periods of rain. A good model is the Ponds where a series of water management flows exist on a land surface very similar to the area around Kingswood.	
23	Residential	Owner Occupied	40	Years		Years	Y		x	x	x			2008; 2012	20cm at the fence line; 20cm at the fence line	Medium	Yes	No		No		Lack of stormwater infrastructure in Smith St lots	We have available stormwater connections at the rear of properties in Plunket St but very few to none have bothered to connect. The stormwater just flows down the middle of the lots.	
24	Residential	Owner Occupied	31	Years	40	Years	Y		x					1/01/2015	Back corner of the house and into the backyard - 12 inches deep at the highest level. Approx 2 inches of water sitting in backyard during heavy rain	Low	Yes	Yes		Yes	Granny flat bedroom walls, ceiling, carpet, and wardrobe had to be replaced.		Make sure all drains are well cleared all the time. I have a good drainage system in and around my house but water banks up as it doesn't seem to be able to get away down the stormwater pipes.	
25	Residential	Owner Occupied	25	Years	25	Years																	I have never been affected by flooding during the 25years I have lived in the area.	
26	Residential	Owner Occupied	6	Years	36	Years											No			No			Stormwater drains need to be kept free of debris to allow for stormwater to flow freely.	
27	Residential	Owner Occupied	4.5	Years	30	Years											No	No		No			Whilst my property has not been affected by flooding in the 4.5 years I have lived here, I have seen the paddocks/vacant land between Werrington Road and John Bateman flooded. I have also experienced flooding at the Kingsway, where that road gets closed and everyone has to go to the GWH via werrington road. it becomes very congested.	
28	Residential	Rental Property		Years		Years											No	No		No				
29	Residential	Owner Occupied		Years	40	Years	Y	x					Nature strip covered by water		Corner of John Oxley and Malcolm Ave	Low	Yes	No		No		Sewerage outlet overflow that causes the initial flooding problem	The last time it flooded I phoned the PCC and was told to contact the water board, which I did and was told that when the storm water cannot cope it diverts the water into the sewerage system. I am not making that up and the guys here involved in trades just laughed. Initially the outlet (whatever technical term) on the flood plain on the corner of John Oxley Av and Malcolm Av initiates the 'flood', and then the square thingy (again technical term) on the driveway of 49 John Oxley Av is next and the water springs up like a fountain and then the sewerage follows. Effluent and used toilet paper, odour etc. May I also mention that the dish drain opposite 4 Malcolm Avenue has almost reached capacity a few of times, but has never in the 40 years has it overflowed, quite the opposite the 'flood' water flows into it.	Attached 3 photos showing positions of drains on the street that are causing the problem.
30	Residential	Owner Occupied	32	Years		Years	Y		x	x				Early 2012	Ankle deep	Medium	Yes	No		Yes	Items sitting on the floor of the garage.	Insufficient drainage on the properties situated behind our property		
31	Residential	Owner Occupied	12	Years	25	Years											Yes	No		No				
32	Residential	Owner Occupied	7	Years	28	Years	Y	x	x				Back room flooded		5-10cm on left side of backyard; 3-5cm in back room near left side of backyard	Medium	Yes	No		No	Was at home so was able to move belongings to a higher side of the room, otherwise home belongings would have been damaged.	Both insufficient creek and storm capacity		
33	Residential	Rental Property	6	Years	39	Years											No	No		No				
34	Residential	Owner Occupied	19	Years	31	Years	Y				x			10/02/2012	30cm under house from run-off; 1-2m flooding in the general area	Medium	Yes	No		Yes	Carpet and furniture ruined and had to be replaced.	Overland flow impediments (eg. Fences, buildings)	At the time of the Super Storm there were earth works taking place uphill from our house to construct the new ARV retirement village. Whilst there was high flash flooding in the general area it is felt the earth works contributed to our flooding. This is the only time we have been affected by flash flooding and never by general flooding. It is felt not enough site provision whilst developing building sites was made to cater for the eventuality of this type of storm.	
35	Residential	Rental Property	18	Years		Years																		
36	Residential		8	Years	35	Years																		
37	Residential	Rental Property	4	Years		Years																		
38	Residential	Rental Property	32	Years	32	Years	Y		x	x							Yes	No		No		Overland flow impediments (eg. Fences, buildings)		
39	Residential	Owner Occupied	41	Years	41	Years																		
40	Residential	Owner Occupied	2	Years		Years											No	No		No				
41	Residential	Owner Occupied	25	Years	25	Years																		
42	Residential	Owner Occupied	38	Years	38	Years																	Home has never been affected by flooding.	
43	Residential	Owner Occupied	8	Years	33	Years																		
44	Residential	Owner Occupied	45	Years	68	Years	Y	x						12/01/2010	50cm on Gasgoigne St near Nichols Place	Medium	Yes	No		No	House car and caravan damaged by hail.	Extreme hail storm blocked stormwater drains		
45	Residential	Owner Occupied	16	Years	25	Years	Y	x						2010	30-40cm on Burton Street	Medium	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains		
46	Residential	Owner Occupied	45	Years	54	Years											No	No		No				
47	Residential	Owner Occupied	10	Years	10	Years											No	No		No		Insufficient creek capacity		
48	Residential	Owner Occupied	6.42	Years		Years														No				
49	Residential	Owner Occupied	23	Years		Years	Y		x					2010	5cm	High	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains		

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
50	Residential	Owner Occupied	33	Years	35	Years																		
51	Residential	Owner Occupied	1	Years	37	Years																		
52	Residential	Owner Occupied	16	Years	21	Years	Y		x	x				Every time there is heavy rainfall	10cm in backyard; driveway covered; 5cm in garage	High	Yes	No		No		Insufficient storm capacity		
53	Residential	Owner Occupied	14	Years	25	Years	Y	x						2000	50cm on Cnr Kazanis Cct & Victoria St Footpath/Roadway	Low	Yes	No		No		Blockage of creeks, stormwater inlet, bridges or drains		
54	Residential	Owner Occupied	15	Years	15	Years														No				
55	Residential	Owner Occupied	36	Years	36	Years																		
56	Residential	Owner Occupied	20	Years	47	Years																	I believe if the drainage reserve throughout the Penrith area be planted out with local endemic speices of trees, shrubs, reeds, sedges and grasses the plants would take up some of the water and slow the water down before it gets to the creek/river system. This would also have a flow on effect for the area in trying to cool the local environment and keep parts of Penrith cooler in summer season. This would also reduce the mowing of the retention basins as they are mostly all vegetated by grass. The down side would be residents complaining about looking untidy,snakes, blocking views, shade and other issues. With some of the older retention basins the water drain point is alway at the lowest point so when the retention basin fills, it drains just as quickly not really slowing the water down if these drain point were higher it would hold water for longer.	
57	Residential	Owner Occupied	45	Years	51.5	Years																		
58	Residential	Owner Occupied		Years		Years																		
59	Residential	Owner Occupied	8	Years	42	Years																	Drains are regularly blocked by litter. Example the drains at the lower end of Dundee St are full of green refuse and litter. The drain at the park on the corner of Sandringham and Dundee is regularly full of litter. The street drain on Sandringham at the low level is normally blocked. You can also see how much litter there is in Werrington Creek at Victoria Street. Litter is a big problem for drain blockage.	
60	Residential	Owner Occupied	38	Years	40	Years																		
61	Residential	Owner Occupied	13	Years		Years																		
62	Residential	Owner Occupied	36	Years	36	Years																		
63	Residential	Owner Occupied	2	Years	4	Years											No	No		No				
64	Residential	Owner Occupied	5	Years	5	Years																		
65	Residential	Rental Property	6	Years		Years												No		No				
66	Residential	Owner Occupied	20	Years	32	Years	Y	x					Live opposite Werrington Lake and have seen water up to the tree lines.	Within the past few years	3-4 inches	High	Yes	No		No		Land development	Drudge greeks more often.	
67	Residential	Owner Occupied	40	Years	63	Years	Y		x	x				On 3 occasions the garage flooded but can't remember dates	Garage and through to the back of the house	Medium	Yes	No		Yes	Items were damaged in the garage.	Blockage of creeks, stormwater inlets, bridges or drains	There have been 3 occasions where the backflow came up and flooded Unit 3, and water also went into Unit 2. When there is heavy rain, the overflow of water from the houses in Somerset Street runs into the driveway and into the storm water line, quite often the overflow runs down into Unit 3 and the back yard is under water. There are 3 storm water pits down the driveway, which when we have heavy rain totally fill up. There is an on-site detention system provided to restrict storm water discharge but sometime with heavy rain, this get full. There used to be a creek through the backyard at Unit 3.	
68	Residential	Owner Occupied	10	Years	32	Years																Insufficient storm capacity	I have had flooding in my previous address within the catchment off Werrington road, with the amount of rain that we had there was nowhere for the water to go to - causing me not to be able to attend work for the day until it subsided. This was back in approx 2004.	
69	Residential	Owner Occupied	40	Years	40	Years																		
70	Residential	Owner Occupied	23	Years	27	Years														No				
71	Residential	Owner Occupied	15	Years	40	Years														No				
72	Residential	Owner Occupied	1	Years		Years																	There is no flooding in our street.	
73	Residential	Owner Occupied	10	Years	34	Years																		
74	Residential	Owner Occupied	15	Years	15	Years														No	While I have not been directly affected by flooding, I do notice that when it rains, a bit of water seems to flow down the gutter on the Northern side of Jamison Road and across the intersection of Somerset Street. This goes all the way down the drain after the intersection, suggesting that there may be some blockage of the drains somewhere.		While I have not been directly affected by flooding I do notice that when it rains, a bit of water seems to flow down the gutter on the Northern side of Jamison Road and across the intersection of Somerset Street. This all goes down the drain after the intersection. It suggests that there may be some blockage of the drains somewhere.	
75	Residential	Owner Occupied	41	Years		Years																		
76	Residential	Owner Occupied	8	Years		Years	Y		x				Under the house	Every time there is heavy rain	10-15cm	High	Yes	Yes		Yes	Cracks in walls above areas where house pieres are located.	Overland flow impediments (eg. Fences, buildings)		Attached 4 photos depicting broken bricks and debris.
77	Residential	Owner Occupied	22	Years	22	Years	Y		x				Far right corner of the backyard.	About 20 years ago			Yes	No		No		Insufficient storm capacity		
78	Residential	Owner Occupied	3.6	Years		Years							Water retention underneath the house during heavy rain.	1/04/2015; 06/01/2012	2 inches under house; 3 inches under house	High	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains	I am not sure if the information I have given you is relevant, but would be happy to discuss. Note: due to the grated drain it is always covered with debris eg rubbish, natural debris soil grass etc.	
79	Residential	Owner Occupied	7	Years	32	Years																		
80	Residential	Owner Occupied	44	Years	44	Years														No		Insufficient creek capacity	Keep the creeks and Rivers free of debris and rubbish.	
81	Residential	Owner Occupied	7	Years		Years	Y	x	x					2011	30cm on Chapman and Landers Street	Medium	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains	Vacant bushland adjoining Walker and landers Streets has been rezoned and sold. Was owned by USWNSW. This Land is currently set up as a Stormwater retention Basin. If this Land should get developed our Flood Problems will greatly increase.	
82	Residential	Owner Occupied	46	Years	46	Years																		
83	Residential	Owner Occupied	21	Years	29	Years																	A stormwater collection grill at the T-intersection of Cosgrove Crescent and Pearson Street, Kingswood would ensure timely drainage and reduce traffic hazard in times of heavy rain.	
84	Residential	Rental Property	16	Years	30	Years	Y	x					Bottom of the street was completely flooded.	3 times in the last 30 years	About 1m after the creek at the bottom of the street breaks	Medium	Yes	No		No		Insufficient creek capacity		
85	Residential	Owner Occupied	2	Years		Years																	To my knowledge, our street has not been affected by flood waters.	
86	Residential	Rental Property		Years		Years														No				
87	Residential	Owner Occupied	4	Years		Years														No				
88	Residential	Rental Property		Years	10	Years	Y				x		Flooding under the house frequently					No		No			General stormwater runoff from properties to rear and side of house leads to frequent flooding of my property in rainy weather resulting in moist conditions under the brick veneer house flooring. Highly moist conditions on the property and under flooring leads to an unsafe environment for the tenants.	
89	Residential	Owner Occupied	42	Years		Years	Y	x	x	x			Vehicles flooded	1/02/2012; previous	60cm on building; 66cm on building	High	Yes	No		Yes	Vehicles were damaged, garage contents and machinery damaged, gardens obliterated.	Insufficient creek capacity, insufficient storm capacity	Cowlege Creek isn't cleared of debris on a regular basis and therefore doesn't allow for a clear flow of water in heavy rain periods. The area where the creek flows under the railwayline is often filled with debris and causes backup of water. Most of the damage to our house and neibouring houses was caused by excessive runoff from UWS grounds as there are no retention areas or enough drains on UWS grounds. The mulch from the UWS gardens caused blocked drains and build up on fences and gates to a height of over 60cm in the last 2 floods. Improvements were made with block walls made higher where the creek passes under Second Ave to help prevent bank wash away, but the problem with excessive runoff and mulch from UWS needs to be addressed, as does the stormwater run off from the grounds. Werrington Creek is overgrown with bushshrubs, further impeding clear water flow.	
90	Residential	Owner Occupied	38	Years	52	Years																		
91	Residential	Rental Property		Years		Years																		
92	Residential	Rental Property	12	Years		Years																	For as long as I have had the property, I have not been affected with any flood problems. However, I have a concern with the new constructions and development next to 1 George Street: Title Subdivision Lots 58; 57; 56; 54; 53; 51; 50; and 52 DP 1069025 French Street, Werrington. Hopefully adequate drainage systems will be put in place to accomodate stormwater run off, because if in the future 1 George Street, Kingswood experiences any flooding, the above development will in all probability be the cause.	
93	Residential	Owner Occupied	58	Years	24	Years	Y		x	x	x		Screened enclosure and games room and garden sheds were flooded.	2006; 2010; 2011; 2012	50cm on fence and building walls; 50cm on fence and building walls; 50cm on fence and building walls; 50cm on fence and building walls	High	Yes	Yes		Yes	Carpets, furniture, 2 refrigerators, photos, CDs, personal belongings etc. were all damaged.	Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains from adjoining property; no stormwater access in Stafford Street; overland flow impediments	Thank you for the opportunity to provide information and experiences to assist you in your preparation for an overland flow flood study for catchments in various areas including Kingswood. As you value community support, I hope that you will accept and give consideration to the detailed information and photos enclosed. This information became necessary to Penrith Council over a 7 year period due to the flooding of our property in 2006, 2010, 2011, and 2012. Due to development in the area, units have been built on either side of our property. The middle unit at 27 Stafford Street interrupts te flow of the natural water course, causing the drainage system during torrential rain to be inadequate. As a result of this development, we are being dammed in.	Attached 15 photos showing knee-high water level in the games room, sun room, and backyard. Attached letters to Penrith Council, Mayor, Claims Management Australasia, and the press in an attempt to rectify the flooding issue.
94	Residential	Owner Occupied	0.17	Years	0.17	Years																		
95	Residential	Rental Property	3	Years	3	Years																		
96	Residential	Owner Occupied	25	Years	11	Years	Y	x	x					1990			Yes	Yes		No		Blockage of creeks, stormwater inlets, bridges or drains	The WSU project is looking to build in a flood prone area. Care must be taken to protect properties from future development and re-distribution of flood protection.	
97	Residential	Owner Occupied	34	Years		Years																		
98	Residential	Owner Occupied	4	Years	4	Years	Y		x	x				Apr-15	5-10cm	Medium	Yes	No		Yes	Cupboards inside garage damaged	Insufficient storm capacity		
99	Residential	Owner Occupied	0.25	Years		Years																		
100	Residential	Owner Occupied	0.1	Years		Years																		
101	Residential	Rental Property		Years		Years																	Have owned this property for 22 years and it has never flooded.	

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
102	Residential	Owner Occupied	10	Years	15	Years	Y	x	x				Motor vehicle parked in carport was partially flooded	09/02/2012; 10/02/2012	10cm on the brick fence; 10cm on brick fence	High	Yes	Yes		Yes	Downpipe broke at joints due to volume of water. Auto electrician was required to solve electrical issues with the vehicle following some water inundation of electronic bays and switches.	Insufficient creek capacity, overland flow impediments		Letter was attached detailing slight damage done to his property as well as significant damage done to neighbouring properties. Believes that construction of an aged care facility blocked access of runoff to lower ground. Attached newspaper article and police warnings of the 2012 flash flood, as well as 4 Google map photos of the location of aged care facility in relation to property.
103	Other	Owner Occupied		Years		Years	Y	x	x		x		Overland flow pipes				Yes	Yes		Yes		Insufficient creek capacity; overland flow impediments; blockage of creeks, stormwater inlets, bridges or drains		Attached 27 photos showing damage done to the exterior and interior of UWS campus. Interior was flooded and ceiling had deteriorated and fallen. Lecture rooms were flooded and exterior fences had toppled over due to debris blocking access of runoff to lower ground. Included was a report summarising costs of replacement and repair of damaged property. Also included was a Culvert Inspection report by the Tasman Associates.
104	Residential	Owner Occupied	5	Years		Years	Y	x	x	x				6/10/2011	50cm	Medium	No	Yes	Yes	Yes	Water under the unit had to be pumped out and the garden was destroyed	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Creek is covered in vegetation that has only been cleaned out twice and even then it was only cleaned out on one side.	5 photos depicting garden tables nearly submerged and the debris left in the aftermath.
105	Residential	Owner Occupied	2.5	Years	10	Years																		
106	Residential	Owner Occupied	3	Years	3	Years																		
107	Residential	Owner Occupied	12	Years	20	Years	Y		x						Ankle deep		Yes	No		No		Insufficient storm capacity; blockage of stormwater inlets and drains	In the twelve years since living here, three times in extreme heavy rain and storm has the water not been able to get away quick enough down the stormwater drains in the common area at the back of the town house complex, thus building up like a mini lake. However, the water level was not high enough to flood anyone's property. On all occasions, the water went down pretty quickly after the rain had stopped however I'm not sure if things would be different had the heavy rain stayed around for some days. I did contact Strata at the time and told them what happened.	
108	Residential	Rental Property	45	Years	50	Years																		
109	Residential	Owner Occupied	2	Years		Years																	Water was just a foot or so under bridge in Burton Street on one occasion. Run off from neighbour's property from under the fence into our rear yard is a little concerning.	
110	Residential	Owner Occupied	7	Years	12	Years																		
111	Residential	Owner Occupied	13	Years	40	Years																	I feel quite safe here.	
112	Residential	Owner Occupied	4	Years	6	Years																		
113				Years		Years																		A letter addressed to Mr Wilkinson had been sent in on 18th July 2014 in regards to the South Creek Flood Study. He has nothing further to add to that letter.
114	Residential	Owner Occupied	5	Years	17	Years																	The main issue that places away from or within flood areas are facing are the drainage systems on main streets and roads. I have noticed that they are slowly being changed due to previous issues with blocked drains from not only debris but also hail blocking the water flow. To ensure proper flow in the event of a flood, a proper design of the drainage system and the quantity and quality of these systems must be maintained. Sometimes they are spread too far to relieve the flow from a huge downpour.	
115	Residential	Owner Occupied	45	Years	55	Years																		
116	Residential	Owner Occupied	53	Years		Years																	I hope we all hear the results of this study. Thank you.	
117	Residential	Owner Occupied	29	Years	40	Years																		
118	Residential	Owner Occupied	2	Years		Years																		
119	Residential	Owner Occupied	3	Years		Years																		
120	Residential	Owner Occupied	53	Years	53	Years																		
121	Residential	Owner Occupied	13	Years		Years																		
122	Residential	Rental Property		Years	34	Years																		
123	Residential	Owner Occupied	27	Years	29	Years																		
124	Residential	Rental Property	10	Years	50	Years																Blockage of creeks, stormwater inlets, bridges or drains		
125	Residential	Owner Occupied	21	Years		Years																		
126	Residential	Owner Occupied	41	Years	41	Years																	Keep street drains clean as this causes a lot of trouble when it rains in the area. More regular street sweeping may help.	
127	Residential	Owner Occupied	28	Years		Years																	I have a stormwater and sewerage manhole in my backyard and during heavy rain they overflow which causes mt sewer to block/overflow.	
128	Residential	Rental Property		Years		Years																	I own one unit in the unit building and it is situated near the Werrington railway station and as far as I know, we have never had any flooding in the 25 years that I have owned the property.	
129	Residential	Rental Property	12	Years	45	Years																		
130	Residential	Owner Occupied	40	Years		Years	Y	x						1988/1989	2m in total (1m over the bridge at Burton Street)	Low	Yes							
131	Residential	Owner Occupied	12	Years	19	Years	Y		x						7cm on the garage wall	High	Yes	No		No		Insufficient storm capacity	Lack of proper drainage on Parker Street and on the road verge.	
132	Residential	Owner Occupied	8	Years	8	Years																		
133	Residential	Owner Occupied	30	Years	68	Years																	A couple of years ago we had some heavy rain and a river of water came from the top of the hill where UWS is and it flowed down Chapman Street. It flooded the townhouses at the Western end of the street. The next day the whole of Railway Street and Walker Street was under water and we couldn't get to Werrington Road until it cleared. There has also been flooding around the creek in Railway Street near the station in years gone by.	
134	Residential	Owner Occupied	50	Years		Years																		
135	Residential	Owner Occupied	34	Years		Years																		
136	Residential	Rental Property		Years		Years																		
137	Residential	Owner Occupied	40	Years	40	Years																Approximately between 1985 to 1990, we experienced very heavy rain which lasted a few days and in that period there was flooding down Victoria Road at Werrington Station. Water was about ankle deep.		
138	Residential	Owner Occupied	3	Years		Years																		
139	Residential	Owner Occupied	22	Years	48	Years																		
140	Residential	Rental Property	30	Years		Years																		
141	Residential	Rental Property	12	Years	20	Years	Y	x	x	x			Cars flooded	Feb-12	50cm about 4 steps from the front door	Low	Yes	No		Yes	Gardens, pool, outside area, and car were flooded		Drains completely filled and overflowed since the rain was substantial	
142	Residential	Owner Occupied	45	Years		Years																		
143	Residential	Owner Occupied	37	Years	45	Years																		
144	Residential	Owner Occupied	6	Years	31	Years	Y			x							No	No		No			Slightly flooded but no property damage. Happens when rain is extremely heavy and continuous. Possible levelling of the property is required.	
145	Residential	Owner Occupied	4.5	Years		Years	Y	x	x				Flooding underneath the house	Jun-12	Over paved area in the backyard	Low	Yes			Yes	Had to have the water underneath the house pumped and extra air flow (via holes) done underneath the house in order to dry out the area.	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	The water flowed down between units in a torrent up to the bottom step of my unit. Water came from up past Railway Street.	
146	Residential	Owner Occupied	13	Years		Years																		
147	Residential	Owner Occupied	8	Years	10	Years																		
148	Residential	Rental Property	35	Years		Years																	It has never flooded in my period of ownership (1980-2015). This includes the large Nepean floods of the early '80s and '90s.	
149	Residential	Owner Occupied	3	Years		Years	Y	x	x					Every time it rains	40-50cm on the fence	High	Yes	Yes		Yes	There is a smell afterwards and the ground is soaked and muddy for a long time.	Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; drains are too small and need to be bigger		Attached 7 photos depicting water flowing down the street, as well as ponding on the property.
150	Residential	Owner Occupied	39	Years		Years	Y		x	x	x						Yes	No		Yes	Water was running down walls after it was blown in under roof capping. Garage flooded and carpet was ruined (twice). Other gear and furniture all but flowed under the back door.	Water couldn't get away fast enough and wind was blowing rain under roof capping	Easier to send someone out to talk to me. Could show and explain better.	
151	Residential	Rental Property	1	Years	1	Years																		
152	Residential	Owner Occupied	5	Years	50	Years	Y		x					2012	1cm to the front step of the front verendah	High	Yes	No		No		Overland flow impediments (eg. Fences, buildings)	Werrington and South Creeks have always historically flooded. As you know, the more buildings and roads cause less natural absorption of water, heightening runoff. I would not recommend any alterations to either as there is a dynamic ecosystem along both, and seeing what developers did at Woodcroft to the natural creek there destroyed a whole animal community as it displaced or buried them completely. I wonder sometimes the qualifications of people who make such decisions or their ulterior motive. PS. I am not a greenie.	
153	Residential	Owner Occupied	37	Years		Years	Y	x	x		x						No	No		Yes	Sunroom flooded from massive rain a few years back and needed to be demolished	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges pr drains; overland flow impediments (eg. Fences, buildings)	When it rains heavily we constantly have a massive puddle of water throughout the whole season on the side of the house. We also retain puddles of water in the backyard. This always happens and is very unhealthy.	
154	Residential	Owner Occupied	2.5	Years	3.5	Years	Y		x						10cm in the front driveway	Medium	Yes	No		No		Downsizing of 4th drainage pipe	Our driveway has 4 drainage pipes. Number 1 and 2 work, number 3 was downsized prior to us moving in, and number 4 is too small so it gets blocked in every time there is heavy rain.	
155	Other	Owner Occupied	16	Years	39	Years	Y	x						1970s			No	No		No		Insufficient creek capacity, weeks of rain, opening Warragamba flood gates	From memory, flooding in the general area was caused by the South Creek area and was a combination of saturated land and the natural flow of water going across the land to reach the Hawkesbury river. Areas I saw flooded were the Northern Road near Richmond Road, Werrington Road, the highway at St Marys, various roads near Oakville. Because the Hawkesbury River narrows, the water can't escape so it banks up.	
156	Residential	Owner Occupied		Years	39	Years																		
157	Residential	Owner Occupied	12	Years	12	Years																		
158	Residential	Owner Occupied	29	Years	29	Years																		
159	Residential	Owner Occupied	37	Years	44	Years																		
160	Residential	Owner Occupied	44	Years	44	Years																	I have been here before Werrington Lakes (my father-in-law actually dug the hole and the overpass at Werrington Station). I remember the Kackery Pits and oritginal creek. At the worst flooding in the mid '80s, there was no real problem and if my memory serves me right, some water came up the storm water pipes in the street. That night it took me 7-8 hours to get home from Smithfield and I saw a lot of flooding that night and spent the next day stripping the interior of the car to drain out the water.	
161	Residential	Owner Occupied	23	Years	23	Years																	Because I reside opposite Kingswood High School, the street sweeper does his best to sweep our gutter but due to the students parking this is not done frequently and some fo their rubbish gets thrown into our drain outlets. Can this be corrected by contacting council with school principal to remedy this by not parking on the residential side of Bringelly Road opposite the high school. I do my best to clean up most of their rubbish but would appreciate help from council.	

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
162	Residential	Rental Property		Years	32	Years																	Damage has been caused to local storm water drains in our area due to building Pergolas along and over the route of these storm water pipes. Some residents do not realise this. We have experienced minor flooding due to this.	
163	Residential	Owner Occupied	32	Years	32	Years																	I have never been affected by flooding, nor has our area ever been affected by flooding. The only flooding I've ever seen is Werrington Creek, Dunneved Road at the bridge, and the old road to St Marys at the playing fields.	
164	Residential	Owner Occupied	22	Years	22	Years																		
165	Residential	Owner Occupied	11	Years	11	Years																		
166	Residential	Owner Occupied	50	Years	54	Years																		
167	Residential	Owner Occupied	50	Years	50	Years	Y	x	x	x				1970	6-8 inches above the footpath	Medium		No		No		Insufficient creek capacity; blockage of creeks, stormwater inlets, bridges or drains	Shortly after this flood, the existing stormwater drains were replaced with larger pipes and there have been no floods since. Suggestion: people living on the street with the drain should assist by keeping it clear of rubbish.	
168	Residential	Owner Occupied	31	Years		Years	Y	x		x					Knee height on the road and ankle deep in the garage	High	Yes			No	Insufficient storm capacity			
169	Residential	Owner Occupied	43	Years		Years																	Nothing noticeable in this area	
170	Residential	Owner Occupied	35	Years		Years																		
171	Residential	Owner Occupied	15.5	Years	33	Years																	Property doesn't flood but if there is a huge downpour, the road floods as the drainage can't handle it. Better drainage or bigger drains would help.	
172	Residential	Owner Occupied	17	Years	20	Years																	We live in Lethbridge Avenue, where we're physically a bit higher. If heavy rains occur, we noticed that John Oxley Drive next to the park were flooded and towards the creek (Werrington Lakes). Also happens in Victoria Street so cars can be diverted to Parker Street rather than Great Western Highwat to come home. My backyard can be a bit flooded (car block in Princess and Lethbridge and store water for a bit longer).	
173	Residential	Owner Occupied	20	Years		Years																		
174	Residential	Owner Occupied	40	Years		Years																		
175	Residential	Rental Property	2.5	Years	35	Years																		
176	Residential	Owner Occupied	55	Years	79	Years																		
177	Residential	Owner Occupied	33	Years	33	Years																		
178	Residential	Owner Occupied	31	Years		Years	Y	x	x	x				10/02/2012	50cm lapping under floodboards	Medium	Yes	Yes	Yes	Yes	Floodin of: garage, shed rollerdoor, air conditioner motor, hotwater system, everything stored at ground level to 1m	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	This area was established post-war, which means outdated stormwater drainage, poor maintenance of parklands/creeks, infrastructure not designed to cope with medium density living, lack of forward planning in established areas for new developments. Please feel free to contact us regarding these issues.	Disc was supplied. Attached 14 photos showing aforementioned water level in the garage, as well as debris left on the porch and garden the following day(s).
179	Residential	Rental Property		Years		Years	Y	x						Feb-12	Water flowed over the 2 bridges	High	Yes	Yes		No	Luckily the water level was about 10cm below front door entry. The common driveway was coompletely flooded.	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments (eg. Fences, buildings)	In my opinion, the inability of flood water to flow away from Cosgrove Crescent, Kingswood downstream to the Nepean River is the main problem. As a member of Kingswood Bowling Clib in Santley Crescent, I saw the greens and clubhouse and carparks flooded because of insufficient drainage. Both property's drainage appear to meet at a common junction. Any impedence to water flow upstream may have helped prevent greater damage further downstream from higher water levels.	Attached 5 photos of debris blocking drains and 3 Google map images showing a view of Cosgrove Street in relation to its surroundings.
180	Residential	Rental Property		Years		Years																		
181	Residential	Owner Occupied	8	Years		Years	Y		x	x			Water came into the villa	2009	2 inches in the garage	Medium	Yes	No		No		Insufficient storm capacity	Water through the garage has quickly subsided into the drain in the backyard. No damage was done as I lifted contents before damage was done. The water came within 1-2 inches of entering my front door. The villa next door had water enter and the occupants had to dry the articles outside. Another flood occurred about a year ago but did not affect me too much.	
182	Residential	Rental Property		Years		Years	Y		x						30cm on back fence	Medium	Yes	No		No	High water mark can be seen on fence.	Overland flow impediments (eg. Fences, buildings)	Occurs during major downpours. Extra drainage required at property directly behind my property (5 Angel Street) through 7 Fawkener Street. Previous owners of 7 Fawkener Street had raised garden bed at our common boundary fence, and was told they did this to prevent storm water from coming through their back door.	
183	Residential	Rental Property	10	Years	34	Years																		
184	Residential	Owner Occupied	44	Years		Years	Y	x									Yes	No		No		Stormwater drains (four around my property) are blocked by debris; blockage of stormwater inlets, overland flow impediments		
185	Residential	Owner Occupied	26	Years	26	Years																	Despite no effects by flooding at this address for the past 26 years, we do question possible future problems in the area caused by recent major building projects at Cadens and the Knoll now being covered by roads, roof tiles and concrete driveways on very small building plots. The soakaway effect of the previous grasslands and ponds now reduced, thus increasing the run off load to the current drainage system.	
186	Residential	Owner Occupied	43	Years		Years	Y	x	x					2010	3 inches deep	Medium	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains	The corner of Daphne Close and Cosgrove Crescent still collects water and will damage the road surface in time. In heavy continuous rain, the water still covers the width of the road.	
187	Residential	Owner Occupied	26	Years	50	Years											No	No		No			Council needs to keep drains and drain catchments clear and clean.	
188	Residential	Rental Property	22	Years	53	Years																		
189	Residential	Rental Property		Years		Years																		
190	Residential	Owner Occupied	1	Years	53	Years	Y				x			1995	1 inch	Low								
191	Residential	Owner Occupied	50	Years		Years																		
192	Residential	Rental Property		Years	2	Years	Y		x	x				2014	5-10cm in the garage and backyard	Low	Yes	No		No		Overland flow impediments (eg. Fences, buildings)		
193	Residential	Owner Occupied	45	Years	45	Years	Y	x	x	x				Feb-12			Yes	Yes		Yes	Driveway, fence, and air conditioner flooded; car that was parked in the garage was written off; various tools in the garage damaged	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets. Bridges or drains; new building developments with no improvement to drainage	Road was cut and water filled the yard on approximately 10 occasions over the past 45 years. Really concerned about the new developments going on around - they cut down water absorbing ground which sends drainage water rushing down an already inadequate creek that is expected to be the major stormwater drain. The creek has silted up (the pipes under the road also) and there has been very little improvement or maintenance while putting more demand on it with all the new developments.	
194	Residential	Owner Occupied	13	Years		Years	Y		x			x		2015			Yes	No		Yes	Sewage was backflowed around carport which smelt terrible	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets		
195	Residential	Owner Occupied	42	Years		Years	Y	x	x	x			Shed in backyard was flooded		30cm in front/back yard, shed, and garage		No	Yes		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments (eg. Fences, buildings)	Issues include: over development, piping in natural waterways, letting neighbours put up structures on fence line without approval, 200 foot driveway by neighbour with no gutter which means that rain floods into my yard during constant and heavy rain, overflow from neighbour's pool pours under fence when pool fills in heavy rain. I have purchased 2 water pumps to get rid of excess water in front and back yards. Never had issues until over development was allowed.	
196	Residential	Owner Occupied	35	Years		Years																	Never had concerns.	
197	Residential	Owner Occupied	15	Years		Years	Y		x								Yes	No		Yes	Crack cement paths	Insufficient storm capacity; blockage of stormwater inlets and drains; overland flow impediments (eg. Fences, buildings)	I feel that there needs to be more drainage. As I live on a corner block, most of the land belongs to the council. I am hoping that something will be done.	
198	Residential	Owner Occupied	12	Years	14	Years	Y	x	x					2010-2011	2m inside front boundary line	Medium	Yes	No		Yes	Washed garden beds away	Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Completely isolated on both frontages on front. Keep creek beds and surrounding areas clear of vegetation and rubbish. Water wouldn't go through pipes under bridge on Victoria Street so it flowed over top of road and caused back-up back to Railway property.	
199	Residential	Owner Occupied	39	Years		Years	Y	x	x						25-50cm	Medium	Yes	No	No	No		Insufficient storm capacity	When there was a house on the land next dorr, the SES had to evacuate the people on two occasions. On one occasion, the water around the Werrington train station was waist deep.	
200	Residential	Owner Occupied	29	Years	34	Years	Y	x						1986; 1988; every 3-4 years since 1988	1m on fence; 1.4m up to front steps of house; 30-80cm on footpath/fence	Medium	No	Yes		No		Insufficient storm capacity (as storm water grates are located where floods are deepest)	As Dunkley Place is a cul-de-sac, any exit to Gibson Avenue is blocked until the flood water subside - sometimes a few hours, sometimes a day or more. This can create access problems getting to work/appointments for anyone on the Eastern end of the street.	Attached 2 pictures from July 1988 depicting road completely flooded.
201	Vacant Land	Other	45	Years		Years	Y	x	x								Yes	No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Instead of solving the flooding problem, Council has made it worse by incorrectly locating the drainage channel 45 years ago. This has resulted in raising the 1 in 100 year flood levels, thus reducing the area of land available for housing and public benefits. It should now fix the problem by getting the necessary approvals, to firstly implement a practical engineering solution by relocating the channel or a buried pipeline so that flood water flows in the same direction as in Werrington Creek, rather than against the flood waters of the creek. Council should also clean out the bottom of the Werrington Creek to improve the velocity of flow, so that flood waters will drain away without overtopping the banks of the creek and inundating the surrounding lands.	Attached a detailed response to the 'Any Suggestions?' question
202	Residential	Owner Occupied	4	Years	10	Years																	The intersection at Jamison Road and Somerset Street always has build up of feep puddles, even with not a lot of rain. Maybe more drainage at this intersection may help.	
203	Residential	Owner Occupied	11	Years		Years																		
204	Residential	Owner Occupied	43	Years	43	Years																		
205	Residential	Owner Occupied	33	Years		Years																		
206	Residential	Owner Occupied	3	Years	36	Years																		
207	Residential	Owner Occupied	34	Years	37	Years																		
208	Residential	Owner Occupied	59	Years	60	Years	Y	x						1978;1989	Too deep to drive through; across Heavey Street	Medium	Yes	No		No		Overflow from Werrington Creek - not enough water storage	Within the last 2 years, Council has correctly refused an application to subdivide and build on lots 19 and 20 DP1942 No 29 Heavey Street. This block is the only storage that Werrington Creek has, when it's in overflow. Residents of Heavey Street and surrounds are keen to ensure that this storage block is kept. Even with this torage, Heavey Street, Lack Place, Andro Place and Burton Street floods.	
209	Residential	Owner Occupied	33	Years		Years											Yes	No		No				
210	Residential	Owner Occupied	31	Years		Years	Y	x	x					2012	Very high, up to the first verendah step		Yes	Yes		No		Insufficient creek capacity; insufficient storm capacity	Creekbed needs to be cleared more often	
211	Residential	Rental Property	7	Years		Years	Y						Flooding in complex, garage, bin area, basement, walls discoloured											Attached a picture of a pool of water trapped inside the compounds
212	Residential	Owner Occupied	41	Years		Years	Y	x														Blockage of creeks, stormwater inlets, bridges or drains	A neighbour on the west has not put in a proper drainage system. They have just put in a slotted drain pipe near the fence which has come under the fence to my side, thus flooding my yard and flooding under the house. This is causing trouble under the brick steps and balustrade at the front of my house. The water is then going down a ditch on the footpath of the other side of the street that people have tripped over walking down there in front of their place.	
213	Residential	Owner Occupied	26	Years	26	Years	Y	x	x					2006	20cm	Low	Yes	No		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Storm water drains couldn't take the capacity of rain and run off from the storm.	
214	Residential	Owner Occupied	15	Years		Years	Y		x				When it rains, it floods all under my house				Yes	No		Yes	Visibly no, but who knows what is happening under the house			
215	Residential	Owner Occupied	15	Years	50	Years	Y	x	x	x				Jan-July 2006; Feb 2012	Water rose to 35cm high at back fence; 44cm at the distance between base of gutter and highest point of driveway	High	Yes	Yes		Yes	Silt built up on the back fence and water flowed through the garage	Insufficient storm capacity		Attached 4 photos showing damage to garde (2006) and walking flowing down the street (2012)

#	Property Type	Occupier Status	How long have your lived in area? Current Address		In the general area?		Have you been affected by flooding?	How were you affected by flooding? Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Can you provide additional information on these past floods? Date of Floods	Location of depth/height	Confidence Level	Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage: Was your property damaged by floodwaters?	Details	In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
216	Residential	Owner Occupied	8	Years		Years																		
217	Residential	Owner Occupied	5.5	Years	27	Years	Y	x	x					19/12/2011	15cm at the fence and garden brick border	High	Yes	Yes		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments (eg. Fences, buildings)	The bridge on Burton Street and Victoria Street in Werrington both went under during this flood event, even though it doesn't impact our ability to get around as there are other streets not impacted by flooding. Our backyard always retains water during heavy rain. Our neighbour, who is an oritginal owner in the street, mentioned that there were special drain-like systems put in during housing development. These are meant to run along, underground, the back fence where flooding occurs, so I do question their effectiveness. The park across the road floods in heavy rain events, suggesting that the drain and stormwater struggle to keep up with the volume of water that runs down hill from the park.	Attached 4 photos depicting ponding in the backyard and water gushing across vacant land and into a drain
218	Residential	Owner Occupied	30	Years		Years																		
219	Residential	Owner Occupied	35	Years	40	Years	Y	x	x				In 1986, there was a blackout and shops were flooded and no road access	1986; 1988	25cm in the front/side yards and 30cm along back fence; 40cm in the paddock and Heavey St completely inundated	High	Yes			Yes	The floor of the garden shed and was undermined, leaving a large hole	Insufficient creek capacity; insufficient storm capacity; overflow of pondage in UWS grounds	Recently, applications for development of the paddock in Heavey Street for housing has occurred twice. Fortunately, Council has recognised the concerns of local residents that such developments would cause flood events to be more dangerous and destructive. The open plain of the creek allows the water to spread and slowly disperse as flooding subsides. The Dunheven Road and Werrington Road development have already restricted the natural flow of floodwater.	Attached 2 photos of paddock flooding
220	Residential	Rental Property		Years	20	Years	Y		x	x			Driveway leading into townhouse complex flooded	2010	16cm lapped at bottom of rear sliding glass door, water entered garage through rear door	High	Yes	Yes		Yes	Damage to goods/boxes on the garage floor. Much of it was thrown away due to water damage. Had only recently moved into townhouse so there were many boxes in the garage	Insufficient storm capacity; proximity of complex to creek at rear	Townhouse complex is located on land that slopes away from the side of First Street and is on the same side as the creek (runs through easement at rear of complex). Entry to driveway is lowest point and allows rainwater to escape First Street and run into the complex. Water ran down complex driveway and across nature strip into townhouses' backyards. Storm water drains in street back up and overflowing, unable to cope with the volume of rain that fell in a very short period.	
221	Residential	Owner Occupied	34	Years	55	Years																		
222	Residential	Owner Occupied	22	Years		Years	Y		x								Yes	No		No		Heavy rain		
223	Residential	Owner Occupied	45	Years		Years												No		No		Blockage of creeks, stormwater inlets, bridges or drains	I think the creeks need a good clean out and kept clean. I know this is not the council's fault where see rubbish hooked on trees and shrubs. It is the people who don't put rubbish in bins. The same with the storm water catchment areas.	
224	Residential	Owner Occupied	40	Years		Years																		
225	Residential	Owner Occupied	38	Years		Years																		
226	Residential	Owner Occupied	6	Years		Years																		
227	Residential	Owner Occupied	45	Years		Years																		
228	Residential	Owner Occupied	9	Years		Years	Y	x									Yes	No		No	Insufficient storm capacity	Main cause of flooding was South Creek and waters from Werrington Lake		
229	Residential	Owner Occupied	3	Years		Years																		
230	Residential	Owner Occupied	8	Years		Years																		
231	Residential	Owner Occupied	13	Years	38	Years																		
232	Residential	Owner Occupied	26	Years	26	Years	Y		x	x							Yes	No		No		Insufficient storm capacity	We have no drainage in our property. Our neighbours are the same. In excessive rain, the water races across our powers out the back and laps at the back door. All the water travels down the street through each property.	
233	Residential	Rental Property	3	Years		Years																		
234	Residential	Owner Occupied	30	Years	80	Years																	No flooding in this street.	
235	Residential	Owner Occupied	58	Years	59	Years	Y		x									No				Overland flow impediments (eg. Fences, buildings); house next door stops runoff	Next door is 18 Oxford Street. It stops runoff of water by blocking the bottom of the fence within fibro so that the water can't get away. Due to the slope of the land, during heavy rains the water takes a long time to get away. It has been like this for 30 years when it rains heavily.	
236	Residential	Owner Occupied	59	Years		Years											Yes			No		Insufficient storm capacity	For years we had a creek in the block at the back of us, then council put 2 huge pipes in but they aren't big. About 5-6 years ago, the town houses had their underground parking flooded and it took fire brigade 3.5 days to pump it out.	
237	Residential	Owner Occupied	37	Years	40	Years																	Keep weeds cut where Orth and College Creeks cross Victoria Road	
238	Residential	Owner Occupied	44	Years		Years																		
239	Residential	Owner Occupied	64	Years		Years																		
240	Residential	Owner Occupied	54	Years		Years																		
241	Residential	Owner Occupied	43	Years		Years	Y	x	x	x			Side and back fences were damaged	Feb-12	1.5m	Low	Yes	Yes		Yes	Side/back fences damaged. Garden shed flooded, lawn mowers/line trimmers destroyed, potted plants washed away	Insufficient creek capacity; blockage of creeks, stormwater inlets, bridges or drains	Large opened area north of railway viadvet narrows into creek behind the houses. In heavy rain,. Water from under the railway can't flow into the narro creek due to reeds, trees and rubbish. Creek requires dredging on a regular basis. I also feel that the openings under the Victoria Street bridge are too small to allow the water to pass through, causing it to back up and spill over onto Heath Street.	
242	Residential	Owner Occupied	35	Years	35	Years																		
243	Residential	Owner Occupied	2	Years		Years	Y		x					2015	Front yard was flooded (almost coming into the house)	Medium	Yes	No		No	Insufficient creek capacity; insufficient storm capacity	The day the flood happened I was so shocked. Especially the way the water was coming from the bush side. The water ran through Chapman Street but the capacity of drainage is not enough to take the water so the water level was gradually built and I thought that my house would be flooded. I am more than happy to help so please let me know if you would like to talk.		
244	Residential	Owner Occupied	5	Years	16	Years																		
245	Residential	Owner Occupied	9	Years		Years																		
246	Residential	Owner Occupied	9	Years	9	Years	Y		x	x				May-Jun 2015	30cm along the back fence	Medium	Yes	No		No	Not really but the back garden was ruined	Insufficient storm capacity	A new stormwater drain was put in next door to service the run off from the newly built villa homes. The flooding occurred before this happened. Minor flooding still occurs when it rains heavily.	
247	Residential	Owner Occupied	51	Years	51	Years	Y	x	x						4 inches		Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains	The house next door (27 Walter Street) doesn't havent guttering or downpipes on sheds and so water comes into our yard and flooding it. The water that doesn't flow away stays under our house for some time before it dries up. We aren't sure if all the down pipes on house 27 Walter Street are connected to drains and to the outside gutter.	
248	Residential	Owner Occupied	35	Years		Years																	If the creeks are cleaned on a regular basis, water will flow better.	
249	Residential	Owner Occupied	57	Years		Years																		
250	Residential	Rental Property		Years		Years																	No flooding noted on contract of sale when purchased.	
251	Residential	Owner Occupied	0.8	Years		Years																		
252	Residential	Owner Occupied	45	Years		Years																		
253	Residential	Owner Occupied	15	Years		Years																		
254	Residential	Owner Occupied	35	Years	35	Years	Y			x								No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	No major flooding has occurred around our house as we live on the high side of the street.	
255	Residential	Owner Occupied	53	Years		Years																	In the 53 years, it has never flooded at this address.	
256	Residential	Owner Occupied	44	Years	44	Years																		
257	Residential	Owner Occupied	27	Years		Years																		
258	Residential	Rental Property		Years		Years																		
259	Residential	Rental Property		Years		Years																		
260	Residential	Rental Property		Years		Years																	Never lived at the property and only purchased it 6 months ago.	
261	Commercial	Other	40	Years		Years																		
262	Residential	Owner Occupied	39	Years		Years	Y	x						Early 1980's			Yes	No		No		Insufficient creek capacity; blockage of creeks, stormwater inlets, bridges or drains		Attached a shaded map of the flooded zones.
263	Residential	Rental Property		Years	25	Years																		
264	Residential	Owner Occupied	54	Years	54	Years																		
265	Residential	Owner Occupied	48	Years		Years	Y		x								Yes	No		No			We have not flooded since the council put in large pipes at the back of our back fence in Devon Park Epping Close street end.	
266	Commercial	Owner Occupied	15	Years		Years	Y						Overflow from storm water drain	Feb-12	30cm	Medium	Yes	No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains		
267	Residential	Owner Occupied	11.5	Years	11.5	Years																	When heavy rain occurs, the drains in the street don't cope and this affects the telephone cables. It may be beneficial to clean out drains as they tend to clog in the spring/summer seasons. This is partly due to the dropping of the bottlebrush trees which line the whole street and drop a lot of debris during springtime. When heavy rain occurs, I have been told by Telstra the cables and unit at the corner of Princess St collects water and this affects telephone and internet services. I have had episodes lasting 4-6 weeks without these essential services.	
268	Residential	Owner Occupied	40.75	Years	42	Years	Y	x	x					Before 1988; April 1988	35cm along the wall; 45cm along the wall	High	Yes	Yes		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments (eg. Fences, buildings)	After the 1988 flood, I joined a committee to pressure the State government and council to spend money on flood mitigation projects. I still have paper work from the minutes of those meetings. Lots of work was carried out, but since then most of the work has been taken away and abandoned. I have a theory as to why we flooded and as yet the reason has not been addressed.	
269	Residential	Owner Occupied	38	Years	40	Years	Y	x									Yes	No		No		Insufficient storm capacity		
270	Residential	Owner Occupied	60	Years		Years											Yes	No		No				
271	Residential	Owner Occupied	41	Years		Years																		
272	Residential	Owner Occupied	46	Years		Years																		
273	Residential	Owner Occupied	31	Years		Years																		
274	Residential	Owner Occupied	22	Years	62	Years																	The area has changed due to more development. When there is heavy rain, there are blockages of small storm water drains which taken a while to subside. I assume local blocked drains is also due to leaves etc blocking drains and other matter being washed down.	
275	Residential	Owner Occupied	4	Years	10	Years																	My home is situated on the highest point of Castle Road and definitely wouldn't flood.	
276	Residential	Owner Occupied	30	Years		Years																		
277	Residential	Owner Occupied	44	Years		Years	Y		x								Yes	No		No		Overland flow impediments (eg. Fences, buildings)		
278	Residential	Owner Occupied	25	Years	25	Years																	At the bottom of our yard there is flooding during extensive rainfall. There is a storm water drain in the neighbour's backyard behind us. We aren't sure if he cleans it out, which in turn means there is a build up of water at the end of our yard. We always ensure that the stormwater drain and gutters out the front of our property is clean.	
279	Residential	Owner Occupied		Years		Years																	The only flooding we saw was at Werrington shops and parts of Dunheved Road, but this was during a period of really heavy rain.	
280	Residential	Owner Occupied	21	Years	33	Years	Y		x					2000	10cm against the wall	High	Yes	No		No		Torrential rain overwhelmed storm capacity but drained in < 1hr		
281	Residential	Rental Property	20	Years		Years	Y		x					A few years ago	20cm behind the garage	Medium		No		No		Blockage of creeks, stormwater inlet, bridges or drains		
282	Residential	Rental Property		Years	45	Years											No	No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains		
283	Residential	Owner Occupied	27	Years	27	Years																		
284	Residential	Owner Occupied	40	Years	40	Years																		
285	Residential	Owner Occupied	39	Years	39	Years																		
286	Residential	Owner Occupied	55	Years		Years																		
287	Residential	Owner Occupied	44	Years	44	Years	Y		x								Yes	No		No		Overland flow impediments (eg. Fences, buildings)		
288	Residential	Owner Occupied	43	Years		Years																		
289	Residential	Owner Occupied	13	Years	20	Years																	I have a stormwater pit in my backyard.	
290	Residential	Owner Occupied	38	Years		Years																		

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
291	Residential	Owner Occupied	10	Years	15	Years											No	No		No		Blockage of creeks, stormwater inlets, bridges or drains	The street drain often gets full of predictable leaves and matter which leads to predictable local street flooding. Local trees shed leaves and bark predictably every year, that then clog drainage systems. Simple targeted street sweeping, more than normal at the right time, would allow the system to function properly. So buy more street sweepers and use them.	
292	Residential	Owner Occupied	47	Years		Years																		
293	Residential	Rental Property	10	Years	35	Years											Yes	No		No			No flooding in this area to the best of my knowledge.	
294	Residential	Owner Occupied	43	Years		Years											No	No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains		
295	Residential	Owner Occupied	33	Years	45	Years																	The only flooding occurred at Werrington Creek at the bridge on John Oxley Road, and occurred once in 10 years.	
296	Commercial	Business	18	Years		Years	Y	x	x	x					30cm throughout the property and on Cox Avenue	High	Yes	Yes		Yes	Mud throughout the building	Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Flooding has occurred many times over the past 18 years.	Evidence of flooding available on Youtube: "hail storm at Penrith KSRSmashrepairs".
297	Residential	Owner Occupied	3	Years		Years																		
298	Residential	Owner Occupied	3	Years	30	Years																		
299	Residential	Owner Occupied	30	Years		Years	Y		x	x				Between 2005-2007	12cm	Medium	Yes	No		No				
300	Residential	Owner Occupied	5	Years		Years																	So far so good, the property is built high so no rainwater comes into the townhouse. The drains and sewers should be more looked at so that they aren't clogged out on the roads.	
301	Residential	Owner Occupied	13	Years	13	Years																		
302	Residential	Owner Occupied	44	Years		Years																		
303	Residential	Owner Occupied	55	Years	55	Years																		
304	Residential	Owner Occupied	45	Years		Years	Y	x	x				Sewer pit in my backyard always gets blocked when it rains heavily				Yes	No		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains		
305	Residential	Owner Occupied	8	Years	39	Years																	Stop owners from blocking off natural water flow when it is not affecting their property.	
306	Residential	Owner Occupied	20	Years	30	Years																		
307	Residential	Owner Occupied	42	Years	42	Years																		
308	Residential	Owner Occupied	2	Years		Years																		
309	Residential	Owner Occupied	36	Years	36	Years	Y	x						1980s	2-3 inches on the roadway	Medium	No	Yes		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	The street doesn't flood as it did in earlier years due to better stormwater drainage. Our street was established before north of Dunneved Road. The extra stormwater from there joining our stormwater meant that the stormwater drainage could not cope, resulting in flooding.	Attached 2 photos of the street and cars partially submerged in water.
310	Residential	Owner Occupied	16	Years	16	Years																		
311	Residential	Owner Occupied	40	Years		Years																		
312	Residential	Owner Occupied	30	Years	40	Years																		
313	Residential	Owner Occupied	50	Years		Years											Yes							
314	Residential	Owner Occupied	2	Years	30	Years																		
315	Residential	Owner Occupied	12	Years	50	Years	Y	x	x					1967	3 feet	Low	Yes	No		No		Blockage of creeks, stormwater inlets, bridges or drains	Water was over knee deep to get to the railway station and around that area.	
316	Residential	Owner Occupied	25	Years		Years	Y		x	x					17.5cm	Low	Yes	No		No		Overland flow impediments (eg. Fences, buildings)		
317	Residential	Rental Property		Years		Years																		
318	Residential	Owner Occupied		Years		Years																		
319	Residential	Owner Occupied	20	Years		Years																		
320	Residential	Owner Occupied		Years		Years																	There has been no flooding in 40 years.	
321	Residential	Owner Occupied	9	Years	9	Years																	Never witnessed any flooding where I am located. Where I am, the street is slightly higher so during heavy downpour, water runs off easily. It has never been a concern.	
322	Residential	Owner Occupied	2	Years	2	Years	Y	x					Water ponds in the gutter at the front of the driveway		6 inches in the gutter at the base of the driveway and down the street	Medium	Yes	No		No		Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Water ponds in the gutter from our driveway up to Jamison Road. It occurs every time there is constant, medium rain.	
323	Residential	Owner Occupied	3	Years		Years																	Clear stormwater drains and creeks of rubbish more often.	
324	Residential	Owner Occupied	40	Years		Years												No		No				
325	Residential	Owner Occupied	35	Years	50	Years																	I believe that stormwater drains require frequent cleaning, as well as street sweeping.	
326	Residential	Owner Occupied	55	Years		Years																		
327	Residential	Rental Property	35	Years	38	Years																		
328	Residential	Owner Occupied	11	Years		Years																		
329	Residential	Owner Occupied	43	Years		Years																	All drains in my area go to Werrington Lake. Its been many years since I have seen a drain cleaner truck in our area. I was on the first committee when the dirt was being taken out to make the overpass over the railway. Our main concern was safety as the water is very deep in the middle near the island. Council promised that the water would be clean, as we all know that it's only a big storm water drain. The only flooding I have seen was in Heavey St.	
330	Commercial	Business	19	Years		Years																		
331	Residential	Owner Occupied	39	Years		Years																		
332	Residential	Owner Occupied	34	Years		Years	Y			x			Broken easement pipe	2012	Fast flowing water	Low	Yes	No		Yes	Garage foundations affected and front driveway had to be replaced	Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Easement through the property wasn't maintained, causing fracture in the drain pipe. During heavy storms, no silt pit or surge pit installed at gutter exit. A file on this problem exists at the council. This property does not get any service or benefit from the stormwater pipe.	
333	Residential	Owner Occupied	57	Years		Years	Y	x	x					Always	Above the road and into the front yard. Covers the entire corner of Devon Road and Wrench Street	High	Yes	No		No		Insufficient storm capacity		
334	Residential	Owner Occupied	15	Years		Years																		
335	Residential	Owner Occupied	27	Years		Years																		
336	Residential	Owner Occupied	26	Years		Years	Y		x	x							Yes	No		Yes	Stormwater entered house and damaged carpet and furniture and flooded garage	Insufficient storm capacity; stormwater runoff from council reserve	Put some drainage to stop the water coming through the property as it also affects the other houses behind and beside me.	
337	Residential	Owner Occupied	31	Years		Years	Y		x						Went up to the fence	Low	No	No		No		Blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments (eg. Fences, buildings)		
338	Residential	Owner Occupied	21.5	Years	21.5	Years																		
339	Residential	Owner Occupied	3.5	Years	20	Years																	In the 3 years I have lived here, I have had to call Sydney Water 4 times. Whenever there happens to be heavy rainfall, the sewer overflows through the small metal lid-type hatch that is located on my driveway. It flows into the stormwater drain, but leaves a 5 metre trail of sewage from the hatch to the beginning of the driveway.	
340	Residential	Owner Occupied	1	Years	1	Years																		
341	Residential	Owner Occupied	46	Years		Years																		
342	Residential	Owner Occupied	23	Years	49	Years																		
343	Residential	Owner Occupied	20	Years	20	Years																		
344	Residential	Rental Property		Years	10	Years																		
345	Residential	Owner Occupied		Years		Years																		
346	Residential	Owner Occupied	35	Years	47	Years																		
347	Residential	Owner Occupied	44	Years		Years																		
348	Residential	Rental Property	14	Years		Years																		
349	Residential	Owner Occupied	29	Years		Years																		
350	Commercial	Rental Property	23	Years		Years																		
351	Other	Owner Occupied	29	Years		Years																		
352	Industrial	Business	15	Years		Years																		
353	Residential	Owner Occupied	36	Years	44	Years	Y	x						1975	1 foot on the road	Medium	Yes	No		No	Insufficient storm capacity	Problem seems to have been solved after adding storm-holding dams and a large drain.		
354	Residential	Owner Occupied	23	Years		Years																		
355	Residential	Rental Property	43	Years		Years																		
356	Residential	Owner Occupied	34	Years		Years																		
357	Vacant Land	Owner Occupied	0.5	Years	28	Years																	In 1988 we bought land and build a house in the Tiverchase Estate at Emu Heights. At the time when the river flooded, flood waters would flow into the reserve adjoining the estate. In the 1990 floods, river water in the reserve was 1m below the street level. Penrith Council took action by piping so the floodwaters didn't drain into the adjoining reserve when the river flooded. Since then, the adjoining reserve has never had floddwaters banking up from the river.	
358	Residential	Owner Occupied	29	Years		Years																		
359	Residential	Owner Occupied	40	Years	40	Years																		
360	Residential	Owner Occupied	14	Years	25	Years																	I believe that we do not do enough to harvest water during large rain periods. All water from roods and roads end up in streams and creeks. There are huge volumes of water because of the amount of housing water is unable to soak into these large areas of land. If possible, large dams could be created along side creek systems with a spillway that when the creeks rise, would overflow into these dams. Without damming of creeks, they would still be flushed during rain periods. This water would provide areas for bird and wildlife and could also be used as pick up points for helicopter fire fighters during bushfires. There is a great spot for one of these dams in the reserve down the road from my place.	
361	Residential	Owner Occupied	43	Years		Years												No		No				
362	Residential	Owner Occupied	42	Years		Years																	We have lived here for 42 years and have had a lot of rain, but we have never flooded.	
363	Residential	Rental Property	50	Years	50	Years																		
364	Residential	Owner Occupied	15.5	Years	15.5	Years																	In the years we have been at this address, Werrington Creek has always tolerated heavy rains well and we have never been in danger of the street being flooded unless it has occurred when we've been away on holiday.	
365	Residential	Owner Occupied	16	Years	16	Years																		
366	Residential	Rental Property	43	Years	43	Years																	Elizabeth Crescent has never been flood-affected.	
367	Residential	Owner Occupied	35	Years		Years	Y	x						Many times since 1980s	Different heights blocking the street		Yes			No		Insufficient creek capacity; insufficient storm capacity; 2 drains overflowing	Each time we have continual rain for over a week, our street is cut by water. The water is too deep for any car to pass and parking in the street is impossible. Usually when the creek floods, the 2 drains in our street overflow.	
368	Residential	Owner Occupied	7	Years		Years																		
369	Residential	Owner Occupied	42	Years		Years	Y	x	x					1988	Front step	High	Yes	Yes		No		Blockage of creeks, stormwater inlets, bridges or drains		
370	Residential	Owner Occupied	1.5	Years		Years																		
371	Residential	Owner Occupied		Years	15	Years																		
372	Residential	Owner Occupied	35	Years	35	Years																	We are not affected by floods in this street.	

#	Property Type	Occupier Status	How long have your lived in area?				Have you been affected by flooding?	How were you affected by flooding?						Can you provide additional information on these past floods?			Could we come and speak with you at a later date?	Photo / Video?	Would you like us to return them to you?	Property Damage		In your opinion, what was the main cause of flooding?	Do you have any other comments, information or suggestions?	Comments
			Current Address		In the general area?			Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Sewer or water was turned off at my property	Other	Date of Floods	Location of depth/height	Confidence Level				Was your property damaged by floodwaters?	Details			
373	Residential	Owner Occupied	49	Years		Years																		
374	Residential	Owner Occupied	45	Years		Years																	Have never seen flooding in this area. I am on the high end of the street.	
375	Residential	Owner Occupied	41	Years		Years											No	No		No		Insufficient creek capacity		
376	Residential	Owner Occupied	23	Years	23	Years	Y		x				Side of house next door	At least 6 times over the years	8 inches under and on the side of the house	Medium	Yes	No		Yes	Concrete pathway and side of house have deteriorated and under the house as it is on piers	Insufficient storm capacity	These events occur in extreme storms and we get run off from land reserve behind our residential homes.	
377	Residential	Owner Occupied	15	Years		Years																		
378	Residential	Owner Occupied	55	Years	55	Years																		
379	Residential	Owner Occupied	50	Years		Years																		
380	Residential	Owner Occupied		Years		Years																		
381	Residential	Owner Occupied	50	Years		Years																		
382	Residential	Owner Occupied	25	Years		Years																		
383	Residential	Rental Property	3	Years		Years																		
384	Residential	Owner Occupied	1	Years	4.5	Years	Y	x	x				End of street flooded the dead end street	Feb-12	30cm up to weep holes on house	Medium	No	No		No		Insufficient creek capacity; blockage of creeks, stormwater inlets, bridges or drains		
385	Residential	Owner Occupied	40	Years	40	Years	Y	x	x	x				1988	15-20cm up to the house foundations	Medium	Yes	No		No		Insufficient storm capacity	Since 1988 they have more stormwater pipes installed in the road and through the park. We don't have floods as bad as before.	
386	Residential	Owner Occupied	52	Years		Years																		
387	Residential	Owner Occupied	38.5	Years	38.5	Years																		
388	Residential	Owner Occupied	40	Years		Years	Y		x					Any time there is heavy rain	20cm up to the garden shed/fence	Medium	Yes	No		Yes	Anything sitting on the concrete slab was affected, especially the garden products	Overland flow impediments (eg. Fences, buildings); gutter on the carport in adjoining property is missing	As I live at the bottom of the hill, I get run-off water from all adjoining properties. There is an easement located in this area of my property but I don't believe it is made use of.	
389	Residential	Owner Occupied	45	Years		Years																	Sewer came through the area in the early to mid 1970s, but most stormwater in our area going to the sewer network is ultimately overwhelming.	
390	Residential	Owner Occupied	55	Years		Years	Y		x					1961-1962	50cm on the building	Low	Yes	Yes		No		No stormwater channels	More often cleaning of gutter and drains, because if not then the situation will happen like in 1961.	Attached 2 photos of street submerged in water.
391	Residential	Owner Occupied		Years		Years	Y											No		No	Constantly damp underneath the house	Insufficient storm capacity	Flooding occurred from run-off from neighbour's property. We fixed this issue in 2006 during home renovations that invluded a drain being put in along the fence line. We consider this flooding issue to be minor. Our property also contains a 2m drain water easements across the backyard.	
392	Residential	Owner Occupied	26	Years		Years																	Keeping our creeks and water ways clean would help.	
393	Residential	Owner Occupied	26	Years		Years																		
394	Residential	Owner Occupied	6	Years	28	Years																	Would like to mention that Stafford Street at my end floods when we get heavy rain. It seems like the drains cannot handle all the water.	
395	Residential	Owner Occupied	34	Years	34	Years																		
396	Commercial	Business		Years		Years																		
397	Residential	Owner Occupied	39	Years	39	Years																	The creek not far from our home flooded once and it came all the way to 3 Anthony Crescent. The council cleared the creek and with all the rain it has not flooded since.	
398	Residential	Rental Property		Years	3	Years																		
399	Other	Other	3	Years	3	Years																		
400	Residential	Owner Occupied	7	Years		Years																		
401	Residential	Owner Occupied	10	Years		Years																		
402	Residential	Owner Occupied	20	Years	25	Years	Y	x	x	x				9/02/2011	25cm	High	Yes	No		No		Insufficient creek capacity; insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains	Werrington Creek overflowed. Maintenance of creeks and keeping them cleared of debris is a must. I actually am employed with Penrith City Council, North Ward, in parks under supervisor John Reilly. I have been with P.C.C for over 6 years and have noticed the hired "spider" tractor with flail extensions at several locations clearing the creeks in my work area and also along the creek near my house. He doesnt a very good job to a high standard.	
403	Residential	Owner Occupied	40	Years	40	Years																	If we ever get flooded, all of Penrith will be in big trouble!	
404	Residential	Rental Property	13	Years	53	Years	Y		x	x					6 inches on the garage wall	Medium	No	No		No		Blocked stormwater pits on roads	Improve/replace stormwater pits throughout the area as they are old and are never cleaned.	
405	Residential	Owner Occupied	51	Years		Years																		
406	Residential	Owner Occupied	1.25	Years		Years																	I would like to be informed.	
407	Residential	Owner Occupied	26	Years	30	Years																	Because I have not been affected by flooding, I feel I have no suggestion. However, I think the flood study must be of great value to the whole area.	
408	Residential	Owner Occupied	28	Years	28	Years																		
409	Residential	Owner Occupied	20	Years		Years	Y		x				Backyard and driveway were water logged with heavy rain				Yes	No		No	No permanent damage but white ant problem due to dampness	Insufficient storm capacity		
410	Residential	Owner Occupied	15	Years	58	Years																		
411	Residential	Owner Occupied	43	Years	43	Years																	The only known flooding is from the creek is Second Avenue in heavy rains. This appears to have improved after work was done some years ago.	
412	Residential	Owner Occupied	41	Years	41	Years	Y	x						Jul-86	Above headlights on a 2-tonne truck on John Oxley Drive	Medium	Yes	No		No		Insufficient storm capacity	The only known flooding is from the creek is Second Avenue in heavy rains. This appears to have improved after work was done some years ago.	
413	Residential	Owner Occupied	5	Years	12	Years	y		x					16/01/2011	50cm	Medium		No		Yes	We lost a car and hot water system was damaged	Insufficient storm capacity; blockage of creeks, stormwater inlets, bridges or drains; overland flow impediments	There is no storm water solution in our street at all. When we purchased the property, the water was just coming out of the pipe flowing on the ground to next door. When we asked council how/where we should direct the storm water, we were advised to buy a pump and pump it to the street. We understand that there was a pit system from way back, but these are not functioning anymore. I should not have to go around asking all who live around me how their storm water is managed and whether they could fix it so that my house is not flooded every time we get a storm. I should be able to rely on the council to have a plan and advise residents on how storm water is to be managed and follow up that it is being done so that no damage is caused to other properties.	
414	Residential	Owner Occupied	38	Years		Years	Y	x	x	x				9/02/2012	30cm in the garage	High	Yes	Yes		No	Insufficient storm capacity			Attached 4 photos of the inside of the garage flooded.
			25		32																			

APPENDIX B

HISTORIC FLOOD PHOTOS

FEBRUARY 2012 FLOOD PHOTOS

Above floor inundation at 29 Stafford Crescent

Above floor inundation at 29 Stafford Crescent

Water depths of ~0.15 metres alongside of property at 29 Stafford Crescent

Knee high water alongside main drain at 29 Stafford Crescent

Debris mark approximately 0.4 metres above ground level at 24 Morley Ave, Kingswood


Above floor inundation at 24 Morley Ave, Kingswood


Debris mark approximately 0.2 metres above ground level at 24 Morley Ave, Kingswood

Western Sydney University Fence adjoining Second Ave showing debris mark approximately 0.5 metres high

Fence at O’Connell St entrance to Western Sydney University

Above floor inundation of Building BB at Western Sydney University

Debris mark in switch room of Kingswood Sports Club

Sediment deposited across floor of Building R at Western Sydney University after above floor inundation was experienced.

Flooding under floor at 4 Shaw Street (estimated to be 50cm depth)

Debris marks across driveway culverts at 3 Cosgrove Cres

February 2011 Flood Photos

Fence at 66-68 Victoria Street

6 Chisholm Avenue, Werrington County

1986 FLOOD PHOTOS

View from in front of 32 Heavey Street, Werrington looking towards Werrington Creek (1986).

Flood Photos with Unknown Dates

Inundation of back yard at 10 Kingsbury Place (date not nominated)

Inundation of northern end of Kingsbury Place (date not nominated)


Upstream of Victoria Street culvert (date not nominated)


Inundation near 21 Epping Close, Cambridge Park (date not nominated))

Appendix C

Manning's "n" Calculations

Manning's 'n' Calculations

Prepared by: D. Tetley **Date:** 29/01/2016
Checked by: **Date:**

The following provides Manning's' n roughness coefficient calculations based on the modified Cowan method documented in the USGS Paper 2339: "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains' (Arcement & Schneider). The approach was adopted for direct rainfall modelling as it can account for the higher effective roughness likely to be encountered at shallow flow depths

Overview

Manning's 'n' is calculated using the modified Cowan method based on the following formula:

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

Where: n_b = a base value of n for the floodplain's natural bare soil surface
n_1 = a correction factor for the effect of surface irregularities
n_2 = a value for variations in shape and size of the floodplain cross-section (assumed to be 0.0)
n_3 = a value for obstructions
n_4 = a value for vegetation on the floodplain
m = a correction factor for sinuosity (assumed to be 1.0)

Description of Surface / Material Type

Material Type - Grass
Relatively short grass. Occasional obstruction (e.g., fence post)

n_b Calculation

n_b is extracted from the following table:

Table 1. Base Values of Manning's *n*

Bed Material	Median Size of bed material (in millimeters)	Base *n* Value: Straight Uniform Channel[1]	Base *n* Value: Smooth Channel[2]
Sand Channels			
Sand[3]	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025
Firm Soil	--	0.025-0.032	.020

Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
[2] For indicated material; Chow(1959)
[3] Only For Upper regime flow where grain roughness is predominant

Assume "Firm Soil" for grass areas

n_b = 0.025

n_1 Calculation (Degree of Irregularity)

n_1 is extracted from the following table:

Smooth	0.000	Compares to the smoothest, flattest flood-plain attainable in a given bed material.
Minor	0.001-0.005	Is a Flood Plain Slightly irregular in shape. A few rises and dips or sloughs may be more visible on the flood plain.
Moderate	0.006-0.010	Has more rises and dips. Sloughs and hummocks may occur.
Severe	0.011-0.020	Flood Plain very irregular in shape. Many rises and dips or sloughs are visible. Irregular ground surfaces in pasture land and furrows perpendicular to the flow are also included.

Assume "minor" to cater for gradual terrain undulations across most of the study area

n_1 = 0.003

n_3 Calculation (Effect of Obstructions)

n_3 is extracted from the following table:

Negligible	0.000-0.004	Few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	0.040-0.050	Obstructions occupy less than 15 percent of the cross-sectional area.
Appreciable	0.020-0.030	Obstructions occupy from 15 percent to 50 percent of the cross-sectional area.

Occasional tree stump or obstruction may be present:

n_3 = 0.004

n_4 Calculation (Effect of Vegetation)

n_4 is largely driven by the height of flow relative to the height of vegetation as defined in the following table:

Small	0.001-0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow-weed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
Medium	0.010-0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1-to-2-year-old willow trees in the dormant season..
Large	0.025-0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8-to-10-years-old willow or cottonwood trees intergrow with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 0.607 m.;or mature row crops such as small vegetables, or mature field crops where depth flow is at least twice the height of the vegetation.
Very Large	0.050-0.100	Turf grass growing where the average depth of flow is less than half the height of the vegetation; or moderate to dense brush, or heavy stand of timber with few down trees and little undergrowth where depth of flow is

		timber with few down trees and little undergrowth where depth of flow is below branches, or mature field crops where depth of flow is less than the height of the vegetation.
Extreme	0.100-0.200	Dense bushy willow, mesquite, and saltcedar(all vegetation in full foliage), or heavy stand of timber, few down trees, depth of reaching branches.

Assume grass is equal to or less than 0.05 metres in height

n_4 = 0.065	When water depth is < 0.03m	(water depth less than height of grass)
n_4 = 0.035	When water depth is ~ 0.05m	(water depth equal in height to grass)
n_4 = 0.015	When water depth is ~ 0.07m	(water depth less than twice height of grass)
n_4 = 0.005	When water depth is > 0.1m	(water depth more than twice height of grass)

Final 'n' Value

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

n = 0.107	When water depth is < 0.03m
n = 0.077	When water depth is ~ 0.05m
n = 0.052	When water depth is ~ 0.07m
n = 0.031	When water depth is > 0.1m

Manning's 'n' Calculations

Prepared by: D. Tetley | **Date:** 29/01/2016
Checked by: | **Date:**

The following provides Manning's' n roughness coefficient calculations based on the modified Cowan method documented in the USGS Paper 2339: "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains' (Arcement & Schneider). The approach was adopted for direct rainfall modelling as it can account for the higher effective roughness likely to be encountered at shallow flow depths

Overview

Manning's 'n' is calculated using the modified Cowan method based on the following formula:

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

Where: n_b = a base value of n for the floodplain's natural bare soil surface
n_1 = a correction factor for the effect of surface irregularities
n_2 = a value for variations in shape and size of the floodplain cross-section (assumed to be 0.0)
n_3 = a value for obstructions
n_4 = a value for vegetation on the floodplain
m = a correction factor for sinuosity (assumed to be 1.0)

Description of Surface / Material Type

Material Type 3 - Trees
Trees (> 2metres in height) with minimal undergrowth

n_b Calculation

n_b is extracted from the following table:

Table 1. Base Values of Manning's *n*

Bed Material	Median Size of bed material (in millimeters)	Base *n* Value: Straight Uniform Channel[1]	Base *n* Value: Smooth Channel[2]
Sand Channels			
Sand[3]	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025

Firm Soil	--	0.025-0.032	.020
Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
[2] For indicated material; Chow(1959)
[3] Only For Upper regime flow where grain roughness is predominant

Assume "Firm Soil"

n_b = 0.025

n_1 Calculation (Degree of Irregularity)

n_1 is extracted from the following table:

Smooth	0.000	Compares to the smoothest, flattest flood-plain attainable in a given bed material.
Minor	0.001-0.005	Is a Flood Plain Slightly irregular in shape. A few rises and dips or sloughs may be more visible on the flood plain.
Moderate	0.006-0.010	Has more rises and dips. Sloughs and hummocks may occur.
Severe	0.011-0.020	Flood Plain very irregular in shape. Many rises and dips or sloughs are visible. Irregular ground surfaces in pasture land and furrows perpendicular to the flow are also included.

Assume "minor" to cater for gradual terrain undulations across most of the study area

n_1 = 0.003

n_3 Calculation (Effect of Obstructions)

n_3 is extracted from the following table:

Negligible	0.000-0.004	Few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	0.040-0.050	Obstructions occupy less than 15 percent of the cross-sectional area.
Appreciable	0.020-0.030	Obstructions occupy from 15 percent to 50 percent of the cross-sectional area.

Many obstructions likely

n_3 = 0.03

n_4 Calculation (Effect of Vegetation)

n_4 is largely driven by the height of flow relative to the height of vegetation as defined in the following table:

Small	0.001-0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow-weed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
Medium	0.010-0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1-to-2-year-old willow trees in the dormant season..
Large	0.025-0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8-to-10-years-old willow or cottonwood trees intergrow with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 0.607 m.;or mature row crops such as small vegetables, or mature field crops where depth flow is at least twice the height of the vegetation.
Very Large	0.050-0.100	Turf grass growing where the average depth of flow is less than half the

		height of the vegetation, or moderate to dense brush, or heavy stand of timber with few down trees and little undergrowth where depth of flow is below branches, or mature field crops where depth of flow is less than the height of the vegetation.
Extreme	0.100-0.200	Dense bushy willow, mesquite, and saltcedar(all vegetation in full foliage), or heavy stand of timber, few down trees, depth of reaching branches.

Assume undergrowth up to 0.3 m in height, tree tunks only up to 2m & tree branches + trunk above 2m

n_4 = 0.075	When water depth is < 0.3m	(Undergrowth in contact with flow)
n_4 = 0.02	When water depth is ~ 0.5m	(Tree trunks in contact with flow)
n_4 = 0.04	When water depth is >2m	(Tree trunks+ branches in contact with flow)

Final 'n' Value

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

n = 0.133	When water depth is < 0.3m
n = 0.078	When water depth is ~ 0.5m
n = 0.098	When water depth is >2.0m

Manning's 'n' Calculations

Prepared by: D. Tetley **Date:** 29/01/2016
Checked by: **Date:**

The following provides Manning's' n roughness coefficient calculations based on the modified Cowan method documented in the USGS Paper 2339: "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains' (Arcement & Schneider). The approach was adopted for direct rainfall modelling as it can account for the higher effective roughness likely to be encountered at shallow flow depths

Overview

Manning's 'n' is calculated using the modified Cowan method based on the following formula:

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

Where: n_b = a base value of n for the floodplain's natural bare soil surface
n_1 = a correction factor for the effect of surface irregularities
n_2 = a value for variations in shape and size of the floodplain cross-section (assumed to be 0.0)
n_3 = a value for obstructions
n_4 = a value for vegetation on the floodplain
m = a correction factor for sinuosity (assumed to be 1.0)

Description of Surface / Material Type

Material Type - Impervious (concrete, road, car parking area)

n_b Calculation

n_b is extracted from the following table:

Table 1. Base Values of Manning's *n*

		Base *n* Value	
Bed Material	Median Size of bed material (in millimeters)	Straight Uniform Channel[1]	Smooth Channel[2]
Sand Channels			
Sand[3]	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025

Catchment Simulation Solutions

Firm Soil	--	0.025-0.032	.020
Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
[2] For indicated material; Chow(1959)
[3] Only For Upper regime flow where grain roughness is predominant

Assume "Concrete"

n_b = 0.012

n_1 Calculation (Degree of Irregularity)

n_1 is extracted from the following table:

Smooth	0.000	Compares to the smoothest, flattest flood-plain attainable in a given bed material.
Minor	0.001-0.005	Is a Flood Plain Slightly irregular in shape. A few rises and dips or sloughs may be more visible on the flood plain.
Moderate	0.006-0.010	Has more rises and dips. Sloughs and hummocks may occur.
Severe	0.011-0.020	Flood Plain very irregular in shape. Many rises and dips or sloughs are visible. Irregular ground surfaces in pasture land and furrows perpendicular to the flow are also included.

Assume smooth

n_1 = 0

n_3 Calculation (Effect of Obstructions)

n_3 is extracted from the following table:

Negligible	0.000-0.004	Few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	0.040-0.050	Obstructions occupy less than 15 percent of the cross-sectional area.
Appreciable	0.020-0.030	Obstructions occupy from 15 percent to 50 percent of the cross-sectional area.

Assume minimal obstructions

n_3 = 0.002

n_4 Calculation (Effect of Vegetation)

n_4 is largely driven by the height of flow relative to the height of vegetation as defined in the following table:

Small	0.001-0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow-weed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
Medium	0.010-0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1-to-2-year-old willow trees in the dormant season..
Large	0.025-0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8-to-10-years-old willow or cottonwood trees intergrow with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 0.607 m.;or mature row crops such as small vegetables, or mature field crops where depth flow is at least twice the height of the vegetation.
Very Large	0.050-0.100	Turf grass growing where the average depth of flow is less than half the

		height of the vegetation, or moderate to dense brush, or heavy stand of timber with few down trees and little undergrowth where depth of flow is below branches, or mature field crops where depth of flow is less than the height of the vegetation.
Extreme	0.100-0.200	Dense bushy willow, mesquite, and saltcedar(all vegetation in full foliage), or heavy stand of timber, few down trees, depth of reaching branches.

n_4 = 0.02	When water depth is < 0.005m	(Water in contact with aggregate)
n_4 = 0.001	When water depth is > 0.005m	(Water above aggregate height)

Final 'n' Value

$n = m (n_b + n_1 + n_2 + n_3 + n_4)$

n = 0.034	When water depth is < 0.005m
n = 0.015	When water depth is > 0.005m

APPENDIX D

BRIDGE LOSS CALCULATIONS

Representation of Bridges in TUFLOW

TUFLOW does not explicitly allow inclusion of bridge structure details, such as abutments or piers like other software, such as HEC-RAS. Therefore, the variation in energy losses that can be expected through a bridge opening must be defined using a height varying loss coefficent.

This requires calculation of suitable loss coefficient values from the channel invert up to the elevation of the underside of the culvert/bridge deck.

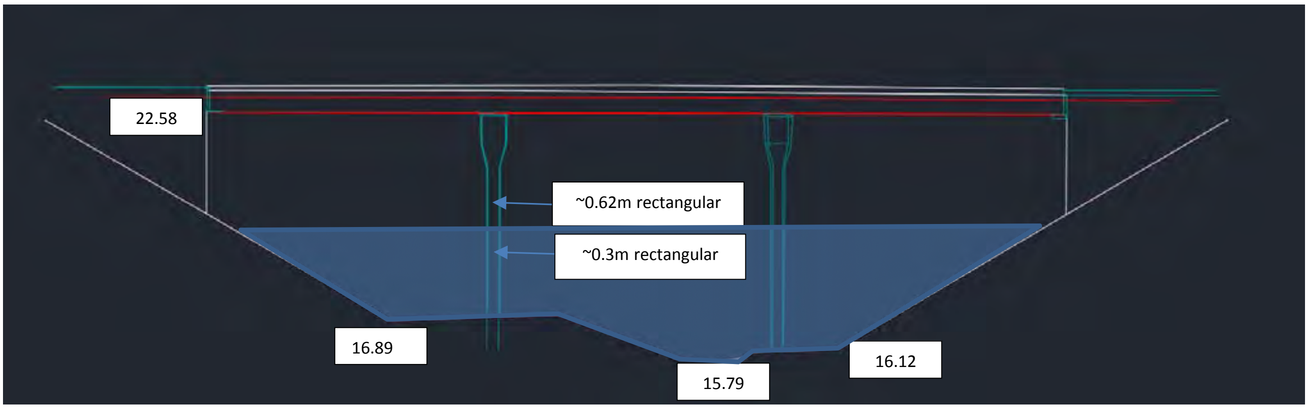
The following pages present the calculations that were completed to determine appropriate bridge loss coefficients.

All calculations were completed in accordance with procedures detailed in the 'TUFLOW User Manual' (BMT WBM, 2010) and 'Hydraulics of Bridge Waterways' (Bradley, 1978).

Dunheved Road Crossing of Werrington Creek - Half Bank Full Capacity

Prepared by: J Hannan **Date:** 16/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)



Water level = 19.19mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

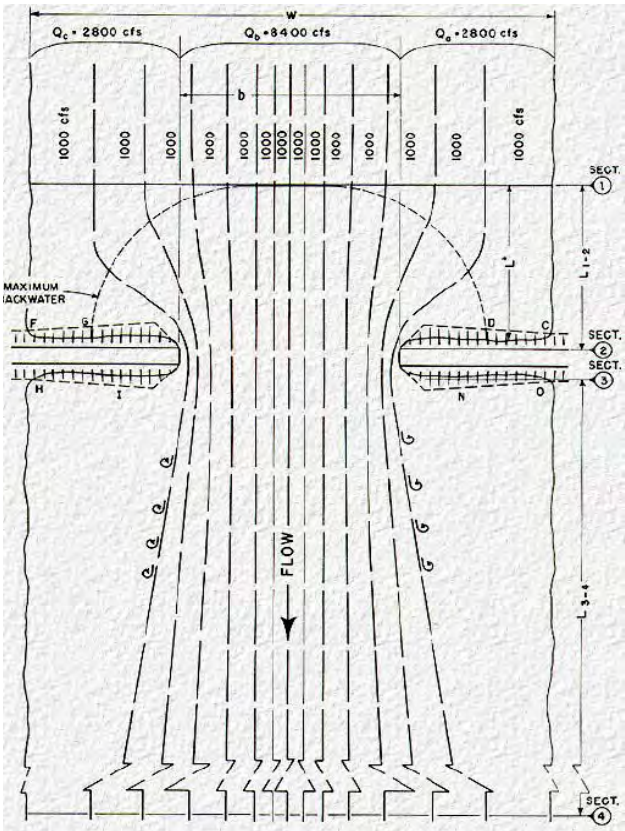
K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$

All flow contained in channel

Unimpeded Flow = 76.3 m^3/s
Bridge Flow= 76.3 m^3/s
M = 1.00

where:	(Bridge)	
A=	46.4	
P=	22.0	
n=	0.1	
S=	0.010	assumed



Catchment Simulation Solutions

Abutment Type = 90o Wingwall

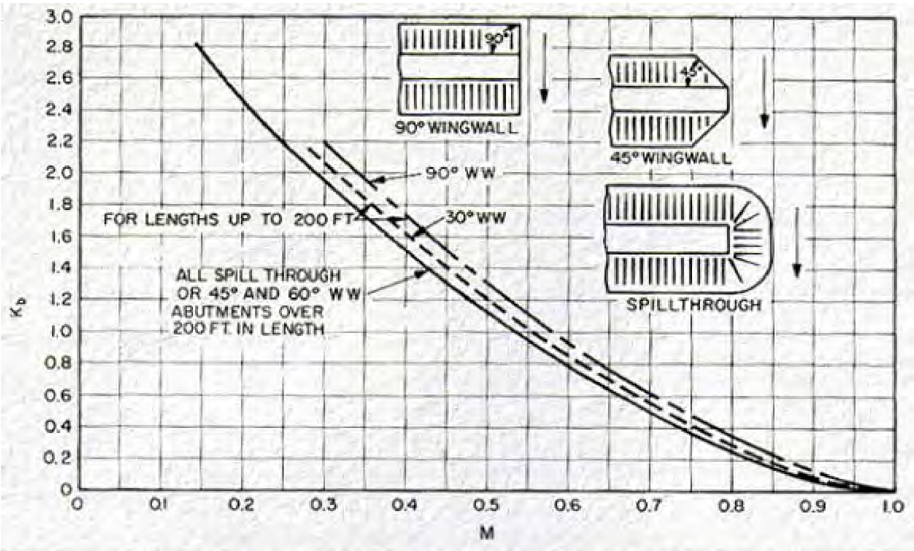


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

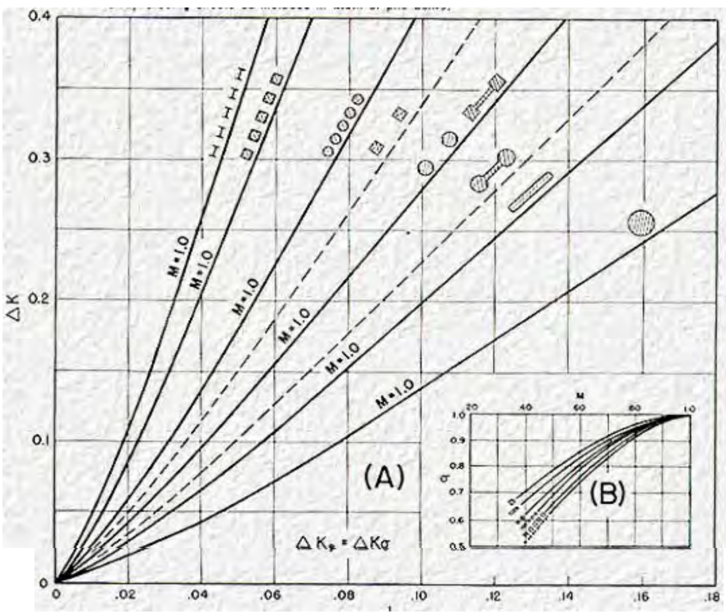
Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$

J = 0.043965517

A_p = 2.04 m^2

A_{n2} = 46.4 m^2



Pier Type: Single Rectangular Pier

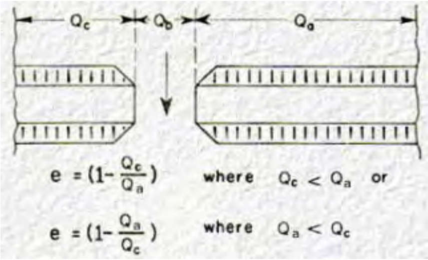
σ = 1.00

ΔK = 0.08

$K_p = \sigma\Delta K$

K_p = 0.08

K_e (Eccentricity Coefficient)



$Q_c = 1$	m^3/s
$Q_a = 1$	m^3/s

e = 0.00

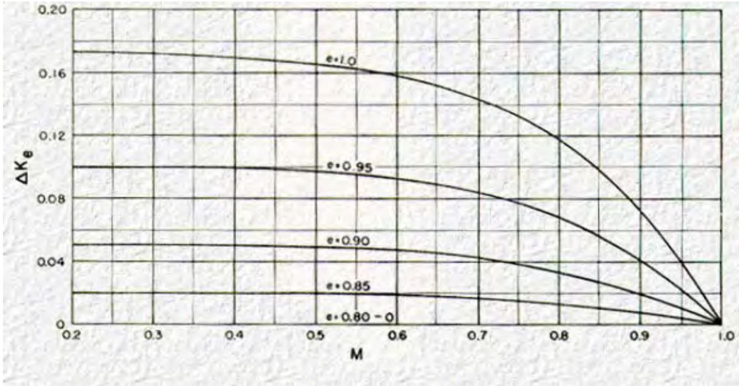


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

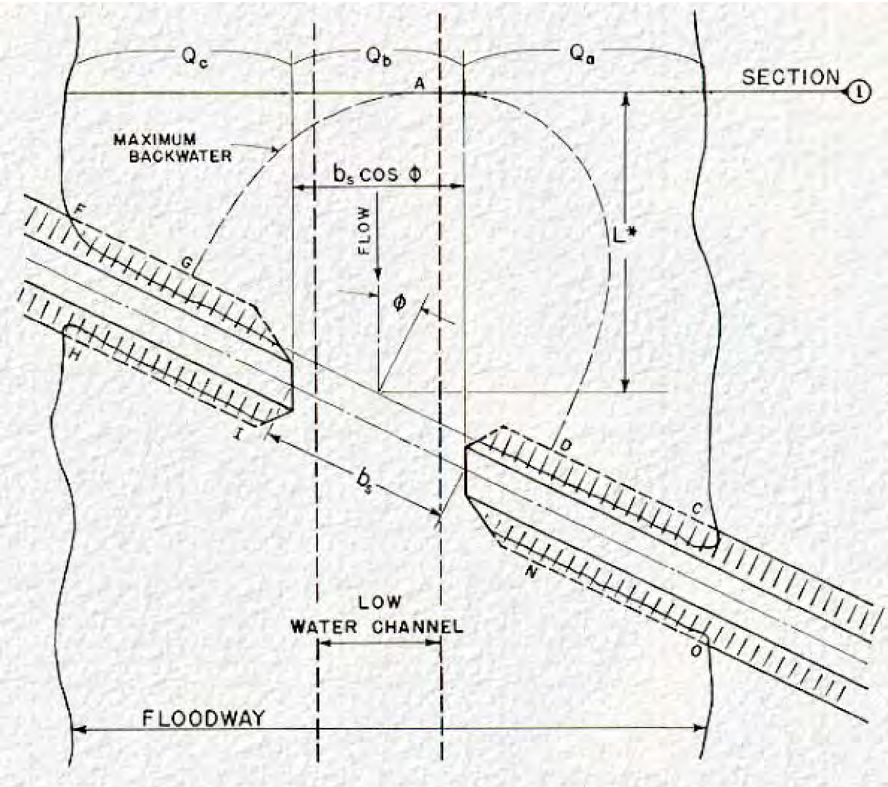


Figure 9. Skewed crossings.

ϕ = 5

Abutment Type = (B)-Straight

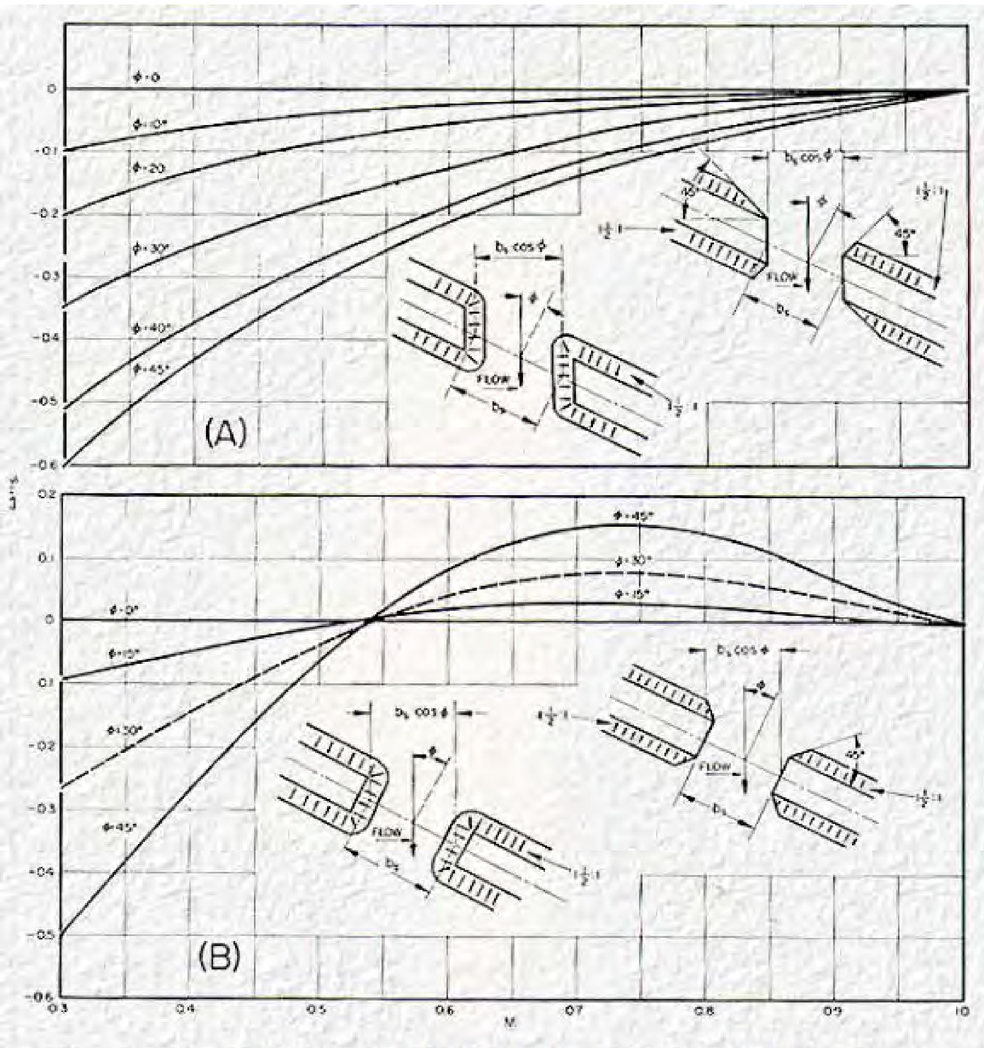


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

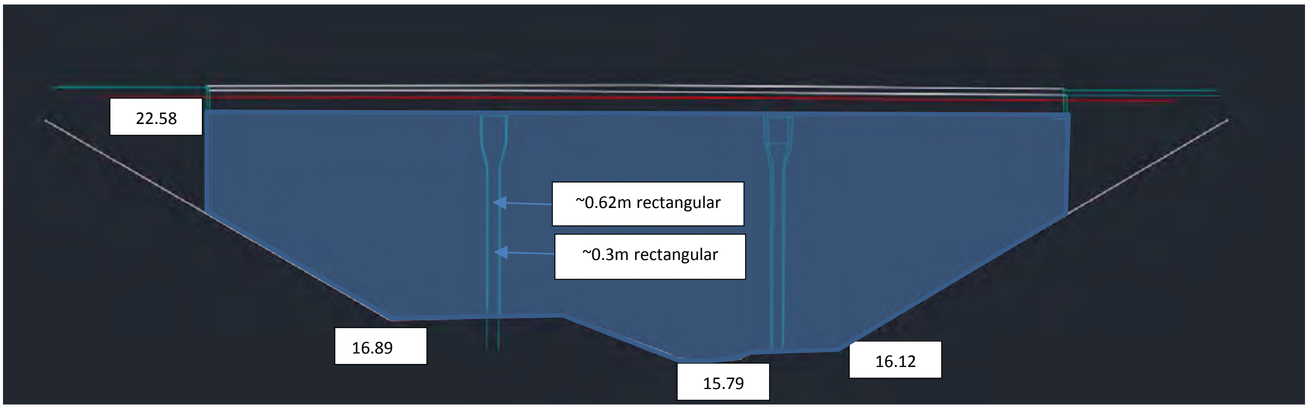
K* = 0.08

Notes

Dunheved Road Crossing of Werrington Creek - Bank Full Capacity

Prepared by: J Hannan **Date:** 16/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)

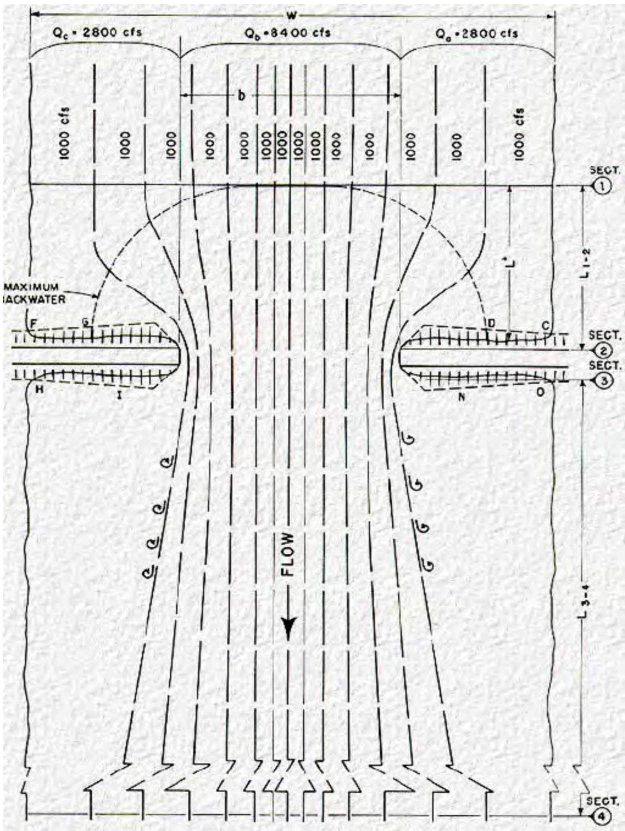


Water level = 22.58mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$



All flow contained in channel

Unimpeded Flow =	412.2	m^3/s
Bridge Flow=	316.3	m^3/s
	M = 0.77	

where:	(Bridge)	(Unimpeded)
A=	124.1	135.9
P=	30.5	36.5
n=	0.1	0.1
S=	0.010	

Abutment Type = 90o Wingwall

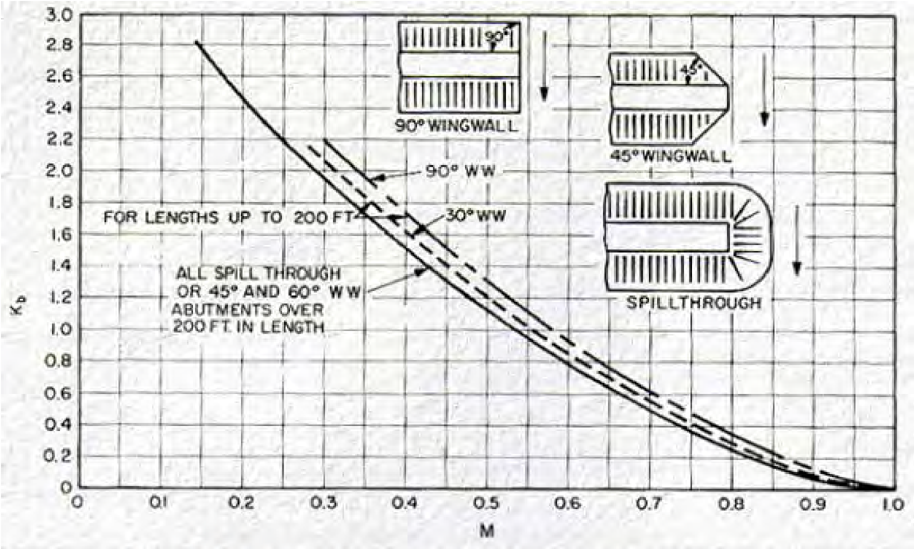


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.44

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

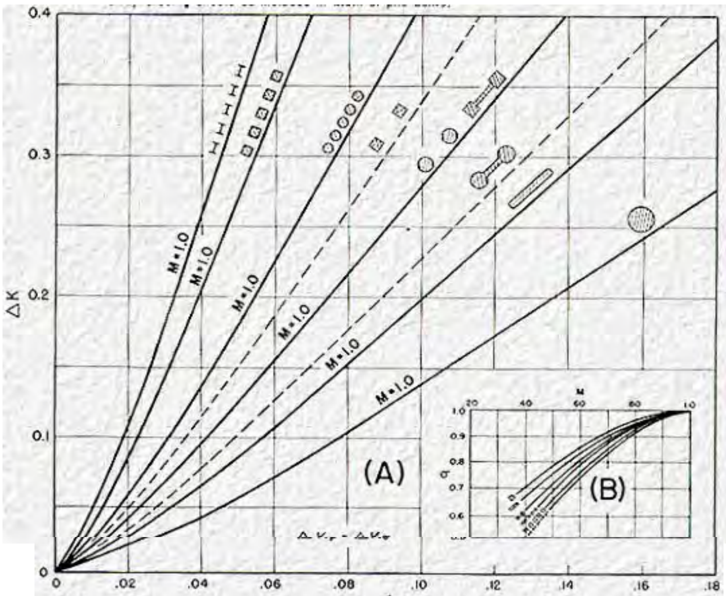
$J = A_p / A_{n3}$

J = 0.037228042

A_p = 4.62 m^2

A_{n2} = 124.1 m^2

Pier Type: Single Rectangular Pier



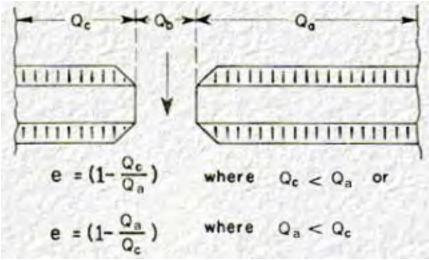
σ = 0.93

ΔK = 0.06

$K_p = \sigma\Delta K$

K_p = 0.06

K_e (Eccentricity Coefficient)



Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

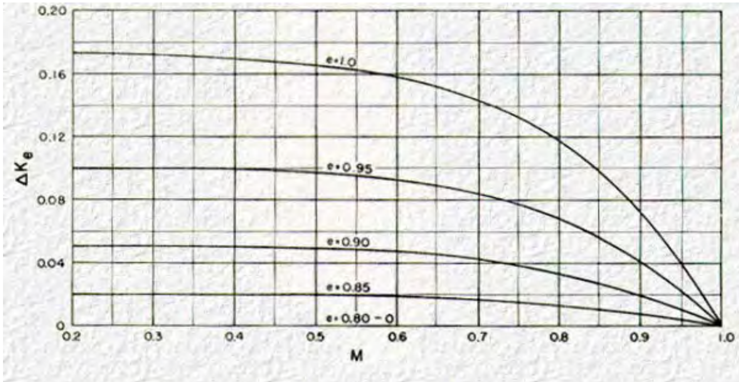


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

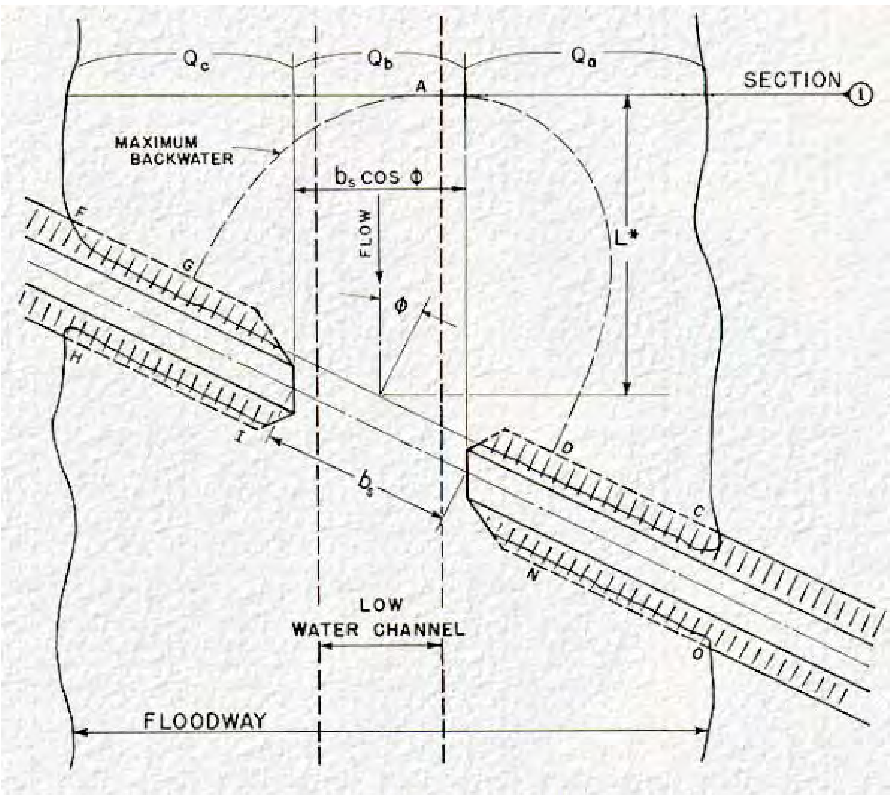


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

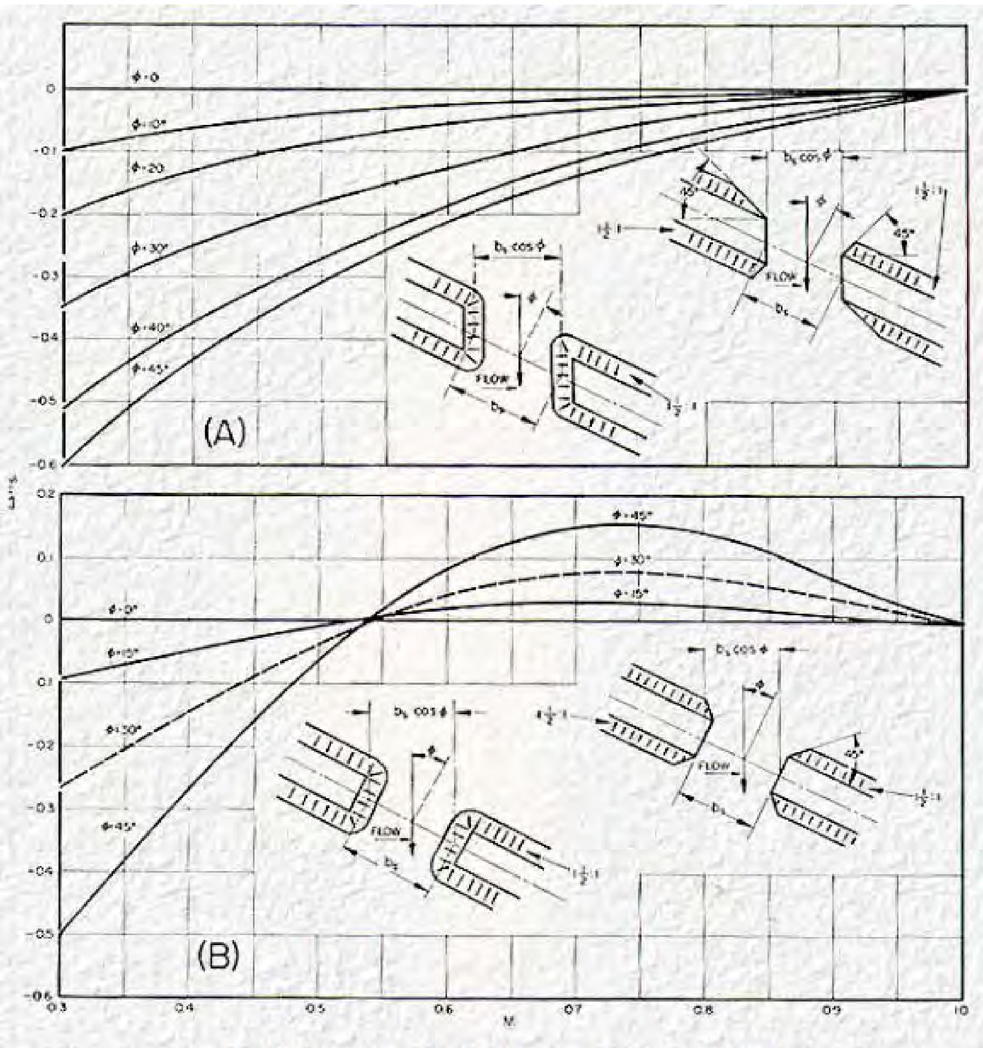


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

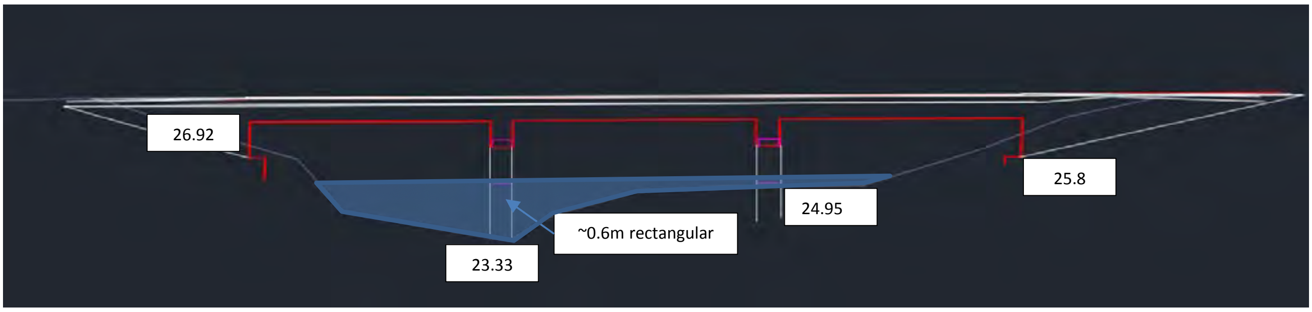
K* = 0.50

Notes

Burton Street Crossing of Werrington Creek - Half Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)



Water level = 25.13mAHD

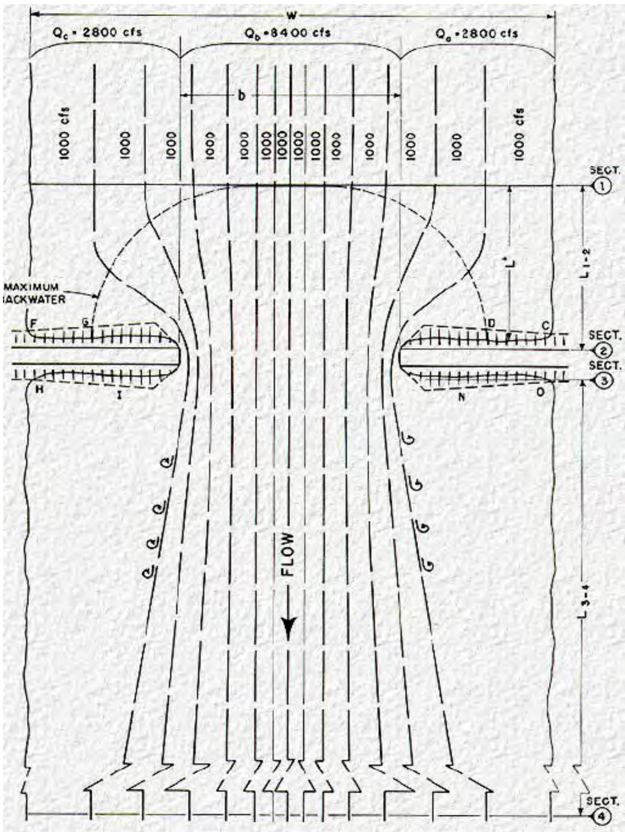
The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$

All flow contained in channel
Unimpeded Flow = 23.5 m^3/s
Bridge Flow= 23.5 m^3/s
M = 1.00

where:	(Bridge)
A=	8.5
P=	17.5
n=	0.03
S=	0.018



Catchment Simulation Solutions

Abutment Type = 90o Wingwall

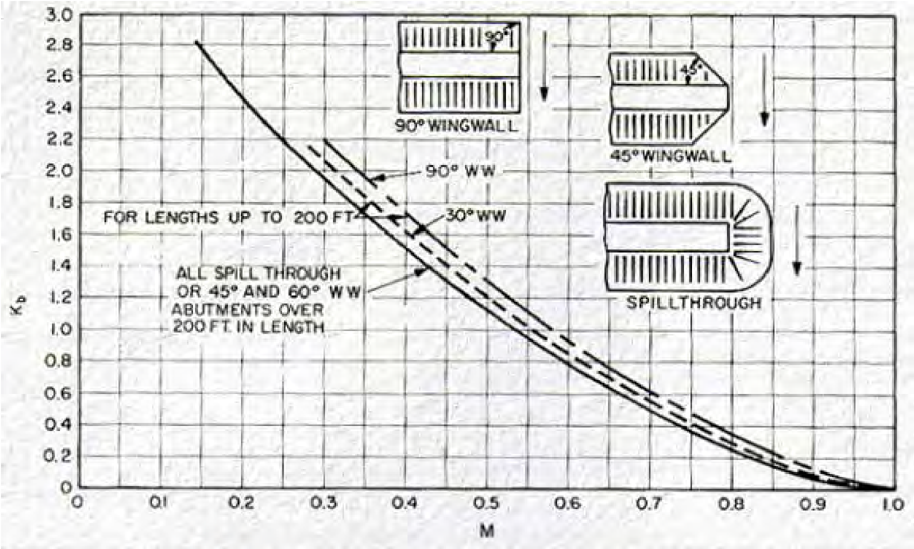


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

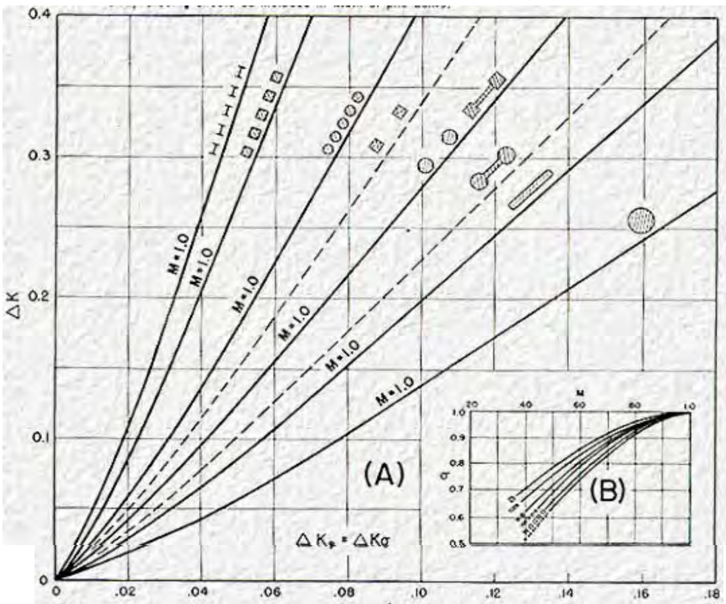
$J = A_p / A_{n3}$

J = 0.140425532

A_p = 1.188 m^2

A_{n2} = 8.5 m^2

Pier Type: Dual Square Pier



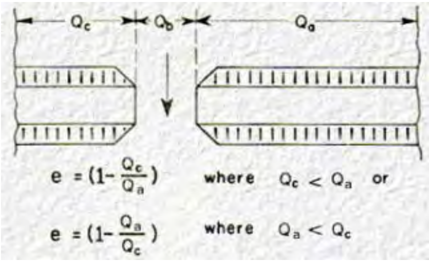
σ = 1.00

ΔK = 0.40

$K_p = \sigma \Delta K$

K_p = 0.40

K_e (Eccentricity Coefficient)



$Q_c = 1$ m^3/s

$Q_a = 1$ m^3/s

e = 0.00

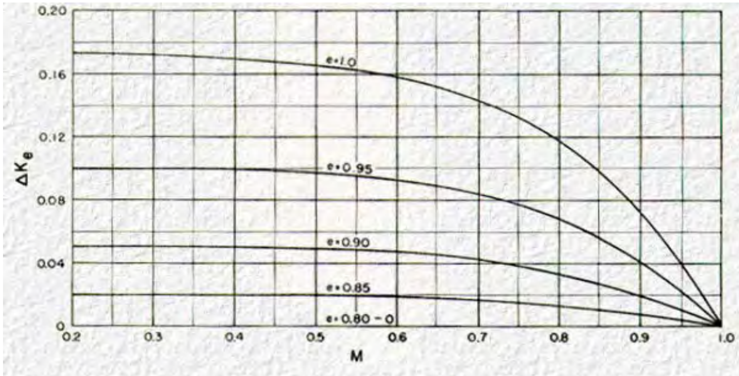


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

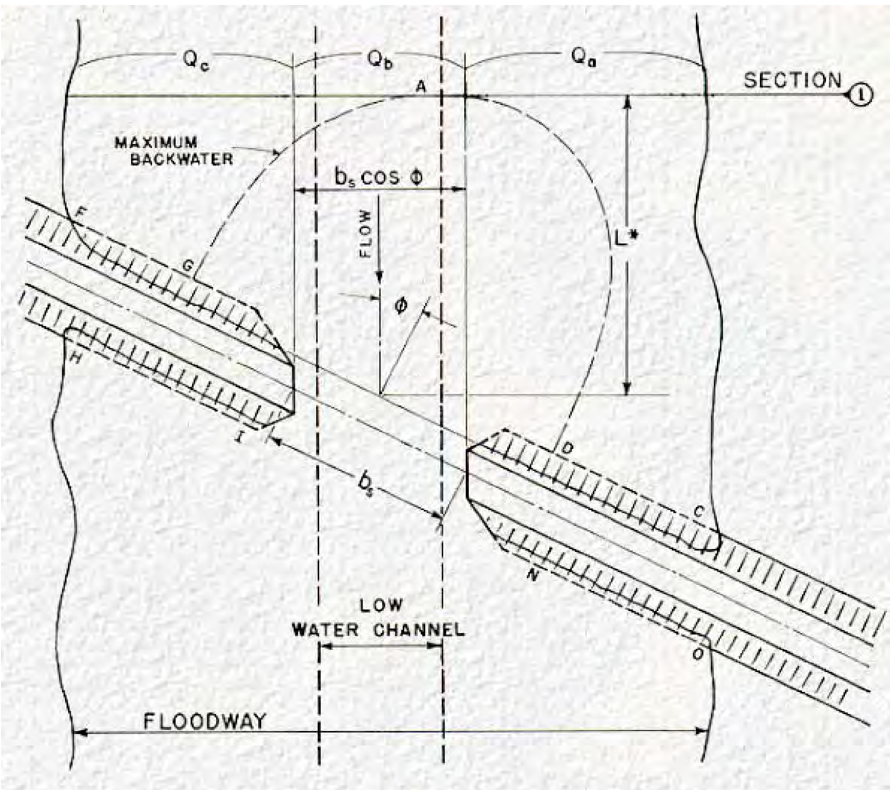


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

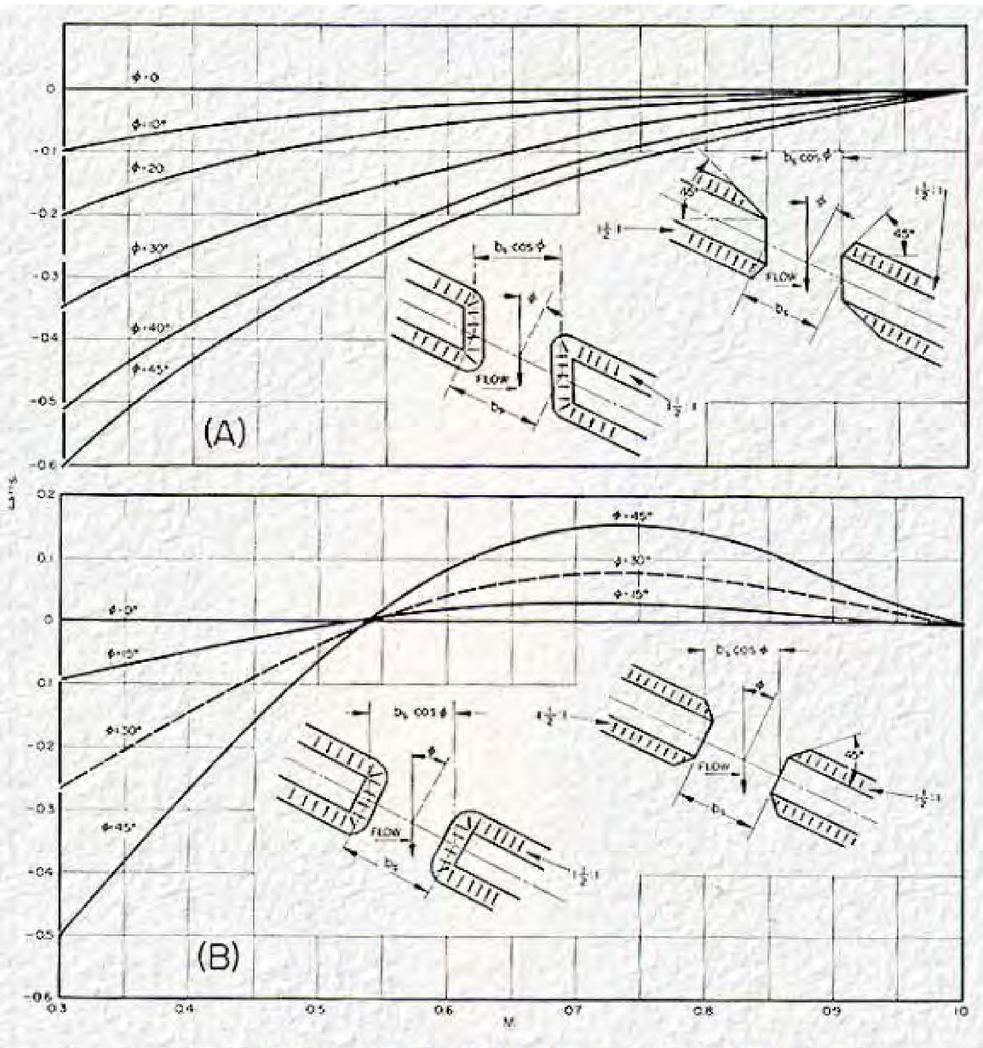


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

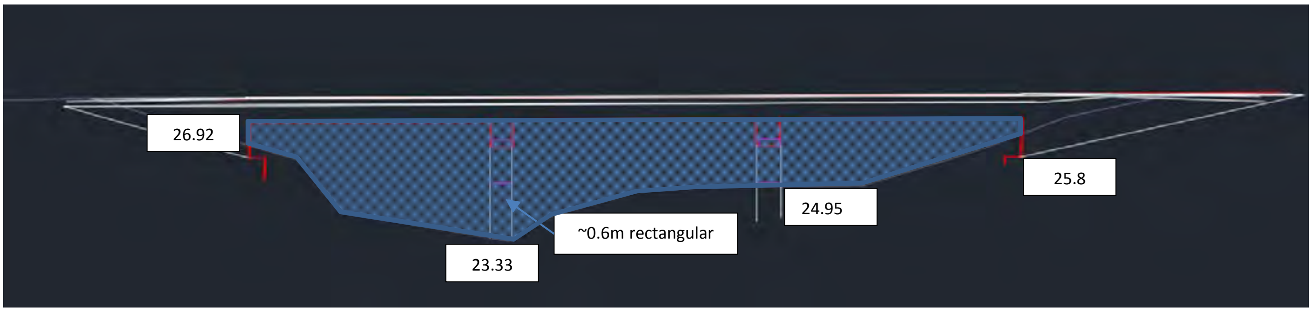
K^* = 0.40

Notes

Burton Street Crossing of Werrington Creek - Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)

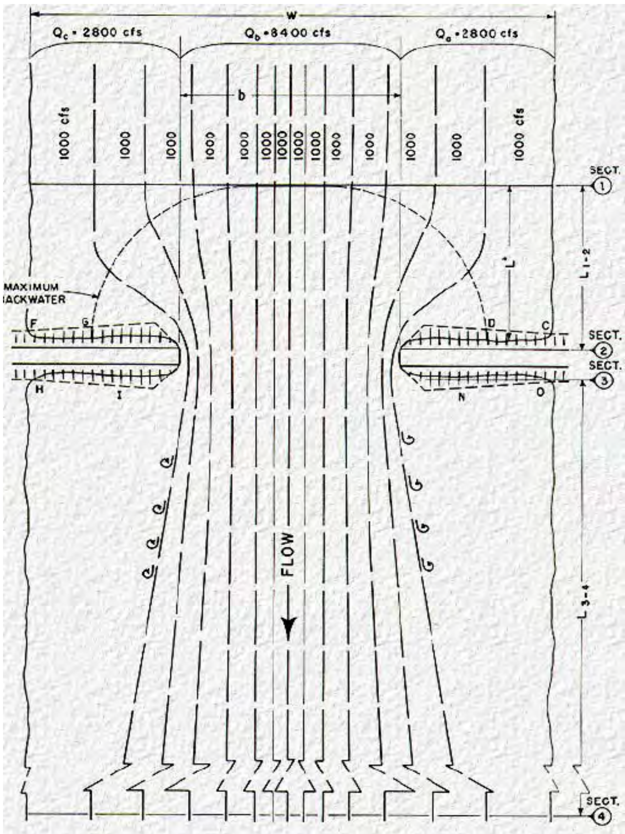


Water level = 26.92mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$



All flow contained in channel

Unimpeded Flow = 283.6 m^3/s
Bridge Flow= 283.1 m^3/s
M = 1.00

where:	(Bridge)	(Unimpeded)
A=	44.4	45.4
P=	25.5	27.5
n=	0.03	0.03
S=	0.018	0.018

Catchment Simulation Solutions

Abutment Type = 90o Wingwall

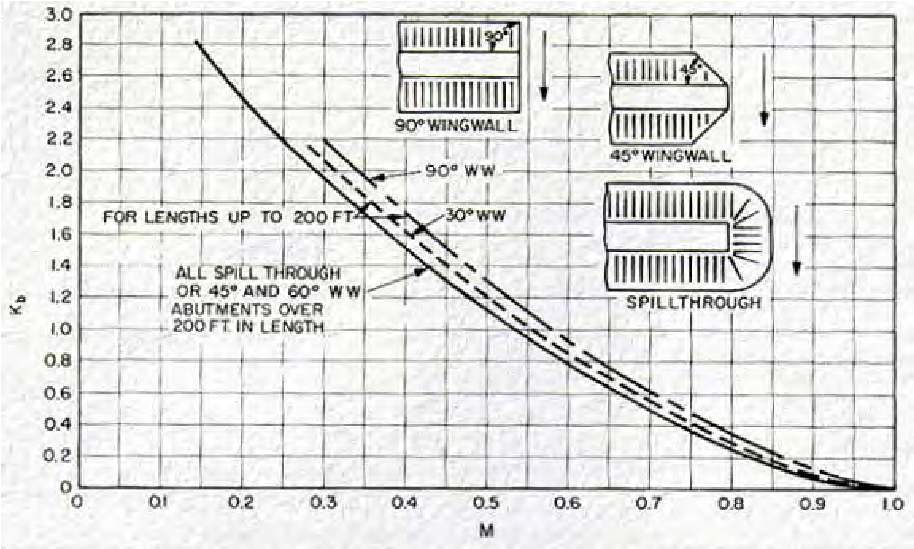


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

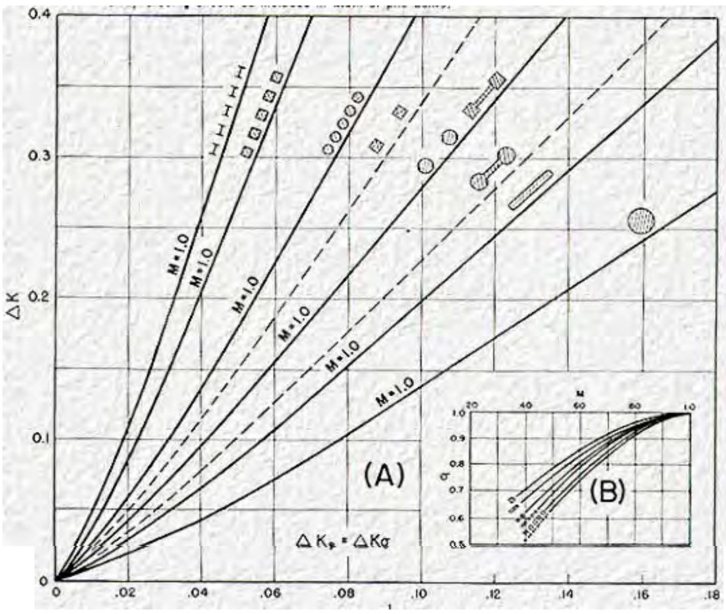
Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$

J = 0.075198648

A_p = 3.3 m^2

A_{n2} = 44.4 m^2



Pier Type: Multi- Square Pier

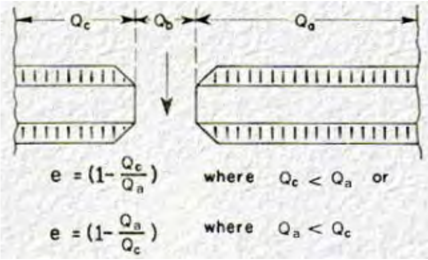
σ = 1.00

ΔK = 0.39

$K_p = \sigma \Delta K$

K_p = 0.39

K_e (Eccentricity Coefficient)



Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

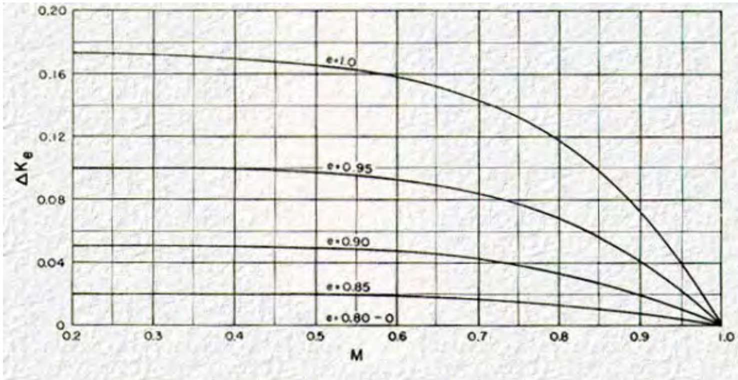


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

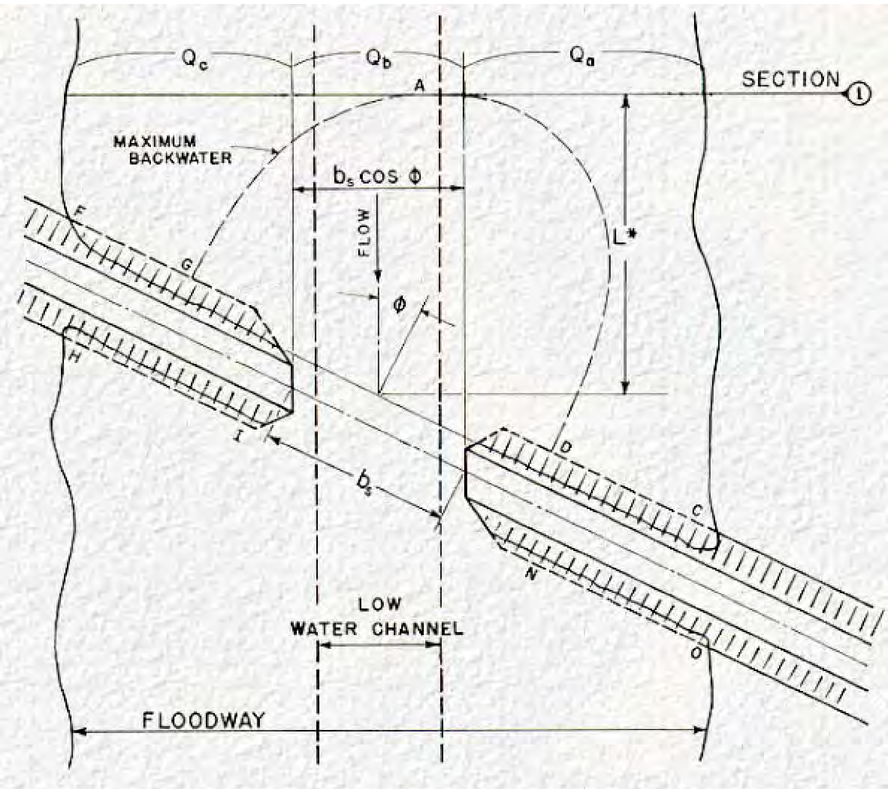


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

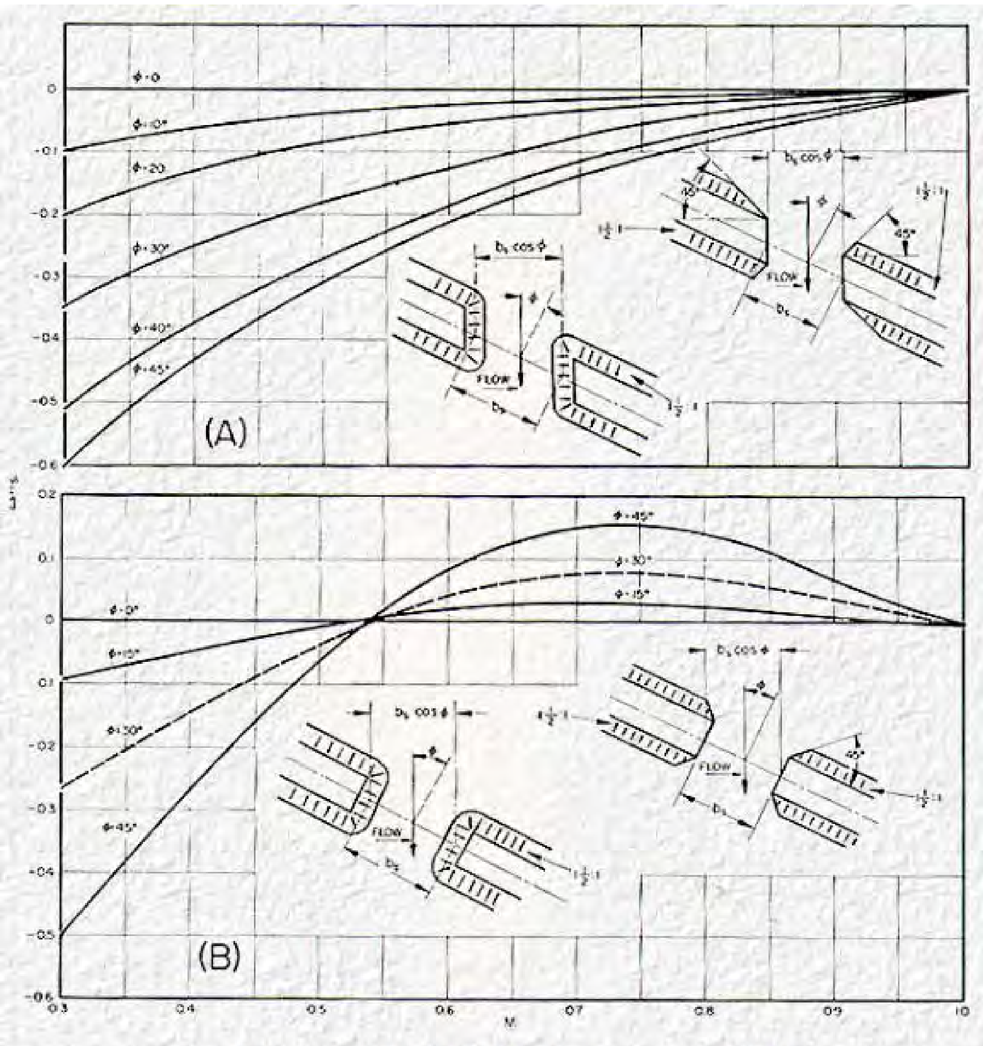


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

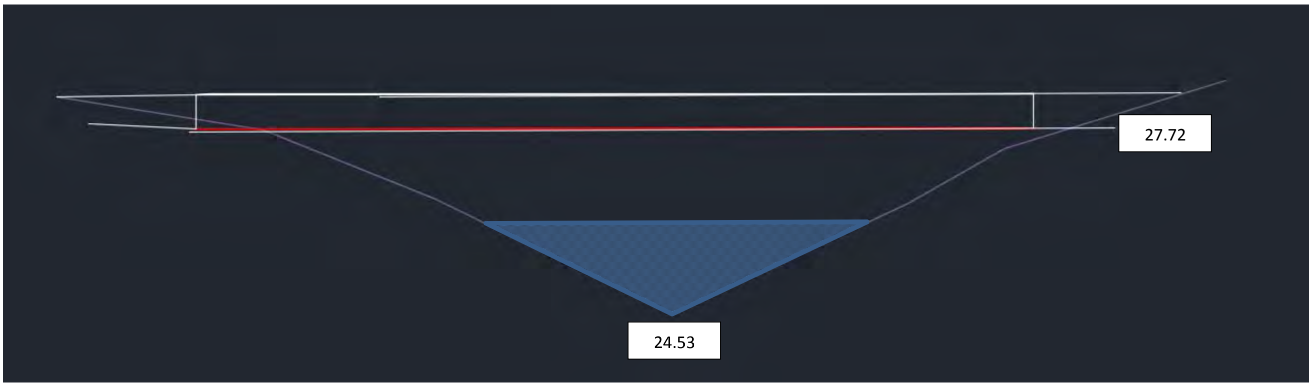
K* = 0.39

Notes

Werrington Lakes Reserve Footbridge Crossing of Werrington Creek - Half Bank Full Capacity

Prepared by:	J Hannan	**Date:**	21/03/2016
Checked by:		**Date:**	

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)



Water level = 26.13mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

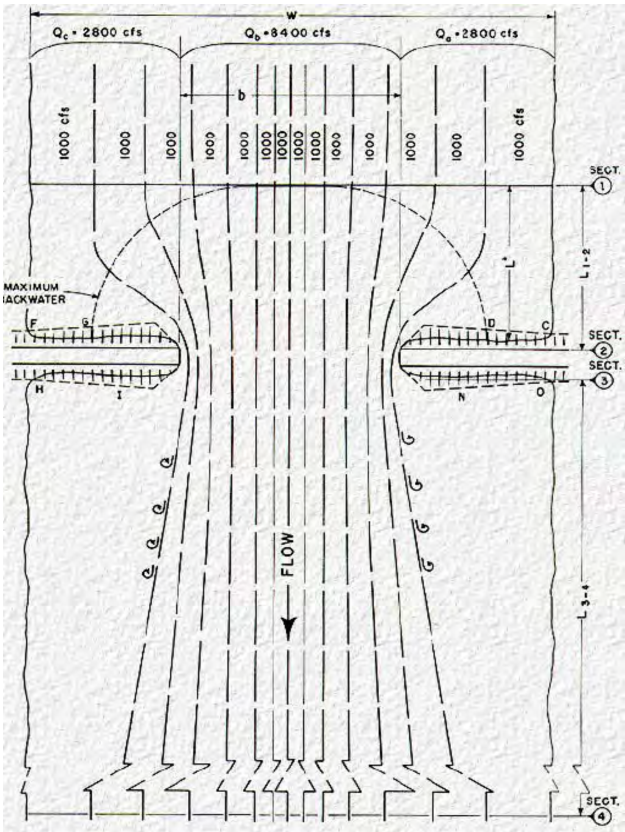
K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$

All flow contained in channel

Unimpeded Flow =	42.0	m^3/s
Bridge Flow=	42.0	m^3/s
M = 1.00		

where:	(Bridge)
A=	4.5
P=	7.6
n=	0.03
S=	0.158



Catchment Simulation Solutions

Abutment Type = 90o Wingwall

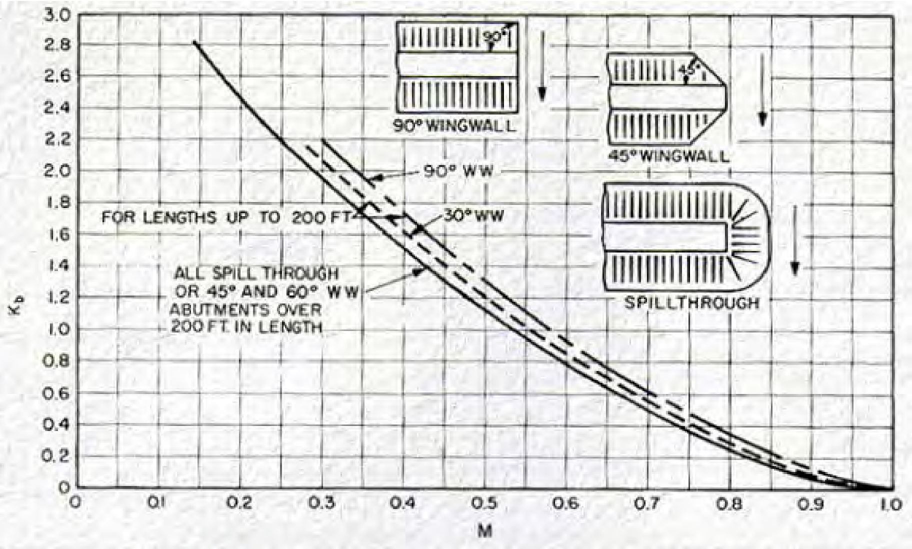


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

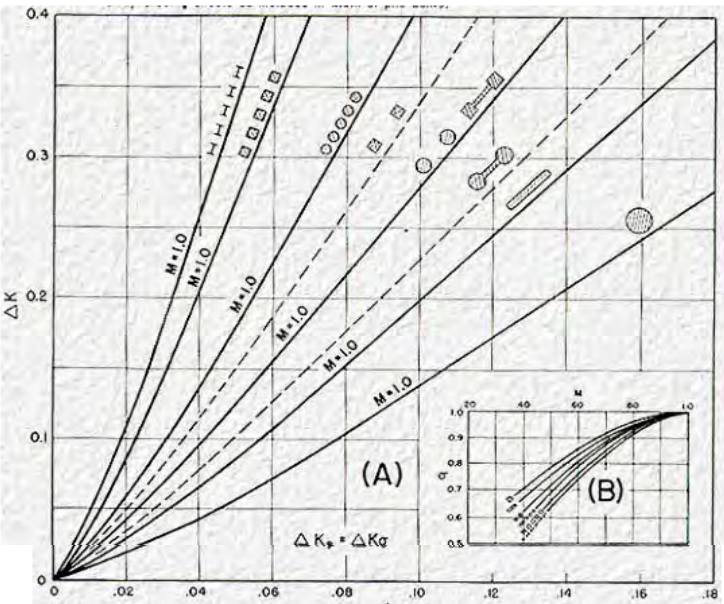
Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$

J = 0

A_p = 0 m^2

A_{n2} = 4.5 m^2



Pier Type: No Piers

σ = 0.00

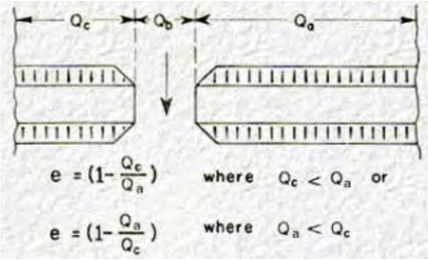
ΔK = 0.00

$K_p = \sigma \Delta K$

K_p = 0.00

Catchment Simulation Solutions

K_e (Eccentricity Coefficient)



Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

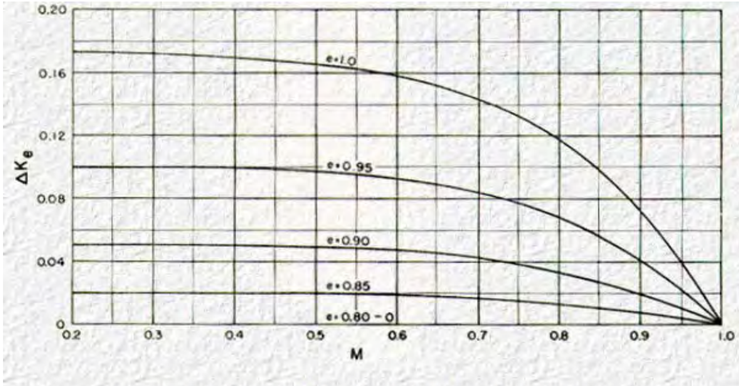


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

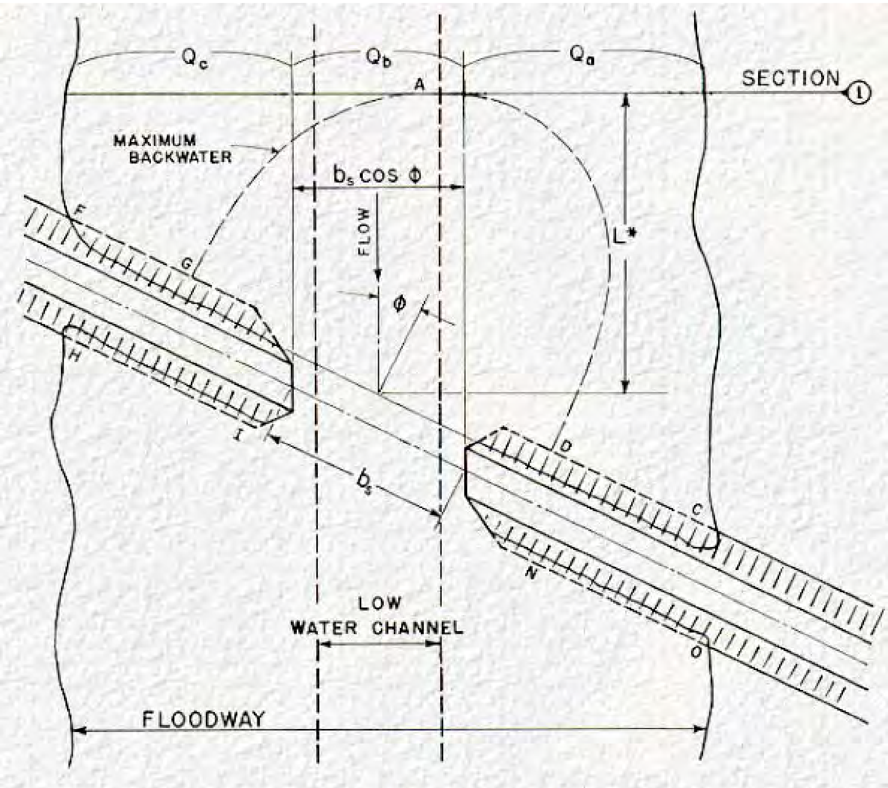


Figure 9. Skewed crossings.

ϕ =	0

Abutment Type =	(B)-Straight

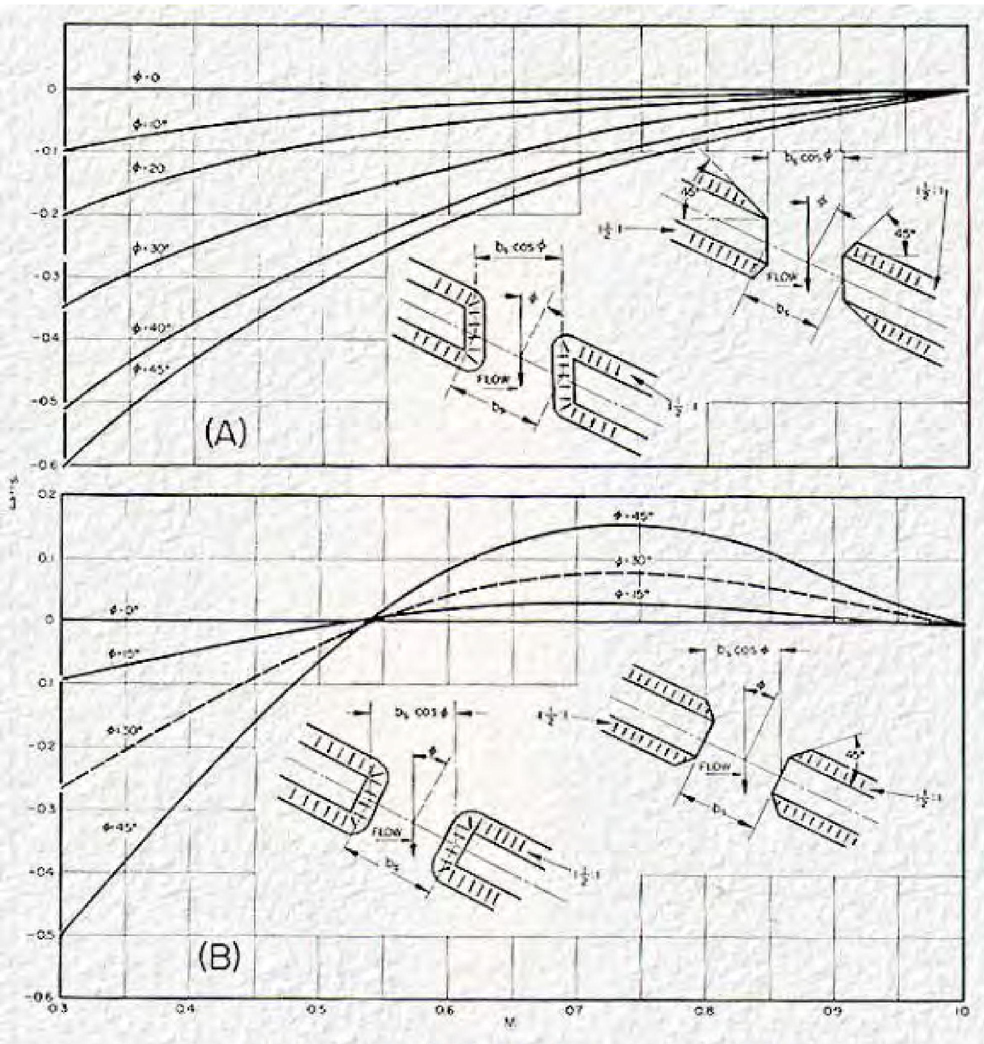


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

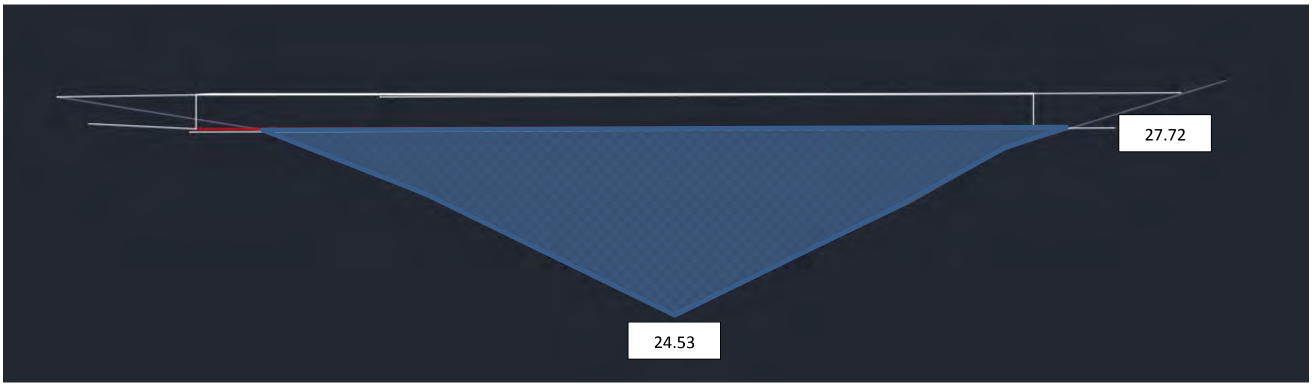
K^* = 0.00

Notes

Werrington Lakes Reserve Footbridge Crossing of Werrington Creek - Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)



Water level = 26.13mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

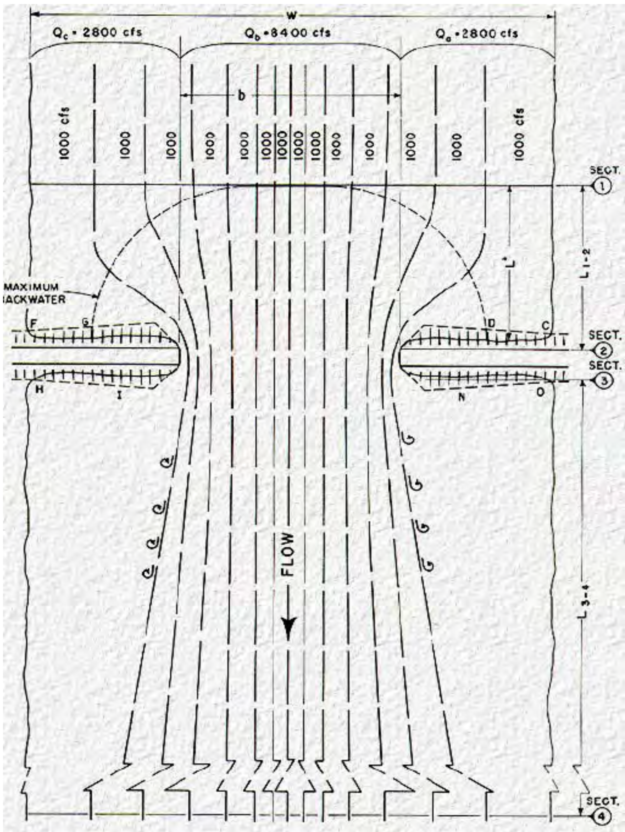
K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$

All flow contained in channel

Unimpeded Flow =	381.5	m^3/s
Bridge Flow=	381.5	m^3/s
	M = 1.00	

where:	(Bridge)
A=	22.3
P=	15.2
n=	0.03
S=	0.158



Catchment Simulation Solutions

Abutment Type = 90o Wingwall

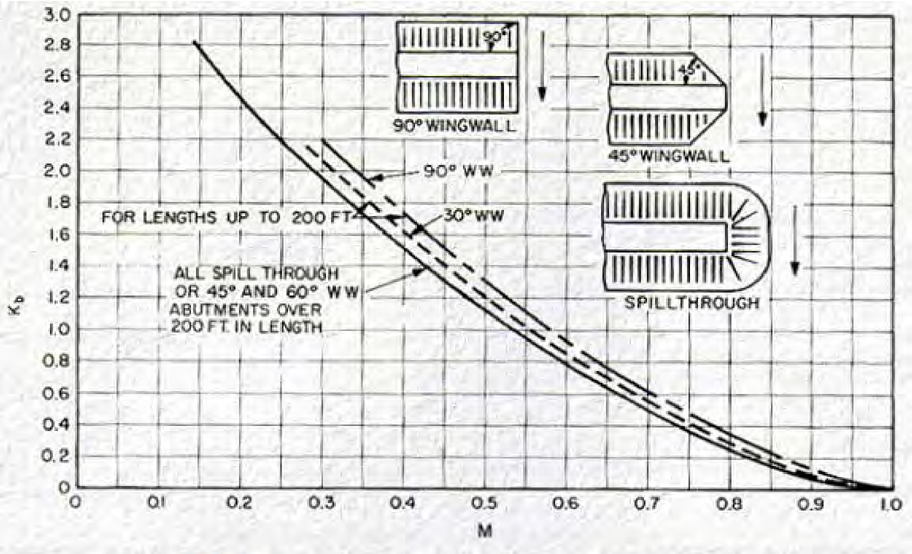


Figure 6. Backwater coefficient base curves (subcritical flow).

$K_b = 0.00$

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

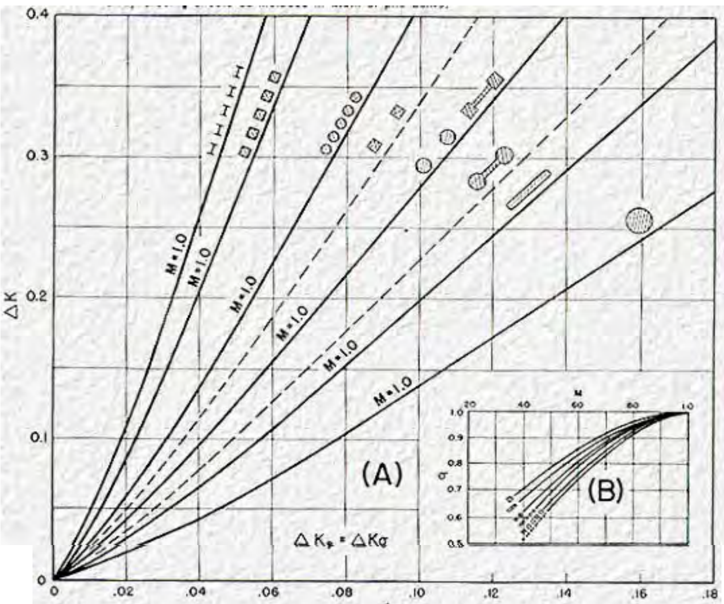
$J = A_p / A_{n3}$

J = 0

A_p = 0 m^2

A_{n2} = 22.3 m^2

Pier Type: No Piers



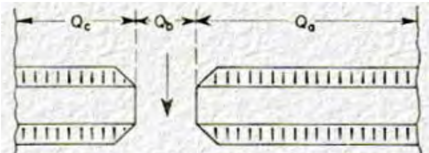
$\sigma = 0.00$

$\Delta K = 0.00$

$K_p = \sigma\Delta K$

$K_p = 0.00$

K_e (Eccentricity Coefficient)



$$e = \left(1 - \frac{Q_c}{Q_a}\right) \quad \text{where} \quad Q_c < Q_a \quad \text{or}$$

$$e = \left(1 - \frac{Q_a}{Q_c}\right) \quad \text{where} \quad Q_a < Q_c$$

Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

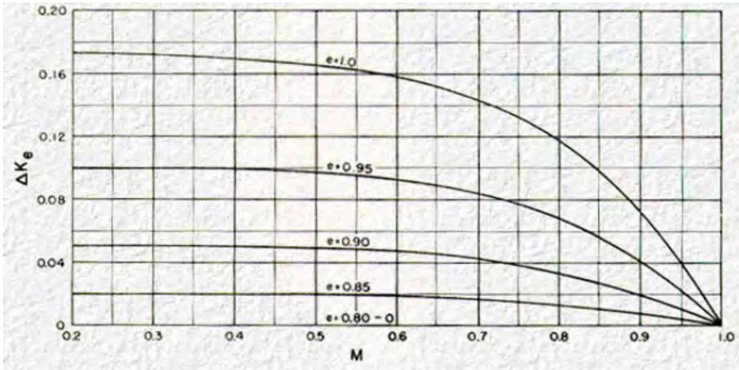


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

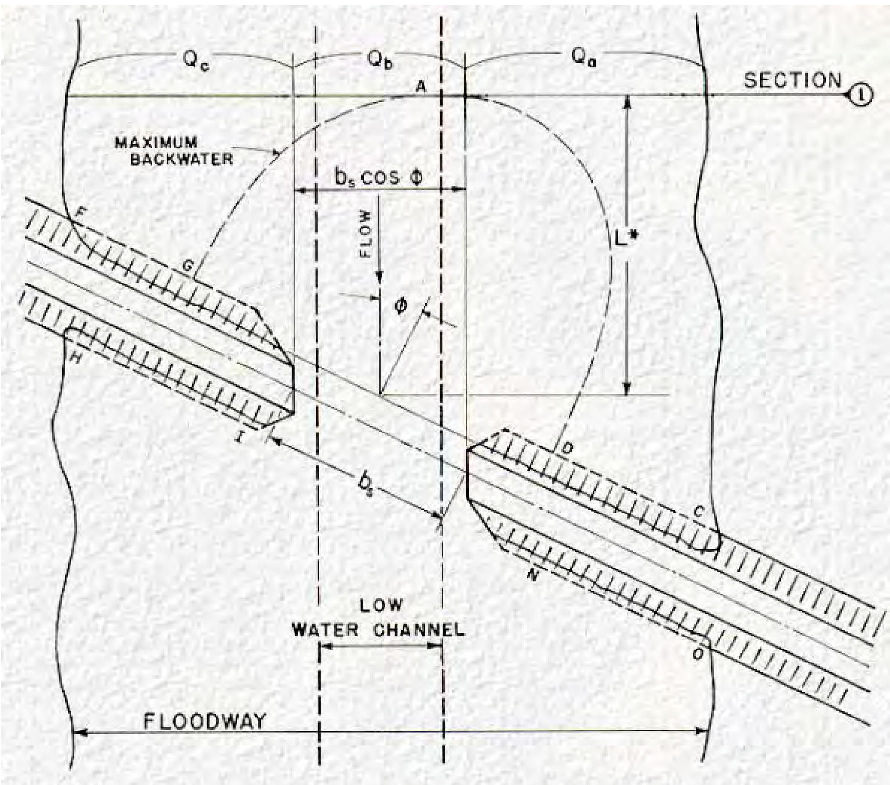


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

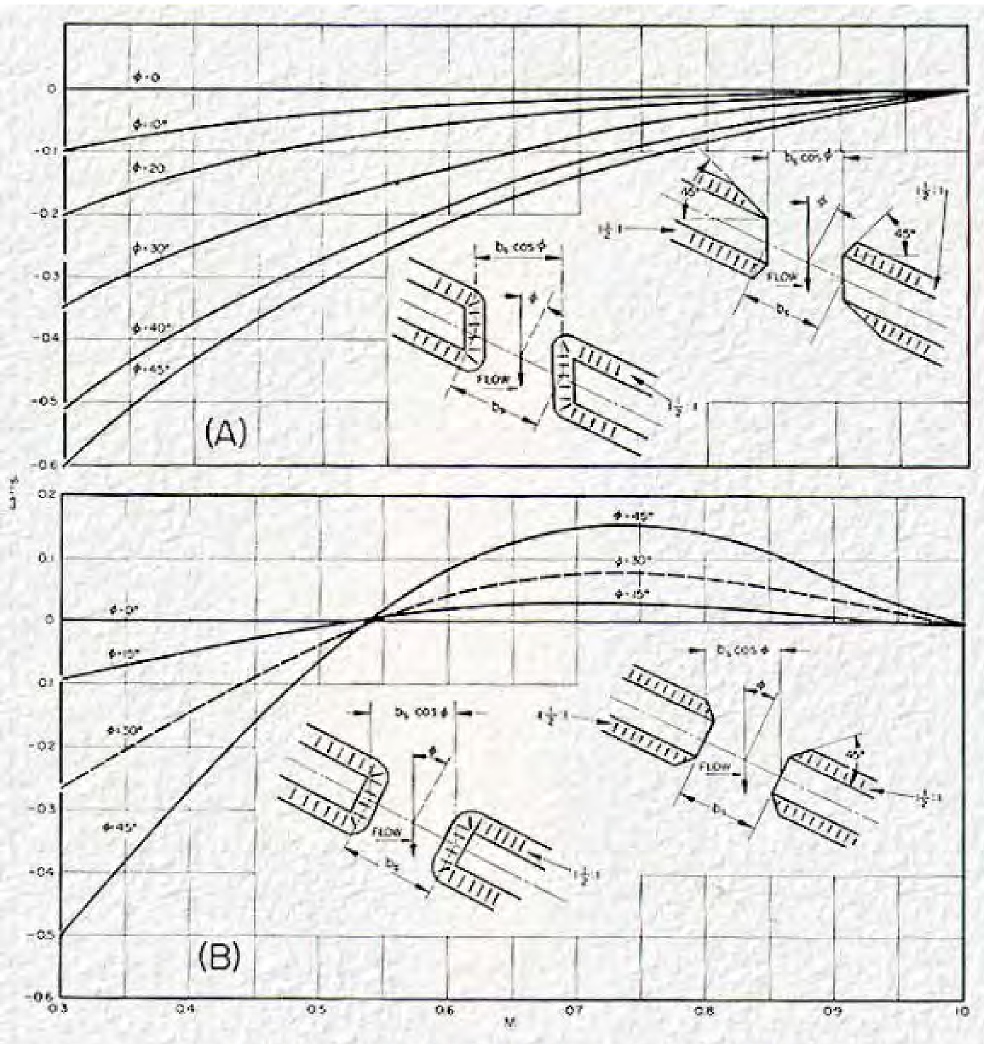


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

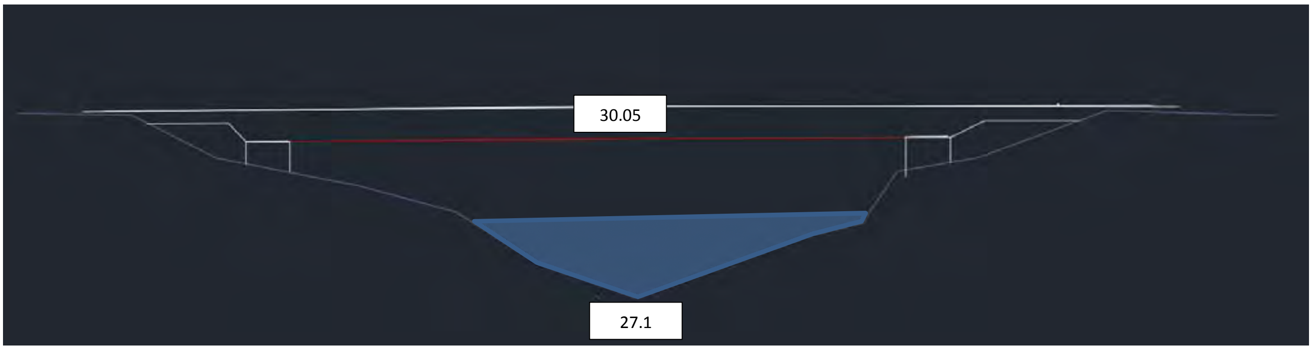
K* = 0.00

Notes

Shaw Park Footbridge Crossing of Werrington Creek Tributary - Half Bank Full Capacity

Prepared by: J Hannan	**Date:** 21/03/2016
Checked by:	**Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)



Water level = 28.58mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

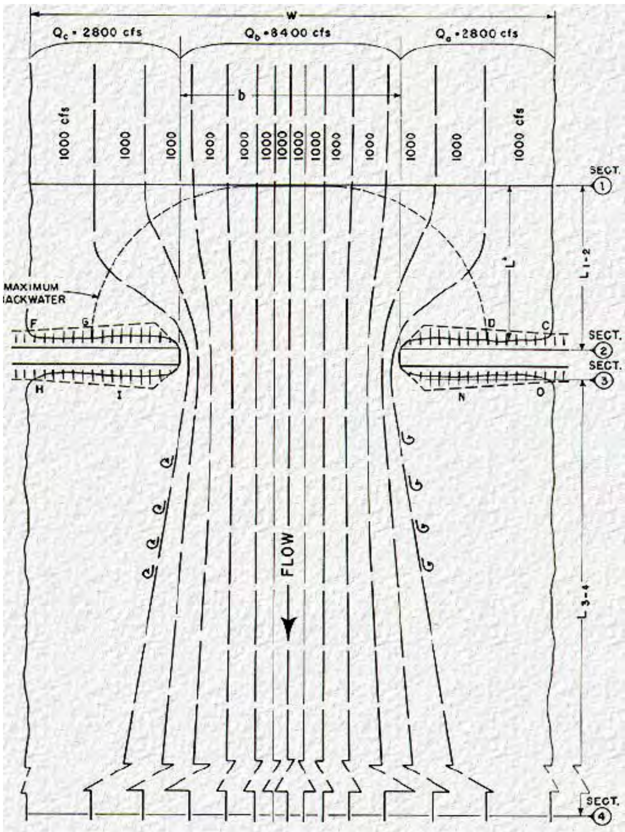
K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$

All flow contained in channel

Unimpeded Flow =	12.1	m^3/s
Bridge Flow=	12.1	m^3/s
M = 1.00		

where:	(Bridge)
A=	5.3
P=	7.5
n=	0.06
S=	0.03



Abutment Type = 90o Wingwall

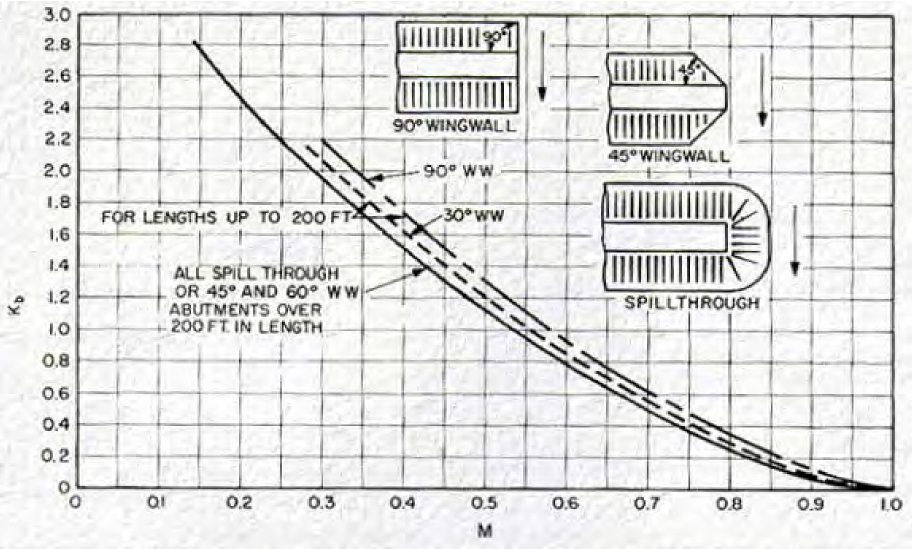


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

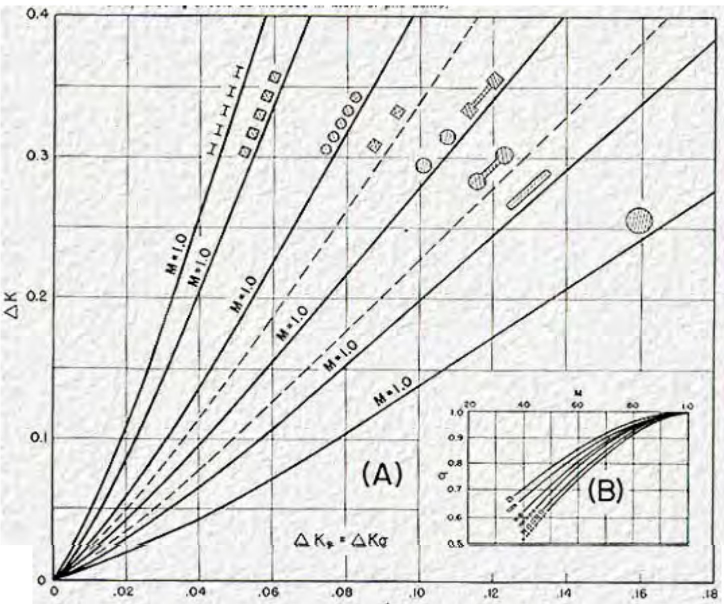
$J = A_p / A_{n3}$

J = 0

A_p = 0 m^2

A_{n2} = 5.3 m^2

Pier Type: No Piers



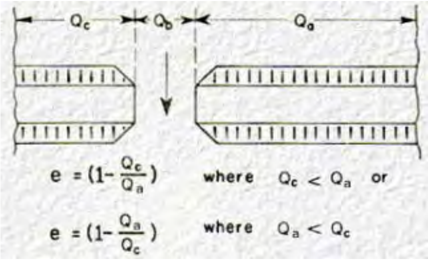
σ = 0.00

ΔK = 0.00

$K_p = \sigma \Delta K$

K_p = 0.00

K_e (Eccentricity Coefficient)



$Q_c = 1$	m^3/s
$Q_a = 1$	m^3/s

e = 0.00

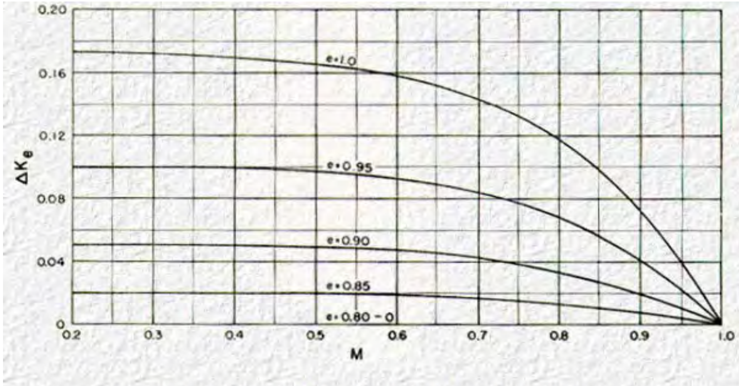


Figure 8. Incremental backwater coefficient for eccentricity.

$K_e = 0.00$

K_s (Skew Coefficient)

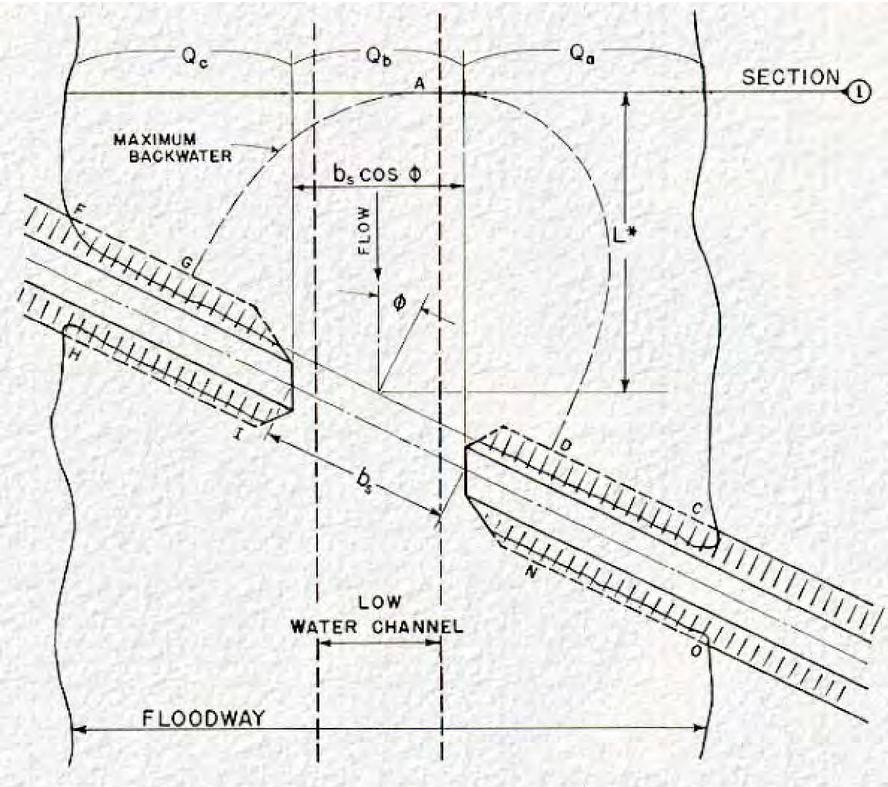


Figure 9. Skewed crossings.

$\phi = 0$

Abutment Type =	(B)-Straight

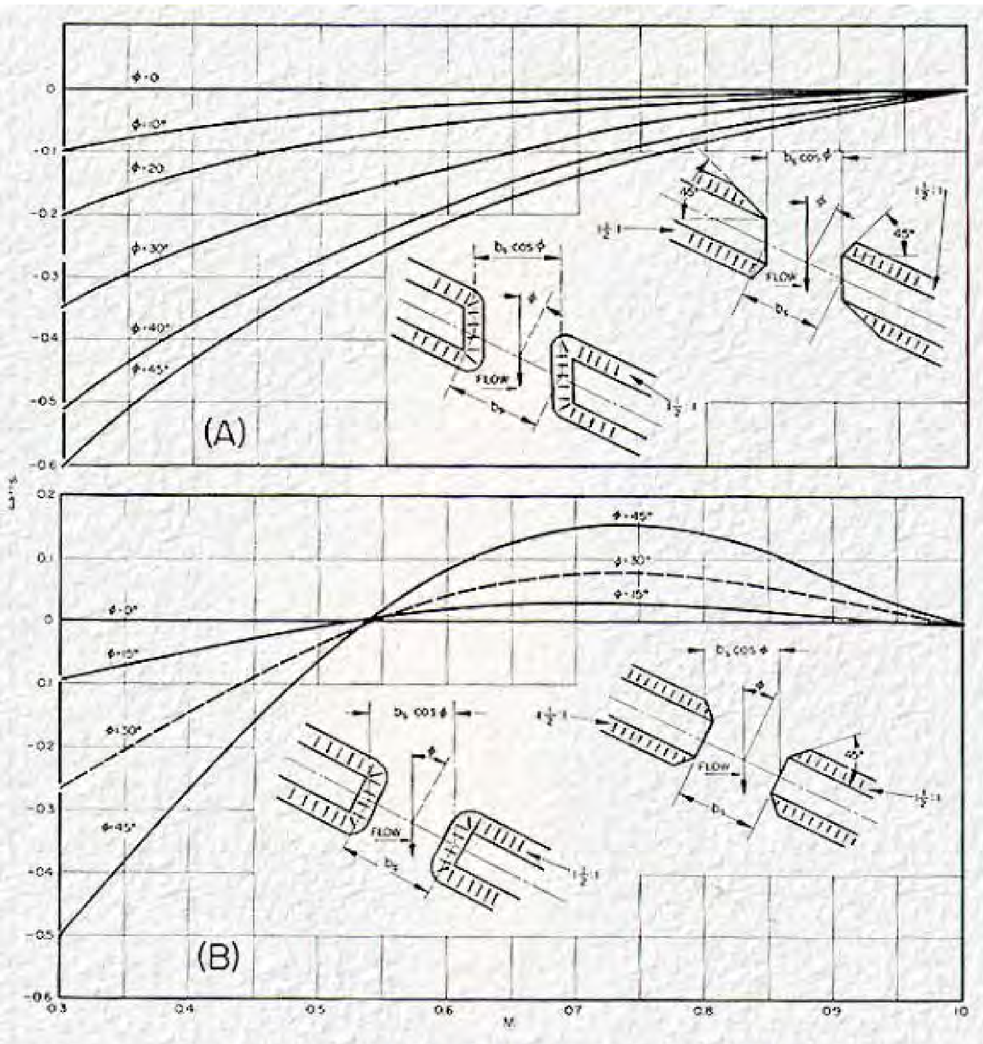


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

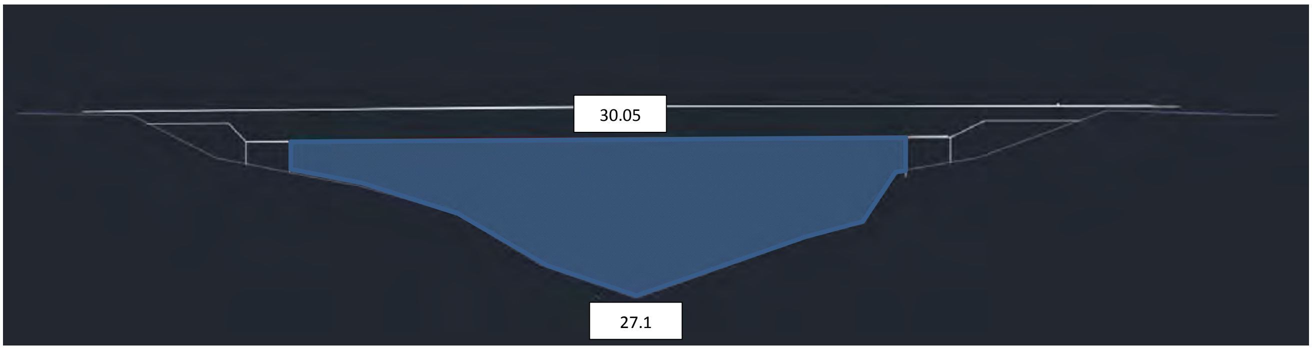
K* = 0.00

Notes

Shaw Park Footbridge Crossing of Werrington Creek Tributary - Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)

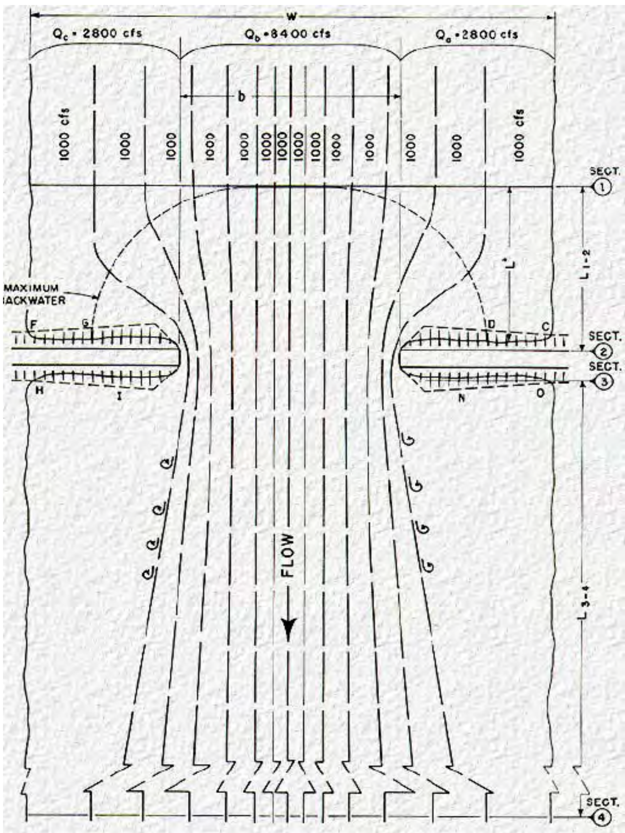


Water level = 30.05mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$



All flow contained in channel
Unimpeded Flow = 68.1 m^3/s
Bridge Flow= 72.5 m^3/s
M = 1.06

where:	(Bridge)	(Unimpeded)
A=	19.6	20.7
P=	13.5	17.0
n=	0.06	0.06
S=	0.03	0.03

Abutment Type = 90o Wingwall

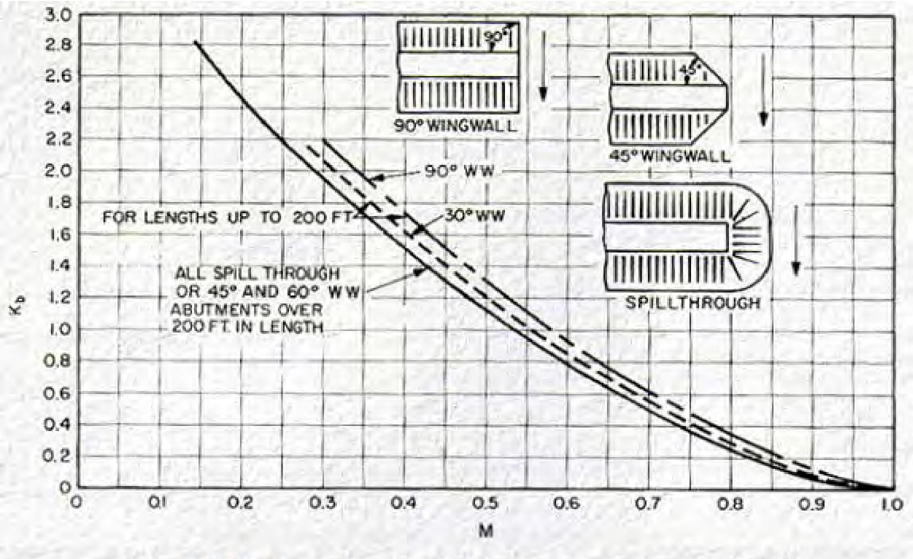


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

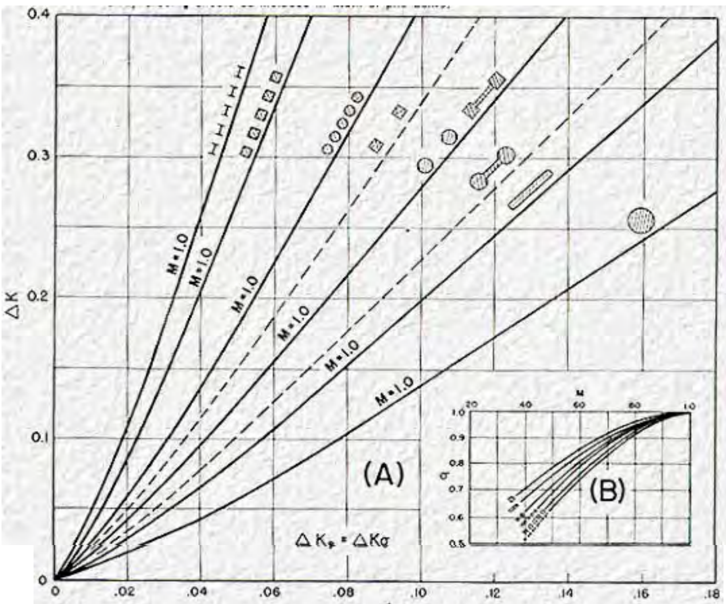
Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$

J = 0

A_p = 0 m^2

A_{n2} = 19.6 m^2



Pier Type: No Piers

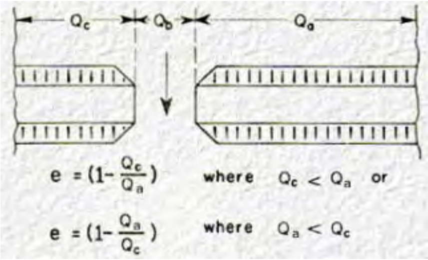
σ = 0.00

ΔK = 0.00

$K_p = \sigma\Delta K$

K_p = 0.00

K_e (Eccentricity Coefficient)



Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

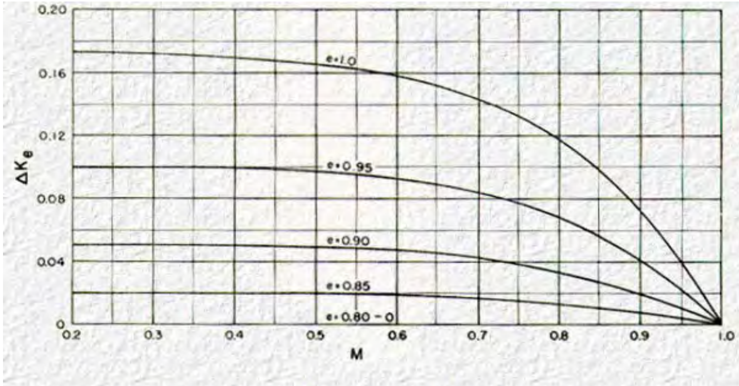


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

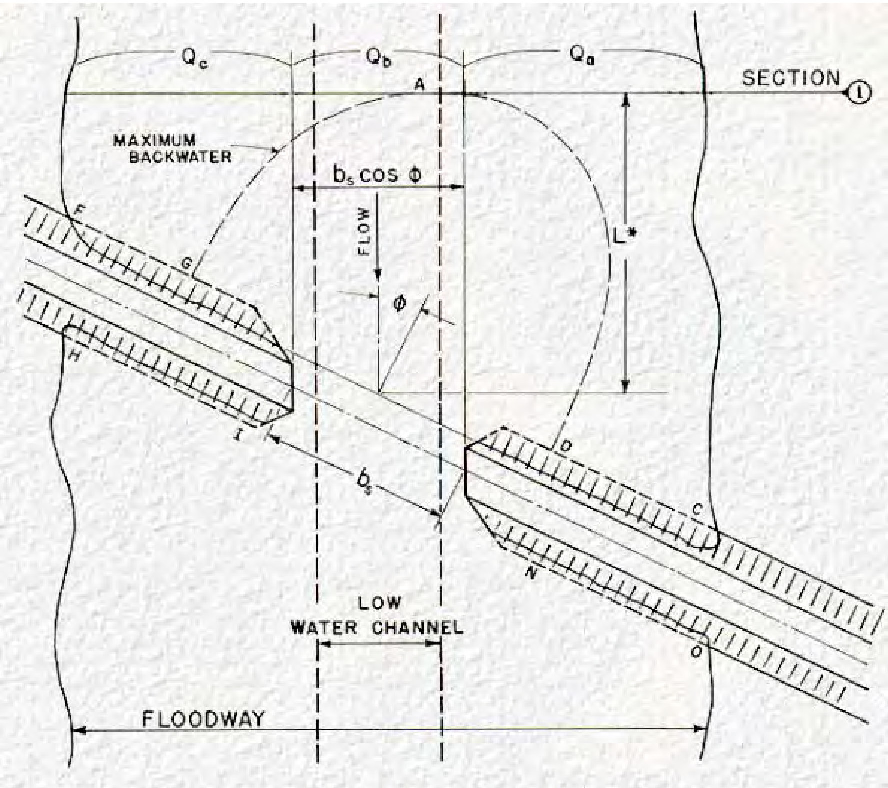


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

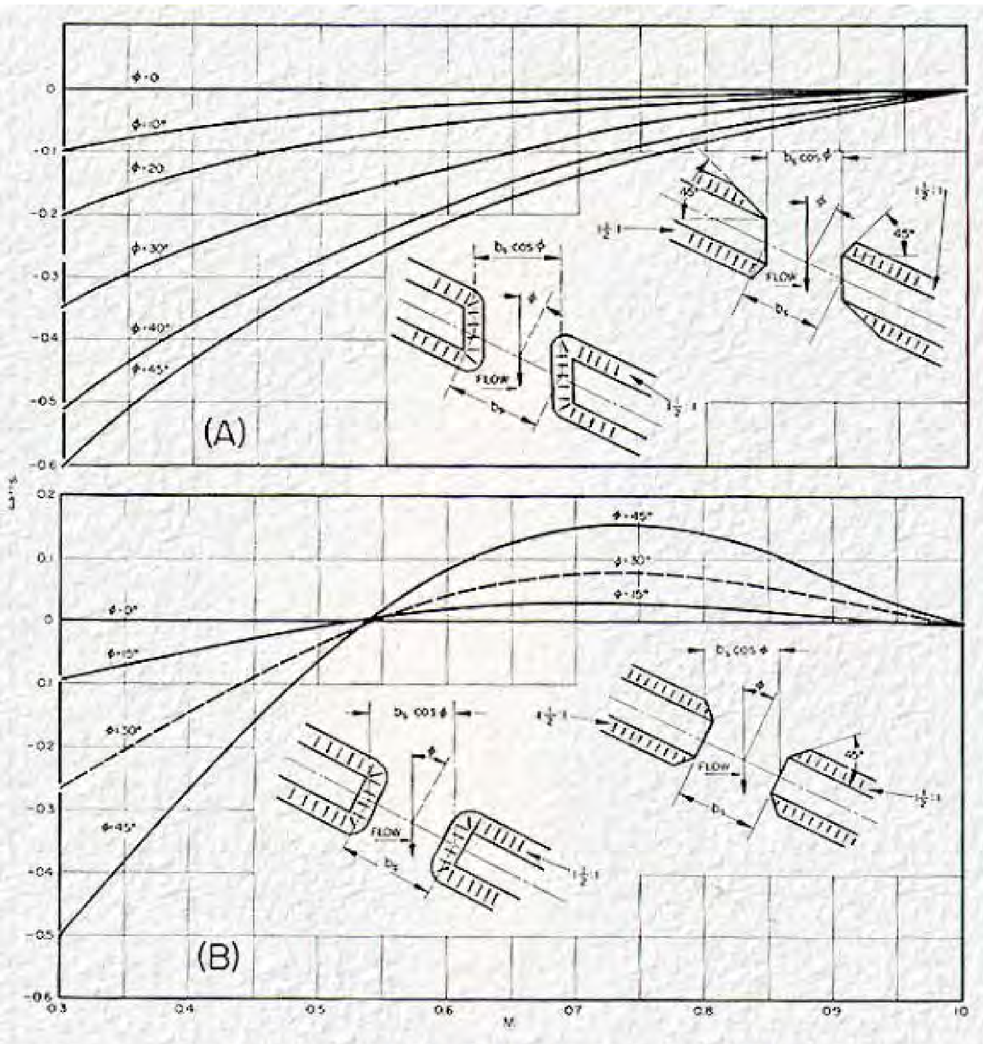


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

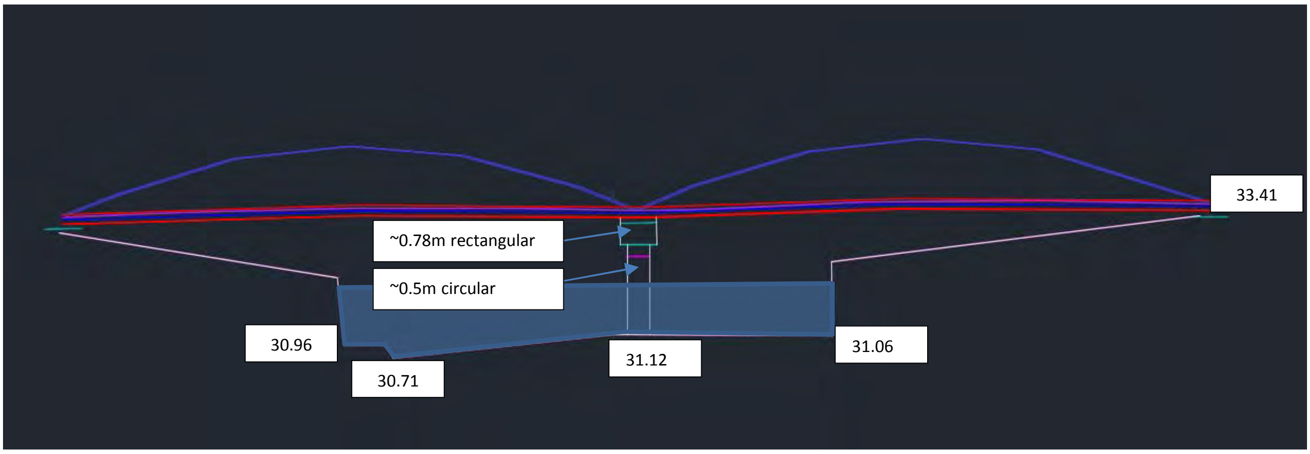
K* = 0.00

Notes

Park Avenue Crossing of Werrington Creek Tributary - Half Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)

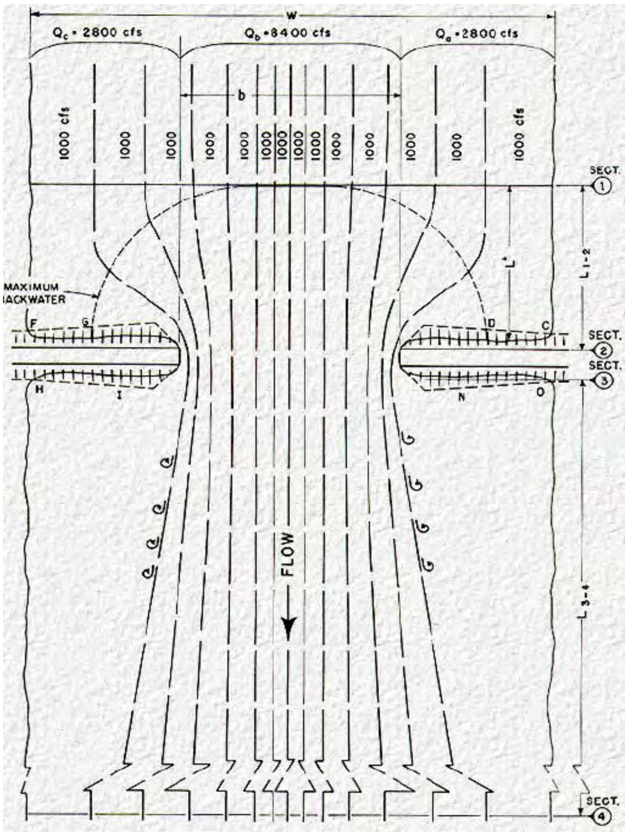


Water level = 32.15mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$



All flow contained in channel

Unimpeded Flow =	21.8	m^3/s
Bridge Flow=	21.8	m^3/s
	M = 1.00	

where:	(Bridge)
A=	12.9
P=	14.5
n=	0.06
S=	0.012

Catchment Simulation Solutions

Abutment Type = 90o Wingwall

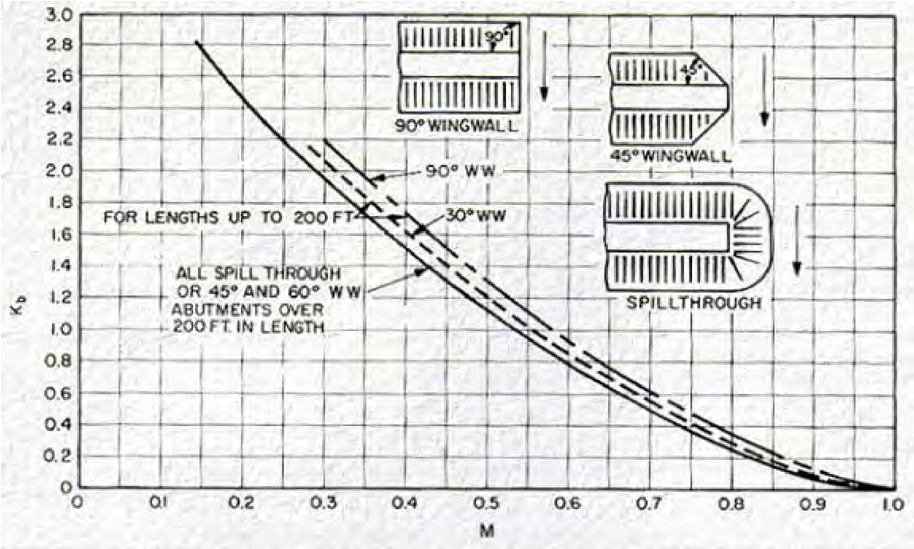


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

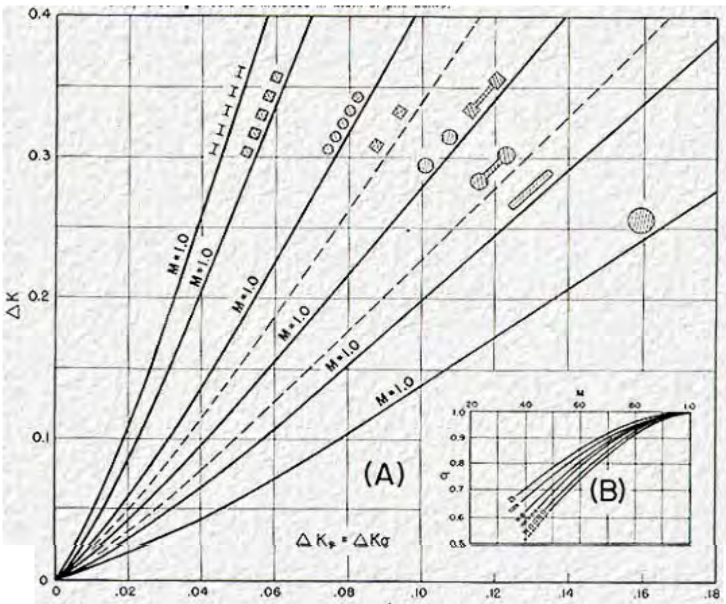
$J = A_p / A_{n3}$

J = 0.039876113

A_p = 0.515 m^2

A_{n2} = 12.9 m^2

Pier Type: Dual Circular Pier



σ = 1.00

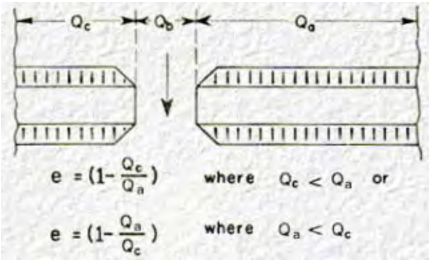
ΔK = 0.09

$K_p = \sigma\Delta K$

K_p = 0.09

Catchment Simulation Solutions

K_e (Eccentricity Coefficient)



$Q_c = 1$	m^3/s
$Q_a = 1$	m^3/s

e = 0.00

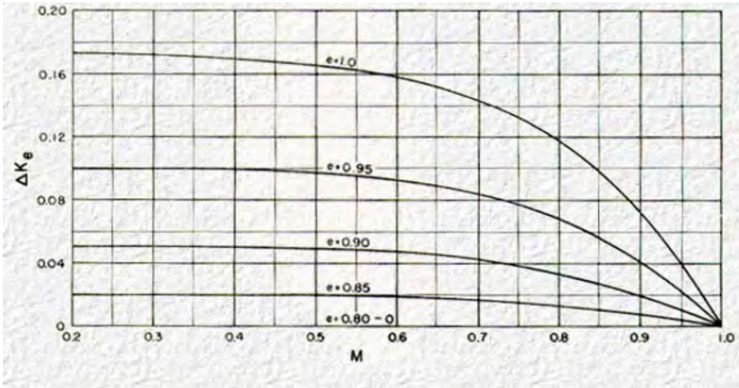


Figure 8. Incremental backwater coefficient for eccentricity.

$K_e = 0.00$

K_s (Skew Coefficient)

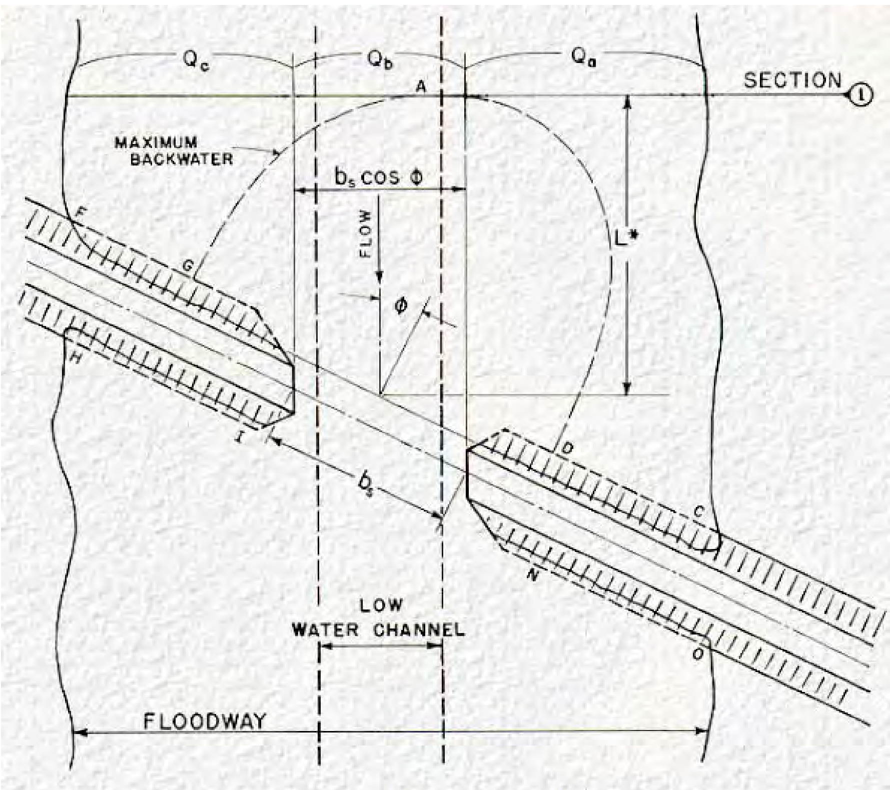


Figure 9. Skewed crossings.

$\phi =$ 0

Abutment Type =	(B)-Straight

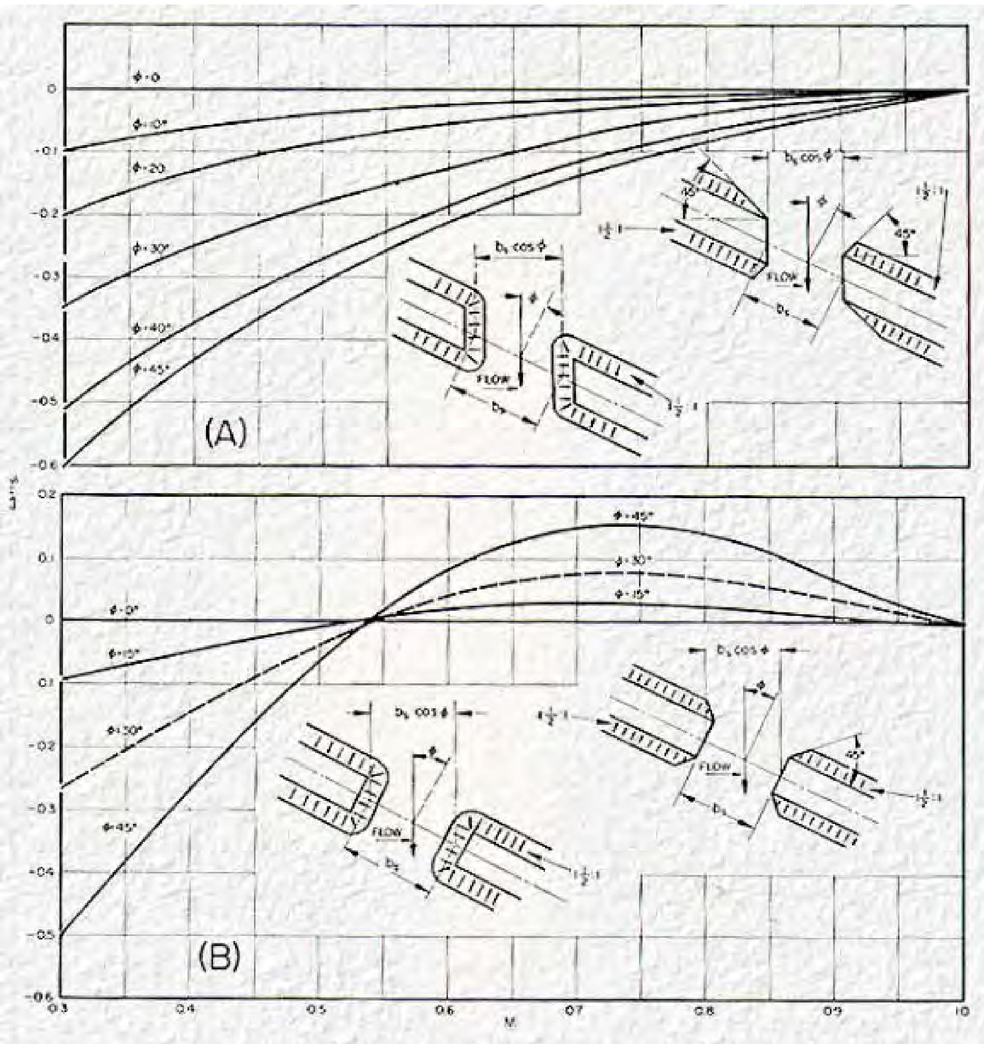


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

$K^* = K_b + K_p + K_e + K_s$

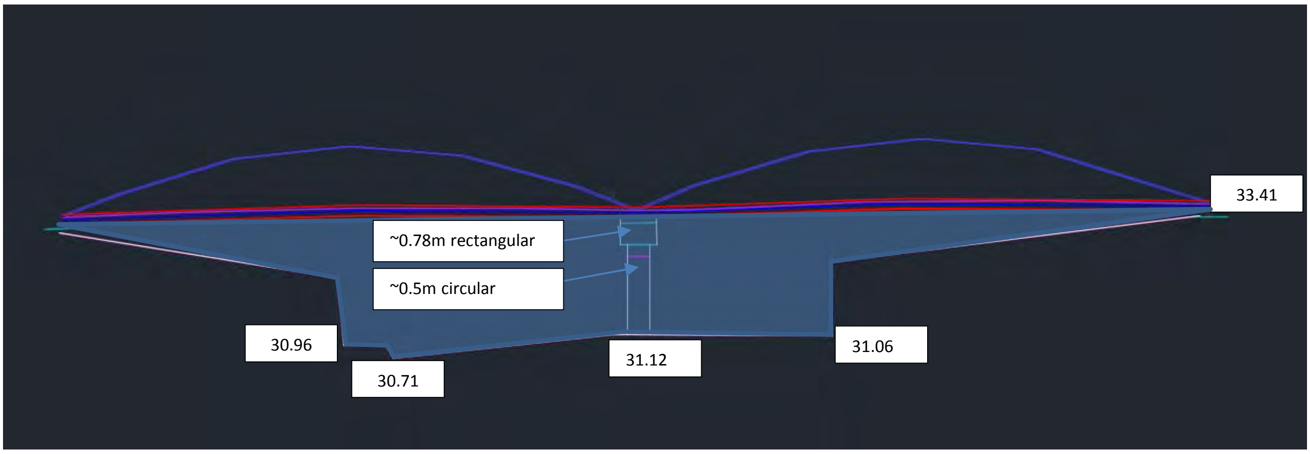
K* = 0.09

Notes

Park Avenue Crossing of Werrington Creek Tributary - Bank Full Capacity

Prepared by: J Hannan **Date:** 21/03/2016
Checked by: **Date:**

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978)

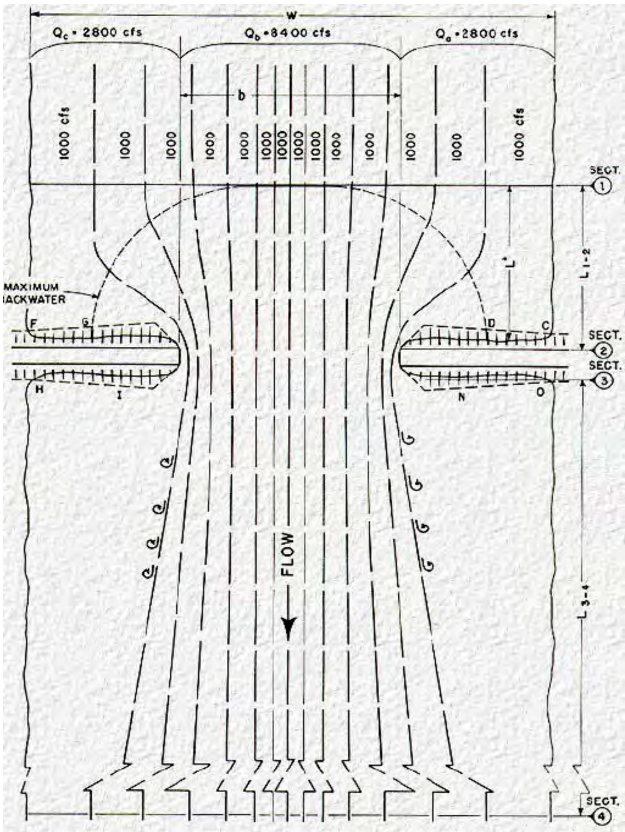


Water level = 32.15mAHD

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

First need to calculate the Bridge Opening Ratio (M)
M = Bridge Flow /Umimpeded Flow
$M = Q_b / (Q_a + Q_b + Q_c)$



All flow contained in channel

Unimpeded Flow =	76.4	m^3/s
Bridge Flow=	76.4	m^3/s
	M = 1.00	

where:	(Bridge)
A=	37.6
P=	32.0
n=	0.06
S=	0.012

Catchment Simulation Solutions

Abutment Type = 90o Wingwall

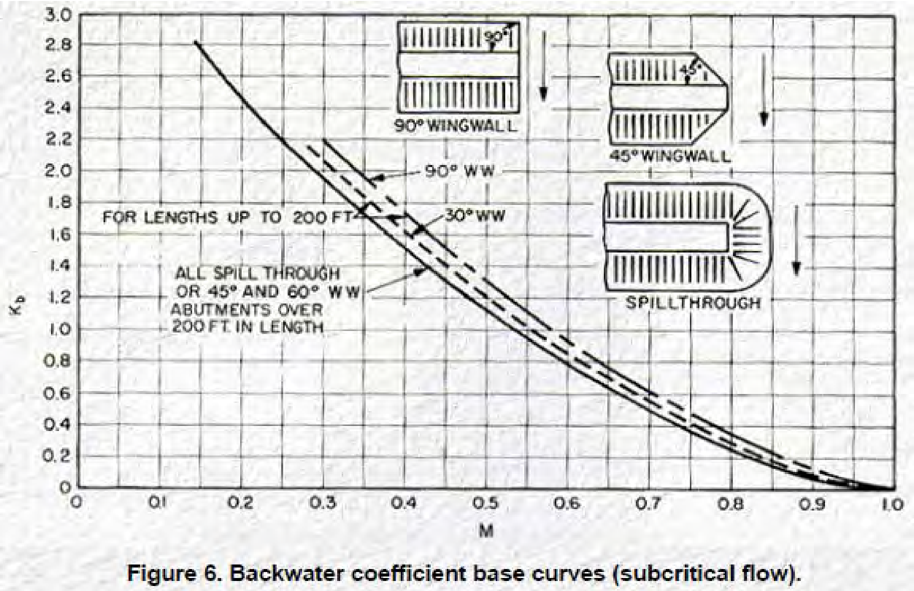


Figure 6. Backwater coefficient base curves (subcritical flow).

K_b = 0.00

K_p (Pier Coefficient)

Ratio of gross waterway area to pier area

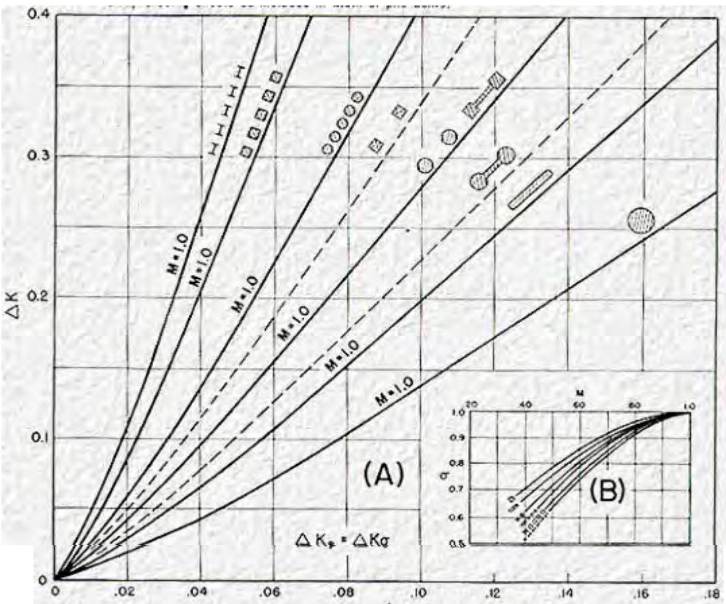
$J = A_p / A_{n3}$

J = 0.034206463

A_p = 1.285 m^2

A_{n2} = 37.6 m^2

Pier Type: Dual Circular Pier



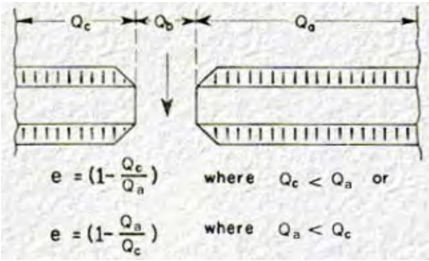
σ = 1.00

ΔK = 0.08

$K_p = \sigma \Delta K$

K_p = 0.08

K_e (Eccentricity Coefficient)



Q_c = 1	m^3/s
Q_a = 1	m^3/s

e = 0.00

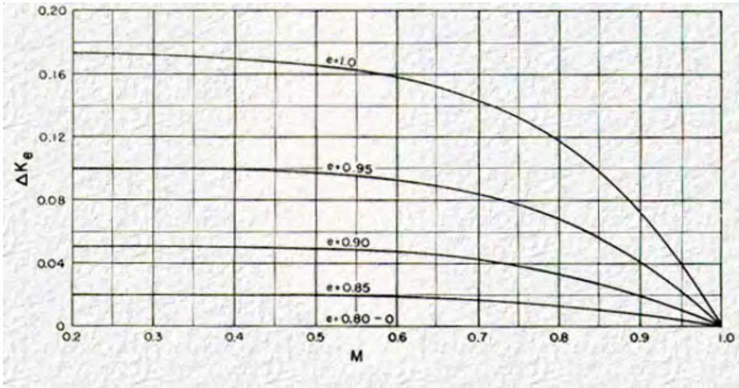


Figure 8. Incremental backwater coefficient for eccentricity.

K_e = 0.00

K_s (Skew Coefficient)

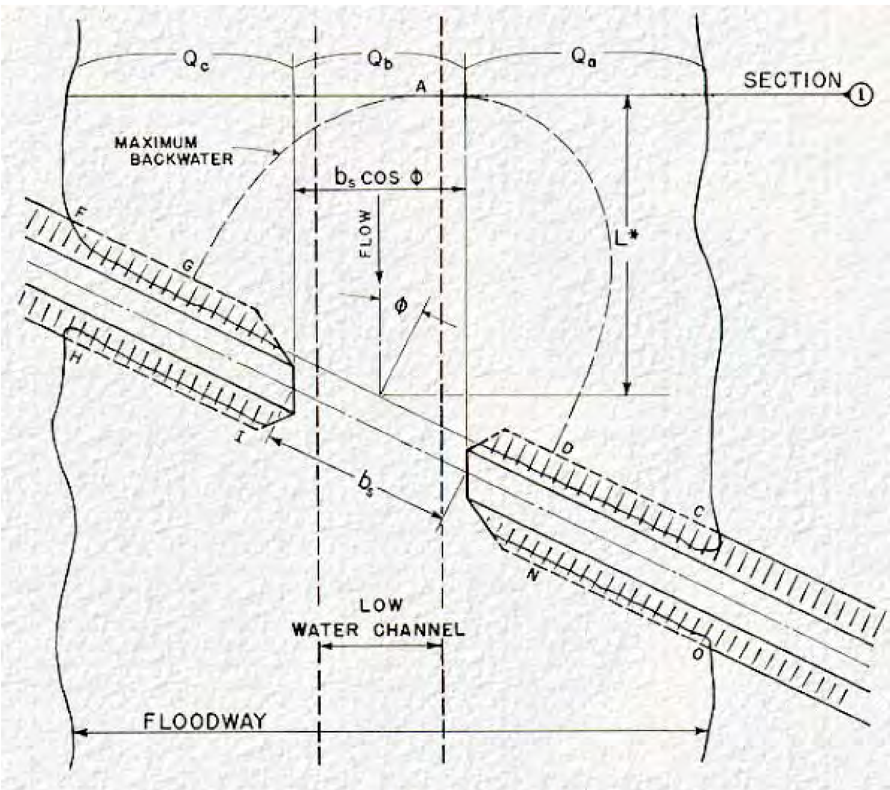


Figure 9. Skewed crossings.

ϕ = 0

Abutment Type =	(B)-Straight

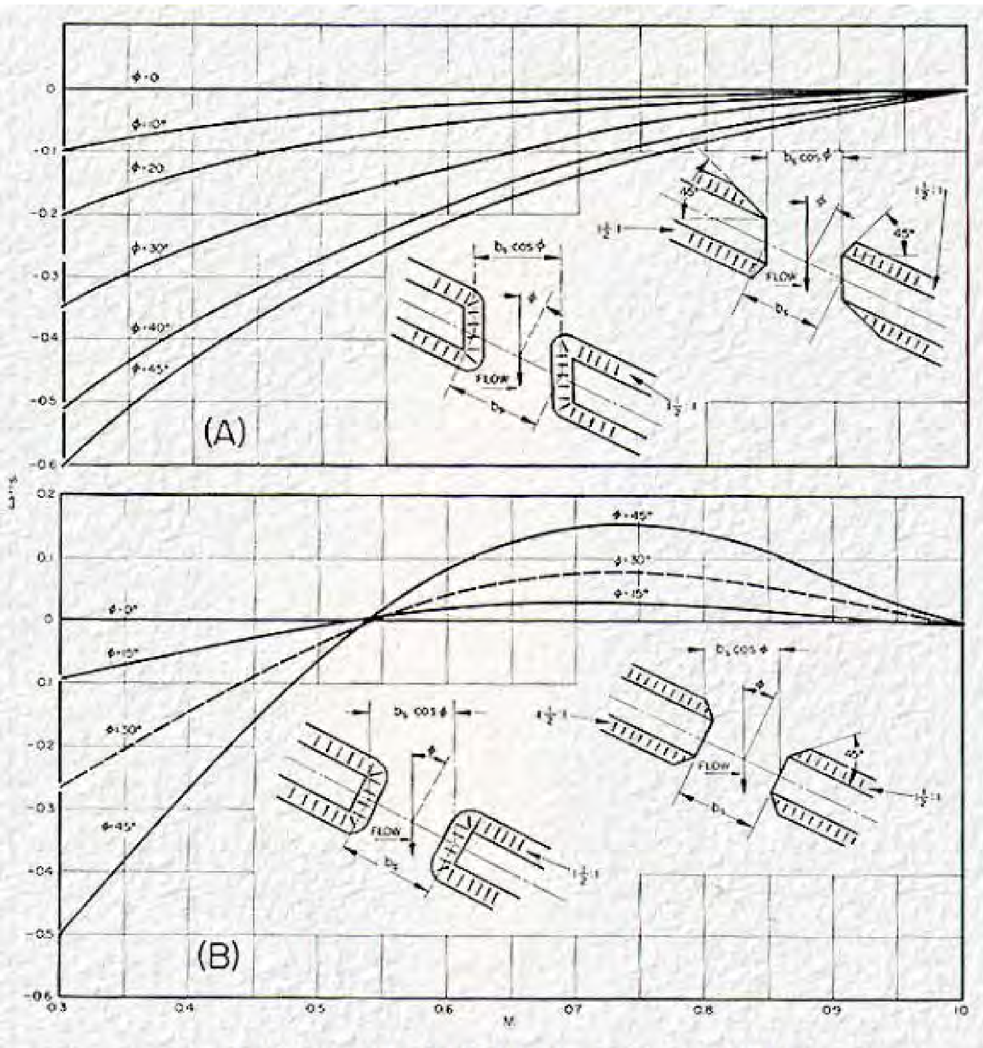


Figure 10. Incremental backwater coefficient for skew.

K_s = 0.00

(K*) Total Backwater Coefficient

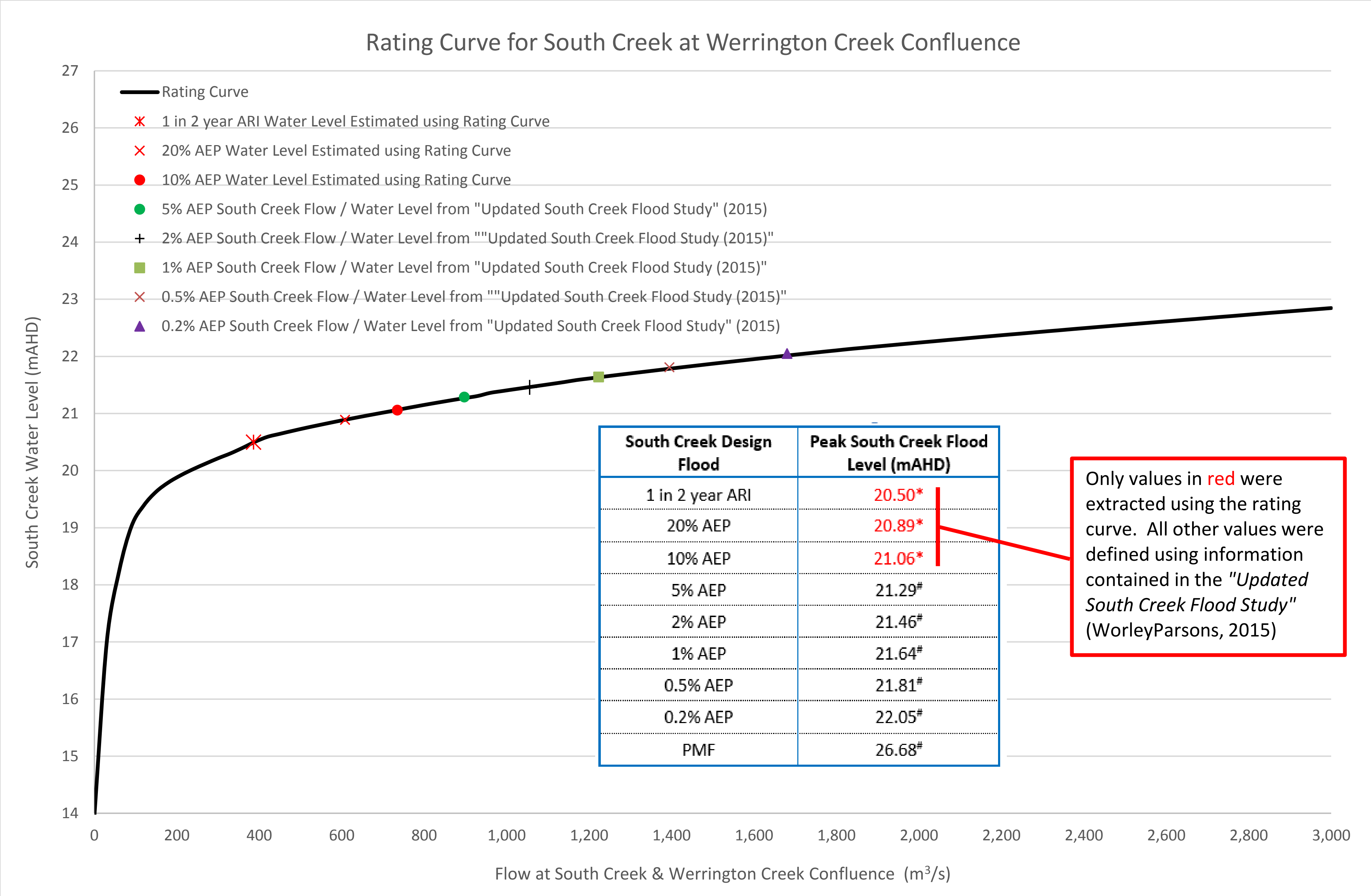
$K^* = K_b + K_p + K_e + K_s$

K* = 0.08

Notes

APPENDIX E

SOUTH CREEK RATING CURVE

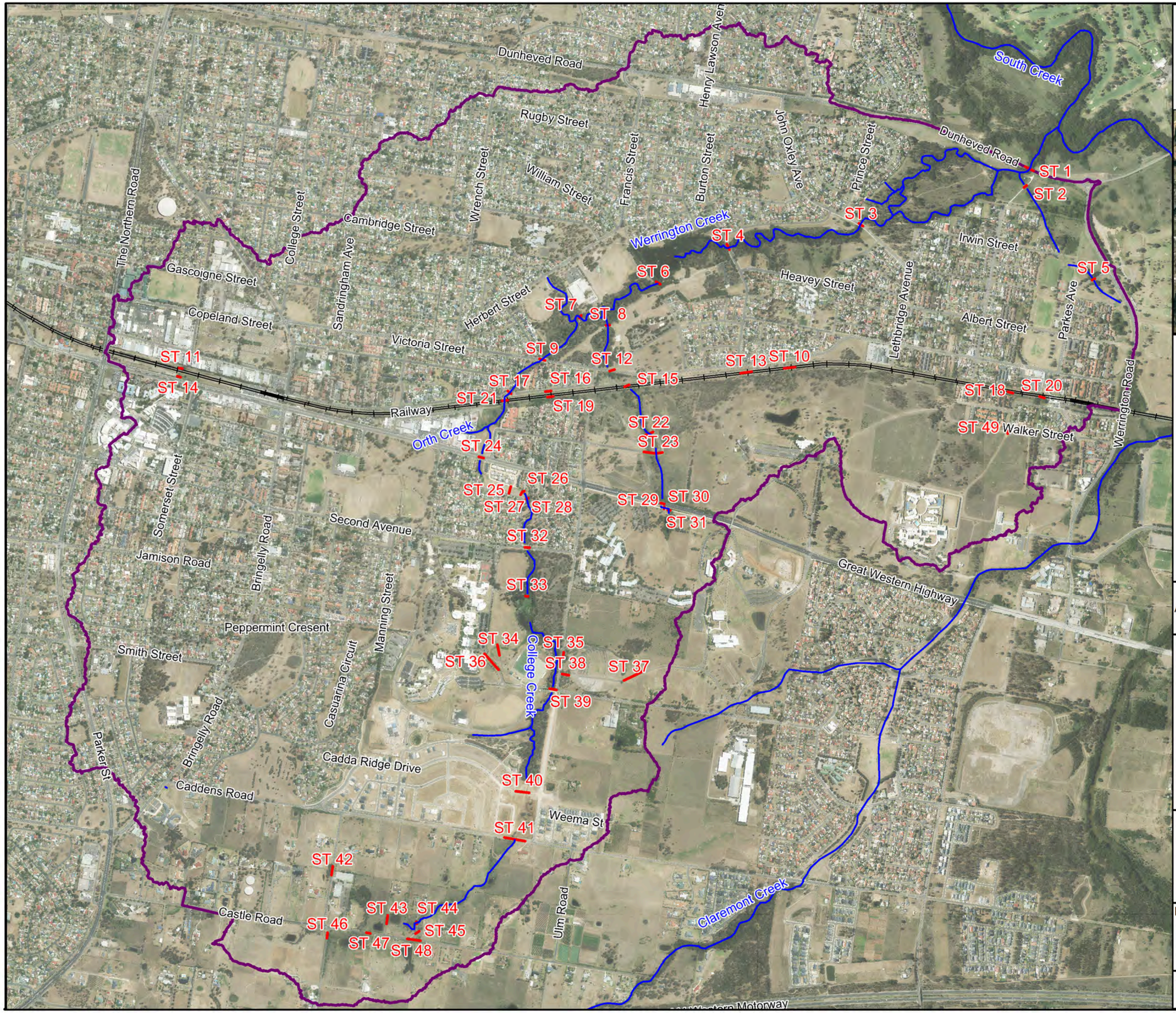


South Creek Design Flood	Peak South Creek Flood Level (mAHD)
1 in 2 year ARI	20.50*
20% AEP	20.89*
10% AEP	21.06*
5% AEP	21.29#
2% AEP	21.46#
1% AEP	21.64#
0.5% AEP	21.81#
0.2% AEP	22.05#
PMF	26.68#

Only values in red were extracted using the rating curve. All other values were defined using information contained in the *"Updated South Creek Flood Study"* (WorleyParsons, 2015)

APPENDIX F

BLOCKAGE ASSESSMENT



PENRITH CITY COUNCIL

LEGEND

College, Orth and Werrington Creeks Catchment

ST 1 Hydraulic Structure

Notes:
Aerial photograph date: 2014.

N W E S

Scale 1:16,000 (at A3)

0 0.5 1 Km

Figure F1
Hydraulic Structure Locations

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig F1 - Hydraulic Structure Locations.wor

STRUCTURE BLOCKAGE ASSESSMENT

College, Orth and Werrington Creek Flood Study

Structure ID	Roadway	Waterway	Structure Type	Structure Dimensions			Land Use Across Upstream Catchment	Max. L10 (m)	Control Dimension	Main Stream Slope (%)	Debris Availability (L, M, H)	Debris Mobility (L, M, H)	Debris Transportability (L, M, H)	Debris Potential	Debris Potential at Structure	Adjustment for AEP			Design Blockage Level		
				Dia/Width/Span	Height	Cells / Spans										AEP >5%	AEP 5%-0.5%	AEP < 0.5%	AEP >5%	AEP 5%-0.5%	AEP < 0.5%
ST 1	DUNHEVED RD	Werrington Creek	Bridge	7	N/A	3	22% Impervious, 47% Grass, 24% Trees, 8% Buildings	3.00	L<W<3L	0.47	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	10%
ST 2	DUNHEVED RD	Unnamed Tributary	Pipe Culvert	1.8	N/A	2	30% Impervious, 47% Grass, 10% Trees, 13% Buildings	1.50	L<W<3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 3	JOHN OXLEY AVE	Werrington Creek	Box Culvert	3.6	3.6	3	32% Impervious, 12% Buildings, 43% Grass, 14% Trees	1.50	L<W<3L	0.23	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 4	BURTON ST	Werrington Creek	Bridge	6.9	N/A	3	33% Grass, 36% Impervious, 14% Buildings, 14% Trees, 2% Water	1.50	W>3L	0.57	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
ST 5	PARKES AVE	Unnamed Tributary	Box Culvert	1.65	0.375	1	12% Trees, 29% Impervious, 48% Grass, 10% Buildings	1.50	L<W<3L	0.48	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 6	OPPOSITE WILLIAM ST IN PARK	Werrington Creek	Bridge	13.8	N/A	1	54% Grass, 34% Trees, 8% Impervious, 4% Buildings	3.00	W>3L	0.11	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	0%
ST 7	WALKING PATH BEHIND SPORTS CENTRE	Werrington Creek	Bridge	18	N/A	1	34% Impervious, 13% Buildings, 38% Grass, 14% Trees	1.50	W>3L	0.68	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
ST 8	PARK	Unnamed Tributary	Pipe Culvert	0.9	N/A	1	52% Grass, 29% Trees, 17% Impervious, 2% Buildings	3.00	W<L	0	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
ST 9	VICTORIA ST	Werrington Creek	Box Culvert	3.35	1.8	5	36% Grass, 8% Trees, 41% Impervious, 15% Buildings	3.00	L<W<3L	0.44	M	M	L	**MML**	Low	Low	Low	Medium	10%	25%	50%
ST 10	RAILWAY	Unnamed Tributary	Pipe Culvert	0.375	N/A	2	11% Impervious, 60% Grass, 19% Trees, 7% Water, 3% Buildings	0.50	W<L	0.03	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
ST 11	RAILWAY	Unnamed Tributary	Pipe Culvert	1.2	N/A	2	36% Grass, 39% Impervious, 10% Trees, 16% Buildings	1.50	W<L	1.96	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
ST 12	VICTORIA ST	Unnamed Tributary	Pipe Culvert	0.9	N/A	2	32% Impervious, 49% Grass, 20% Trees	1.50	W<L	0	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
ST 13	RAILWAY	Unnamed Tributary	Pipe Culvert	0.375	N/A	2	4% Impervious, 64% Grass, 32% Trees	3.00	W<L	4.25	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
ST 14	GREAT WESTERN HIGHWAY	Unnamed Tributary	Pipe Culvert	1.05	N/A	3	57% Grass, 43% Impervious	1.50	W<L	2.14	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
ST 15	VICTORIA ST	Unnamed Tributary	Pipe Culvert	0.9	N/A	2	20% Impervious, 31% Grass, 22% Trees, 26% Areas under construction	3.00	W<L	0	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
ST 16	PARK AVE	Unnamed Tributary	Box Culvert	2.4	1.2	1	67% Grass, 33% Impervious	1.50	L<W<3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 17	PARK AVE/HEATH ST	Werrington Creek	Bridge	14.2	N/A	2	16% Buildings, 38% Impervious, 35% Grass, 12% Trees	1.50	W>3L	0.71	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
ST 18	RAILWAY	Unnamed Tributary	Pipe Culvert	0.75	N/A	1	100% Impervious	1.50	W<L	11.59	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 19	RAILWAY	Unnamed Tributary	Pipe Culvert	1.05	N/A	1	33% Impervious, 32% Grass, 9% Trees, 12% Areas under construction, 14% Buildings	1.50	W<L	1.5	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
ST 20	WERRINGTON RAILWAY STATION	Unnamed Tributary	Pipe Culvert	1.2	N/A	1	10% Impervious, 75% Grass, 11% Trees, 4% Buildings	0.50	L<W<3L	0.41	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 21	RAILWAY - PARK AVE	Werrington Creek	Pipe Culvert	2.25	N/A	4	31% Impervious, 41% Grass, 11% Trees, 14% Buildings, 3% Areas under construction	1.50	L<W<3L	0.87	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 22		Werrington Creek	Box Culvert	1.5	0.9	1	13% Impervious, 14% Areas under construction, 66% Grass, 4% Trees, 2% Water, 2% Buildings	0.50	L<W<3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 23		Werrington Creek	Box Culvert	2.7	0.6	1	4% Areas under construction, 76% Grass, 11% Impervious, 9% Trees	0.50	W>3L	1.85	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
ST 24	GREAT WESTERN HIGHWAY	College Creek	Box Culvert	1.96	1.8	2	41% Impervious, 37% Grass, 7% Trees, 15% Buildings	1.50	L<W<3L	0.43	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 25	FOOTBRIDGE	Werrington Creek	Bridge	12.5	0.2	2	34% Grass, 42% Impervious, 5% Trees, 19% Buildings	1.50	W>3L	1.7	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10
ST 26		College Creek	Pipe Culvert	1.2	N/A	2	44% Impervious, 22% Grass, 13% Trees, 20% Buildings	1.50	W<L	0	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
ST 27	ACCESS ROAD	College Creek	Box Culvert	4.02	1.01	3	25% Impervious, 39% Grass,36% Trees	3.00	L<W<3L	0.36	M	M	L	**MML**	Low	Low	Low	Medium	25%	50%	100%
ST 28		College Creek	Pipe Culvert	1.8	N/A	2	35% Impervious, 13% Buildings, 18% Trees, 35% Grass	1.50	L<W<3L	0.7	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 29	GREAT WESTERN HIGHWAY	Unnamed Tributary	Box Culvert	1.9	1.5	2	28% Impervious, 49% Grass, 23% Trees	3.00	W<L	0.67	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
ST 30		Unnamed Tributary	Pipe Culvert	0.6	N/A	1	20% Impervious, 80% Grass	0.50	L<W<3L	0.71	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 31		Unnamed Tributary	Box Culvert	2.4	0.75	2	14% Impervious, 74% Grass, 8% Trees, 1% Water, 4% Buildings	0.50	W>3L	2.51	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
ST 32	SECOND AVE	College Creek	Pipe Culvert	1.8	N/A	2	12% Impervious, 34% Trees, 46% Grass, 8% Buildings	3.00	W<L	0	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
ST 33		College Creek	Box Culvert	3	0.9	2	21% Trees, 58% Grass, 7% Water, 9% Impervious, 5% Buildings	3.00	L<W<3L	0.18	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	10%
ST 34	WALKING PATH	Unnamed Tributary	Pipe Culvert	0.375	N/A	1	30% Impervious, 8% Trees, 44% Grass, 18% Buildings	1.50	W<L	3.23	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 35	O'CONNELL ST	Unnamed Tributary	Pipe Culvert	0.45	N/A	1	13% Impervious, 77% Grass, 9% Trees	0.50	W<L	2.7	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
ST 36	UWS ACCESS	Unnamed Tributary	Pipe Culvert	0.675	N/A	2	6% Trees, 19% Impervious, 60% Grass, 15% Buildings	0.50	L<W<3L	3.49	L	M	H	**LMH**	Medium	Low	Medium	High	0%	10%	20%
ST 37	ACCESS ROAD	Unnamed Tributary	Pipe Culvert	0.225	N/A	1	78% Grass, 10% Impervious, 10% Trees, 2% Buildings	0.50	W<L	6.42	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 38	ACCESS ROAD	Unnamed Tributary	Pipe Culvert	0.3	N/A	1	47% Impervious, 35% Grass, 18% Trees	1.50	W<L	4.63	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 39	O'CONNELL ST	College Creek	Pipe Culvert	1.2	N/A	4	51% Grass, 10% Impervious, 4% Buildings, 7% Trees, 28% Areas under construction	3.00	W<L	1.03	M	M	M	**MMM**	Medium	Low	Medium	High	25%	50%	100%
ST 40		College Creek	Box Culvert	1.8	1.8	1	4% Grass, 77% Areas under construction, 16% Impervious, 3% Buildings	0.50	W>3L	1.02	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
ST 41	CADDENS RD	College Creek	Pipe Culvert	0.6	N/A	1	9% Impervious, 86% Grass, 2% Trees, 2% Buildings, 1% Water	0.50	L<W<3L	1.15	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ST 42	KINGSWOOD RD	Unnamed Tributary	Pipe Culvert	0.375	N/A	1	79% Grass, 11% Impervious, 4% Trees, 3% Buildings, 3% Water	0.50	W<L	5.55	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 43	CASTLE ST	College Creek	Pipe Culvert	0.6	N/A	2	15% Impervious, 69% Grass, 12% Trees, 2% Buildings, 1% Water	0.50	L<W<3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
ST 44	ACCESS ROAD	College Creek	Pipe Culvert	0.9	N/A	3	77% Grass, 9% Impervious, 9% Trees, 1% Buildings, 4% Water	0.50	L<W<3L	1.76	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ST 45	ACCESS ROAD	College Creek	Pipe Culvert	0.25	N/A	1	6% Trees, 78% Grass, 17% Impervious	0.50	W<L	3.67	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ST 46	KINGSWOOD RD	College Creek	Pipe Culvert	0.75	N/A	2	10% Impervious, 3% Buildings, 84% Grass, 2% Trees, 1% Water	0.50	L<W<3L	2.26	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ST 47	CASTLE ST	College Creek	Pipe Culvert	0.6	N/A	2	3% Trees, 14% Impervious, 76% Grass, 6% Water, 1% Buildings	0.50	L<W<3L	2.31	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ST 48	CASTLE ST	College Creek	Pipe Culvert	0.75	N/A	1	16% Impervious, 75% Grass, 2% Trees, 5% Water, 2% Buildings	0.50	L<W<3L	2.8	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ST 49		Unnamed Tributary	Pipe Culvert	0.9	N/A	1	6% Impervious, 84% Grass, 5% Trees, 0.15% Water, 4% Buildings	0.50	L<W<3L	1.03	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%

Appendix G

Hydraulic Structure Representation

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1 INTRODUCTION

The College, Orth and Werrington Creeks catchment incorporates numerous hydraulic structures that will influence the movement and distribution of floodwaters across the catchment. This includes culverts and bridges as well as stormwater pits and pipes. In general, the hydraulic properties of each of these structures can be represented directly within the TUFLOW model.

However, there are several hydraulic structures that cannot be directly represented in the TUFLOW model or have unique hydraulic / blockage characteristics that require assessment on a case-by-case basis. A summary of these structures and the approach that was employed to represent them in the TUFLOW model is presented below.

1.1 Francis Street Outlet Structure

This structure is located near the southern send of Francis Street, Cambridge Park. It is located at the downstream end of twin 1.5 metre diameter pipes and, as shown in **Plate 1**, comprises a fully enclosed trash rack with a 0.1 metre gap at the bottom.

Plate 1 View showing upstream outlet structure

As shown in **Plate 2**, an additional vertical trash rack is located approximately 5 metres downstream of the main outlet structure.

Plate 2 View showing downstream trash rack

The trash racks are design to capture gross pollutants mobilised from the upstream catchment during significant runoff events. The degree of blockage of the trash racks may have a significant impact on flood behaviour in the immediate vicinity of each structure. Therefore, it was considered important to include a realistic representation of this blockage potential as part of the TUFLOW simulations.

Little literature is available describing blockage factors for trash racks when undertaking flood simulations. Table 7.1 in the Engineers Australia document titled ‘Project 11: Blockage of Hydraulic Structures’ (Engineers Australia, 2013) suggests that for pipes and culverts with “screened” inlets, a 50% blockage factor should be adopted where no detailed blockage information is available. Although it is noted that the trash rack outlined above are located at the outlet of the structure, it was considered that a 50% blockage factor would serve as a reasonable starting point.

In order to check the suitability of the 50% blockage factor, blockage calculations were also performed based upon more recent guidelines published in ‘Blockage of Hydraulic Structures’ (Engineers Australia, 2015). It is noted that this guideline is intended for application with large hydraulic structures (e.g., bridges and culverts). However, it was considered that the basic principles of considering debris size versus aperture (i.e., grate opening) size is still applicable. This analysis determined that for a trash rack with a <0.05m opening that a blockage factor of 25% was suitable during small events (<5% AEP), 50% blockage during medium events (5% AEP to 0.5% AEP) and 100% during large events (>0.5% AEP) would be appropriate.

It was considered that adopting a 100% blockage factor would be too conservative based on Council's regular maintenance routine (i.e., cleaning every 3 months or after a significant rainfall event – whichever occurs first) and the limited potential for large pieces of debris to enter the upstream stormwater system. Therefore, it was considered that the adoption of a 50% blockage factor for trash racks was appropriate for 'design' conditions.

Therefore, the primary outlet structure was represented using the following configuration (this is also shown in **Plate 1**):

- 25% blockage was assigned to the area between the "floor" of the outlet and the bottom of the track rack (the larger opening size was considered to have a lower potential for blockage)
- 50% blockage was assigned to the vertical trash rack
- No blockage was assigned to the "inclined" trach rack (it was considered that gravity would hinder the ability of debris accumulating on this rack).

This configuration was included in TUFLOW as a layered 'flow constriction' layer which allows the blockage factors and hydraulic losses to be varied with respect to water depth.

The downstream trash rack was also represented in TUFLOW as a flow constriction layer with the following configuration (refer **Plate 2**):

- Complete blockage for the concrete base
- 50% blockage for the low level outlet
- 50% blockage for the vertical trash rack

1.2 Chapman Gardens Inlet Structure, Kingswood

This structure serves as the main outlet to the Chapman Gardens detention area and comprises two main components:

- Main inlet grate (refer **Plate 3**).
- Low level trash rack located at interface between inlet pit and culvert system (refer **Plate 4**)

Plate 3 Main Chapman Gardens inlet structure

Plate 4 Low level trash rack located within inlet pit

For the main inlet grate, a blockage factor of 50% was applied in line with Council's blockage policy for grated sag inlets.

For the low level trash rack contained within the outlet pit, a 50% blockage factor was applied. This was incorporated within TUFLOW by adding a 1D weir element between the inlet pit and the downstream culvert.

1.3 Paskin Street Surcharge Structure, Kingswood

The Paskin Street structure is located at the southern end of Chapman Gardens and comprises a similar inlet configuration to the Chapman Gardens structure described above (i.e., large grate with low level trach rack contained within pit) (refer **Plate 5**). However, this structure is designed to function as a surcharge pit rather than an inlet pit.

A 50% blockage was assigned to the low level trach rack located within the pit. However, because the main pit is primarily designed to surcharge flow, the majority of debris is likely to be conveyed through the pipe system and be trapped within the pit. The pit is unlikely to suffer significant blockage in such circumstances as gravity will have a tendency to prevent debris from accumulating against the underside of the grate. Nevertheless, there is still potential for overland flows to carry debris towards the pit. In this regard the inlet will serve much like an on-grade grated inlet. Council's blockage policy recommends a 50% blockage factor be applied to grated on-grade inlets. Therefore, a 50% blockage factor was applied to the pit.

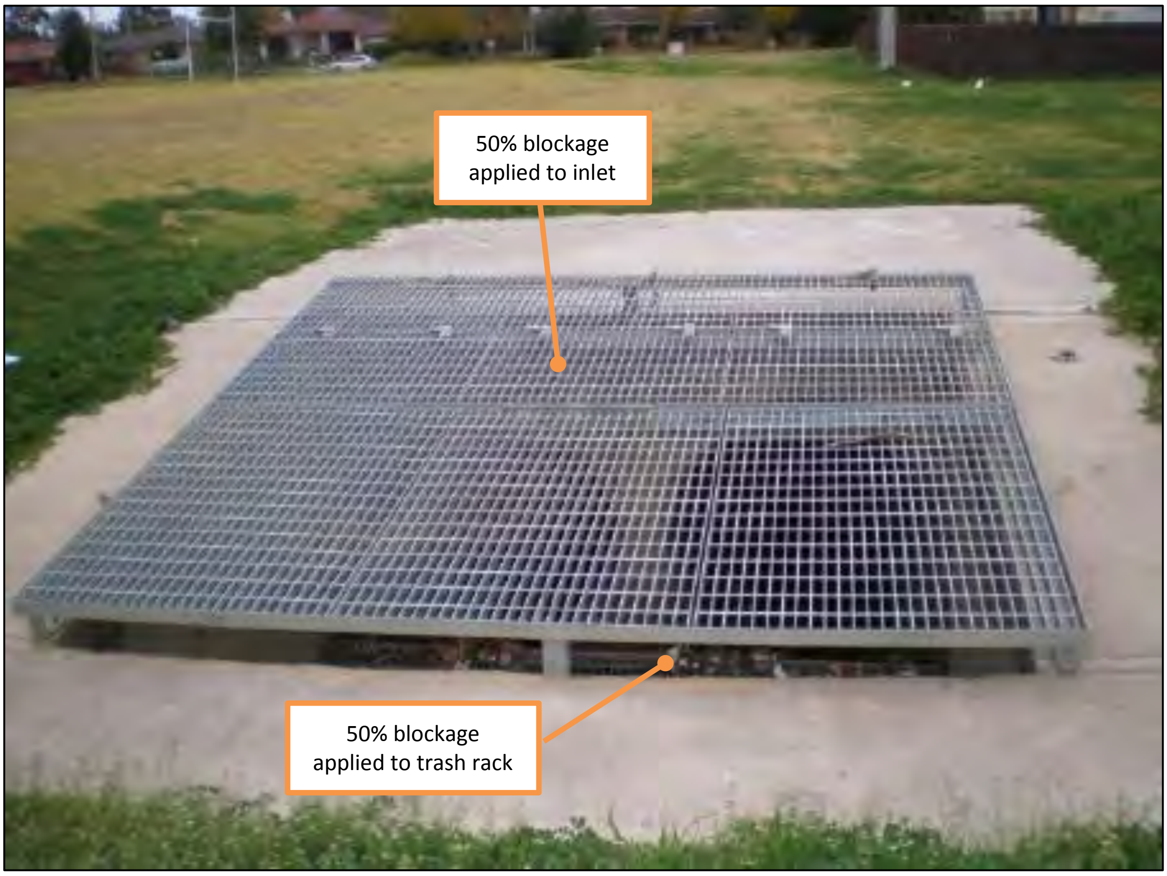


Plate 5 Main Paskin Street structure looking south (i.e., upstream).

1.4 Outlet Structure near Intersection of Herbert St and Campton Ave, Cambridge Park

As shown in **Plate 6**, this structure includes a low level trash rack as well as concrete energy dissipation structures. Application of a 50% blockage factor was considered appropriate for the trash rack. This was represented as a 1D weir structure in TUFLOW.

The energy dissipation structures are designed to slow the movement of water from the culvert outlet before it enters the receiving creek/channel system. As such, the energy dissipation structures can also provide a significant flow obstruction.

The energy dissipation structures shown in **Plate 6** comprises several concrete "blocks". This was considered to behave hydraulically similar to concrete bridge piers. Therefore, the energy losses associated with the energy dissipation structure was approximated by calculating an energy loss coefficient equivalent to a bridge pier system. However, bridge piers are typically "streamlined" to minimise energy losses, whereas the dissipation structure comprises offset blocks that are designed to impede the path of flow. Accordingly, the calculated loss coefficient was doubled to reflect this additional flow impediment. This ultimately yielded a loss coefficient of 0.42. This loss coefficient was included as an additional form loss for the small section of 1D channel located between the pipe outlet and the trash rack.

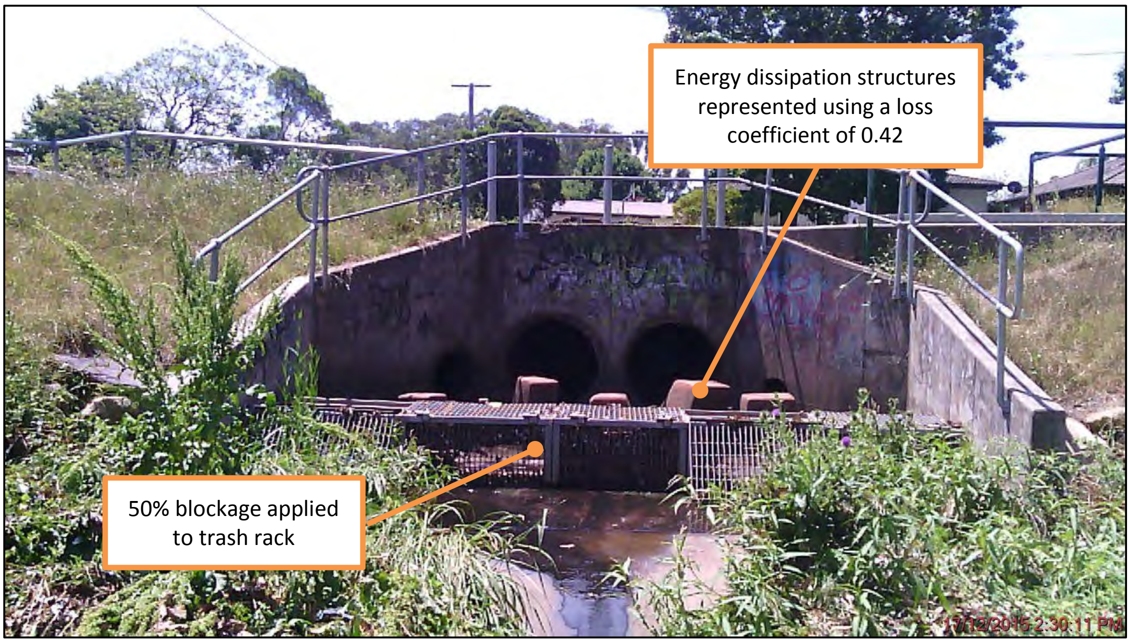


Plate 6 View looking towards Herbert Street showing energy dissipation structures and trash rack

1.5 Cox Avenue Gross Pollutant Trap

The Cox Avenue Gross Pollutant Trap (GPT) is a Rocla CleansAll^{TM} unit that is contained below ground (refer **Plate 7**). It is an “online” GPT that is connected directly to the stormwater pipe system.

Plate 7 Cox Avenue GPT

A conceptual representation of how the GPT works is shown in **Plate 8**. As shown in **Plate 8**, inflows from the stormwater system are diverted into a treatment chamber during small storm/rainfall events. During larger events, the excess water bypasses the treatment chamber. In general, these types of GPT units are only designed to treat flows during relatively frequent events (i.e., < 1 in 1 year ARI event). As a result, during the design events that are being considered as part of this flood study (i.e., 2 year ARI and above), the majority of flows will bypass the treatment system.

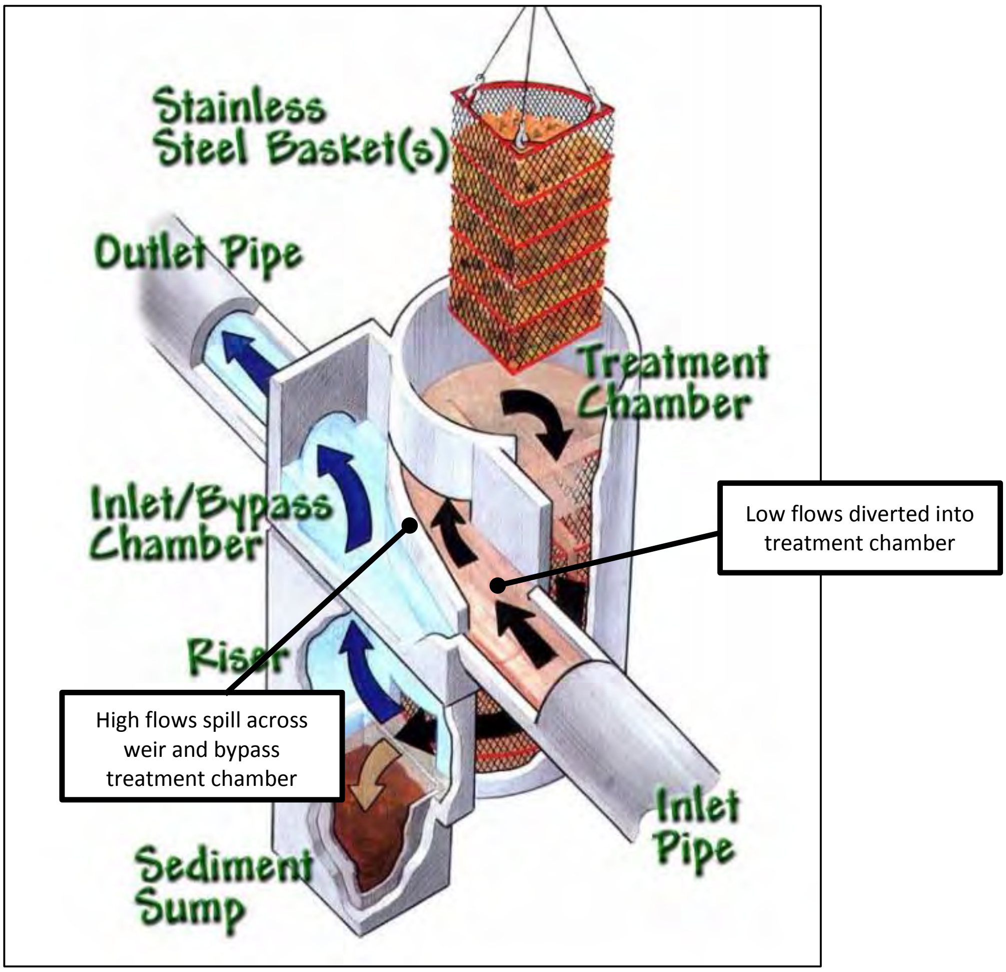


Plate 8 Conceptual representation of how Cox Ave GPT operates (Rocla, 2016)

Information provided by Rocla indicates that these systems generally provide head losses that are comparable to standard junction pits. Therefore, this GPT unit was represented in the TUFLOW model as a junction pit. The losses through this pit were then automatically calculated by TUFLOW for each time step based on the Englehund method.

1.6 Irwin Street GPT, Werrington

This GPT is located at the downstream end of twin 1.2 m diameter stormwater pipes. As shown in **Plate 9**, the GPT comprises a "basin" with a concrete perimeter wall that provides a large area for storage of accumulated debris. A trash rack is also located on top of the concrete perimeter wall. Four circular outlets are embedded within the downstream concrete wall and have include debris capture nets.

The concrete wall was included in the TUFLOW model as a fully impervious wall (i.e., 100% blockage). 50% blockage was assigned to the trach rack sitting atop the concrete wall.

The outlets were included as 1D pipes within the TUFLOW model. A 25% blockage factor was assigned to each outlet to reflect the blockage potential associated with the netting.

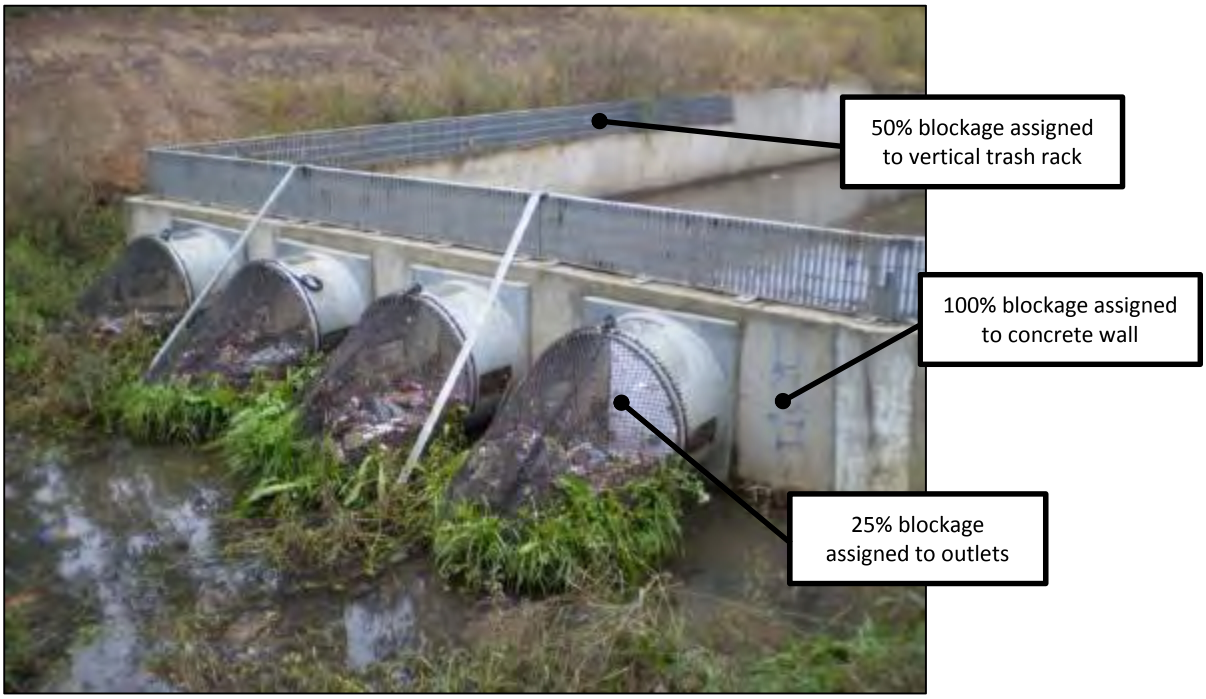


Plate 9 Irwin Street GPT showing concrete wall, trash rack and outlet pipes with debris nets

1.7 Murcott Terrace GPTs, Caddens

Two GPTs are located north of Murcott Terrace at Caddens. This includes:

- Baramy Drycell^{TM} unit (located near Bargo Blvd) (refer **Plate 10**).
- HumeGard^{TM} unit that is located near the 'elbow' in Murcott Terrace near Cadda Ridge Dr intersection (refer **Plate 11**)

Plate 10 Murcott Terrace GPT near Bargo Blvd

Both GPTs are online systems that are connected directly to the stormwater pipe system and outfall via pipe/box culverts to bio-retention/detention basins.

Plate 11 Murcott Terrace GPT near Cadda Ridge Road

Little information is available describing the hydraulic performance of the Drycell^{TM} unit. However, it was assumed that they would function in a similar manner to the Rocla system described in Section 1.5 (i.e., high flows bypass the system and head losses through the system are relatively low). Therefore, this GPT unit was included as a junction pit in the stormwater system representation and the losses through the system were calculated automatically by TUFLOW using the Englehund method.

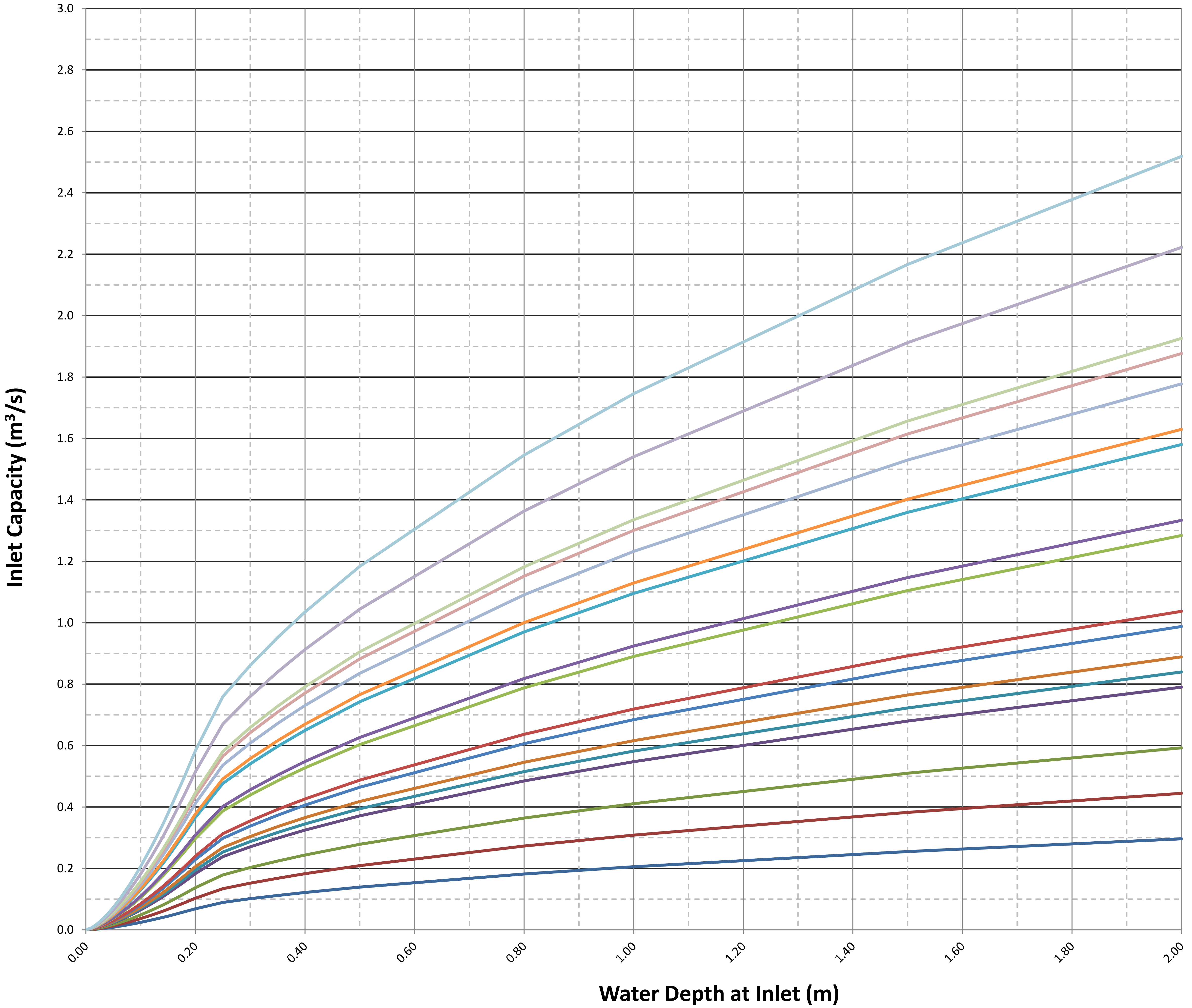
The HumeGard^{TM} system has a stated head loss coefficient of 0.2. Therefore, this structure was included in the TUFLOW model as a junction pit and the loss coefficient of 0.2 was applied directly to this pit.

2 REFERENCES

- Engineers Australia (2013), Project 11 Blockage of Hydraulic Structures - Stage 2 Report. Prepared by W. Weeks, G. Witheridge, A Barthelmess, G. O'Loughlin & E. Rigby.
- Engineers Australia (2015), Blockage of Hydraulic Structures – Blockage Guidelines. Prepared by W. Weeks & E. Rigby.

APPENDIX H

STORMWATER INLET CAPACITY CURVES



LEGEND

- Inlet with 0.6m Side Entry
- Inlet with 0.9m Side Entry
- Inlet with 1.2m Side Entry
- Inlet with 1.6m Side Entry
- Inlet with 1.7m Side Entry
- Inlet with 1.8m Side Entry
- Inlet with 2m Side Entry
- Inlet with 2.1m Side Entry
- Inlet with 2.6m Side Entry
- Inlet with 2.7m Side Entry
- Inlet with 3.2m Side Entry
- Inlet with 3.3m Side Entry
- Inlet with 3.6m Side Entry
- Inlet with 3.8m Side Entry
- Inlet with 3.9m Side Entry
- Inlet with 4.5m Side Entry
- Inlet with 5.1m Side Entry

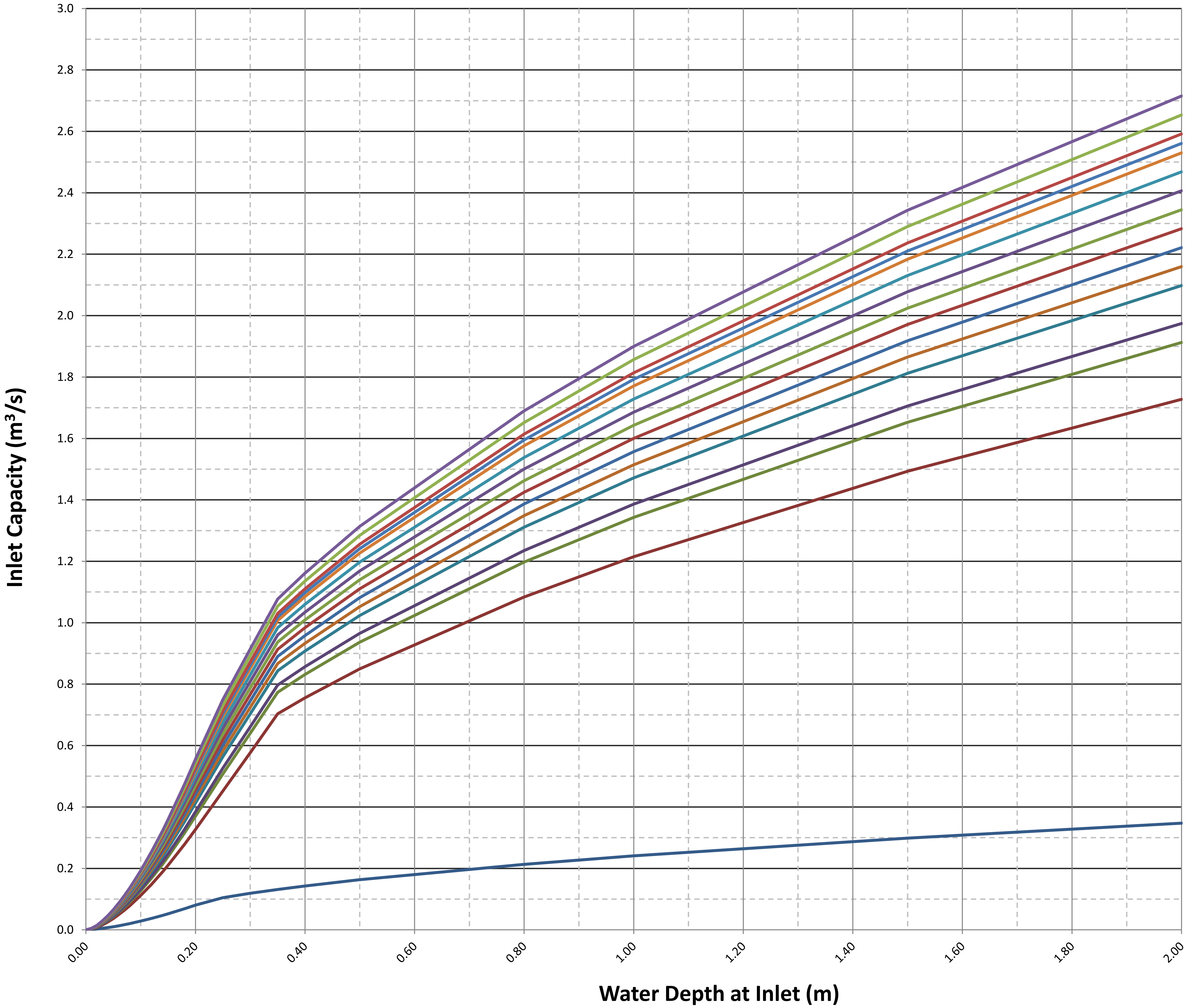
Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H1: Inlet Capacity Curves for Side Entry Pits in Sag

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Inlet Capcacity Curves.xls



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LEGEND

- Combination Inlet with 0.45 m Side Entry
- Combination Inlet with 0.6 m Side Entry
- Combination Inlet with 0.9 m Side Entry
- Combination Inlet with 1 m Side Entry
- Combination Inlet with 1.2 m Side Entry
- Combination Inlet with 1.3 m Side Entry
- Combination Inlet with 1.4 m Side Entry
- Combination Inlet with 1.5 m Side Entry
- Combination Inlet with 1.6 m Side Entry
- Combination Inlet with 1.7 m Side Entry
- Combination Inlet with 1.8 m Side Entry
- Combination Inlet with 1.9 m Side Entry
- Combination Inlet with 1.95 m Side Entry
- Combination Inlet with 2 m Side Entry
- Combination Inlet with 2.1 m Side Entry
- Combination Inlet with 2.2 m Side Entry

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H2a:
Inlet Capacity Curves for Combination Pits in Sag

Prepared By:
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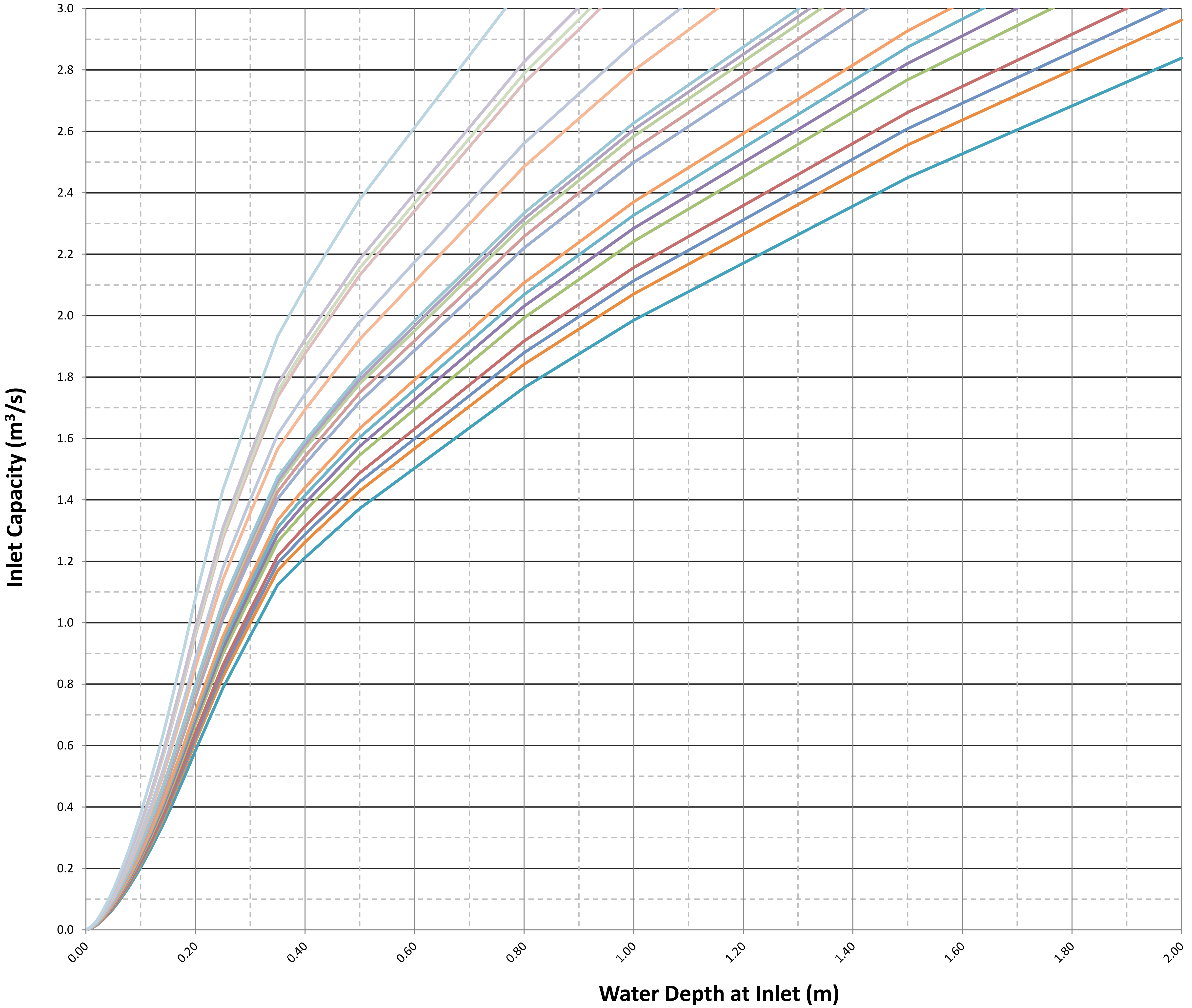
Sydney, NSW, 2000

File Name: Inlet Capcacity Curves.xls



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LEGEND

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H2b:
Inlet Capacity Curves for Combination Pits in Sag

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File Name: Inlet Capcacity Curves.xls

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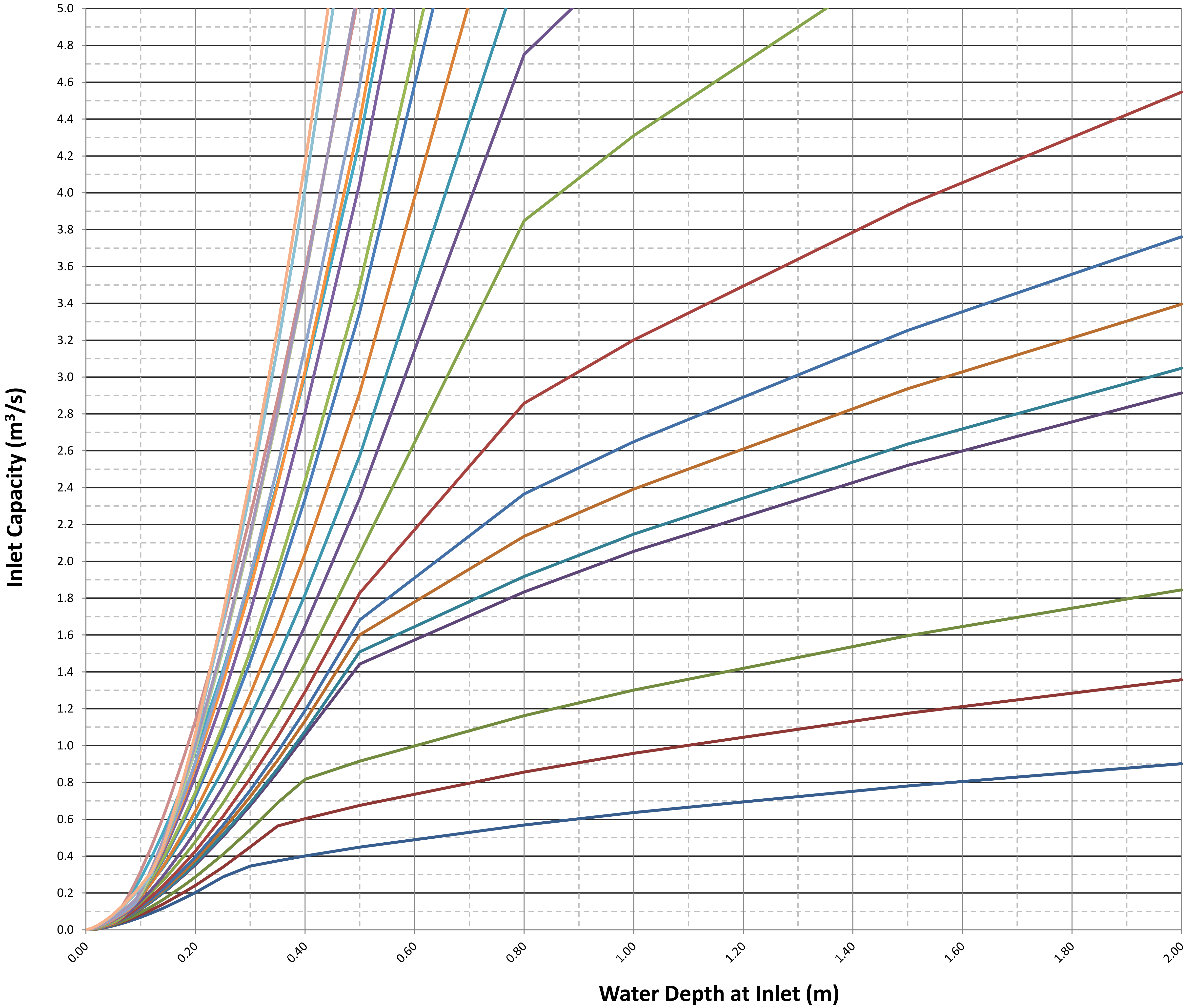

LEGEND

- Inlet with 0.24m2 Grate
- Inlet with 0.36m2 Grate
- Inlet with 0.5m2 Grate
- Inlet with 0.75m2 Grate
- Inlet with 0.8m2 Grate
- Inlet with 0.9m2 Grate
- Inlet with 1m2 Grate
- Inlet with 1.2m2 Grate
- Inlet with 1.6m2 Grate
- Inlet with 2m2 Grate
- Inlet with 2.6m2 Grate
- Inlet with 3.2m2 Grate
- Inlet with 4.4m2 Grate
- Inlet with 4.8m2 Grate
- Inlet with 5.8m2 Grate
- Inlet with 6.8m2 Grate
- Inlet with 7.2m2 Grate
- Inlet with 8.1m2 Grate
- Inlet with 9m2 Grate
- Inlet with 10.2m2 Grate
- Inlet with 11.9m2 Grate
- Inlet with 12.2m2 Grate
- Inlet with 16.8m2 Grate
- Inlet with 18.5m2 Grate

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H3:
Inlet Capacity Curves for Grated Pits in Sag

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Sydney, NSW, 2000

File Name: Inlet Capcacity Curves.xls

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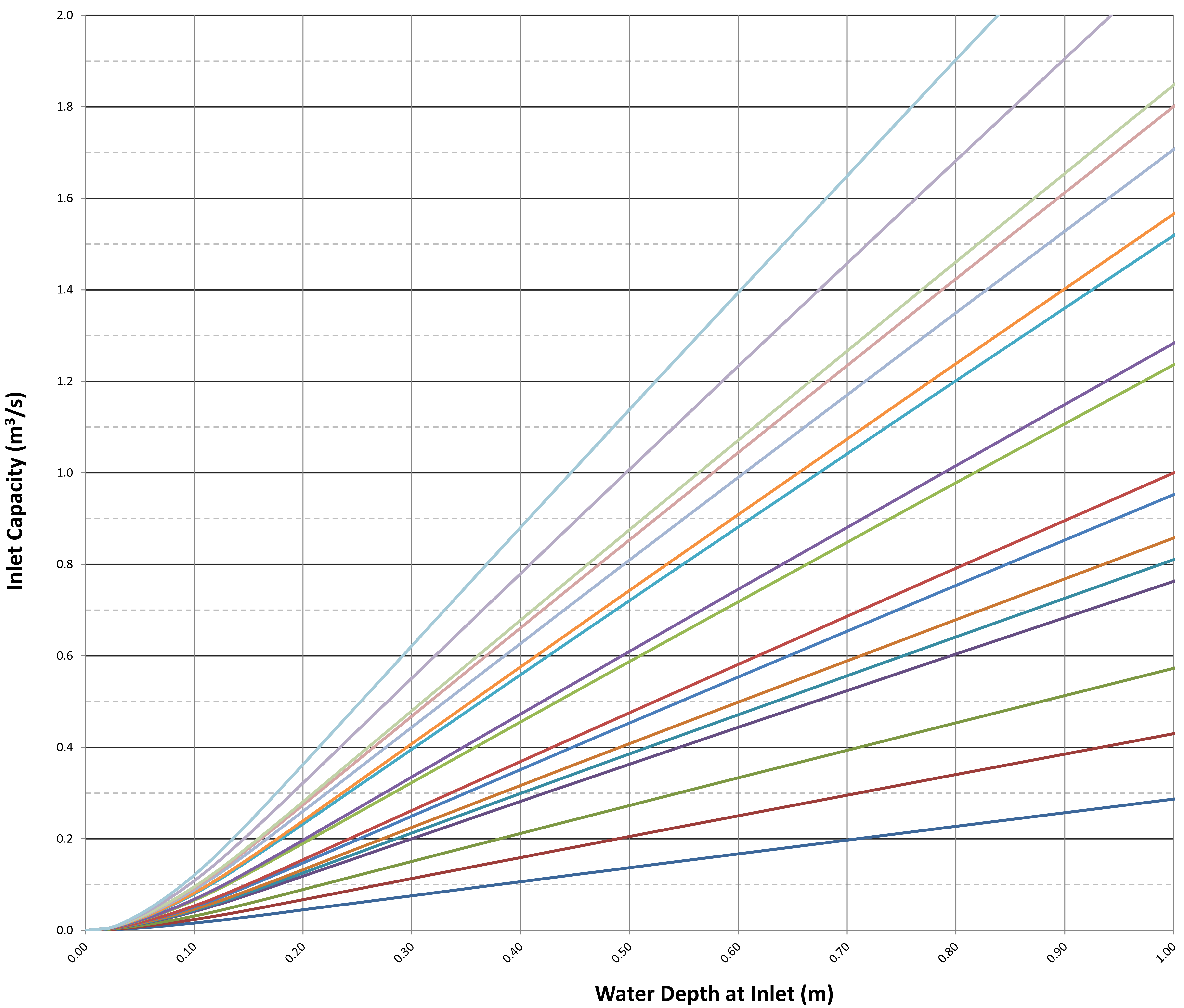

LEGEND

- Inlet with 0.6m Side Entry
- Inlet with 0.9m Side Entry
- Inlet with 1.2m Side Entry
- Inlet with 1.6m Side Entry
- Inlet with 1.7m Side Entry
- Inlet with 1.8m Side Entry
- Inlet with 2m Side Entry
- Inlet with 2.1m Side Entry
- Inlet with 2.6m Side Entry
- Inlet with 2.7m Side Entry
- Inlet with 3.2m Side Entry
- Inlet with 3.3m Side Entry
- Inlet with 3.6m Side Entry
- Inlet with 3.8m Side Entry
- Inlet with 3.9m Side Entry
- Inlet with 4.5m Side Entry
- Inlet with 5.1m Side Entry

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H4: Inlet Capacity Curves for Side Entry Pits on Grade

Prepared By:
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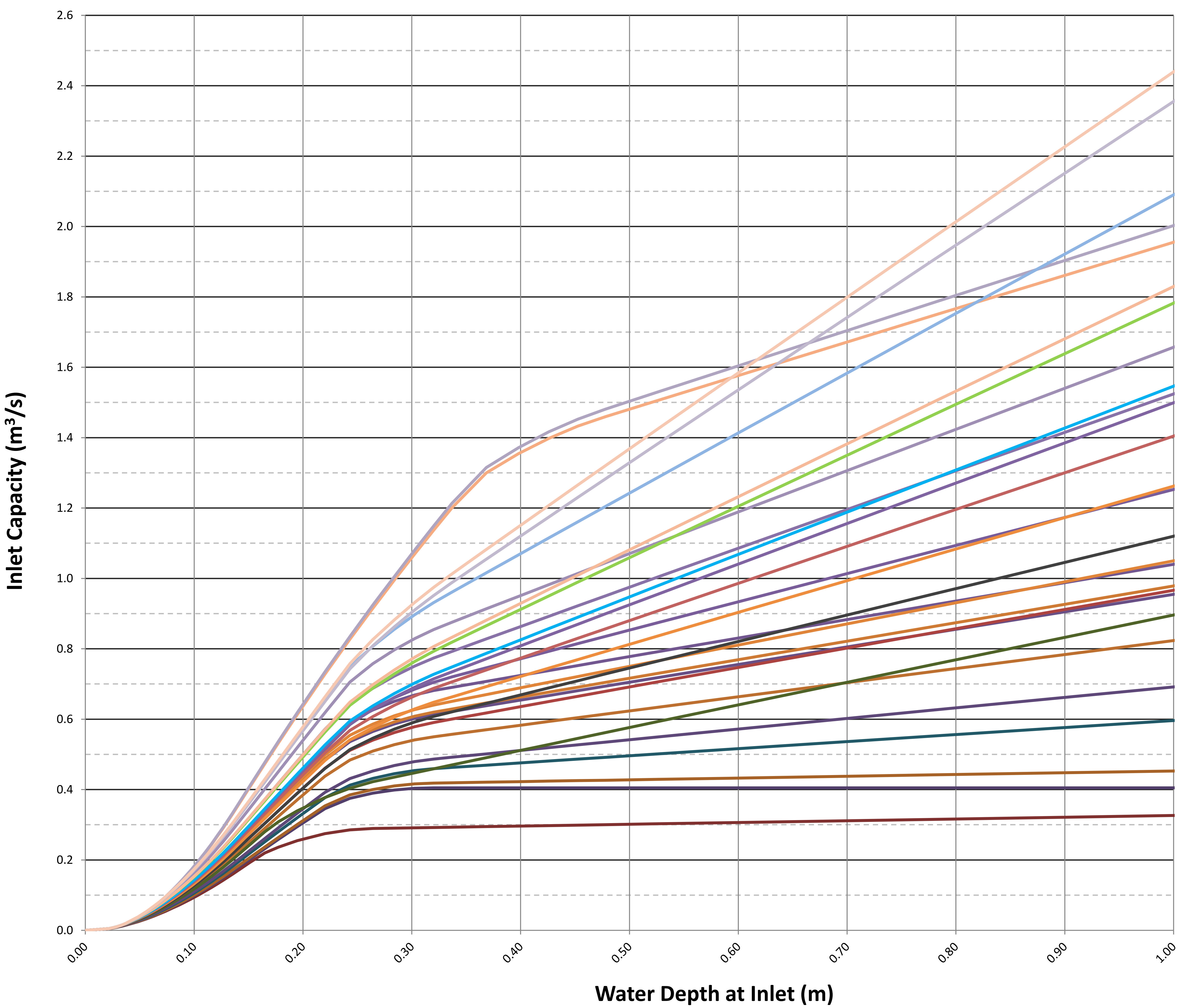
File Name: Inlet Capcacity Curves.xls



LEGEND

- Combination Inlet with 0.6 m Side Entry and 0.24m2 Grate
- Combination Inlet with 0.9 m Side Entry and 0.36m2 Grate
- Combination Inlet with 1 m Side Entry and 0.36m2 Grate
- Combination Inlet with 1.3 m Side Entry and 0.36m2 Grate
- Combination Inlet with 1.5 m Side Entry and 0.36m2 Grate
- Combination Inlet with 1.7 m Side Entry and 0.41m2 Grate
- Combination Inlet with 1.8 m Side Entry and 0.24m2 Grate
- Combination Inlet with 1.8 m Side Entry and 0.41m2 Grate
- Combination Inlet with 1.95 m Side Entry and 0.45m2 Grate
- Combination Inlet with 2 m Side Entry and 0.41m2 Grate
- Combination Inlet with 2 m Side Entry and 0.52m2 Grate
- Combination Inlet with 2.1 m Side Entry and 0.45m2 Grate
- Combination Inlet with 2.4 m Side Entry and 0.36m2 Grate
- Combination Inlet with 2.6 m Side Entry and 0.45m2 Grate
- Combination Inlet with 2.7 m Side Entry and 0.36m2 Grate
- Combination Inlet with 3 m Side Entry and 0.36m2 Grate
- Combination Inlet with 3.1 m Side Entry and 0.45m2 Grate
- Combination Inlet with 3.2 m Side Entry and 0.36m2 Grate
- Combination Inlet with 3.3 m Side Entry and 0.36m2 Grate
- Combination Inlet with 3.3 m Side Entry and 0.52m2 Grate
- Combination Inlet with 3.7 m Side Entry and 0.81m2 Grate
- Combination Inlet with 3.8 m Side Entry and 0.36m2 Grate
- Combination Inlet with 3.8 m Side Entry and 0.81m2 Grate
- Combination Inlet with 3.9 m Side Entry and 0.36m2 Grate
- Combination Inlet with 4.3 m Side Entry and 0.45m2 Grate
- Combination Inlet with 5.02 m Side Entry and 0.36m2 Grate
- Combination Inlet with 5.2 m Side Entry and 0.36m2 Grate

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H5a: Inlet Capacity Curves for Combination Pits on Grade

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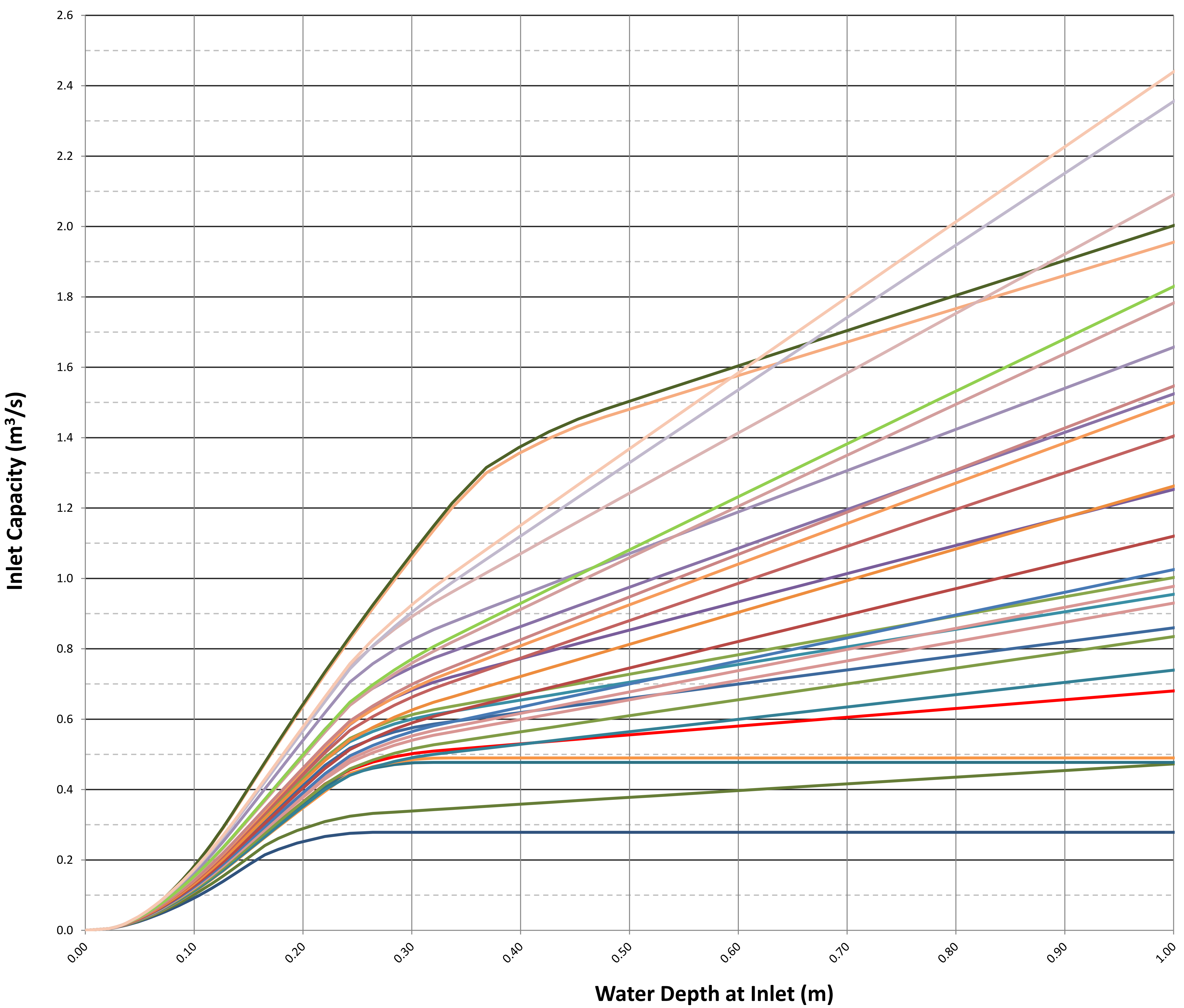
File Name: Inlet Capcacity Curves.xls



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LEGEND

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H5b: Inlet Capacity Curves for Combination Pits on Grade

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File Name: Inlet Capcacity Curves.xls

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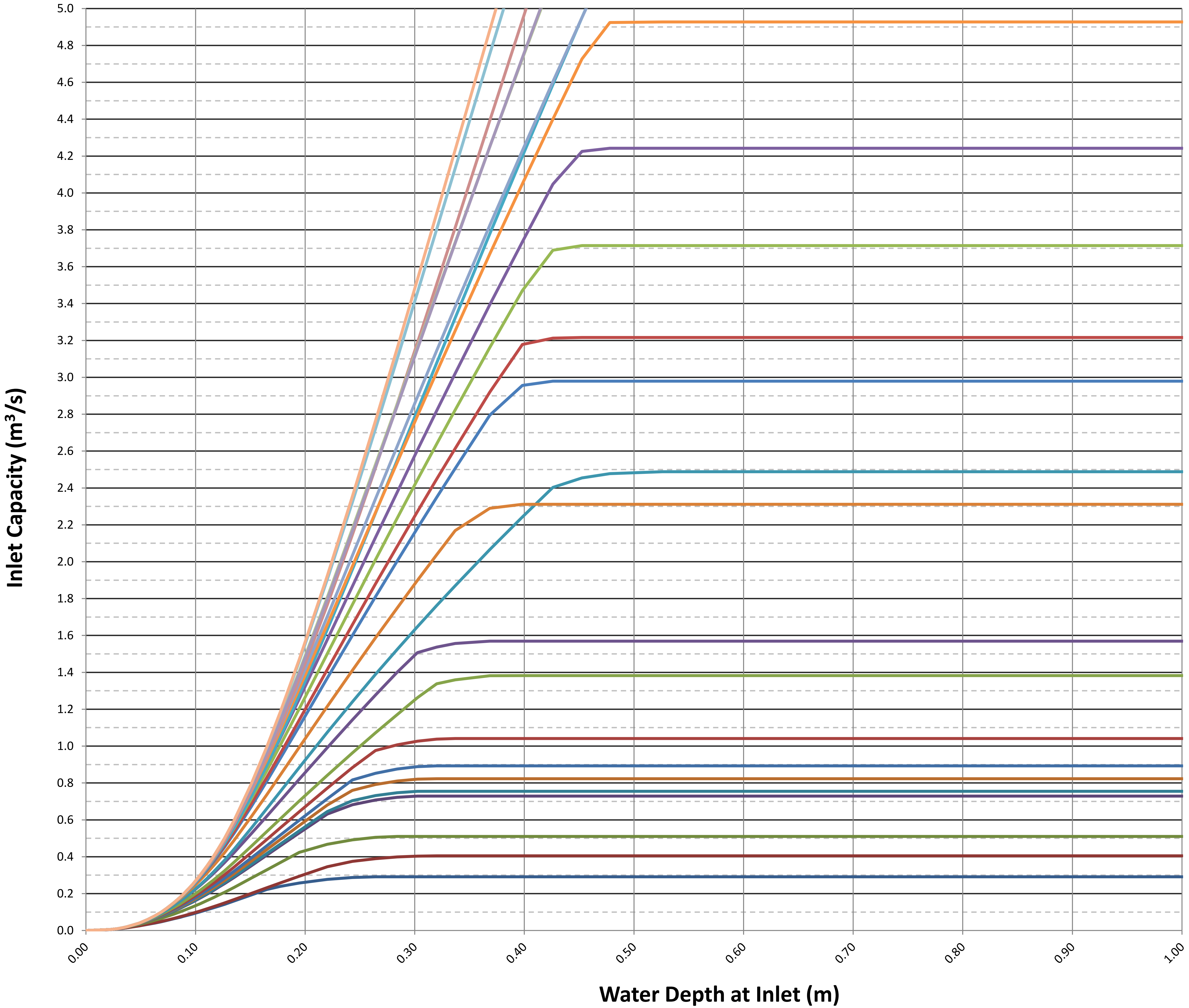

LEGEND

- Inlet with 0.24m2 Grate
- Inlet with 0.36m2 Grate
- Inlet with 0.5m2 Grate
- Inlet with 0.75m2 Grate
- Inlet with 0.8m2 Grate
- Inlet with 0.9m2 Grate
- Inlet with 1m2 Grate
- Inlet with 1.2m2 Grate
- Inlet with 1.6m2 Grate
- Inlet with 2m2 Grate
- Inlet with 2.6m2 Grate
- Inlet with 3.2m2 Grate
- Inlet with 4.4m2 Grate
- Inlet with 4.8m2 Grate
- Inlet with 5.8m2 Grate
- Inlet with 6.8m2 Grate
- Inlet with 7.2m2 Grate
- Inlet with 8.1m2 Grate
- Inlet with 9m2 Grate
- Inlet with 10.2m2 Grate
- Inlet with 11.9m2 Grate
- Inlet with 12.2m2 Grate
- Inlet with 16.8m2 Grate
- Inlet with 18.5m2 Grate

Notes:

Blockage applied to Inlet capacity curves as per section 4.2.6.

Figure H6:
Inlet Capacity Curves for Grated Pits on Grade

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File Name: Inlet Capcacity Curves.xls

APPENDIX I

BUILDING REPRESENTATION

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1 BACKGROUND

1.1 Impact of Buildings on Flood Behaviour

During significant rainfall events within an urban catchment, not all runoff can be carried by the subsurface stormwater system. Runoff in excess of the capacity of the stormwater system will be conveyed overland. The overland flow paths are typically contained to defined drainage reserves or roadways. However, during particularly severe rainfall events, the overland flow paths can also traverse residential, commercial and industrial areas. When overland flow comes into contact with buildings, research has shown that the buildings significantly deflect the flows (Smith et al, 2012). Accordingly, buildings can have a significant impact on the distribution of overland flows in an urbanised catchment.

Typically, buildings are not “water tight”. Therefore, as the depth of water surrounding each building increases, there is potential for water to enter the building through openings around doors and/or windows. Any water entering buildings is likely to move slowly through the building owing to the large number of internal obstructions (e.g., walls, doors, furniture). Accordingly, minimal conveyance capacity is typically provided through buildings. However, the cumulative amount of water stored by all buildings within a particular catchment can be significant, particularly in highly urbanised catchment.

Therefore, the representation of buildings in the TUFLOW model will need to account for the following:

- the significant deflection of flow around the upstream walls of each building; and,
- the storage provided within each building.

1.2 Options for Representing Buildings

The potential interaction between overland flows and buildings is quite complex and there currently isn’t a single, preferred option for representing these complexities within computer flood models. A number of options are available for representing buildings within computer models, with each option having inherent advantages and disadvantages.

The purpose of this investigation was to determine the most appropriate option for representing buildings within the College, Orth and Werrington Creeks catchment. Three options were considered as part of the investigation, namely:

- Option 1 - Representing each building as a complete flow obstruction
- Option 2 - Representing each building as a complete flow obstruction between the ground and floor level of the building, but allowing water to “enter” the building once the water level exceeds the floor level; and;

- Option 3 - Representing the upstream wall of each building as a complete flow obstruction but allowing water to "enter" the downstream side of each building.

The outcomes of the investigation into each of the above options is presented below.

2 Hydraulic Analysis

The TUFLOW hydraulic model of the College, Orth and Werrington Creek catchments was used to assess each of the building representation options. Specifically, the area around Stafford Street (between Derby Street and Jamison Rd), Kingswood was selected for the assessment (refer **Plate 1**). This area was selected as it comprises a significant number of buildings and initial 1% AEP simulations indicates the area is prone to overland flooding.

Plate 1 Location of buildings (yellow polygons) in the vicinity of Stafford Street, Kingswood

2.1 Option 1 – Complete Flow Obstruction

Option 1 attempts to represent buildings as a complete flow obstruction. Two alternatives are available for representing this flow obstruction:

1. Removing computer model cells located within building footprints; or,
2. Elevating computer model cells located within building footprints above the anticipated flood level.

The TUFLOW model developed for the study employs a direct rainfall approach whereby rainfall is applied directly to the model. In order for this approach to provide a reliable representation of catchment runoff volumes, the full extent of the catchment must be represented in the model. Therefore, alternative 1 was not considered to be viable as all cells within building footprints would not be able to contribute runoff to the catchment.

Accordingly, alternative 2 was pursued and was implemented by elevating TUFLOW model cells contained within building footprints by 2.4 metres (to represent a complete flow obstruction up to the eaves of each building).

The TUFLOW model was used to simulate a 1% AEP 120-minute storm with the Option 1 building representation in place. Peak floodwater depths and velocities were extracted from the results of the modelling and are presented in **Inset A** on **Figure G1**. A 0.1m depth cut-off was adopted for the presentation of all floodwater depth results.

Peak floodwater depths and velocities were also extracted at specific locations around two buildings to enable a more detailed assessment of the difference in model results produced by the different building representation techniques. The location of the buildings and the depth and velocity comparison locations is shown in **Plate 2**. The depth and velocity results at each location are summarised in **Tables 1** and **2.**

Plate 2 Location of buildings and depth/velocity comparisons

Table 1 Hydraulic Model Results in the Vicinity of Building #1

Location	Depth (metres)				Velocities (m/s)			
	Option 1	Option 2A	Option 2B	Option 3	Option 1	Option 2A	Option 2B	Option 3
West	0.52	0.61	0.60	0.36	0.57	0.50	0.55	0.65
North	0.37	0.38	0.37	0.37	0.27	0.27	0.26	0.26
South	0.41	0.42	0.42	0.42	0.51	0.55	0.54	0.33
East	0.67	0.73	0.73	0.29	0.50	0.47	0.49	0.94
Internal	0.00	0.55	0.40	0.26	0.00	0.15	0.15	0.04

Table 2 Hydraulic Model Results in the Vicinity of Building #2

Location	Depth (metres)				Velocities (m/s)			
	Option 1	Option 2A	Option 2B	Option 3	Option 1	Option 2A	Option 2B	Option 3
West	0.43	0.46	0.46	0.44	1.54	1.49	1.53	1.59
North	0.26	0.27	0.29	0.22	0.39	0.33	0.40	0.21
South	0.69	0.75	0.74	0.67	0.14	0.21	0.14	0.14
East	0.54	0.54	0.54	0.44	1.59	1.54	1.56	2.19
Internal	0.00	0.60	0.45	0.18	0.00	0.21	0.23	0.11

2.2 Option 2 – Complete Flow Obstruction Up to Floor Level

Option 2 attempts to represent buildings as a complete flow obstruction up to the building floor levels. However, once the water level exceeds the building floor level, it can “enter” the building. However, a high Manning’s “n” value of 10 is applied to the building footprints to reflect the significant impediment to flow afforded by the numerous internal flow obstruction (e.g., doors, walls, furniture) once water enters the building.

Unfortunately, no detailed floor level survey is available across the catchment to define building floor elevations. Therefore, two methods were trialled to approximate building floor levels:

- Option 2A – elevating all cells within buildings by 0.15 metres above ground level; and,
- Option 2B – elevating all cells within buildings by 0.3 metres above ground level.

2.2.1 Option 2A – Complete Flow Obstruction Up to a Depth of 0.15 metres

Option 2A involves elevating cells located within building footprints by 0.15 metres above the existing ground surface. This is intended to represent the complete impediment to flow afforded by ‘low-set’ (i.e., slab-on-ground) buildings (refer **Plate 3**). As discussed, once water depths exceed this level, water is permitted to “enter” the building but would still be subject to a significant flow impediment through application of a high Manning’s “n” coefficient. Accordingly, unlike Option 1, this option makes an allowance for the storage of water within the building.

Plate 3 Example of a building on Cosgrove Crescent

The updated TUFLOW model was used to re-simulate the 1% AEP flood with the Option 2A building representation in place. Peak floodwater depths and velocity vectors from this simulation are provided on **Inset B** on **Figure A1**. Peak floodwater depth and velocities were also extracted in the vicinity of the two buildings and are provided in **Tables 1** and **2**.

2.2.2 Option 2B – Complete Flow Obstruction Up to a Depth of 0.3 metres

Option 2B is similar to Option 2A, however, involves elevating cells located within building footprints by 0.3 metres to reflect 'high-set' buildings (refer **Plate 4**).

Plate 4 Example of a building on Stafford Street showing the building floor level elevated by about 0.3 metres above the adjoining ground surface

The updated TUFLOW model was used to re-simulate the 1% AEP flood with Option 2B in place. Peak floodwater depths and velocity vectors from this simulation are provided in **Inset C** on **Figure G1**. Peak floodwater depth and velocities were also extracted in the vicinity of the two buildings and are provided in **Tables 1** and **2**.

2.3 Option 3 – Upstream Building Walls

Option 3 attempts to represent the complete obstruction/deflection of flow by the upstream wall of each building (similar to Option 1). However, the downstream side of each building is left "open" to allow water to enter the building from the downstream side and helps to ensure the potential flood storage capacity within each building is represented. All cells underlying the upstream building walls were elevated by 2.4 metres to reflect the flow impediment in the TUFLOW model.

The TUFLOW model was updated to include the upstream building walls was used to re-simulate the 1% AEP flood. Peak floodwater depths and velocity vectors from this simulation are provided in in **Inset D** on **Figure A1** (the alignment of the building walls is also shown in **Inset D**). Peak floodwater depths and velocities were also extracted in the vicinity of the two buildings and are presented in **Tables 1** and **2**.

3 Discussion of Results

The velocity vectors shown in **Figure G1** shows that each of the building representation options produces a significant impediment and redistribution of flows in the vicinity of each building. **Figure G1** also shows that the size and orientation of the velocity vectors do not differ significantly between each of the different building representation techniques. Accordingly, it appears that any one of the approaches provide a reasonable representation of the significant impediment to flow afforded by buildings.

Tables 1 and **2** shows that there are some differences in 1% AEP depths and velocities in the vicinity of each building associated with each of the building representation options. In general, the differences are small. However, the following information can be gleaned from the results of the modelling:

- Option 1 and Option 2 typically provide comparable depth and velocity results around the outer perimeter each building. Option 3 provides comparable depths and velocities upstream and downstream of each building but lower depths and higher velocities between building walls. This appears to be associated with the raised 'walls' providing a smaller flow width between buildings.
- Raising the building footprint by 0.15 metres or 0.30 metres above the existing ground level (Scenario 2A and 2B respectively) produces very similar depth and velocity results. This indicates that the adopted floor height does not have a significant impact on the reliability of this approach;

Overall, it is considered that Option 2 is the preferred option for representing buildings within the catchment as it achieves the major objective set out in Section 1.1, namely:

- It provides a good representation of the significant impediment to flow afforded by the buildings; and,
- It accounts for the storage capacity provided within the building itself.

A review of buildings across the catchment using Google Street View indicates that most buildings are older style 'high set' dwellings that are elevated at least 0.3 metres above the ground. Accordingly, Option 2B is considered to be the most appropriate option for the catchment.

4 REFERENCES

- Syme, W.J. (2008). Flooding in Urban Areas – 2D Modelling Approaches for Buildings and Fences. 9th National Conference on Hydraulic in Water Engineering, Australia 23-26 September 2008
- Engineers Australia. (2012). Australian Rainfall & Runoff – Project 15: Two Dimensional Modelling in Urban and Rural Floodplains, Stage 1 & 2 Report, P15/S1/009. Editors: Mark Babister & Cathie Barton. ISBN 978-085825-9850.

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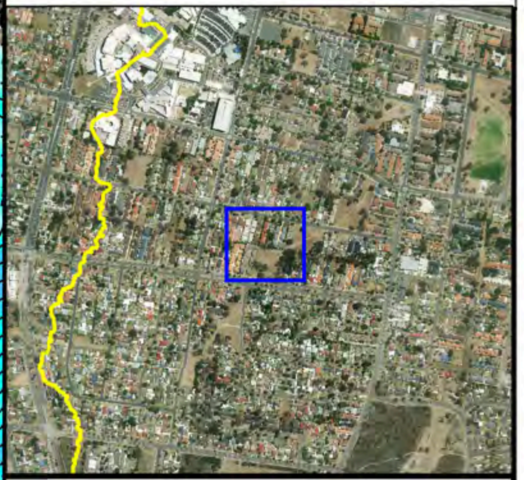

LEGEND

Building

Depths (m)	Velocity Vector (m/s)
0.1	0.5 m/s
0.2	1 m/s
0.3	2 m/s
0.5	
1.0	
2.0	
3.0	

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:1,000 (at A3)

0 25 50 m

Figure I1: Building Representation depth and Velocity Results

Prepared By:

Catchment Simulation Solutions
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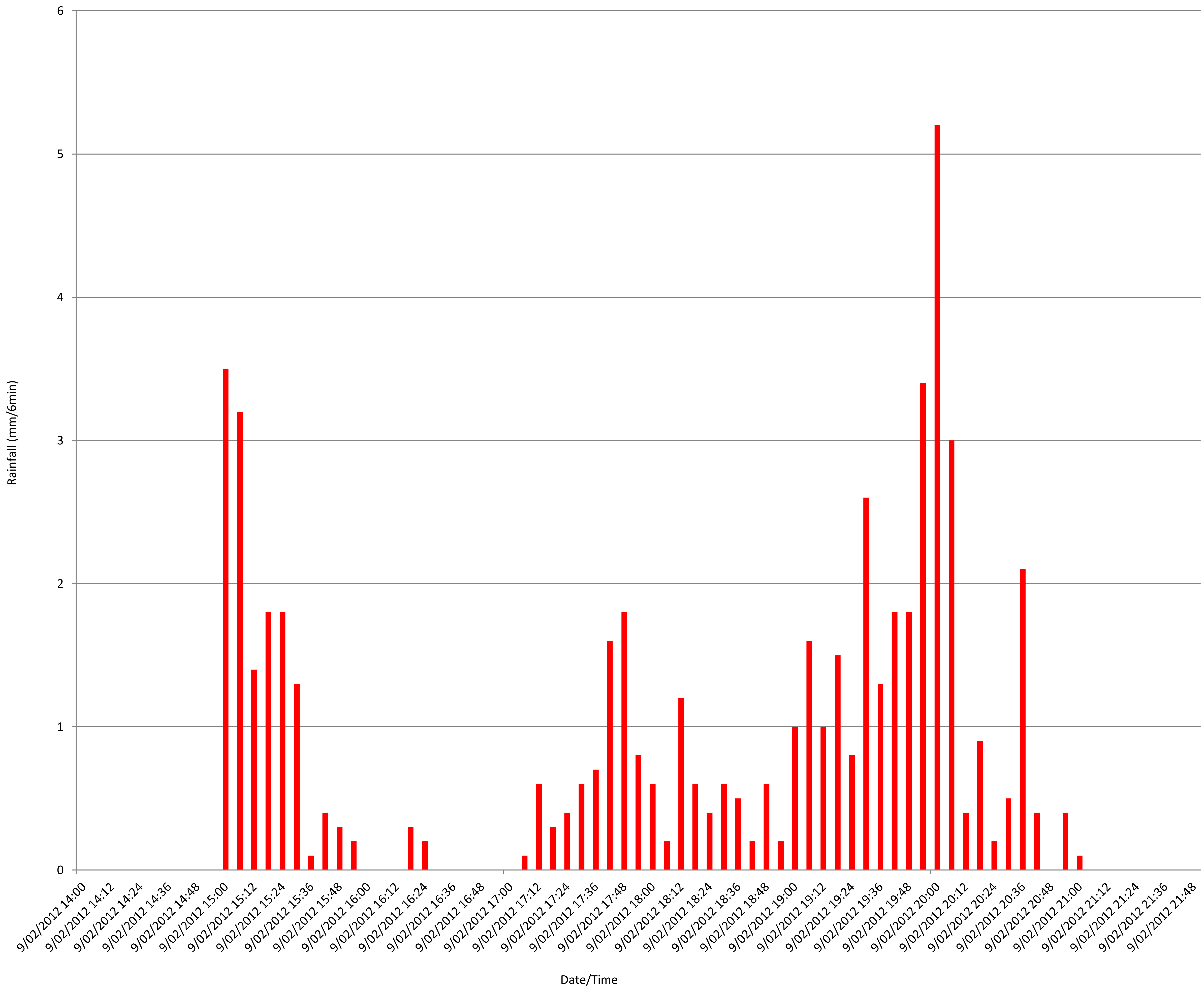
Sydney, NSW 2000

File Name: FigI1 Building Representation Depth and Velocity Results.wor

APPENDIX J

HISTORIC VALIDATION INPUTS



LEGEND:

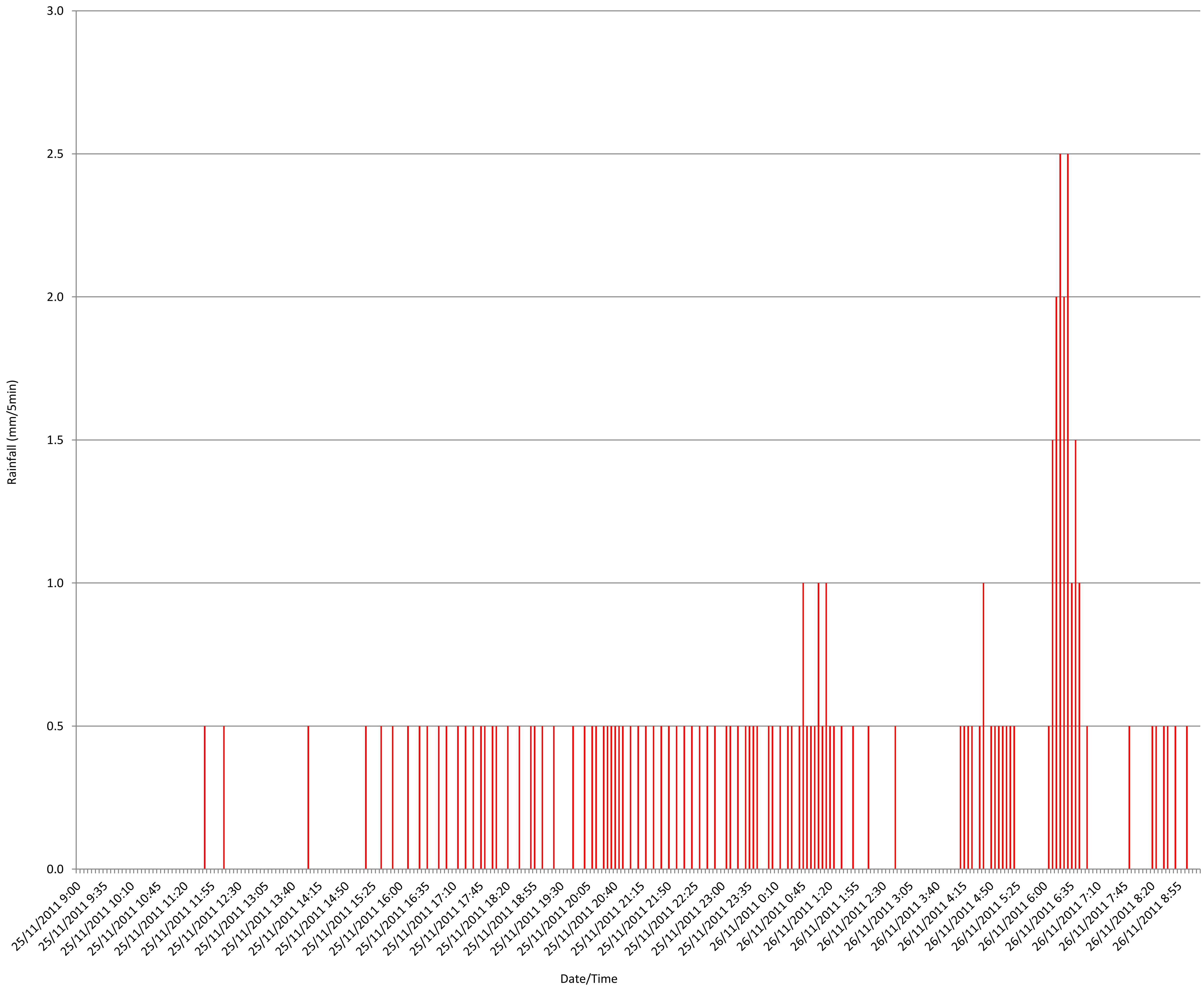
Regentville Rural Fire Service

Notes:

Figure J1:
Continuous Rainfall Data for the February 2012 event

Prepared By:
Catchment Simulation Solutions
Suite 302, 5 Hunter Street
Sydney, NSW, 2000

File Name: .xls



LEGEND:

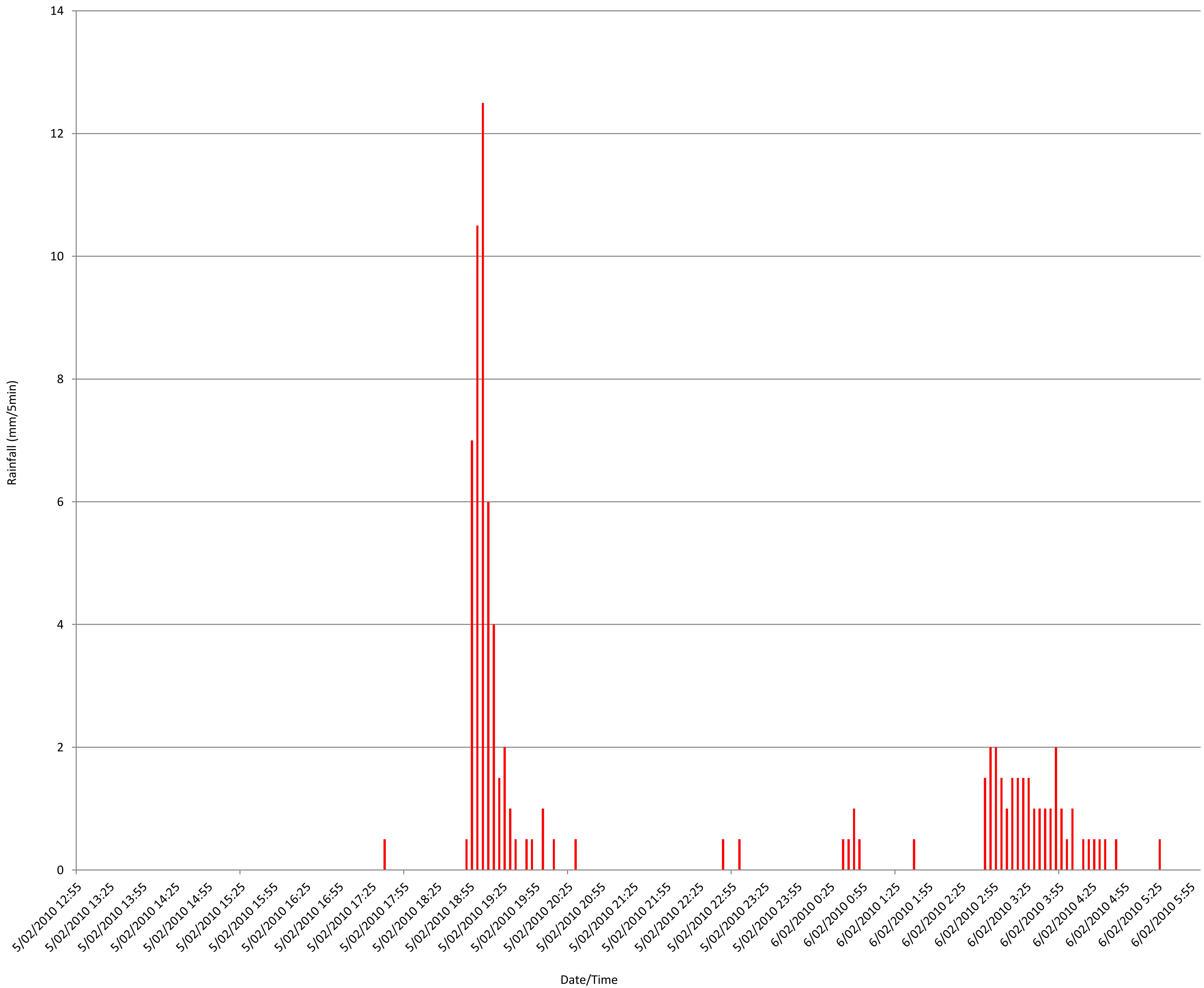
Regentville Rural Fire Service

Notes:

Figure J2: Continuous Rainfall Data for the November 2011 event

Prepared By:
Catchment Simulation Solutions
Suite 302, 5 Hunter Street
Sydney, NSW, 2000

File Name: .xls



LEGEND:

■ Regentville Rural Fire Service

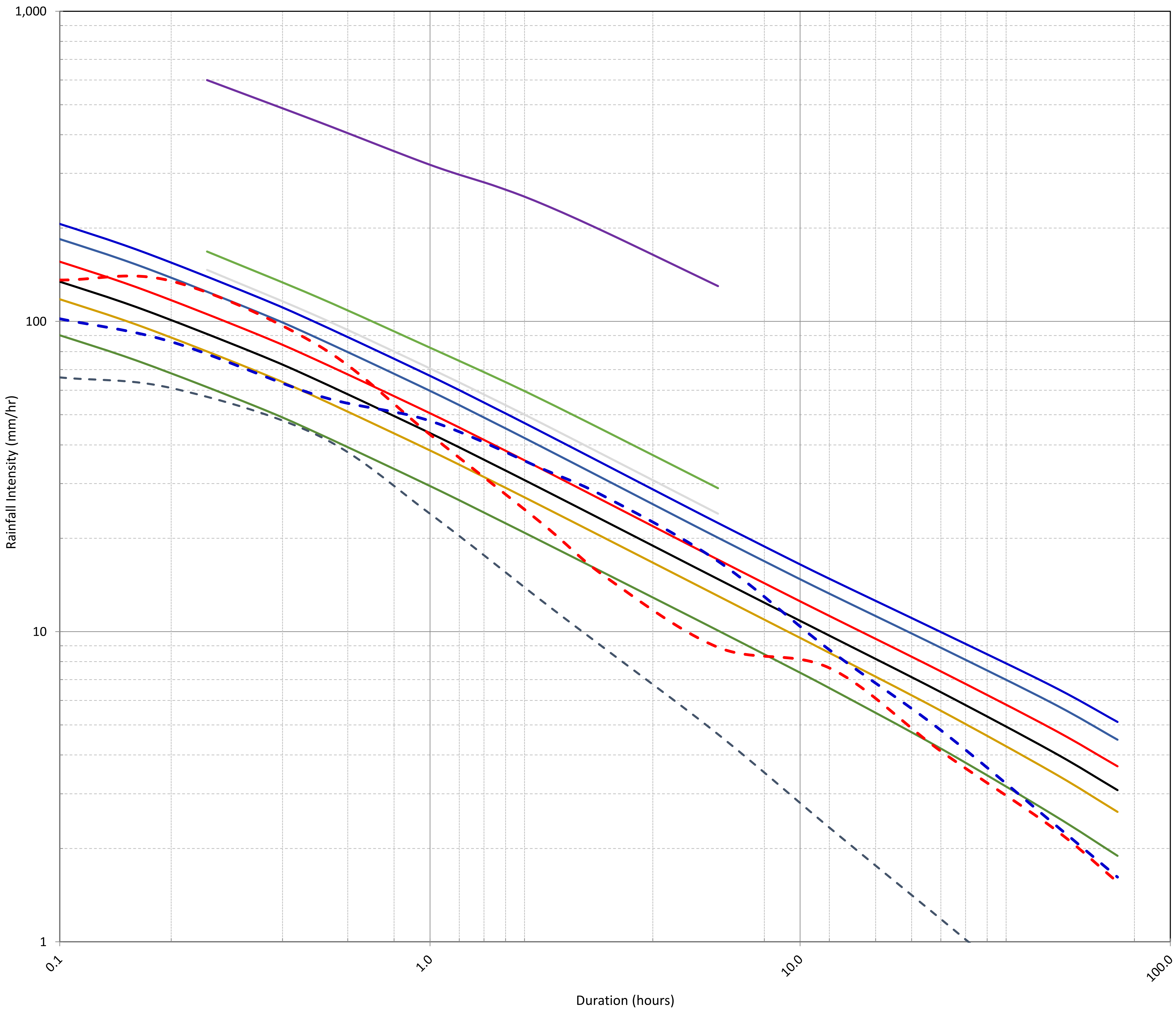
Notes:

Figure J3:
Continuous Rainfall Data for the February 2010 event

Prepared By:

Catchment Simulation Solutions
Suite 302, 5 Hunter Street
Sydney, NSW, 2000

File Name: .xls



PENRITH CITY COUNCIL

LEGEND:

- PMP
- 0.2% AEP
- 0.5% AEP
- 1% AEP
- 2% AEP
- 5% AEP
- 10% AEP
- 20% AEP
- 2 year ARI
- 2010 Rainfall
- 2011 Rainfall
- 2012 Rainfall

Notes:

Figure J4: Design Intensity - Frequency - Duration Curves Vs Historic Rainfall

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx

APPENDIX K

EXTREME RAINFALL CALCULATIONS

GSDM CALCULATION SHEET

LOCATION INFORMATION

Catchment Werrington Creek   Area 11.94 km^2

State New South Wales   Duration Limit 6.0 hrs

Latitude 33.7616^0S Longitude 150.7327^0E

Portion of Area Considered:

Smooth, **S** = 0.00 (0.0 - 1.0)   Rough, **R** = 1.00 (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation 46 m

Adjustment for Elevation (-0.05 per 300m above 1500m) 0.00

EAF = **1.00** (0.85 – 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF = **0.70** (0.40-1.00)

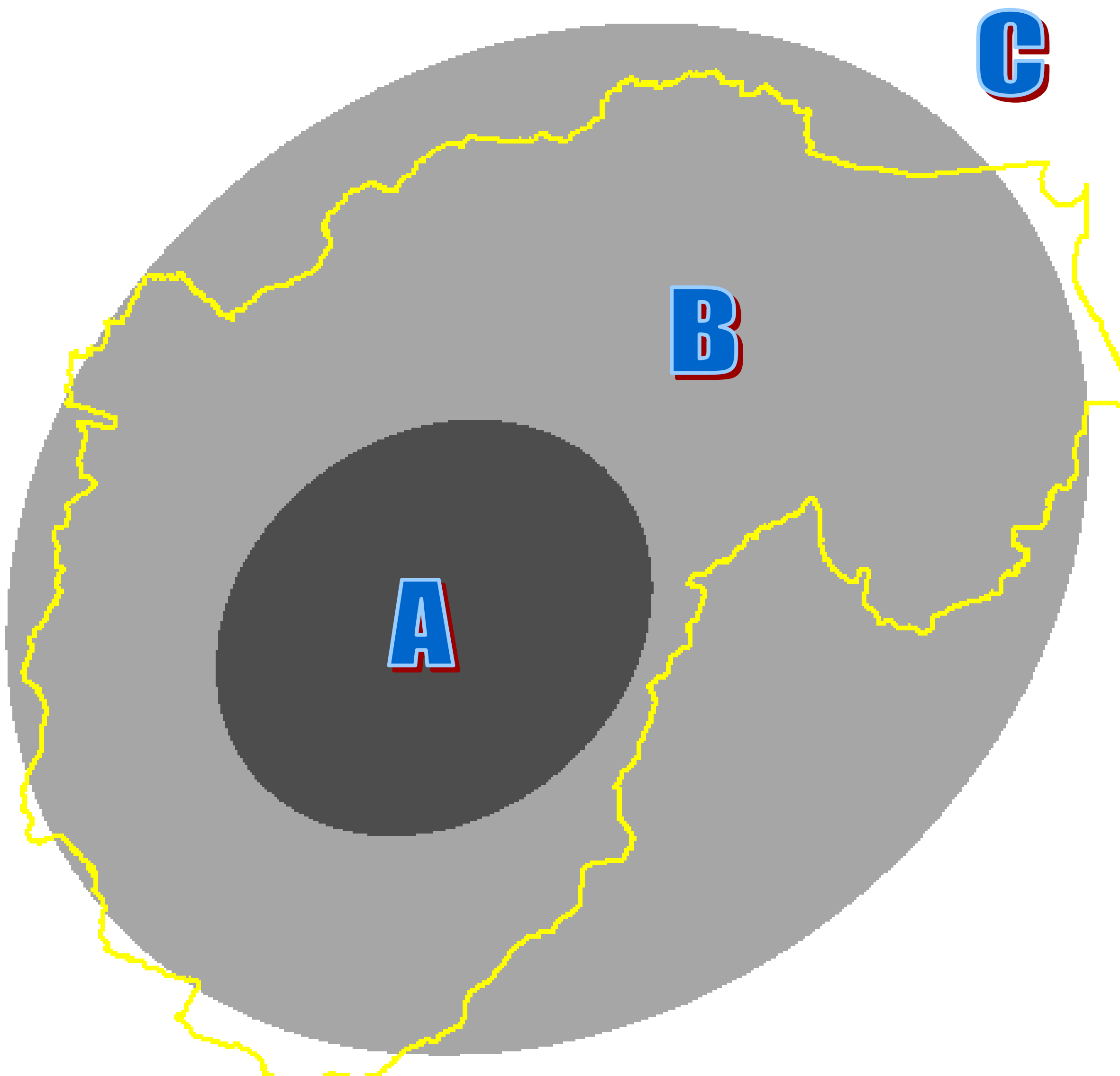
PMP VALUES (mm)

Duration (hours)	Initial Depth -Smooth (D_S)	Initial Depth -Rough (D_R)	PMP Estimate = (D_SxS + D_RxR) x MAF x EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	209	209	147	150
0.50	308	308	216	220
0.75	389	389	272	270
1.00	458	458	321	320
1.50	523	586	411	410
2.00	586	687	481	480
2.50	624	757	530	530
3.00	656	828	579	580
4.00	723	948	663	660
5.00	778	1042	729	730
6.00	825	1108	775	780

Prepared By David Tetley   Date 18/11/2015

Checked By Chris Ryan   Date 10/05/2016

GSDM SPATIAL DISTRIBUTION



GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 0.25 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	232	162	422	422	162
B	9.00	11.60	210	147	1704	1282	142
C	0.34	11.94	209	147	1751	47	136
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 0.50 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	336	235	611	611	235
B	9.00	11.60	309	216	2510	1899	211
C	0.34	11.94	308	216	2579	69	201
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 0.75 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse (mm.km^2)	Rainfall Volume between Ellipses (mm.km^2)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	425	298	773	773	298
B	9.00	11.60	390	273	3164	2391	266
C	0.34	11.94	389	272	3253	90	260
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 1.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse (mm.km^2)	Rainfall Volume between Ellipses (mm.km^2)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	493	345	896	896	345
B	9.00	11.60	459	321	3729	2833	315
C	0.34	11.94	458	321	3833	104	302
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 1.5 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	636	445	1156	1156	445
B	9.00	11.60	587	411	4770	3614	401
C	0.34	11.94	586	411	4904	133	388
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 2.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	744	521	1352	1352	521
B	9.00	11.60	688	482	5588	4235	470
C	0.34	11.94	687	481	5743	155	451
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 2.5 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	821	575	1492	1492	575
B	9.00	11.60	758	531	6156	4664	518
C	0.34	11.94	757	530	6328	172	500
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 3.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	901	631	1638	1638	631
B	9.00	11.60	829	580	6732	5094	566
C	0.34	11.94	828	579	6920	187	544
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 4.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	1030	721	1872	1872	721
B	9.00	11.60	949	665	7710	5837	648
C	0.34	11.94	948	663	7923	214	620
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 5.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	1135	795	2063	2063	795
B	9.00	11.60	1044	731	8475	6412	712
C	0.34	11.94	1042	729	8710	235	682
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 6.0 Hours							
Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse (mm.km^2)	Rainfall Volume between Ellipses (mm.km^2)	Mean Rainfall Depth between ellipses (mm)
A	2.60	2.60	1200	840	2181	2181	840
B	9.00	11.60	1110	777	9011	6829	759
C	0.34	11.94	1108	775	9261	251	728
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

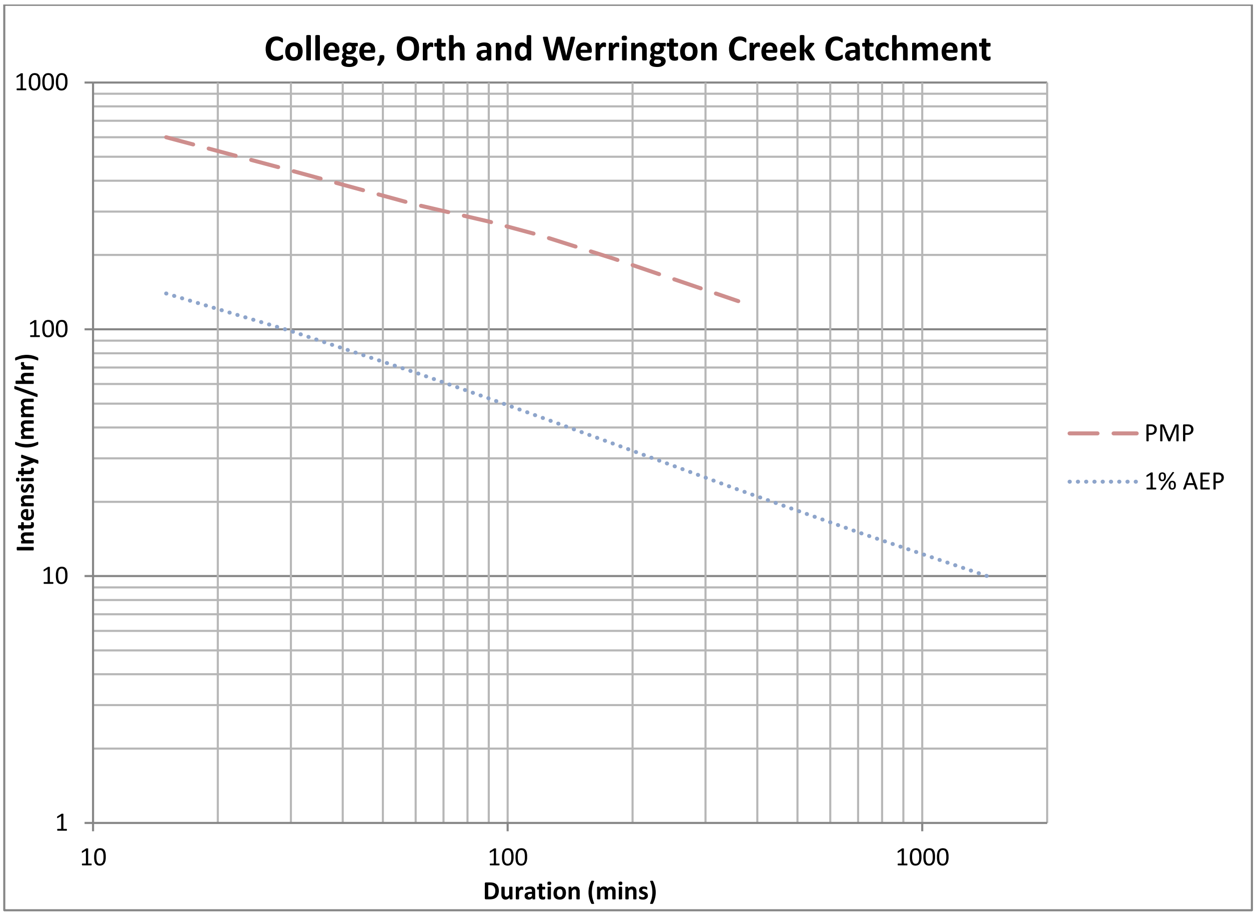
Estimation of 0.5% AEP and 0.2% AEP Rainfall

Overview

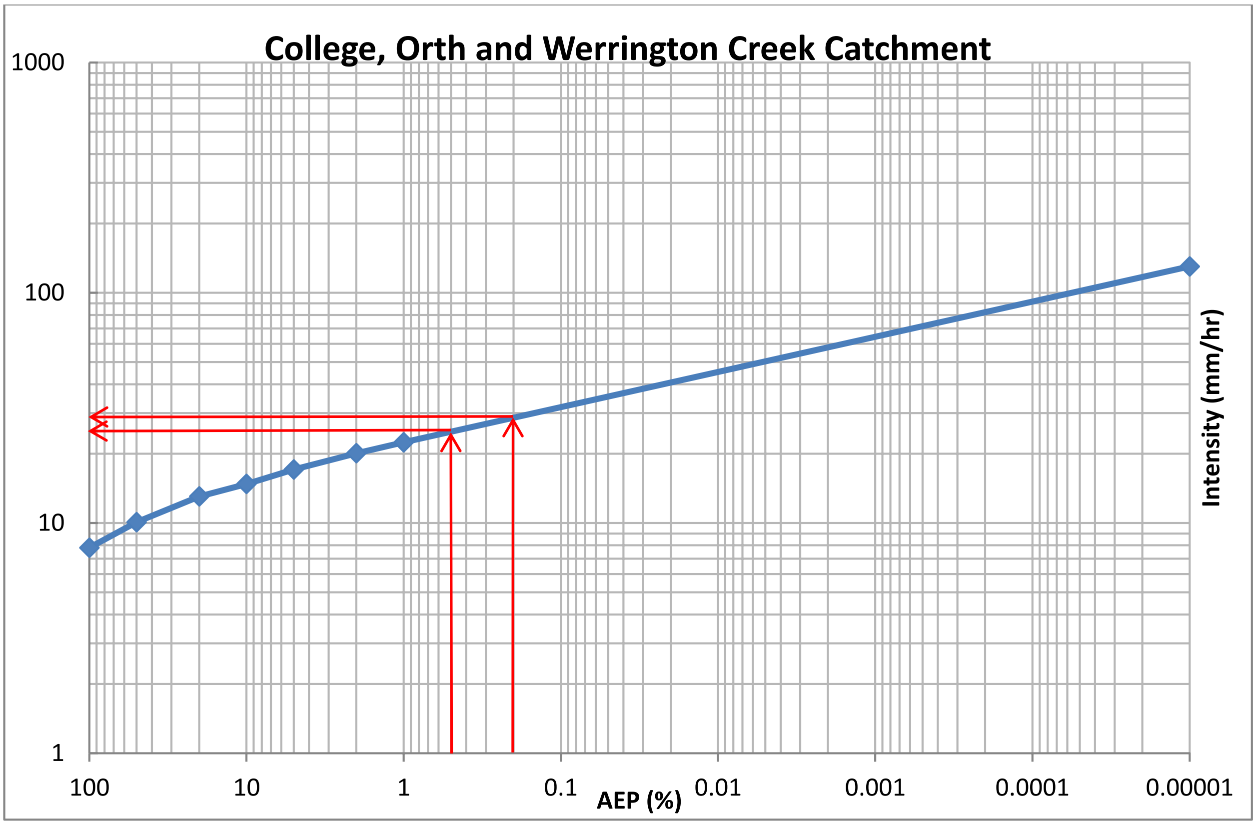
The 0.5% AEP and 0.2% AEP rainfall were estimated as part of the College, Orth and Werrington Creeks Catchment Flood Study. The calculations were completed in accordance with procedures set out in 'Australian Rainfall & Runoff- A Guideline to Flood Estimation' (Engineers Australia, 1998) for extreme rainfall. A summary of the calculation technique is provided below.

Calculations

The 1% AEP rainfall intensities were plotted on a chart for a range of different storm durations. The Probable Maximum Precipitation intensities were also included on the chart. A nominal ARI of 10,000,000 years was adopted for the PMP in accordance with Chapter 8 of the Bureau of Meteorology's Generalised Short Duration Method (GSDM) for catchments with areas of less than 100 km^2 (Bureau of Meteorology, 2003). The resulting chart is provided below.



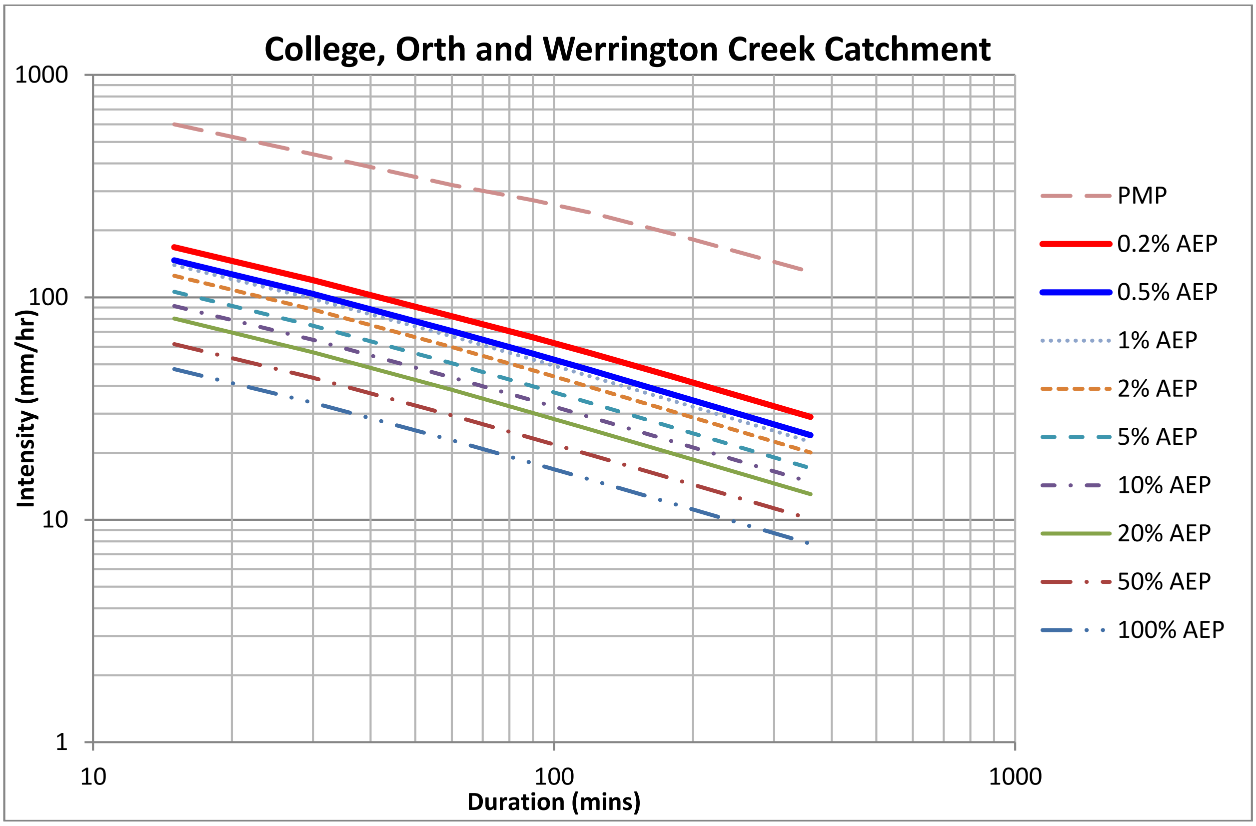
The 6 hour rainfall intensities were extracted from the above charts and were plotted against ARI. The resulting chart is presented below (note: log scales are applied to both X and Y axis).



6 hour rainfall intensities for the 0.5% AEP and 0.2% AEP event were extracted from the above chart. This produced the following 6 hour intensity values:

- 0.5% AEP, 6 hour intensity = 24 mm/hr
- 0.2% AEP, 6 hour intensity = 29 mm/hr

The 0.5% AEP and 0.2% AEP, 6 hour rainfall intensities were included on the original IFD chart and a line was drawn from this point parallel to the 1% AEP and PMF IFD lines (refer blue and red lines in chart below). The blue line represents the 0.5% AEP storm, and the red line represents the 0.2% AEP storm.



The 0.5% AEP and 0.2% AEP intensities were subsequently extracted from the chart for a range of durations:

Storm Duration	0.5% AEP Intensity (mm/hr)	0.2% AEP Intensity (mm/hr)
15 mins	147	168
30 mins	104	119
1 hour	70.6	82.3
2 hours	47.0	56.1
3 hours	36.7	44.1
6 hours	24.0	29.0

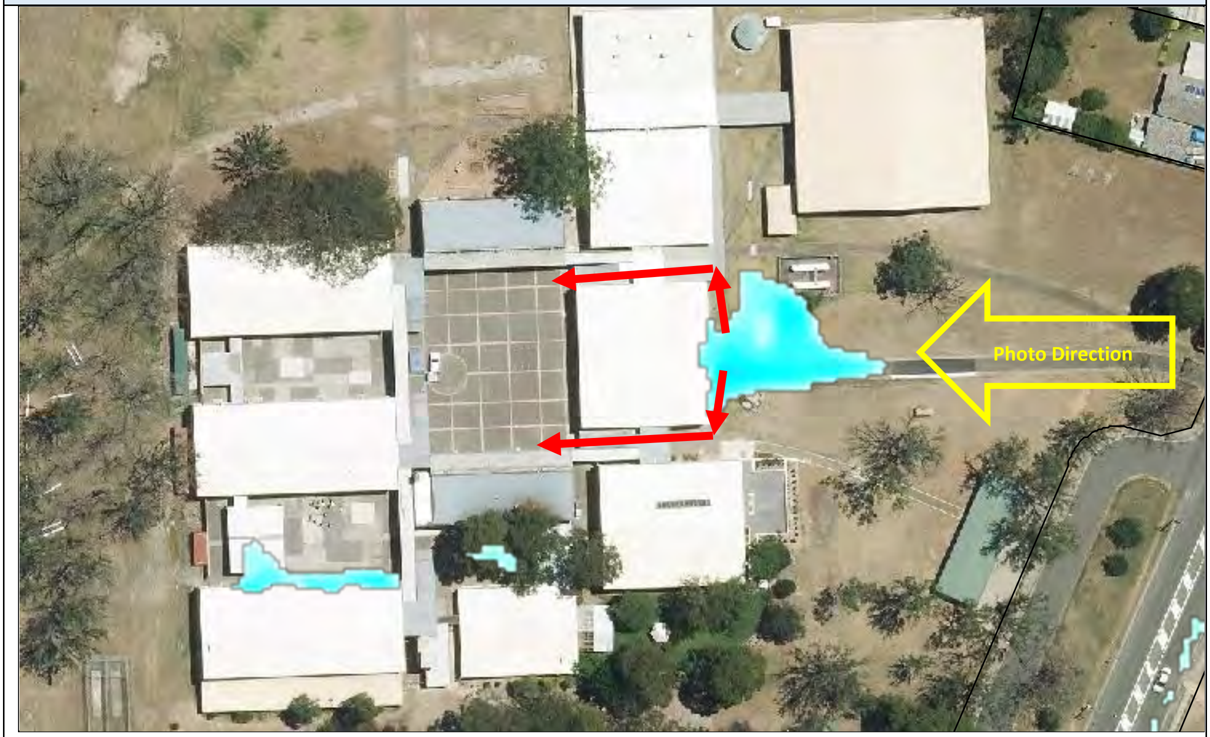
Appendix L

Ground Truthing

LOCATION:
116 Bringelly Road, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
The "hump" in the reserve lowers adjacent to the fence line which would allow water to move towards the street rather than build up against the back of the house, however, some pooling would occur in the backyard. **Retain in mapping**.

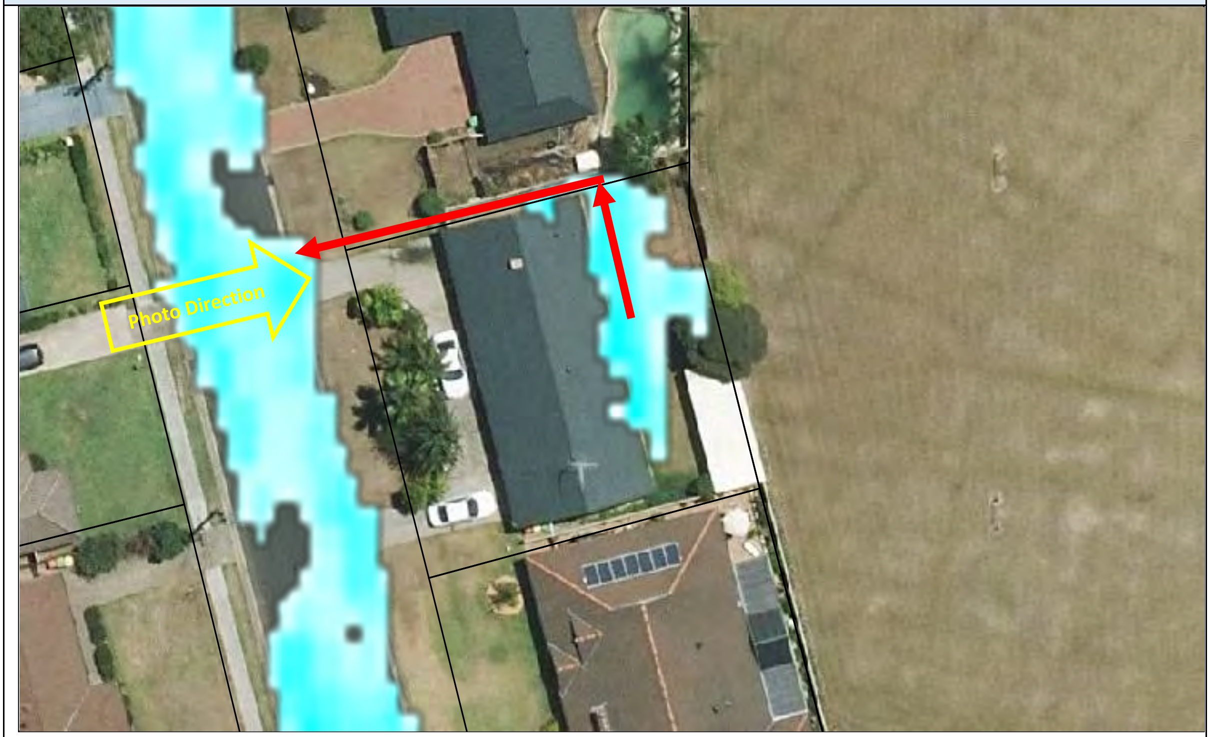
LOCATION:
Kingswood High School, 131 Bringelly Road, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Low Point - water would pool in location. **Keep in mapping**.

LOCATION:
27 Oag Cres, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
No access to rear of property. DEM indicates a local depression at rear of property. Therefore, **retain in mapping**.

LOCATION:
13 Tent St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Water from backyard could pass down northern side of house and down to street (gap between buildings less than 2 metres). **Remove from mapping.**

LOCATION:

29-39 Smith St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

There does appear to be a low point in the rear of the properties. **Retain on mapping**.

LOCATION:

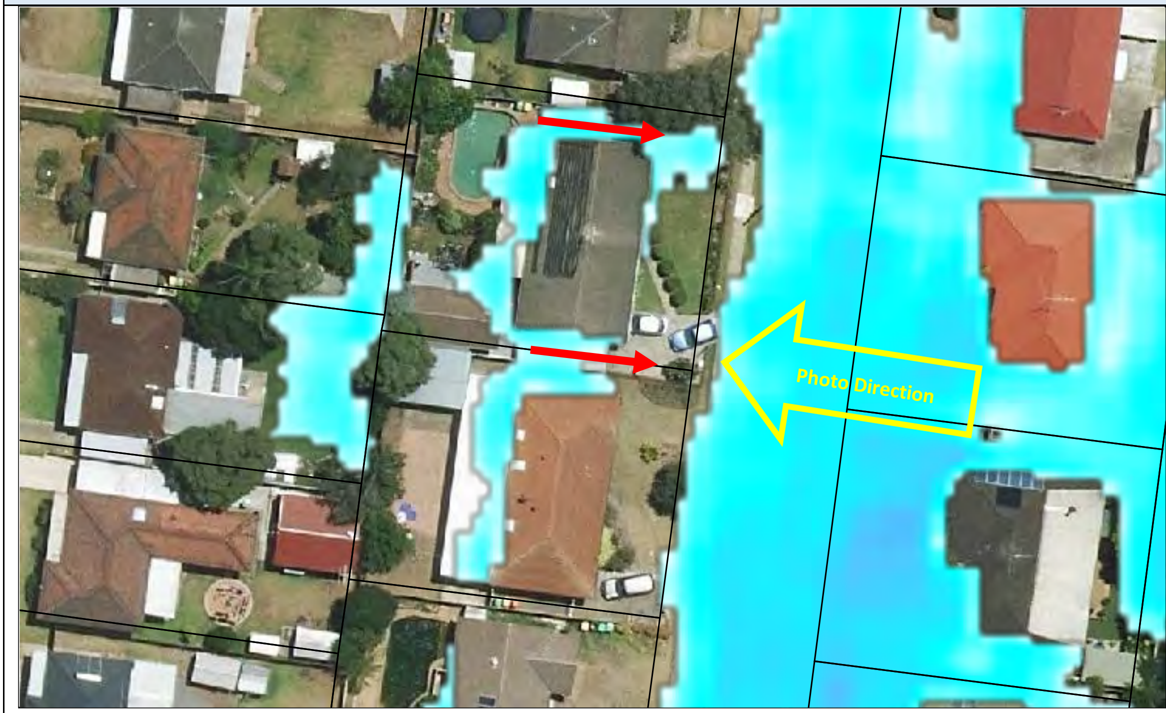
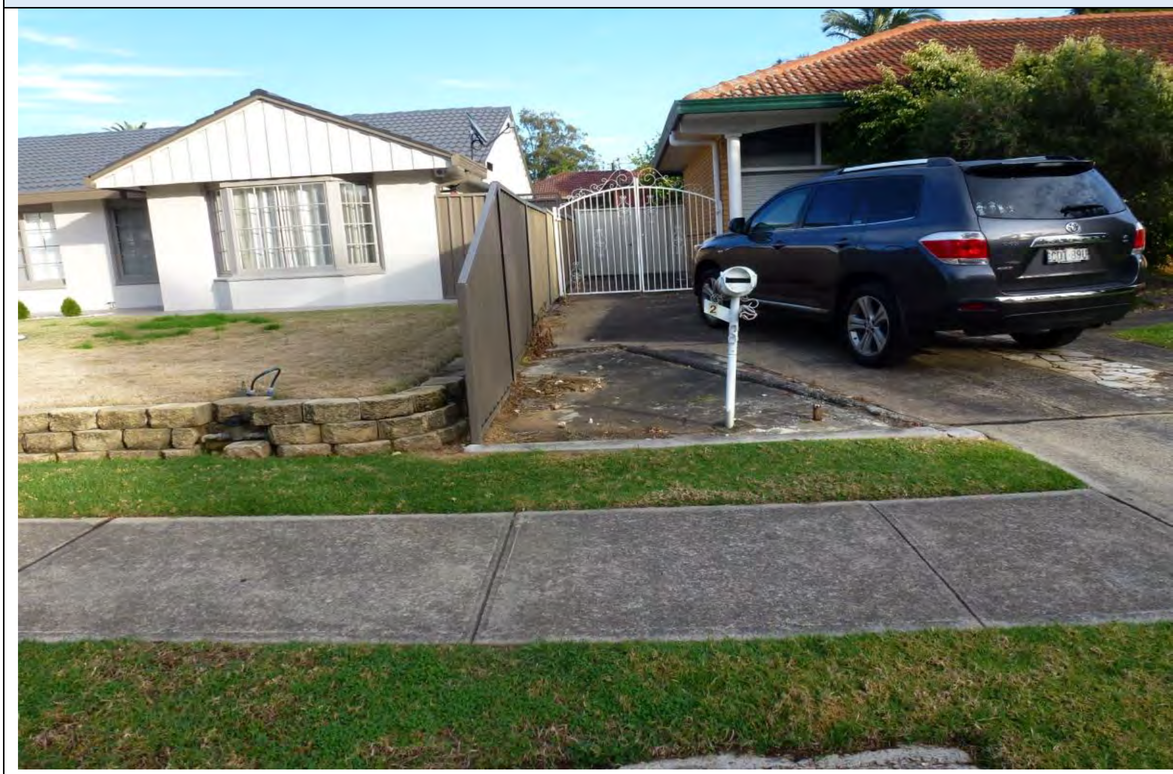
23-27 Stapley St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Localised low point with restricted flow path between buildings. **Retain in mapping**.

LOCATION:
29-31 Stapley St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Flow can pass around side of number 29 fairly easily, but with some restriction by various fence types. Upstream sag point indicates potential for water to "spill" through these properties. **Retain in Mapping.**

LOCATION:
55 Elizabeth Cres, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

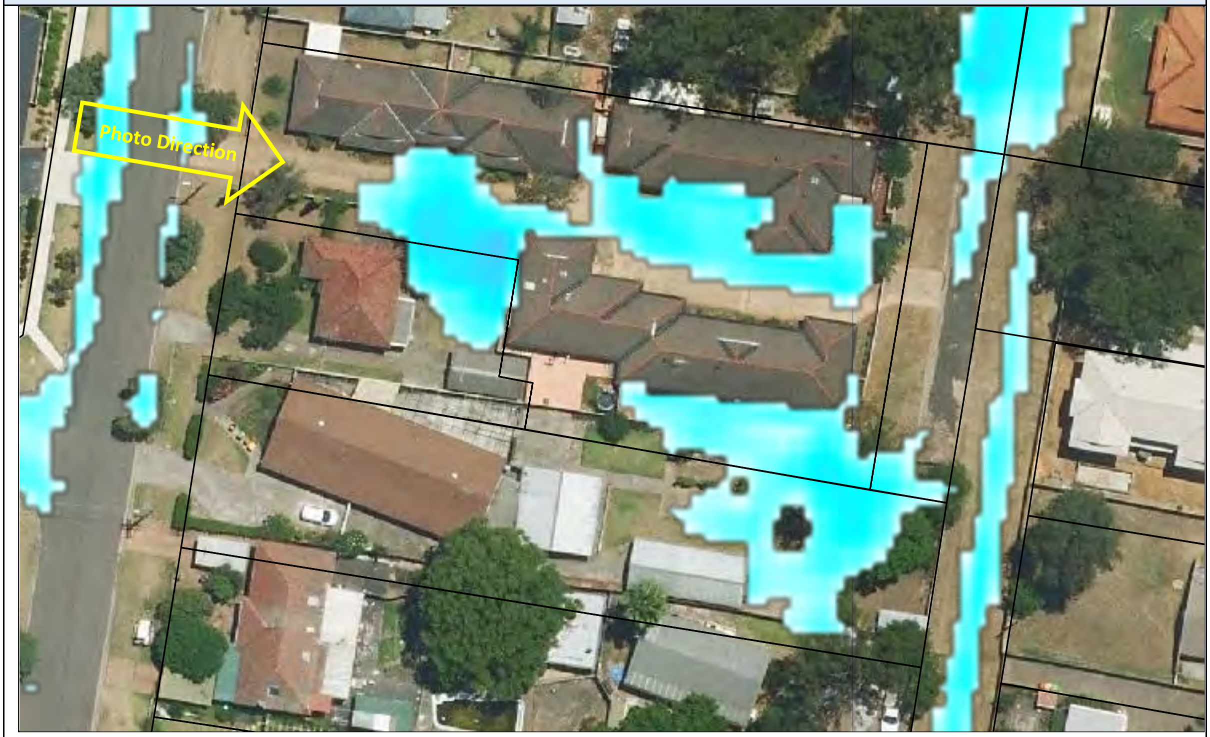
PHOTOGRAPH OF LOCATION:

COMMENT:
On-site drainage system along driveway, and any build-up above gutter height can move around southern building through the paling fence. **Remove from mapping**.

LOCATION:
32-38 First St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
On-site drainage system exists along driveway of no. 32 and 34, and an OSD area is present at the rear of no 34 (showing greater depths). A low point does exist in the rear of no 36. **Retain on mapping.**

LOCATION:
14-18 First St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
On site drainage system exists with pits in notable sag points. Modelled inundation extents likely to be exaggerated. However, onsite system likely to have limited capacity. **Retain on mapping**.

LOCATION:
41 Jones St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
On site drainage system exists within sag points and excess water would spill through fence adjacent to the western building. **Remove from mapping.**

LOCATION:
5A Edith St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Gated community – no access. On site drainage system can be seen and it appears a low point exists in the roadway in the northern section of the property. **Retain on mapping.**

LOCATION:
30 Casuarina Ct, Caddens
PRELIMINARY 1% AEP DEPTH MAP:

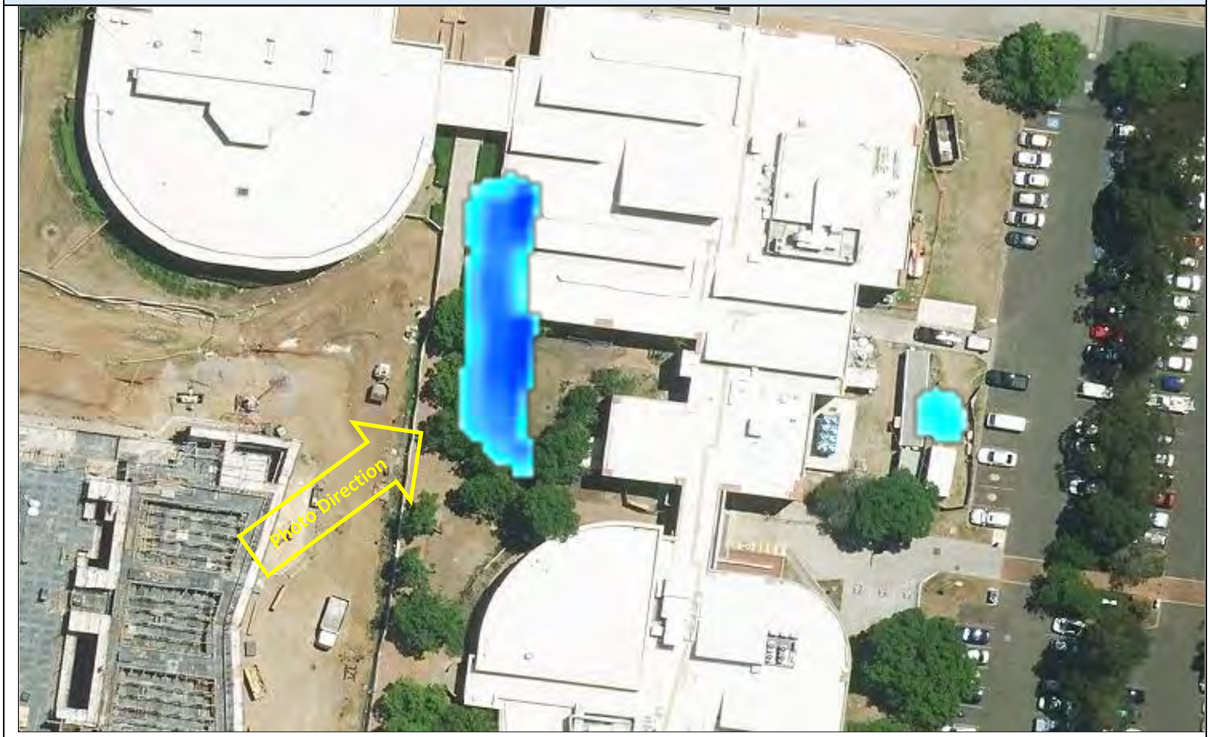
PHOTOGRAPH OF LOCATION:

COMMENT:
Flow could pass around the southern side and northern side of number 30 with some minor impediment from a colorbond fence. Depth exaggerated by retaining wall at rear of property. **Remove from mapping**.

LOCATION:
Newmarch House, Allyn Blvd, Caddens
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Potential for water to pass between buildings, however, not across building footprint. **Remove flow path across building footprint from mapping.**

LOCATION:
Western Sydney University
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
On site drainage system exists in low area. Continuing construction in area could alter terrain from when ALS was collected. **Remove from mapping.**

LOCATION:

Nepean College, O'Connell St, Kingswood #1

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Building located at the top of a hill. On site drainage network exists. It appears an artificial build-up is occurring on the roadway (DEM unreliable in area) and it would actually flow away downhill. **Remove from mapping**.

LOCATION:
Nepean College, O'Connell St, Kingswood #2

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

On site drainage system exists in low points upstream of building. Once water builds up, it can pass around the side of the building. **Remove from mapping**.

LOCATION:
38 Algie Cres, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Localised low point. Path between no 38 and 40 is thickly vegetated and has a fence across it which would restrict water movement. **Retain in mapping**.

LOCATION:
10-20 George St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Low point evident and property is surrounded by colorbond fencing which would significantly restrict movement of water during large events. **Retain in mapping.**

LOCATION:

28-34 George St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

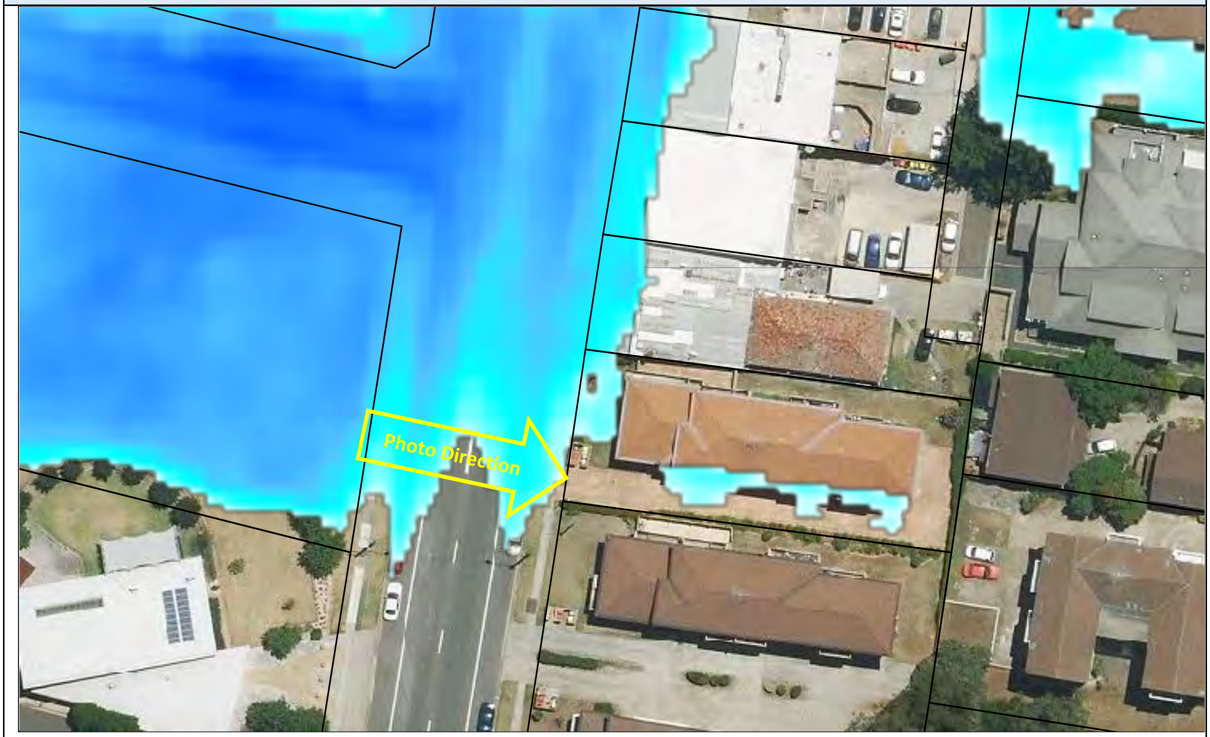
COMMENT:

Appears to be located in a depression area / overland flow path. **Retain in mapping.**

LOCATION:
146-154 Great Western Highway, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Notable onsite stormwater pits onsite, but pipe appear quite small – unlikely to be able to drain all water during large events. **Retain in mapping**.

LOCATION:
14 Bringelly Road, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
On site drainage system exists and driveway generally grades down towards roadway. **Remove from mapping**.

LOCATION:
19 Bringelly Road, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

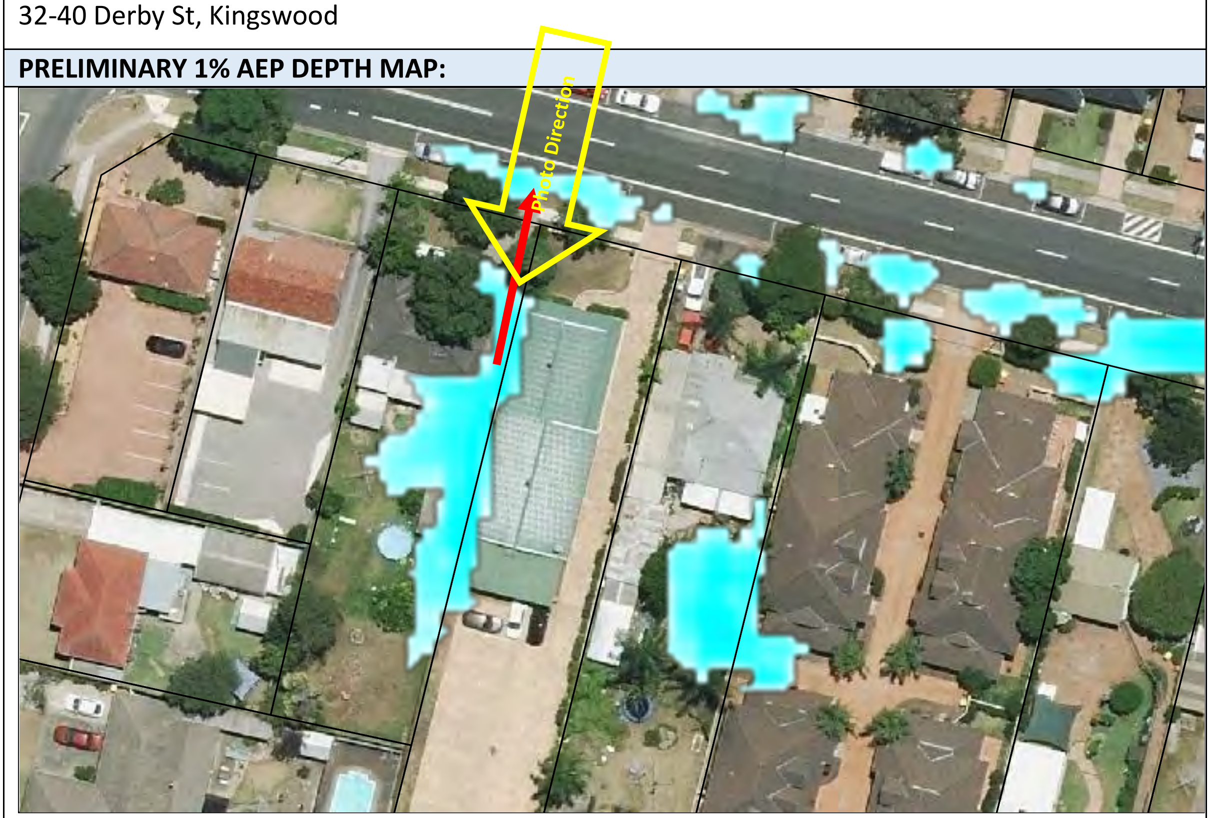
PHOTOGRAPH OF LOCATION:

COMMENT:

On site drainage system exists removing ponding on driveway. Could not access rear area over back fence, however assumed on site drainage system would exist. **Remove smaller "puddles" from mapping but retain more significant flow path at rear of property.**

LOCATION:
32-40 Derby St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:



PHOTOGRAPH OF LOCATION:

COMMENT:
Water from rear of no 40 can easily pass down driveway to Derby Street. **Remove from Mapping.**

LOCATION:
25 Derby St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

No ponding is possible near the front of no 29, and build up in rear of property could pass under Colorbond gate to Derby St. **Remove from mapping**.

LOCATION:
18 Rodgers St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Could not access area between buildings, however significant on-site drainage system is evident. Build up in front of no 20-26 Rodgers St is not realistic. **Remove from mapping.**

LOCATION:
117-123 Cox Ave, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Build up at no 117 would flow south to Cox St and north to stormwater pit. **Remove from mapping.**

LOCATION:
58 Copeland St, Kingswood (next to 117-123 Cox Ave)
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Build up against buildings would not occur as there are open gaps between structures. Some potential for build-up of water behind small grass embankment. **Retain "puddle" behind embankment**

LOCATION:
19 Copeland St, Kingswood (#1)
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Water may build up on the upstream side of the building but then spill towards the west and onto Phillip St at sufficient depth. **Retain in mapping.**

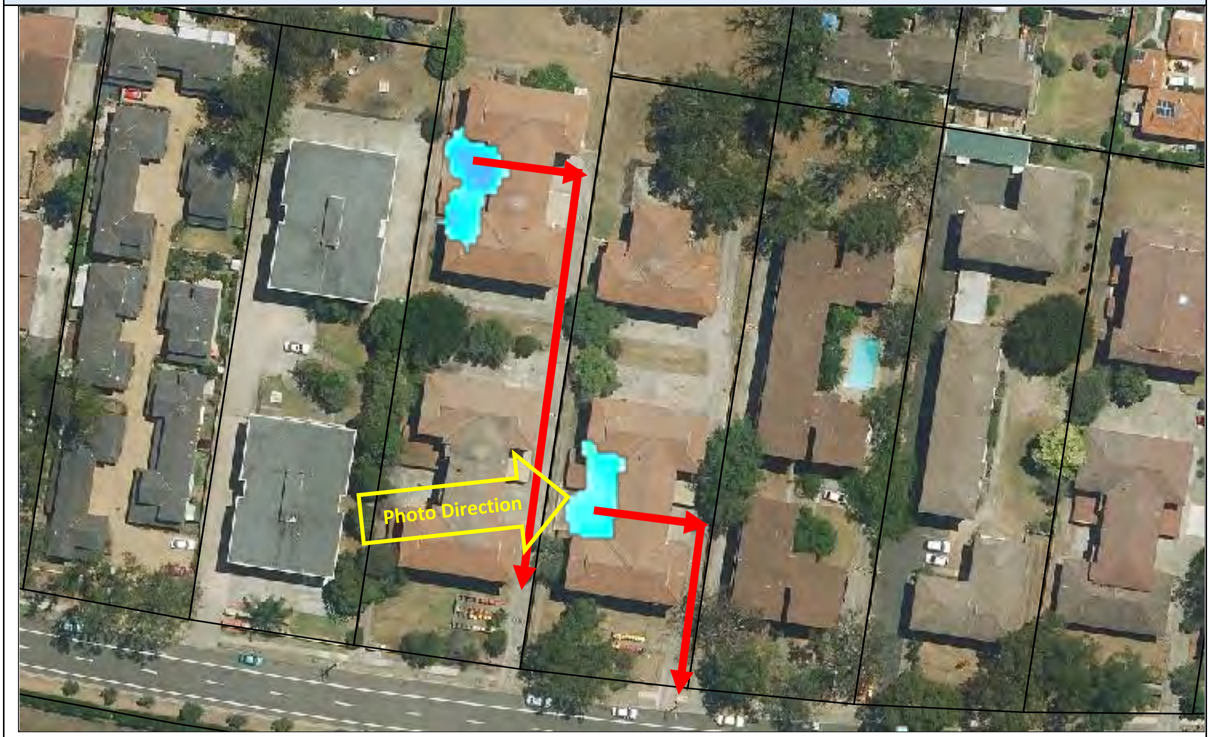
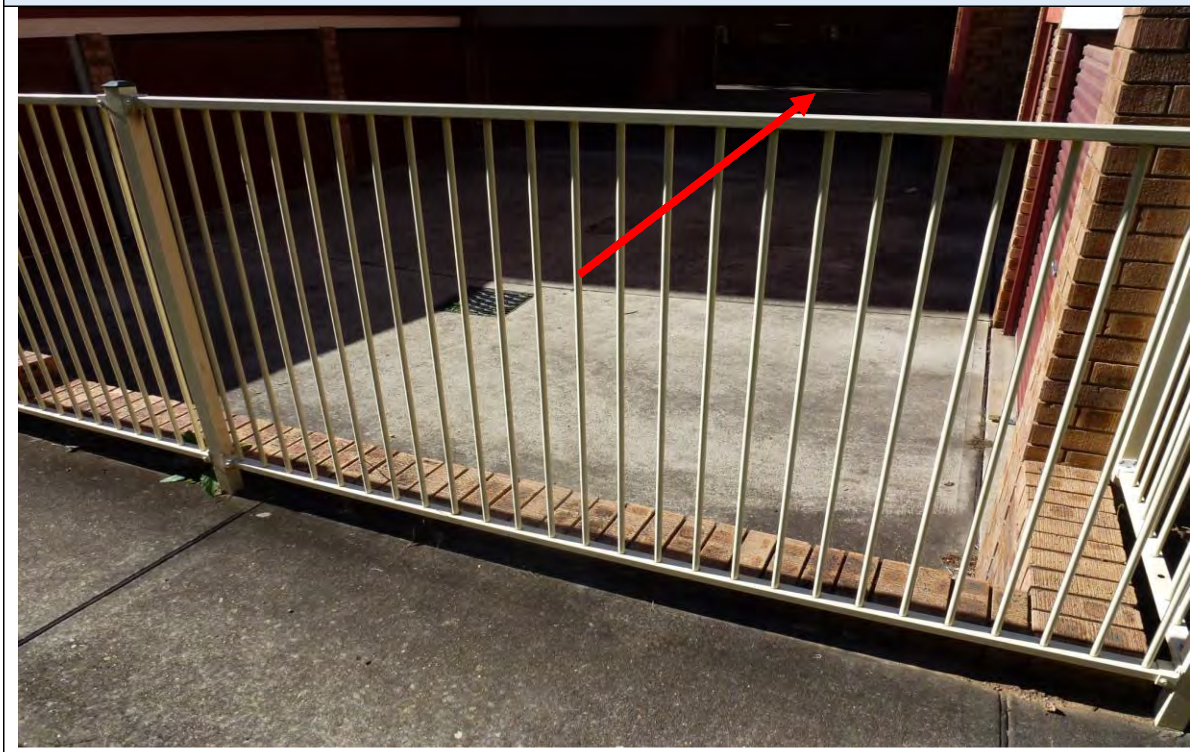
LOCATION:
19 Copeland St, Kingswood (#2)

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

No access to rear of industrial property. However, very flat so potential for some "ponding" behind buildings. **Retain in mapping**.

LOCATION:
64 Park Ave, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Water being trapped in "open" area where flow could freely discharge. **Remove from mapping**.

LOCATION:
1 Amaroo St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:

Water building up in low point in terrain. No drainage infrastructure evident to drain water. **Retain in mapping**.

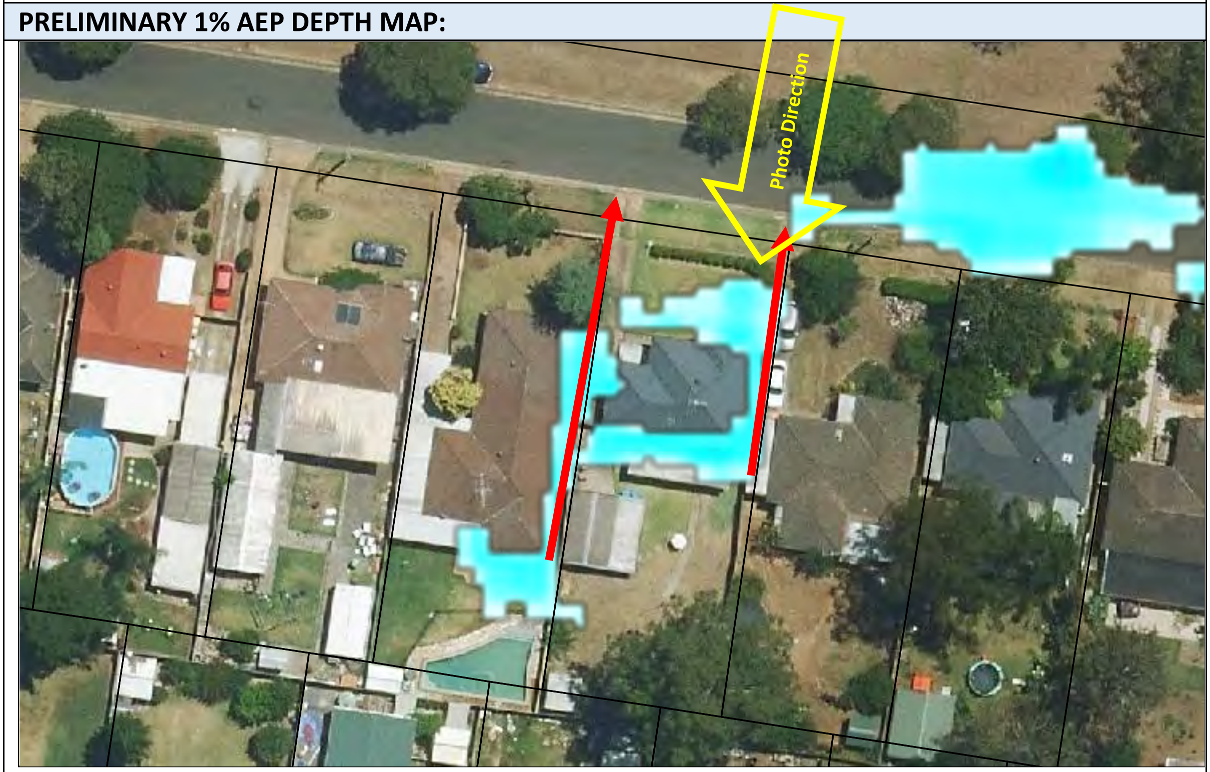
LOCATION:
71-85 Joseph St, Kingswood
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Retaining wall would limit water entering no 71-85 and divert it towards the large inlet in the reserve. On site drainage system exists. Flooding would occur, potentially not to the extent currently shown. **Retain in mapping.**

LOCATION:
18-20 Epping Cl, Cambridge Park

PRELIMINARY 1% AEP DEPTH MAP:



PHOTOGRAPH OF LOCATION:

COMMENT:

Modelling results show a relatively continuous overland flow path. Water would be concentrated along sides of house and any blockage of gates would increase flooding potential. **Retain in mapping**.

LOCATION:
22-27 Lincoln Dr, Cambridge Park
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Low area in rear of no 22 Lincoln Dr can be drained by holes under fence and a local drainage system. Build up at no 24 and 27 does appear to drain towards rear of property from street and would need to travel overland in an easterly direction. **Retain in mapping.**

LOCATION:
Cambridge Park High School, Harrow Rd
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
A retaining wall forms a low point at the base of the buildings. No obvious way for overland flows to escape near north-western corner of school building (**retain in mapping**).

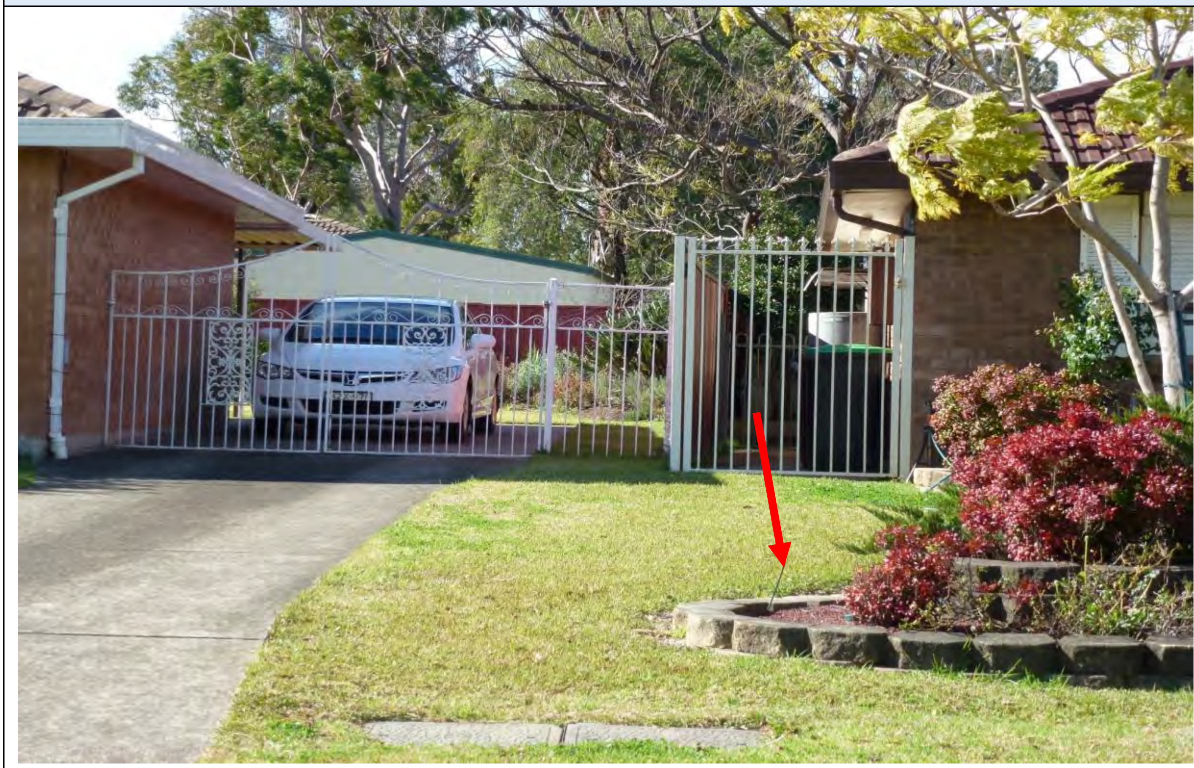
LOCATION:
14-16 Francis St, Werrington County
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
No access to rear of property was possible, however, the front of property appears to drop away towards the rear. **Retain in mapping.**

LOCATION:
3 Fawkener Place, Werrington County
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

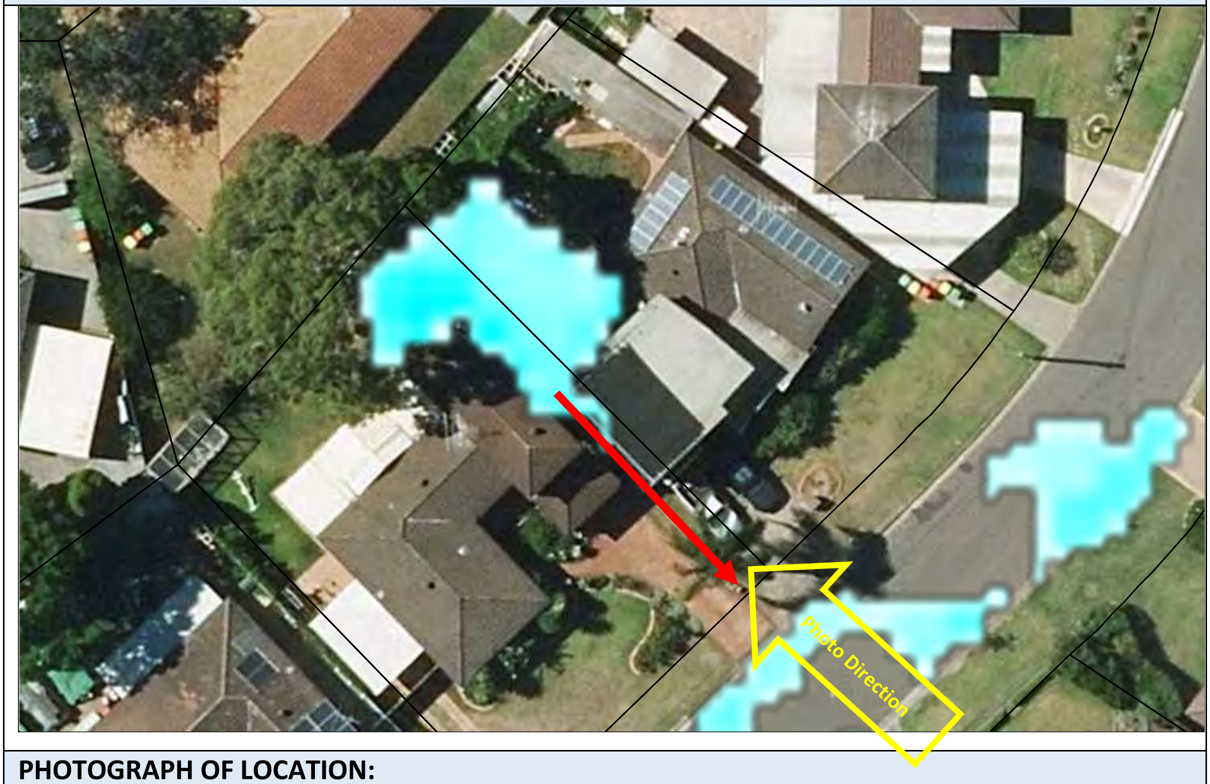


COMMENT:

No access to rear of no 3 Fawkner Pl, however both the northern and southern sides of the building are open gates and would allow flow to pass to the street. **Remove from mapping.**

LOCATION:
63-65 Hume Cres, Werrington County

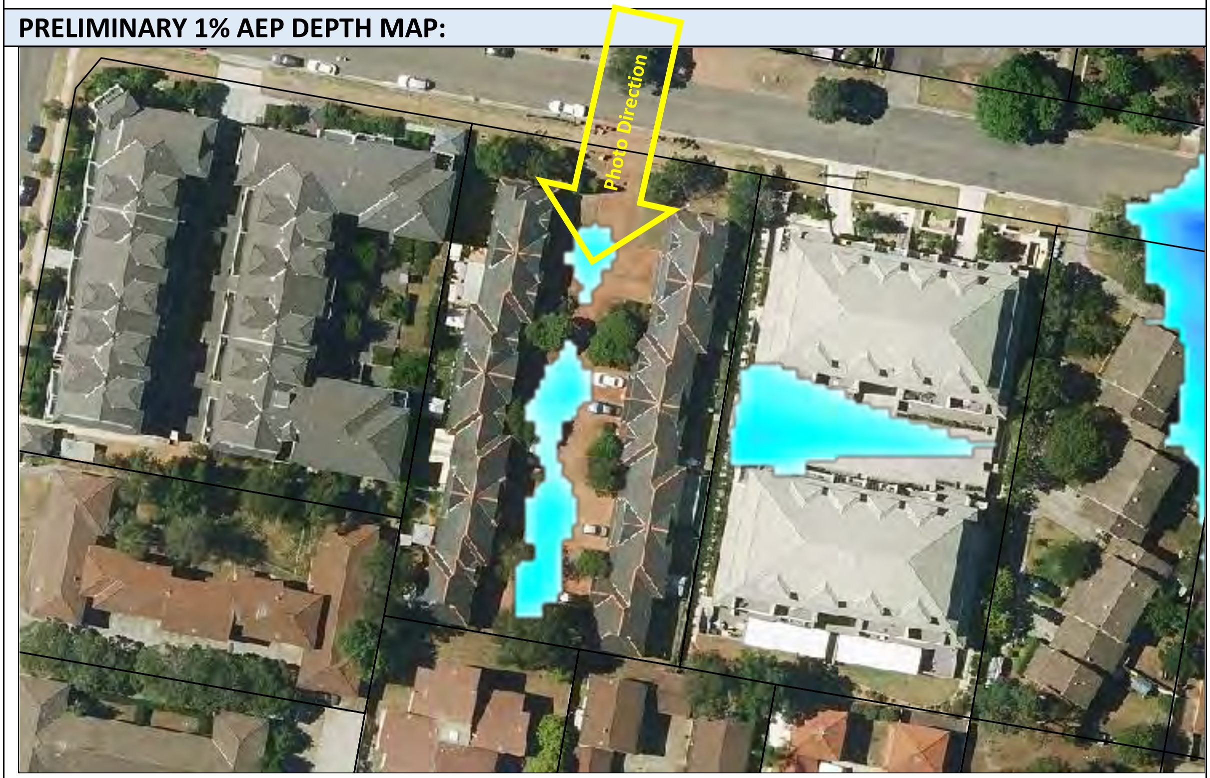
PRELIMINARY 1% AEP DEPTH MAP:



PHOTOGRAPH OF LOCATION:

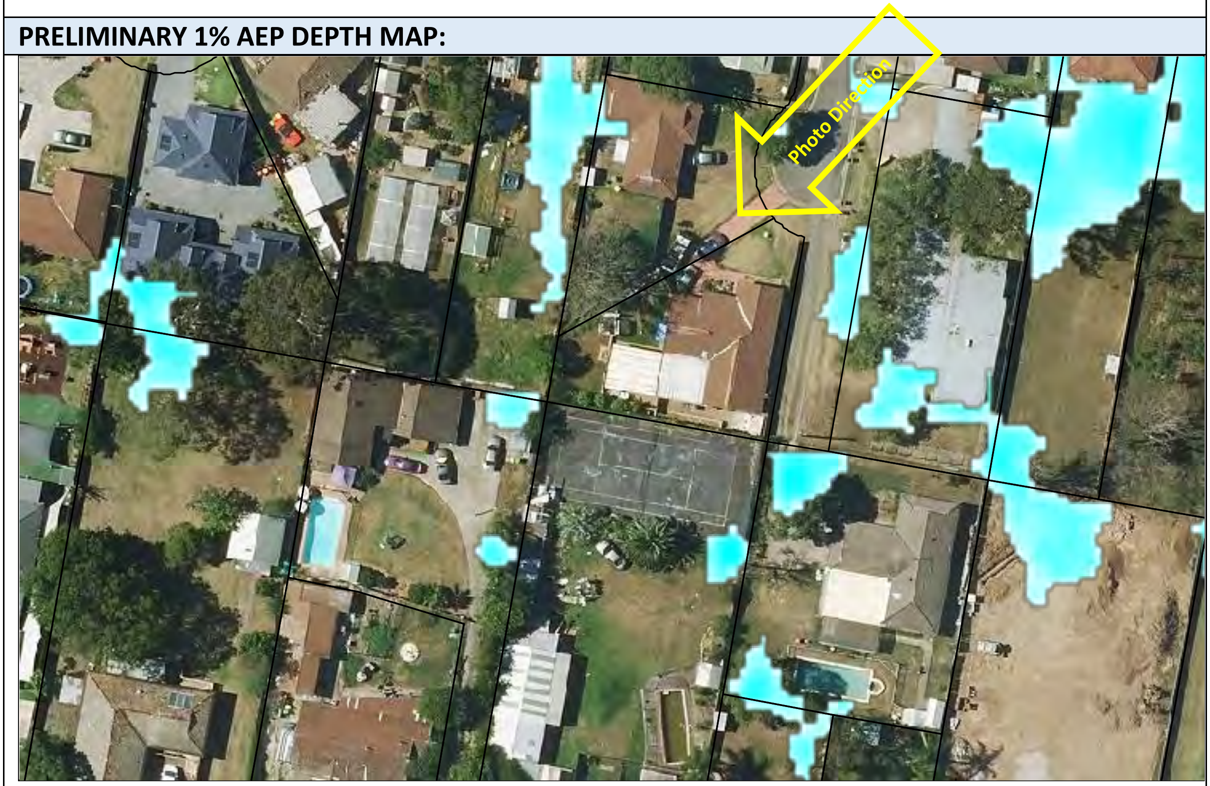
COMMENT:

No access to rear of property, however, sufficient gap between no 63 and 65 Hume Crescent would allow flow through colorbond gates to street. **Remove from mapping.**

LOCATION:
40 Albert St, Werrington
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

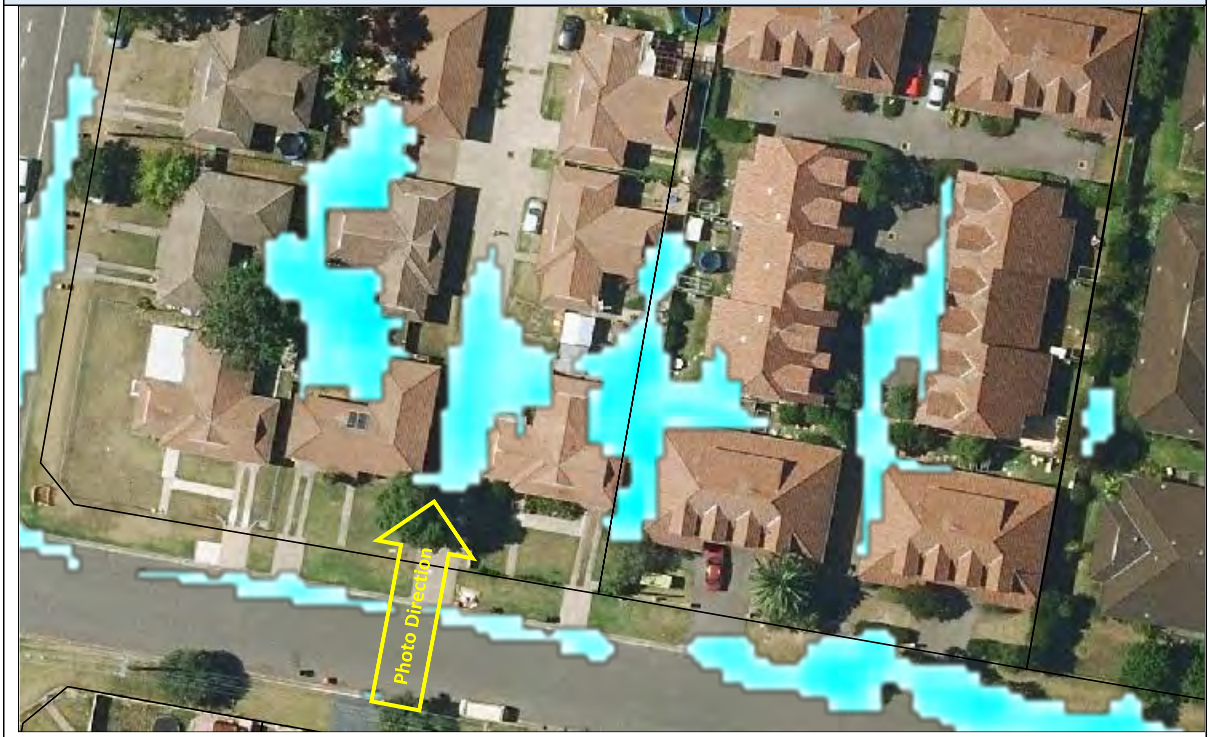
COMMENT:
Significant on site drainage system exists at sag locations. **Remove from mapping.**

LOCATION:
Between Judith Cl & Elaine Ct, Werrington
PRELIMINARY 1% AEP DEPTH MAP:



PHOTOGRAPH OF LOCATION:

COMMENT:
No access to rear of properties. Fairly flat area with no obvious flow paths / drainage depressions. Most "puddles" appear to be associated with localised build-up of water behind fences. **Remove from mapping.**

LOCATION:
115-117 Albert St, Werrington
PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

COMMENT:
Depression along driveway that generally, drains towards Albert St. **Retain in mapping**.

LOCATION:

Werrington Public School, Heavy St, Werrington

PRELIMINARY 1% AEP DEPTH MAP:

PHOTOGRAPH OF LOCATION:

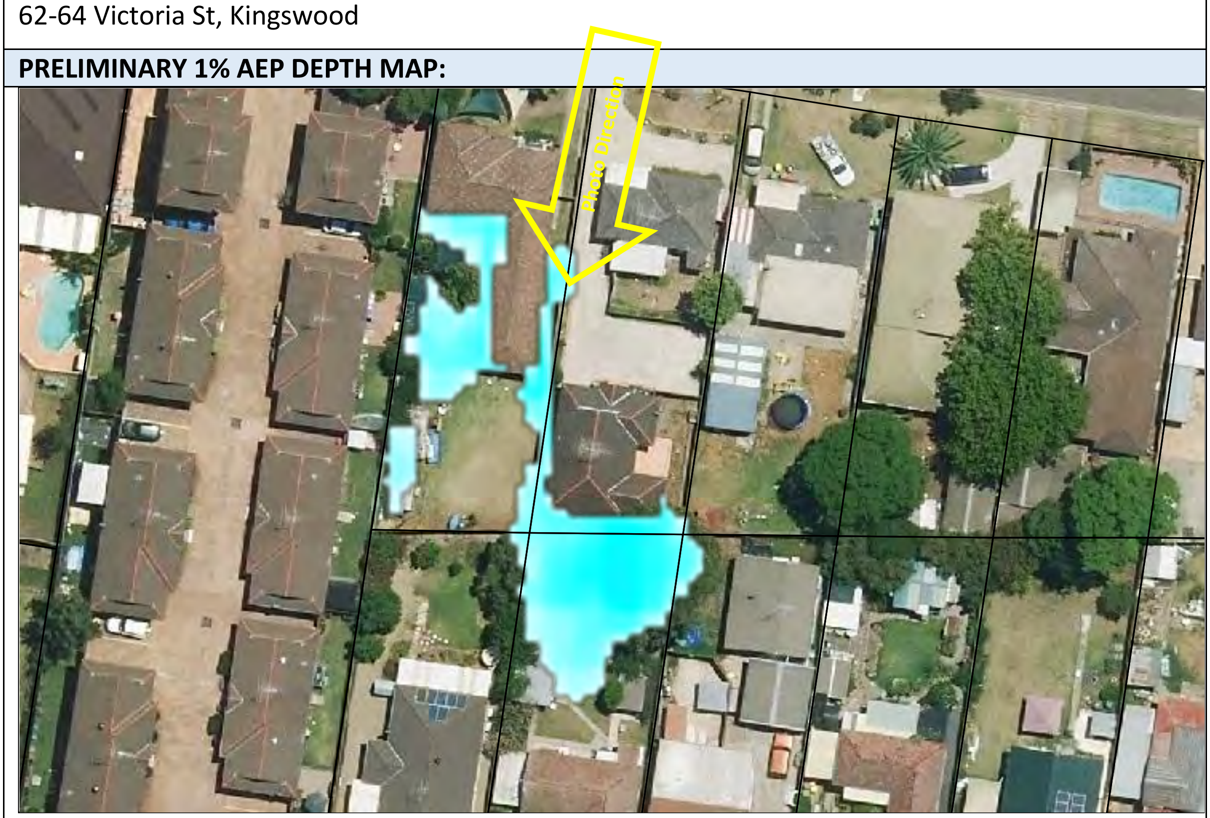
COMMENT:

Small culvert exists indicating some build-up of water. Low point existing in 35 Armstein Crescent.

Retain in modelling

LOCATION:
62-64 Victoria St, Kingswood

PRELIMINARY 1% AEP DEPTH MAP:



PHOTOGRAPH OF LOCATION:

COMMENT:

No access to rear of 62 Victoria St, however, appears to be drainage depression running along fence line. **Retain in mapping.**

APPENDIX M

TUFLOW MODEL RESULTS TABLES

Peak 1 in 2 Year ARI Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	20.52	3.72	0.42
2	JohnOxleyAveWerringtonCreek	23.17	2.20	1.49
3	JohnOxleyAve	22.96	0.56	0.10
4	BurtonSt	26.40	2.62	0.64
5	VictoriaSt	30.90	1.99	1.53
6	Railway	32.88	1.73	1.11
7	GreatWesternHwyCollegeCreek	34.41	0.27	0.53
8	CosgroveCres			
9	SecondAve	37.17	1.11	0.99
10	LamrockReserve	42.42	1.50	0.03
11	OConnellSt	44.43	0.82	0.38
12	OConnellStJohnFlakAve	44.51	0.76	0.96
13	CaddaRidgeDrOConnellLn	51.96	1.86	0.06
14	CaddensRdandOConnellLn	53.33	1.12	0.77
15	CastleRd			
16	CastleRdcloseKingswood	63.00	0.44	0.35
17	KingswoodRd	67.62	0.76	1.19
18	WerringtonCreekNearDunheved	20.57	3.98	0.05
19	ParkesAve	20.79	0.32	0.03
20	IrwinSt			
21	DunkleyPl	20.95	0.75	0.01
22	PrincessSt	21.45	0.44	0.22
23	AlbertStNearEdwardCl			
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	20.94	0.61	0.05
27	AlbertSt	20.94	0.36	0.23
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation			
31	ChapmanSt			
32	WalkerSt	23.77	0.75	1.89
33	HeaveyStandLethbridgeAve	25.06	0.37	0.07
34	HumeCresNearPrinceSt	24.55	0.20	0.27
35	PrinceStandJohnOxleyAve	24.74	0.34	0.07
36	PrinceSt			
37	BurkeAve			
38	CharlesSturtDr			
39	ChisholmAve			
40	HuntPl			
41	RugbySt			
42	CharlesToddCresandRugbySt			
43	DunhevedRdandJohnOxleyAve	34.59	0.19	0.23
44	HumeCres			
45	HeaveySt	25.80	1.36	0.19
46	ArmsteinCresandDannySt			
47	ArmsteinCres			
48	ArmsteinCresandInnesPl			
49	VictoriaStbelowReindeerPl			
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl			
54	CarleenCl			
55	DeslieAve	29.58	0.18	0.21

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt			
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.28	1.32	1.25
60	FrancisSt			
61	GlencoeAve			
62	GlencoeAveNearBeverleyPl	33.27	0.41	0.34
63	DunbarAve	34.36	0.20	0.27
64	RugbyStandOrletonPl			
65	OrletonPl	37.01	0.40	0.12
66	DunhevedRd	39.50	0.25	0.27
67	FrancisStN			
68	BenineDr	34.13	0.14	0.17
69	WilliamSt			
70	SuttonRd	34.40	0.34	0.21
71	TwickhenhamAveandNeetaAve			
72	WembleyAve	38.37	0.40	0.11
73	RugbyStN	40.59	0.16	0.38
74	SuttonRdandWillamSt	38.07	0.15	0.19
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.64	0.12	1.06
77	JordonSt	45.16	0.23	0.13
78	HarrowRd	30.81	0.24	0.05
79	HerbertSt	32.54	0.99	1.21
80	WeatherbyAveandCamptonAve	37.19	0.28	1.36
81	WrenchStNearDevonRd	39.28	0.21	0.34
82	CambridgeSt	41.15	0.49	0.10
83	LincolnDr	43.50	0.35	0.08
84	CheltenhamAve	47.45	0.16	0.17
85	AberdeenSt			
86	StirlingSt			
87	DevonRd			
88	EppingCl			
89	SandringhamAve	51.63	0.52	0.09
90	CottageSt			
91	VictoriaStnearParkAve	34.03	0.15	0.63
92	railwayNearVictoriaSt	35.67	2.60	0.28
93	GreatWesternHwy			
94	KerranCl			
95	WeatherbyAve	38.01	0.17	0.49
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.70	0.37	0.05
98	ParkAve	36.96	0.56	0.36
99	AmarooSt	38.31	0.16	0.69
100	JosephSt			
101	WalterSt	42.24	0.26	0.17
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve			
105	GreatWesternHwyNearSantleyCres	37.38	1.42	0.58
106	SantleyCres			
107	DougRennieField	38.86	0.40	0.93
108	FirstStN	40.99	0.85	0.52
109	BringellyRdNearFirst	42.61	0.11	0.89
110	HargraveSt	43.68	0.34	0.19

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.50	0.30	0.08
112	StaffordSyNearBringellyRd			
113	StaffordSt			
114	JamisonRd	49.15	0.23	1.11
115	StapleySt			
116	StapleyStandClemsonSt	49.88	0.26	0.32
117	ClemsonSt			
118	LucySt			
119	SmithSt	53.92	0.19	0.13
120	OagCresandTentSt			
121	TentSt			
122	TentStandPiperCl			
123	PiperCl			
124	BringellyRd			
125	BringellyRdandCaddensSt			
126	AngophoraAve			
127	CaddensRd			
128	OagCres			
129	TheNorthernRd			
130	ElliottSt			
131	GladysSt	55.43	0.20	0.13
132	SomersetNearHargraveSt			
133	SomersetStandDerbySt			
134	OrthSt	45.25	0.51	0.12
135	SomersetSt	46.90	0.30	0.11
136	GreatWesternHwySomersetSt	48.69	0.20	0.16
137	GreatWesternHwyHospital	48.48	0.21	0.37
138	RailwaynearHospital	48.95	1.07	1.33
139	CoxAve	50.54	0.29	0.24
140	CopelandSt	53.68	0.18	0.30
141	PhillipSt			
142	GascoigneSt			
143	RichmondRd			
144	SecondAveandJonesSt	41.78	0.16	0.09
145	BadenPowellAve			
146	FirstSt	46.07	0.12	0.56
147	BadenPowellAveandFirstSt			
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve			
150	PeppermintCres			
151	PeppermintCresandYeelannaPl	56.74	0.15	0.73
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens			
154	SecondAveandManningSt			
155	EdnaSt	42.75	0.20	0.35
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit			
160	CaddensRdandCaddaRidgeDr	75.80	0.17	0.20
161	KearneyAve	57.88	1.00	0.02
162	CaddaRidgeDr			
163	BringellyRdandGreatWesternHwy			

Peak 20% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	20.91	4.10	0.44
2	JohnOxleyAveWerringtonCreek	23.53	2.56	1.50
3	JohnOxleyAve	23.06	0.65	0.12
4	BurtonSt	26.76	2.98	0.67
5	VictoriaSt	31.30	2.38	1.39
6	Railway	33.28	2.13	1.21
7	GreatWesternHwyCollegeCreek	34.99	0.85	0.70
8	CosgroveCres			
9	SecondAve	37.52	1.45	1.08
10	LamrockReserve	42.78	1.86	0.03
11	OConnellSt	44.48	0.87	0.39
12	OConnellStJohnFlakAve	44.98	1.22	1.03
13	CaddaRidgeDrOConnellLn	52.04	1.94	0.11
14	CaddensRdandOConnellLn	53.39	1.18	0.35
15	CastleRd			
16	CastleRdcloseKingswood	63.22	0.63	0.41
17	KingswoodRd	67.87	1.01	1.38
18	WerringtonCreekNearDunheved	20.97	4.38	0.03
19	ParkesAve	21.08	0.60	0.29
20	IrwinSt			
21	DunkleyPl	21.62	1.42	0.04
22	PrincessSt	21.65	0.65	0.20
23	AlbertStNearEdwardCl			
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.31	0.98	0.02
27	AlbertSt	21.31	0.73	0.14
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation			
31	ChapmanSt	23.04	0.32	0.16
32	WalkerSt	23.96	0.95	1.55
33	HeaveyStandLethbridgeAve	25.10	0.40	0.10
34	HumeCresNearPrinceSt	24.61	0.26	0.28
35	PrinceStandJohnOxleyAve	24.86	0.45	0.10
36	PrinceSt			
37	BurkeAve			
38	CharlesSturtDr	25.30	0.19	0.20
39	ChisholmAve	27.31	0.19	0.20
40	HuntPl	28.86	0.21	0.26
41	RugbySt			
42	CharlesToddCresandRugbySt			
43	DunhevedRdandJohnOxleyAve	34.77	0.37	0.27
44	HumeCres			
45	HeaveySt	25.84	1.40	0.29
46	ArmsteinCresandDannySt			
47	ArmsteinCres			
48	ArmsteinCresandInnesPl			
49	VictoriaStbelowReindeerPl			
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl			
54	CarleenCl			
55	DeslieAve	29.62	0.22	0.21

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt	28.52	0.17	0.67
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.40	1.44	1.35
60	FrancisSt			
61	GlencoeAve	33.28	0.20	0.51
62	GlencoeAveNearBeverleyPl	33.36	0.50	0.37
63	DunbarAve	34.41	0.24	0.31
64	RugbyStandOrletonPl	35.80	0.21	0.56
65	OrletonPl	37.13	0.52	0.11
66	DunhevedRd	39.56	0.32	0.31
67	FrancisStN			
68	BenineDr	34.20	0.21	0.19
69	WilliamSt			
70	SuttonRd	34.48	0.42	0.20
71	TwickhenhamAveandNeetaAve			
72	WembleyAve	38.50	0.53	0.15
73	RugbyStN	40.62	0.19	0.43
74	SuttonRdandWillamSt	38.26	0.34	0.21
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.73	0.20	1.08
77	JordonSt	45.20	0.27	0.13
78	HarrowRd	30.93	0.36	0.23
79	HerbertSt	32.81	1.26	1.37
80	WeatherbyAveandCamptonAve	37.28	0.37	1.38
81	WrenchStNearDevonRd	39.33	0.26	0.41
82	CambridgeSt	41.20	0.54	0.17
83	LincolnDr	43.64	0.48	0.11
84	CheltenhamAve	47.48	0.18	0.18
85	AberdeenSt			
86	StirlingSt	44.76	0.19	0.31
87	DevonRd			
88	EppingCl	46.59	0.17	0.48
89	SandringhamAve	51.64	0.54	0.08
90	CottageSt			
91	VictoriaStnearParkAve	34.08	0.20	0.62
92	railwayNearVictoriaSt	35.94	2.87	0.36
93	GreatWesternHwy	44.86	0.36	0.90
94	KerranCl			
95	WeatherbyAve	38.07	0.23	0.51
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.79	0.45	0.05
98	ParkAve	37.05	0.66	0.44
99	AmarooSt	38.35	0.20	0.81
100	JosephSt	40.38	0.18	0.53
101	WalterSt	42.25	0.27	0.17
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve			
105	GreatWesternHwyNearSantleyCres	37.49	1.52	0.59
106	SantleyCres	38.86	0.18	0.43
107	DougRennieField	38.98	0.52	1.21
108	FirstStN	41.16	1.02	0.75
109	BringellyRdNearFirst	42.68	0.18	1.06
110	HargraveSt	43.76	0.43	0.31

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.62	0.42	0.08
112	StaffordSyNearBringellyRd	46.59	0.19	0.46
113	StaffordSt	47.05	0.19	0.67
114	JamisonRd	49.18	0.25	1.22
115	StapleySt			
116	StapleyStandClemsonSt	50.01	0.39	0.44
117	ClemsonSt			
118	LucySt			
119	SmithSt	53.98	0.25	0.22
120	OagCresandTentSt			
121	TentSt			
122	TentStandPiperCl			
123	PiperCl			
124	BringellyRd			
125	BringellyRdandCaddensSt	63.07	0.16	0.38
126	AngophoraAve			
127	CaddensRd			
128	OagCres			
129	TheNorthernRd			
130	ElliottSt	52.93	0.15	0.40
131	GladysSt	55.58	0.34	0.13
132	SomersetNearHargraveSt			
133	SomersetStandDerbySt			
134	OrthSt	45.30	0.56	0.18
135	SomersetSt	46.95	0.35	0.18
136	GreatWesternHwySomersetSt	48.73	0.24	0.21
137	GreatWesternHwyHospital	48.51	0.24	0.38
138	RailwaynearHospital	49.00	1.12	1.25
139	CoxAve	50.64	0.39	0.25
140	CopelandSt	53.74	0.25	0.37
141	PhillipSt			
142	GascoigneSt			
143	RichmondRd			
144	SecondAveandJonesSt	41.82	0.21	0.13
145	BadenPowellAve			
146	FirstSt	46.08	0.13	0.68
147	BadenPowellAveandFirstSt			
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.07	0.16	0.16
150	PeppermintCres			
151	PeppermintCresandYeelannaPl	56.80	0.22	0.77
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens			
154	SecondAveandManningSt			
155	EdnaSt	42.97	0.43	0.33
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.27	0.16	0.45
160	CaddensRdandCaddaRidgeDr	75.84	0.20	0.34
161	KearneyAve	57.91	1.02	0.03
162	CaddaRidgeDr			
163	BringellyRdandGreatWesternHwy			

Peak 10% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.08	4.27	0.47
2	JohnOxleyAveWerringtonCreek	23.76	2.79	1.49
3	JohnOxleyAve	23.17	0.76	0.18
4	BurtonSt	26.97	3.19	0.70
5	VictoriaSt	31.49	2.57	1.70
6	Railway	33.47	2.33	1.24
7	GreatWesternHwyCollegeCreek	35.25	1.11	0.76
8	CosgroveCres			
9	SecondAve	37.91	1.85	1.10
10	LamrockReserve	42.93	2.01	0.03
11	OConnellSt	44.50	0.89	0.38
12	OConnellStJohnFlakAve	45.31	1.56	1.04
13	CaddaRidgeDrOConnellLn	52.08	1.98	0.13
14	CaddensRdandOConnellLn	53.42	1.21	0.40
15	CastleRd			
16	CastleRdcloseKingswood	63.30	0.70	0.45
17	KingswoodRd	67.91	1.05	1.31
18	WerringtonCreekNearDunheved	21.17	4.58	0.04
19	ParkesAve	21.22	0.74	0.09
20	IrwinSt			
21	DunkleyPl	21.76	1.57	0.07
22	PrincessSt	21.76	0.76	0.04
23	AlbertStNearEdwardCl			
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.37	1.04	0.04
27	AlbertSt	21.38	0.80	0.30
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation			
31	ChapmanSt	23.18	0.46	0.20
32	WalkerSt	24.03	1.01	1.54
33	HeaveyStandLethbridgeAve	25.11	0.42	0.13
34	HumeCresNearPrinceSt	24.63	0.28	0.28
35	PrinceStandJohnOxleyAve	24.89	0.48	0.12
36	PrinceSt	24.89	0.16	0.50
37	BurkeAve			
38	CharlesSturtDr	25.33	0.22	0.23
39	ChisholmAve	27.35	0.23	0.20
40	HuntPl	28.88	0.23	0.26
41	RugbySt			
42	CharlesToddCresandRugbySt	33.41	0.18	0.21
43	DunhevedRdandJohnOxleyAve	34.81	0.41	0.28
44	HumeCres			
45	HeaveySt	25.85	1.41	0.23
46	ArmsteinCresandDannySt			
47	ArmsteinCres			
48	ArmsteinCresandInnesPl			
49	VictoriaStbelowReindeerPl	32.80	0.16	0.39
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl			
54	CarleenCl	28.66	0.17	0.51
55	DeslieAve	29.64	0.24	0.22

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt	28.54	0.18	0.72
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.48	1.52	1.46
60	FrancisSt	30.58	0.17	1.05
61	GlencoeAve	33.31	0.23	0.84
62	GlencoeAveNearBeverleyPl	33.41	0.55	0.37
63	DunbarAve	34.45	0.28	0.36
64	RugbyStandOrletonPl	35.87	0.28	0.56
65	OrletonPl	37.16	0.55	0.12
66	DunhevedRd	39.62	0.37	0.31
67	FrancisStN	39.38	0.16	0.43
68	BenineDr	34.23	0.24	0.18
69	WilliamSt	30.99	0.19	1.18
70	SuttonRd	34.53	0.47	0.21
71	TwickhenhamAveandNeetaAve	36.62	0.18	0.69
72	WembleyAve	38.54	0.57	0.12
73	RugbyStN	40.65	0.21	0.38
74	SuttonRdandWillamSt	38.31	0.39	0.21
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.75	0.23	1.06
77	JordonSt	45.22	0.29	0.16
78	HarrowRd	30.98	0.41	0.34
79	HerbertSt	32.94	1.39	1.43
80	WeatherbyAveandCamptonAve	37.31	0.41	1.38
81	WrenchStNearDevonRd	39.36	0.29	0.46
82	CambridgeSt	41.24	0.58	0.24
83	LincolnDr	43.68	0.52	0.19
84	CheltenhamAve	47.49	0.20	0.19
85	AberdeenSt			
86	StirlingSt	44.77	0.20	0.32
87	DevonRd	40.95	0.16	0.32
88	EppingCl	46.61	0.19	0.51
89	SandringhamAve	51.65	0.55	0.09
90	CottageSt			
91	VictoriaStnearParkAve	34.10	0.22	0.65
92	railwayNearVictoriaSt	36.08	3.01	0.37
93	GreatWesternHwy	45.06	0.55	0.93
94	KerranCl			
95	WeatherbyAve	38.09	0.25	0.49
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.84	0.50	0.06
98	ParkAve	37.09	0.70	0.42
99	AmarooSt	38.37	0.22	0.87
100	JosephSt	40.39	0.18	0.52
101	WalterSt	42.26	0.28	0.18
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve			
105	GreatWesternHwyNearSantleyCres	37.53	1.56	0.63
106	SantleyCres	38.91	0.23	0.44
107	DougRennieField	39.02	0.56	1.31
108	FirstStN	41.20	1.07	0.80
109	BringellyRdNearFirst	42.74	0.23	1.13
110	HargraveSt	43.81	0.48	0.37

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.70	0.49	0.08
112	StaffordSyNearBringellyRd	46.65	0.25	0.44
113	StaffordSt	47.07	0.21	0.67
114	JamisonRd	49.19	0.27	1.37
115	StapleySt	50.48	0.18	0.71
116	StapleyStandClemsonSt	50.07	0.45	0.50
117	ClemsonSt			
118	LucySt	52.59	0.17	1.65
119	SmithSt	53.99	0.26	0.24
120	OagCresandTentSt			
121	TentSt			
122	TentStandPiperCl	60.57	0.17	0.28
123	PiperCl			
124	BringellyRd			
125	BringellyRdandCaddensSt	63.08	0.18	0.30
126	AngophoraAve			
127	CaddensRd			
128	OagCres	58.15	0.17	0.32
129	TheNorthernRd			
130	ElliottSt	52.95	0.18	0.43
131	GladysSt	55.61	0.37	0.12
132	SomersetNearHargraveSt			
133	SomersetStandDerbySt			
134	OrthSt	45.32	0.58	0.19
135	SomersetSt	46.97	0.37	0.22
136	GreatWesternHwySomersetSt	48.74	0.25	0.21
137	GreatWesternHwyHospital	48.51	0.24	0.38
138	RailwaynearHospital	49.02	1.14	1.50
139	CoxAve	50.69	0.44	0.29
140	CopelandSt	53.78	0.29	0.41
141	PhillipSt	57.99	0.17	0.78
142	GascoigneSt			
143	RichmondRd			
144	SecondAveandJonesSt	41.84	0.22	0.16
145	BadenPowellAve			
146	FirstSt	46.08	0.13	0.72
147	BadenPowellAveandFirstSt			
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.09	0.19	0.17
150	PeppermintCres			
151	PeppermintCresandYeelannaPl	56.84	0.25	0.74
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens			
154	SecondAveandManningSt			
155	EdnaSt	43.01	0.47	0.35
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.29	0.18	0.51
160	CaddensRdandCaddaRidgeDr	75.85	0.21	0.41
161	KearneyAve	57.91	1.03	0.03
162	CaddaRidgeDr			
163	BringellyRdandGreatWesternHwy			

Peak 5% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.31	4.51	0.51
2	JohnOxleyAveWerringtonCreek	23.99	3.02	1.46
3	JohnOxleyAve	23.52	1.11	0.31
4	BurtonSt	27.17	3.39	0.69
5	VictoriaSt	31.74	2.82	1.49
6	Railway	33.76	2.62	1.25
7	GreatWesternHwyCollegeCreek	35.75	1.61	0.95
8	CosgroveCres	36.40	0.42	0.82
9	SecondAve	38.75	2.68	1.11
10	LamrockReserve	43.00	2.08	0.05
11	OConnellSt	44.53	0.91	0.40
12	OConnellStJohnFlakAve	45.88	2.13	0.81
13	CaddaRidgeDrOConnellLn	52.13	2.03	0.16
14	CaddensRdandOConnellLn	53.46	1.25	1.14
15	CastleRd			
16	CastleRdcloseKingswood	63.33	0.73	0.49
17	KingswoodRd	67.94	1.08	1.33
18	WerringtonCreekNearDunheved	21.43	4.84	0.04
19	ParkesAve	21.43	0.95	0.06
20	IrwinSt	21.43	0.22	0.27
21	DunkleyPl	21.89	1.70	0.71
22	PrincessSt	21.92	0.92	0.05
23	AlbertStNearEdwardCl	22.72	0.16	0.91
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.48	1.15	0.06
27	AlbertSt	21.50	0.92	0.65
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation			
31	ChapmanSt	23.41	0.69	0.26
32	WalkerSt	24.07	1.05	1.47
33	HeaveyStandLethbridgeAve	25.13	0.43	0.18
34	HumeCresNearPrinceSt	24.65	0.30	0.27
35	PrinceStandJohnOxleyAve	24.91	0.50	0.13
36	PrinceSt	24.91	0.18	0.64
37	BurkeAve			
38	CharlesSturtDr	25.37	0.25	0.23
39	ChisholmAve	27.38	0.26	0.20
40	HuntPl	28.91	0.25	0.28
41	RugbySt	30.45	0.18	0.43
42	CharlesToddCresandRugbySt	33.43	0.20	0.24
43	DunhevedRdandJohnOxleyAve	34.85	0.45	0.27
44	HumeCres			
45	HeaveySt	25.86	1.43	0.35
46	ArmsteinCresandDannySt			
47	ArmsteinCres			
48	ArmsteinCresandInnesPl			
49	VictoriaStbelowReindeerPl	32.83	0.19	0.39
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	27.41	0.16	0.71
54	CarleenCl	28.68	0.19	0.59
55	DeslieAve	29.66	0.26	0.21

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt	28.56	0.20	0.78
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.64	1.68	1.63
60	FrancisSt	30.63	0.23	1.19
61	GlencoeAve	33.35	0.27	1.10
62	GlencoeAveNearBeverleyPl	33.47	0.60	0.42
63	DunbarAve	34.50	0.34	0.38
64	RugbyStandOrletonPl	35.92	0.34	0.57
65	OrletonPl	37.19	0.58	0.12
66	DunhevedRd	39.69	0.45	0.32
67	FrancisStN	39.40	0.19	0.43
68	BenineDr	34.25	0.27	0.19
69	WilliamSt	31.05	0.25	1.32
70	SuttonRd	34.57	0.51	0.21
71	TwickhenhamAveandNeetaAve	36.66	0.22	0.71
72	WembleyAve	38.58	0.62	0.12
73	RugbyStN	40.67	0.24	0.44
74	SuttonRdandWillamSt	38.34	0.42	0.19
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.79	0.27	1.05
77	JordonSt	45.24	0.31	0.20
78	HarrowRd	31.03	0.46	0.44
79	HerbertSt	33.06	1.51	1.49
80	WeatherbyAveandCamptonAve	37.36	0.45	1.38
81	WrenchStNearDevonRd	39.39	0.33	0.53
82	CambridgeSt	41.27	0.62	0.30
83	LincolnDr	43.70	0.55	0.13
84	CheltenhamAve	47.51	0.22	0.16
85	AberdeenSt	49.06	0.16	0.29
86	StirlingSt	44.79	0.22	0.29
87	DevonRd	40.98	0.18	0.34
88	EppingCl	46.63	0.20	0.51
89	SandringhamAve	51.66	0.56	0.10
90	CottageSt			
91	VictoriaStnearParkAve	34.12	0.24	0.67
92	railwayNearVictoriaSt	36.27	3.20	0.40
93	GreatWesternHwy	45.31	0.80	0.95
94	KerranCl			
95	WeatherbyAve	38.12	0.28	0.53
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.89	0.56	0.07
98	ParkAve	37.14	0.75	0.47
99	AmarooSt	38.39	0.24	0.93
100	JosephSt	40.39	0.19	0.52
101	WalterSt	42.27	0.28	0.19
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve	39.69	0.18	0.72
105	GreatWesternHwyNearSantleyCres	37.56	1.59	0.59
106	SantleyCres	38.98	0.29	0.50
107	DougRennieField	39.06	0.60	1.39
108	FirstStN	41.26	1.12	0.89
109	BringellyRdNearFirst	42.81	0.31	1.17
110	HargraveSt	43.86	0.53	0.45

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.79	0.58	0.09
112	StaffordSyNearBringellyRd	46.71	0.31	0.43
113	StaffordSt	47.10	0.24	0.72
114	JamisonRd	49.22	0.30	1.47
115	StapleySt	50.51	0.22	0.95
116	StapleyStandClemsonSt	50.16	0.54	0.54
117	ClemsonSt			
118	LucySt	52.66	0.24	1.91
119	SmithSt	54.01	0.28	0.24
120	OagCresandTentSt	56.53	0.18	0.69
121	TentSt	58.70	0.18	0.98
122	TentStandPiperCl	60.61	0.21	0.27
123	PiperCl			
124	BringellyRd			
125	BringellyRdandCaddensSt	63.11	0.20	0.28
126	AngophoraAve			
127	CaddensRd			
128	OagCres	58.19	0.21	0.36
129	TheNorthernRd			
130	ElliottSt	52.98	0.21	0.46
131	GladysSt	55.64	0.40	0.13
132	SomersetNearHargraveSt			
133	SomersetStandDerbySt			
134	OrthSt	45.35	0.61	0.21
135	SomersetSt	47.00	0.40	0.25
136	GreatWesternHwySomersetSt	48.75	0.26	0.21
137	GreatWesternHwyHospital	48.52	0.25	0.38
138	RailwaynearHospital	49.03	1.15	1.40
139	CoxAve	50.78	0.53	0.28
140	CopelandSt	53.82	0.33	0.43
141	PhillipSt	58.01	0.19	0.84
142	GascoigneSt			
143	RichmondRd			
144	SecondAveandJonesSt	41.86	0.24	0.21
145	BadenPowellAve	45.23	0.16	0.66
146	FirstSt	46.09	0.14	0.75
147	BadenPowellAveandFirstSt	46.43	0.16	0.69
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.12	0.22	0.15
150	PeppermintCres	49.68	0.15	0.15
151	PeppermintCresandYeelannaPl	56.88	0.29	0.79
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens	40.27	0.19	1.36
154	SecondAveandManningSt			
155	EdnaSt	43.05	0.51	0.35
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.32	0.21	0.60
160	CaddensRdandCaddaRidgeDr	75.86	0.22	0.48
161	KearneyAve	57.92	1.04	0.03
162	CaddaRidgeDr			
163	BringellyRdandGreatWesternHwy			

Peak 2% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.32	4.51	0.58
2	JohnOxleyAveWerringtonCreek	24.16	3.19	1.44
3	JohnOxleyAve	23.96	1.55	0.48
4	BurtonSt	27.34	3.56	0.74
5	VictoriaSt	31.88	2.97	1.27
6	Railway	34.23	3.08	1.25
7	GreatWesternHwyCollegeCreek	36.33	2.19	0.90
8	CosgroveCres	36.66	0.67	0.99
9	SecondAve	39.01	2.95	1.10
10	LamrockReserve	43.05	2.13	0.07
11	OConnellSt	44.55	0.94	0.40
12	OConnellStJohnFlakAve	45.96	2.20	0.81
13	CaddaRidgeDrOConnellLn	52.17	2.07	0.21
14	CaddensRdandOConnellLn	53.51	1.30	0.83
15	CastleRd			
16	CastleRdcloseKingswood	63.35	0.76	0.50
17	KingswoodRd	67.96	1.10	1.34
18	WerringtonCreekNearDunheved	21.47	4.89	0.04
19	ParkesAve	21.48	1.00	0.07
20	IrwinSt	21.48	0.27	0.29
21	DunkleyPl	21.90	1.71	0.76
22	PrincessSt	21.97	0.97	0.06
23	AlbertStNearEdwardCl	22.74	0.18	1.00
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.53	1.19	0.06
27	AlbertSt	21.62	1.03	0.51
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation			
31	ChapmanSt	23.62	0.90	0.38
32	WalkerSt	24.11	1.09	1.57
33	HeaveyStandLethbridgeAve	25.14	0.44	0.20
34	HumeCresNearPrinceSt	24.66	0.31	0.31
35	PrinceStandJohnOxleyAve	24.92	0.52	0.13
36	PrinceSt	24.93	0.20	0.63
37	BurkeAve			
38	CharlesSturtDr	25.39	0.28	0.22
39	ChisholmAve	27.41	0.29	0.22
40	HuntPl	28.94	0.29	0.32
41	RugbySt	30.48	0.21	0.42
42	CharlesToddCresandRugbySt	33.45	0.21	0.29
43	DunhevedRdandJohnOxleyAve	34.88	0.47	0.29
44	HumeCres			
45	HeaveySt	25.87	1.44	0.27
46	ArmsteinCresandDannySt			
47	ArmsteinCres	30.42	0.14	0.10
48	ArmsteinCresandInnesPl			
49	VictoriaStbelowReindeerPl	32.84	0.21	0.37
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	27.42	0.18	0.75
54	CarleenCl	28.69	0.21	0.64
55	DeslieAve	29.67	0.27	0.21

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt	28.58	0.22	0.82
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.81	1.85	1.74
60	FrancisSt	30.69	0.28	1.29
61	GlencoeAve	33.38	0.29	0.91
62	GlencoeAveNearBeverleyPl	33.51	0.65	0.48
63	DunbarAve	34.54	0.38	0.41
64	RugbyStandOrletonPl	35.97	0.38	0.57
65	OrletonPl	37.21	0.60	0.12
66	DunhevedRd	39.73	0.48	0.32
67	FrancisStN	39.41	0.20	0.43
68	BenineDr	34.27	0.28	0.28
69	WilliamSt	31.07	0.28	1.51
70	SuttonRd	34.61	0.54	0.22
71	TwickhenhamAveandNeetaAve	36.69	0.25	0.79
72	WembleyAve	38.62	0.65	0.12
73	RugbyStN	40.69	0.26	0.30
74	SuttonRdandWillamSt	38.37	0.45	0.22
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.81	0.29	1.10
77	JordonSt	45.25	0.31	0.21
78	HarrowRd	31.06	0.49	0.48
79	HerbertSt	33.15	1.60	1.53
80	WeatherbyAveandCamptonAve	37.40	0.49	1.37
81	WrenchStNearDevonRd	39.42	0.35	0.59
82	CambridgeSt	41.30	0.64	0.35
83	LincolnDr	43.72	0.56	0.10
84	CheltenhamAve	47.52	0.23	0.24
85	AberdeenSt	49.07	0.17	0.31
86	StirlingSt	44.81	0.24	0.30
87	DevonRd	41.00	0.20	0.35
88	EppingCl	46.64	0.22	0.55
89	SandringhamAve	51.67	0.57	0.10
90	CottageSt			
91	VictoriaStnearParkAve	34.13	0.25	0.67
92	railwayNearVictoriaSt	36.44	3.37	0.41
93	GreatWesternHwy	45.59	1.08	0.91
94	KerranCl	34.81	0.14	0.99
95	WeatherbyAve	38.13	0.29	0.51
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.93	0.60	0.08
98	ParkAve	37.18	0.79	0.48
99	AmarooSt	38.41	0.26	0.98
100	JosephSt	40.39	0.19	0.50
101	WalterSt	42.28	0.29	0.20
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve	39.70	0.20	0.76
105	GreatWesternHwyNearSantleyCres	37.58	1.61	0.68
106	SantleyCres	39.03	0.35	0.54
107	DougRennieField	39.10	0.64	1.46
108	FirstStN	41.30	1.17	0.95
109	BringellyRdNearFirst	42.90	0.39	1.15
110	HargraveSt	43.91	0.57	0.50

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.85	0.65	0.11
112	StaffordSyNearBringellyRd	46.76	0.35	0.51
113	StaffordSt	47.12	0.26	0.72
114	JamisonRd	49.24	0.32	1.52
115	StapleySt	50.55	0.25	1.14
116	StapleyStandClemsonSt	50.21	0.59	0.55
117	ClemsonSt			
118	LucySt	52.72	0.30	1.99
119	SmithSt	54.02	0.30	0.25
120	OagCresandTentSt	56.58	0.23	0.72
121	TentSt	58.73	0.21	1.13
122	TentStandPiperCl	60.64	0.24	0.33
123	PiperCl			
124	BringellyRd	63.75	0.12	0.30
125	BringellyRdandCaddensSt	63.14	0.24	0.37
126	AngophoraAve			
127	CaddensRd			
128	OagCres	58.22	0.24	0.45
129	TheNorthernRd			
130	ElliottSt	53.00	0.23	0.46
131	GladysSt	55.66	0.42	0.14
132	SomersetNearHargraveSt			
133	SomersetStandDerbySt			
134	OrthSt	45.38	0.64	0.22
135	SomersetSt	47.03	0.43	0.28
136	GreatWesternHwySomersetSt	48.76	0.26	0.22
137	GreatWesternHwyHospital	48.53	0.26	0.38
138	RailwaynearHospital	49.03	1.16	1.37
139	CoxAve	50.86	0.61	0.19
140	CopelandSt	53.84	0.35	0.43
141	PhillipSt	58.03	0.21	0.87
142	GascoigneSt	59.31	0.17	0.40
143	RichmondRd			
144	SecondAveandJonesSt	41.87	0.25	0.28
145	BadenPowellAve	45.25	0.19	0.69
146	FirstSt	46.09	0.14	0.76
147	BadenPowellAveandFirstSt	46.44	0.16	0.71
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.14	0.24	0.17
150	PeppermintCres	49.68	0.16	0.20
151	PeppermintCresandYeelannaPl	56.91	0.32	0.79
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens	40.31	0.23	1.55
154	SecondAveandManningSt			
155	EdnaSt	43.08	0.54	0.37
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.34	0.23	0.67
160	CaddensRdandCaddaRidgeDr	75.87	0.23	0.53
161	KearneyAve	57.93	1.05	0.03
162	CaddaRidgeDr	58.19	0.17	2.20
163	BringellyRdandGreatWesternHwy			

Peak 1% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.32	4.52	0.66
2	JohnOxleyAveWerringtonCreek	24.27	3.30	1.45
3	JohnOxleyAve	24.08	1.67	0.50
4	BurtonSt	27.43	3.65	0.74
5	VictoriaSt	32.02	3.11	1.53
6	Railway	34.61	3.46	1.25
7	GreatWesternHwyCollegeCreek	36.41	2.27	0.98
8	CosgroveCres	36.80	0.82	1.06
9	SecondAve	39.15	3.09	1.11
10	LamrockReserve	43.08	2.16	0.09
11	OConnellSt	44.57	0.96	0.41
12	OConnellStJohnFlakAve	46.02	2.26	0.81
13	CaddaRidgeDrOConnellLn	52.22	2.12	0.26
14	CaddensRdandOConnellLn	53.55	1.34	0.84
15	CastleRd			
16	CastleRdcloseKingswood	63.38	0.79	0.54
17	KingswoodRd	67.98	1.12	1.68
18	WerringtonCreekNearDunheved	21.51	4.93	0.05
19	ParkesAve	21.52	1.04	0.07
20	IrwinSt	21.52	0.31	0.32
21	DunkleyPl	21.91	1.72	0.78
22	PrincessSt	22.01	1.01	0.06
23	AlbertStNearEdwardCl	22.75	0.20	1.09
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.56	1.23	0.06
27	AlbertSt	21.71	1.13	0.51
28	VictoriaStParkesAve			
29	VictoriaStGibsonAve			
30	WerringtonStation	25.06	0.47	0.10
31	ChapmanSt	23.86	1.13	0.84
32	WalkerSt	24.13	1.12	1.58
33	HeaveyStandLethbridgeAve	25.15	0.45	0.24
34	HumeCresNearPrinceSt	24.68	0.32	0.27
35	PrinceStandJohnOxleyAve	24.94	0.53	0.14
36	PrinceSt	24.95	0.22	0.69
37	BurkeAve			
38	CharlesSturtDr	25.43	0.31	0.22
39	ChisholmAve	27.45	0.33	0.21
40	HuntPl	28.97	0.32	0.29
41	RugbySt	30.52	0.24	0.42
42	CharlesToddCresandRugbySt	33.46	0.23	0.33
43	DunhevedRdandJohnOxleyAve	34.90	0.50	0.31
44	HumeCres			
45	HeaveySt	25.88	1.45	0.27
46	ArmsteinCresandDannySt			
47	ArmsteinCres	30.43	0.16	0.13
48	ArmsteinCresandInnesPl	30.43	0.16	0.32
49	VictoriaStbelowReindeerPl	32.86	0.22	0.38
50	VictoriaStCloseRailway			
51	RailwayNearUniversity			
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	27.44	0.19	0.80
54	CarleenCl	28.71	0.22	0.69
55	DeslieAve	29.69	0.29	0.22

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve			
57	GlencoeAveandBurtonSt	28.60	0.25	0.90
58	ChisholmAveandBurtonSt			
59	WerringtonLake	27.90	1.93	1.88
60	FrancisSt	30.73	0.32	1.31
61	GlencoeAve	33.39	0.31	0.98
62	GlencoeAveNearBeverleyPl	33.55	0.68	0.50
63	DunbarAve	34.58	0.42	0.42
64	RugbyStandOrletonPl	36.00	0.41	0.58
65	OrletonPl	37.23	0.62	0.12
66	DunhevedRd	39.75	0.50	0.33
67	FrancisStN	39.43	0.21	0.43
68	BenineDr	34.29	0.31	0.25
69	WilliamSt	31.10	0.31	1.65
70	SuttonRd	34.64	0.58	0.21
71	TwickhenhamAveandNeetaAve	36.73	0.29	0.87
72	WembleyAve	38.65	0.68	0.14
73	RugbyStN	40.71	0.27	0.36
74	SuttonRdandWillamSt	38.37	0.45	0.22
75	TwickenhamAve			
76	WrenchStandWilliamSt	42.84	0.31	1.06
77	JordonSt	45.25	0.32	0.24
78	HarrowRd	31.08	0.51	0.54
79	HerbertSt	33.26	1.71	1.59
80	WeatherbyAveandCamptonAve	37.44	0.53	1.37
81	WrenchStNearDevonRd	39.44	0.38	0.64
82	CambridgeSt	41.33	0.67	0.39
83	LincolnDr	43.74	0.58	0.10
84	CheltenhamAve	47.54	0.24	0.27
85	AberdeenSt	49.08	0.18	0.33
86	StirlingSt	44.82	0.25	0.30
87	DevonRd	41.02	0.22	0.37
88	EppingCl	46.66	0.23	0.62
89	SandringhamAve	51.68	0.57	0.10
90	CottageSt			
91	VictoriaStnearParkAve	34.14	0.26	0.67
92	railwayNearVictoriaSt	36.57	3.50	0.42
93	GreatWesternHwy	45.71	1.20	0.91
94	KerranCl	34.83	0.16	1.03
95	WeatherbyAve	38.15	0.31	0.51
96	WrenchSt			
97	GreatWesternHwyNearFrenchSt	37.96	0.62	0.10
98	ParkAve	37.21	0.82	0.52
99	AmarooSt	38.44	0.29	1.03
100	JosephSt	40.40	0.19	0.51
101	WalterSt	42.28	0.30	0.20
102	VictoriaStW			
103	CollegeSt			
104	WalterStandParkAve	39.72	0.21	0.81
105	GreatWesternHwyNearSantleyCres	37.59	1.63	0.58
106	SantleyCres	39.08	0.39	0.59
107	DougRennieField	39.13	0.67	1.52
108	FirstStN	41.34	1.20	0.99
109	BringellyRdNearFirst	42.97	0.47	1.18
110	HargraveSt	43.95	0.61	0.52

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	44.91	0.71	0.10
112	StaffordSyNearBringellyRd	46.79	0.39	0.54
113	StaffordSt	47.14	0.28	0.70
114	JamisonRd	49.26	0.34	1.62
115	StapleySt	50.58	0.29	1.28
116	StapleyStandClemsonSt	50.28	0.66	0.54
117	ClemsonSt			
118	LucySt	52.77	0.35	2.17
119	SmithSt	54.04	0.31	0.26
120	OagCresandTentSt	56.62	0.26	0.73
121	TentSt	58.76	0.24	1.28
122	TentStandPiperCl	60.69	0.29	0.38
123	PiperCl			
124	BringellyRd	63.76	0.13	0.31
125	BringellyRdandCaddensSt	63.18	0.27	0.42
126	AngophoraAve	67.52	0.15	0.36
127	CaddensRd	64.79	0.15	1.53
128	OagCres	58.24	0.26	0.44
129	TheNorthernRd			
130	ElliottSt	53.02	0.25	0.47
131	GladysSt	55.67	0.44	0.14
132	SomersetNearHargraveSt	49.13	0.12	1.40
133	SomersetStandDerbySt			
134	OrthSt	45.40	0.66	0.23
135	SomersetSt	47.05	0.46	0.32
136	GreatWesternHwySomersetSt	48.76	0.27	0.24
137	GreatWesternHwyHospital	48.54	0.27	0.38
138	RailwaynearHospital	49.04	1.16	1.26
139	CoxAve	50.94	0.69	0.29
140	CopelandSt	53.86	0.37	0.43
141	PhillipSt	58.06	0.23	0.89
142	GascoigneSt	59.36	0.22	0.42
143	RichmondRd			
144	SecondAveandJonesSt	41.88	0.26	0.41
145	BadenPowellAve	45.29	0.22	0.73
146	FirstSt	46.10	0.15	0.78
147	BadenPowellAveandFirstSt	46.45	0.17	0.74
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.17	0.27	0.15
150	PeppermintCres	49.69	0.17	0.21
151	PeppermintCresandYeelannaPl	56.93	0.35	0.75
152	AngophoraAveand PeppermintCres			
153	ChapmanGardens	40.34	0.26	1.63
154	SecondAveandManningSt			
155	EdnaSt	43.10	0.56	0.37
156	EdwardSt			
157	ManningSt			
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.37	0.25	0.76
160	CaddensRdandCaddaRidgeDr	75.88	0.24	0.56
161	KearneyAve	57.95	1.07	0.03
162	CaddaRidgeDr	58.21	0.20	2.31
163	BringellyRdandGreatWesternHwy			

Peak 0.5% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.35	4.54	0.95
2	JohnOxleyAveWerringtonCreek	24.61	3.64	1.44
3	JohnOxleyAve	24.40	1.99	0.76
4	BurtonSt	27.77	3.99	1.02
5	VictoriaSt	32.49	3.58	1.46
6	Railway	35.88	4.73	1.20
7	GreatWesternHwyCollegeCreek	36.76	2.62	1.37
8	CosgroveCres	37.36	1.37	1.28
9	SecondAve	39.79	3.73	1.24
10	LamrockReserve	43.31	2.39	0.25
11	OConnellSt	44.72	1.11	0.51
12	OConnellStJohnFlakAve	46.35	2.60	1.10
13	CaddaRidgeDrOConnellLn	52.52	2.42	0.54
14	CaddensRdandOConnellLn	53.85	1.64	1.12
15	CastleRd			
16	CastleRdcloseKingswood	63.64	1.05	1.18
17	KingswoodRd	68.12	1.26	1.34
18	WerringtonCreekNearDunheved	21.57	4.98	0.05
19	ParkesAve	21.57	1.09	0.11
20	IrwinSt	21.57	0.36	0.56
21	DunkleyPl	22.17	1.98	0.83
22	PrincessSt	22.17	1.16	0.37
23	AlbertStNearEdwardCl	22.86	0.31	1.59
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.61	1.27	0.08
27	AlbertSt	21.78	1.20	0.79
28	VictoriaStParkesAve	21.60	0.15	0.48
29	VictoriaStGibsonAve			
30	WerringtonStation	25.09	0.50	0.11
31	ChapmanSt	24.28	1.55	0.58
32	WalkerSt	24.31	1.29	1.52
33	HeaveyStandLethbridgeAve	25.22	0.53	0.57
34	HumeCresNearPrinceSt	24.75	0.40	0.28
35	PrinceStandJohnOxleyAve	25.03	0.62	0.19
36	PrinceSt	25.05	0.32	0.86
37	BurkeAve			
38	CharlesSturtDr	25.56	0.44	0.31
39	ChisholmAve	27.70	0.58	0.33
40	HuntPl	29.19	0.53	0.35
41	RugbySt	30.75	0.47	0.60
42	CharlesToddCresandRugbySt	33.58	0.34	0.72
43	DunhevedRdandJohnOxleyAve	35.09	0.69	0.31
44	HumeCres			
45	HeaveySt	26.02	1.59	0.58
46	ArmsteinCresandDannySt			
47	ArmsteinCres	30.50	0.23	0.38
48	ArmsteinCresandInnesPl	30.50	0.24	0.32
49	VictoriaStbelowReindeerPl	32.93	0.29	0.46
50	VictoriaStCloseRailway			
51	RailwayNearUniversity	34.22	0.27	0.51
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	27.59	0.35	0.98
54	CarleenCl	28.79	0.30	1.15
55	DeslieAve	29.83	0.43	0.22

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve	30.28	0.23	0.40
57	GlencoeAveandBurtonSt	28.75	0.39	1.21
58	ChisholmAveandBurtonSt	30.59	0.21	1.38
59	WerringtonLake	28.21	2.25	2.49
60	FrancisSt	30.99	0.59	1.59
61	GlencoeAve	33.52	0.43	1.27
62	GlencoeAveNearBeverleyPl	33.78	0.91	1.44
63	DunbarAve	34.80	0.64	0.63
64	RugbyStandOrletonPl	36.19	0.60	0.56
65	OrletonPl	37.39	0.78	0.12
66	DunhevedRd	39.86	0.61	0.68
67	FrancisStN	39.53	0.31	0.41
68	BenineDr	34.44	0.45	0.31
69	WilliamSt	31.28	0.49	2.66
70	SuttonRd	34.94	0.87	0.35
71	TwickhenhamAveandNeetaAve	36.92	0.48	1.31
72	WembleyAve	38.88	0.91	0.43
73	RugbyStN	40.84	0.41	0.47
74	SuttonRdandWillamSt	38.50	0.58	0.21
75	TwickenhamAve			
76	WrenchStandWilliamSt	43.00	0.48	1.10
77	JordonSt	45.34	0.41	0.46
78	HarrowRd	31.20	0.63	0.84
79	HerbertSt	34.35	2.79	2.25
80	WeatherbyAveandCamptonAve	37.69	0.78	1.56
81	WrenchStNearDevonRd	39.61	0.55	1.07
82	CambridgeSt	41.55	0.89	0.62
83	LincolnDr	43.85	0.69	0.32
84	CheltenhamAve	47.62	0.33	0.27
85	AberdeenSt	49.16	0.27	0.30
86	StirlingSt	44.92	0.35	0.34
87	DevonRd	41.19	0.40	0.67
88	EppingCl	46.76	0.34	0.74
89	SandringhamAve	51.77	0.67	0.16
90	CottageSt			
91	VictoriaStnearParkAve	34.40	0.52	0.94
92	railwayNearVictoriaSt	36.83	3.76	0.49
93	GreatWesternHwy	46.18	1.67	1.04
94	KerranCl	34.95	0.28	1.22
95	WeatherbyAve	38.27	0.43	0.49
96	WrenchSt	41.50	0.22	0.72
97	GreatWesternHwyNearFrenchSt	38.08	0.75	0.20
98	ParkAve	37.46	1.07	1.12
99	AmarooSt	38.63	0.48	1.30
100	JosephSt	40.52	0.31	0.57
101	WalterSt	42.38	0.40	0.22
102	VictoriaStW	51.29	0.15	1.50
103	CollegeSt			
104	WalterStandParkAve	39.81	0.30	1.47
105	GreatWesternHwyNearSantleyCres	37.68	1.71	0.76
106	SantleyCres	39.29	0.61	0.95
107	DougRennieField	39.29	0.82	1.72
108	FirstStN	41.51	1.37	1.31
109	BringellyRdNearFirst	43.36	0.86	1.19
110	HargraveSt	44.22	0.89	0.78

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	45.20	1.00	0.13
112	StaffordSyNearBringellyRd	46.98	0.58	1.01
113	StaffordSt	47.30	0.44	1.01
114	JamisonRd	49.48	0.56	1.72
115	StapleySt	50.79	0.50	2.00
116	StapleyStandClemsonSt	50.71	1.09	0.65
117	ClemsonSt			
118	LucySt	53.03	0.61	2.87
119	SmithSt	54.18	0.45	0.29
120	OagCresandTentSt	56.90	0.55	0.50
121	TentSt	59.02	0.50	2.39
122	TentStandPiperCl	60.89	0.49	0.50
123	PiperCl	61.17	0.26	0.33
124	BringellyRd	63.82	0.20	0.46
125	BringellyRdandCaddensSt	63.33	0.43	0.63
126	AngophoraAve	67.62	0.26	0.67
127	CaddensRd	64.86	0.22	2.12
128	OagCres	58.44	0.46	0.30
129	TheNorthernRd			
130	ElliottSt	53.11	0.34	0.54
131	GladysSt	55.77	0.53	0.30
132	SomersetNearHargraveSt	49.18	0.18	1.80
133	SomersetStandDerbySt	49.25	0.15	1.71
134	OrthSt	45.53	0.79	0.28
135	SomersetSt	47.18	0.58	0.48
136	GreatWesternHwySomersetSt	48.81	0.32	0.30
137	GreatWesternHwyHospital	48.59	0.31	0.41
138	RailwaynearHospital	49.07	1.19	1.29
139	CoxAve	51.40	1.15	0.27
140	CopelandSt	53.98	0.49	0.48
141	PhillipSt	58.22	0.40	1.09
142	GascoigneSt	59.57	0.44	0.31
143	RichmondRd			
144	SecondAveandJonesSt	41.96	0.35	0.87
145	BadenPowellAve	45.57	0.50	1.60
146	FirstSt	46.14	0.19	0.84
147	BadenPowellAveandFirstSt	46.54	0.26	1.04
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.39	0.48	0.26
150	PeppermintCres	49.92	0.39	1.12
151	PeppermintCresandYeelannaPl	57.17	0.58	0.74
152	AngophoraAveand PeppermintCres	60.80	0.20	0.84
153	ChapmanGardens	40.46	0.38	2.12
154	SecondAveandManningSt	42.18	0.19	2.44
155	EdnaSt	43.26	0.71	0.36
156	EdwardSt	47.43	0.28	0.36
157	ManningSt	51.16	0.29	1.20
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.55	0.44	1.42
160	CaddensRdandCaddaRidgeDr	75.94	0.30	0.86
161	KearneyAve	58.03	1.14	0.08
162	CaddaRidgeDr	58.31	0.29	3.03
163	BringellyRdandGreatWesternHwy			

Peak 0.2% AEP Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.36	4.56	1.12
2	JohnOxleyAveWerringtonCreek	24.73	3.76	1.44
3	JohnOxleyAve	24.50	2.09	0.85
4	BurtonSt	27.89	4.11	1.15
5	VictoriaSt	32.69	3.77	1.35
6	Railway	36.15	5.00	1.23
7	GreatWesternHwyCollegeCreek	36.88	2.74	1.78
8	CosgroveCres	37.54	1.56	1.41
9	SecondAve	40.03	3.97	1.27
10	LamrockReserve	43.39	2.47	0.32
11	OConnellSt	44.77	1.16	0.56
12	OConnellStJohnFlakAve	46.44	2.69	1.15
13	CaddaRidgeDrOConnellLn	52.60	2.50	0.67
14	CaddensRdandOConnellLn	53.95	1.75	1.22
15	CastleRd			
16	CastleRdcloseKingswood	63.76	1.17	1.20
17	KingswoodRd	68.20	1.34	1.26
18	WerringtonCreekNearDunheved	21.63	5.05	0.05
19	ParkesAve	21.64	1.16	0.13
20	IrwinSt	21.63	0.43	0.61
21	DunkleyPl	22.23	2.04	0.57
22	PrincessSt	22.20	1.20	0.55
23	AlbertStNearEdwardCl	22.89	0.34	1.66
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	21.67	1.34	0.06
27	AlbertSt	21.71	1.13	0.50
28	VictoriaStParkesAve	21.66	0.21	0.50
29	VictoriaStGibsonAve			
30	WerringtonStation	25.10	0.51	0.12
31	ChapmanSt	24.48	1.75	0.68
32	WalkerSt	24.39	1.37	1.54
33	HeaveyStandLethbridgeAve	25.24	0.55	0.67
34	HumeCresNearPrinceSt	24.77	0.41	0.29
35	PrinceStandJohnOxleyAve	25.04	0.63	0.20
36	PrinceSt	25.07	0.34	0.93
37	BurkeAve	27.61	0.16	1.80
38	CharlesSturtDr	25.59	0.47	0.31
39	ChisholmAve	27.78	0.66	0.39
40	HuntPl	29.25	0.59	0.37
41	RugbySt	30.80	0.53	0.66
42	CharlesToddCresandRugbySt	33.61	0.37	0.75
43	DunhevedRdandJohnOxleyAve	35.13	0.73	0.33
44	HumeCres			
45	HeaveySt	26.12	1.68	0.52
46	ArmsteinCresandDannySt			
47	ArmsteinCres	30.52	0.25	0.45
48	ArmsteinCresandInnesPl	30.52	0.25	0.31
49	VictoriaStbelowReindeerPl	32.94	0.31	0.48
50	VictoriaStCloseRailway			
51	RailwayNearUniversity	34.23	0.28	0.51
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	27.64	0.39	0.98
54	CarleenCl	28.81	0.32	1.30
55	DeslieAve	29.86	0.46	0.22

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve	30.30	0.25	0.41
57	GlencoeAveandBurtonSt	28.77	0.42	1.20
58	ChisholmAveandBurtonSt	30.60	0.21	1.44
59	WerringtonLake	28.36	2.40	2.65
60	FrancisSt	31.06	0.65	1.61
61	GlencoeAve	33.54	0.45	1.53
62	GlencoeAveNearBeverleyPl	33.84	0.98	1.67
63	DunbarAve	34.85	0.69	0.68
64	RugbyStandOrletonPl	36.23	0.64	0.56
65	OrletonPl	37.44	0.83	0.12
66	DunhevedRd	39.88	0.63	0.81
67	FrancisStN	39.54	0.33	0.42
68	BenineDr	34.47	0.48	0.32
69	WilliamSt	31.32	0.52	2.85
70	SuttonRd	35.00	0.94	0.41
71	TwickhenhamAveandNeetaAve	36.96	0.52	1.46
72	WembleyAve	38.93	0.97	0.56
73	RugbyStN	40.86	0.43	0.40
74	SuttonRdandWillamSt	38.52	0.61	0.20
75	TwickenhamAve	39.87	0.17	1.32
76	WrenchStandWilliamSt	43.02	0.50	0.99
77	JordonSt	45.37	0.44	0.52
78	HarrowRd	31.24	0.67	0.93
79	HerbertSt	34.57	3.02	1.82
80	WeatherbyAveandCamptonAve	37.77	0.86	1.63
81	WrenchStNearDevonRd	39.63	0.57	1.12
82	CambridgeSt	41.59	0.94	0.77
83	LincolnDr	43.86	0.70	0.38
84	CheltenhamAve	47.64	0.34	0.29
85	AberdeenSt	49.18	0.28	0.32
86	StirlingSt	44.94	0.37	0.38
87	DevonRd	41.23	0.43	0.78
88	EppingCl	46.77	0.35	0.80
89	SandringhamAve	51.79	0.69	0.16
90	CottageSt			
91	VictoriaStnearParkAve	34.45	0.58	0.89
92	railwayNearVictoriaSt	36.89	3.82	0.50
93	GreatWesternHwy	46.25	1.74	1.04
94	KerranCl	34.97	0.30	1.19
95	WeatherbyAve	38.29	0.46	0.49
96	WrenchSt	41.51	0.23	0.73
97	GreatWesternHwyNearFrenchSt	38.11	0.78	0.25
98	ParkAve	37.52	1.13	1.23
99	AmarooSt	38.67	0.52	1.36
100	JosephSt	40.55	0.35	0.70
101	WalterSt	42.45	0.47	0.22
102	VictoriaStW	51.31	0.16	1.54
103	CollegeSt			
104	WalterStandParkAve	39.82	0.32	1.73
105	GreatWesternHwyNearSantleyCres	37.73	1.76	0.61
106	SantleyCres	39.37	0.69	0.98
107	DougRennieField	39.34	0.87	1.81
108	FirstStN	41.56	1.42	1.39
109	BringellyRdNearFirst	43.47	0.96	1.25
110	HargraveSt	44.30	0.97	0.87

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	45.32	1.11	0.18
112	StaffordSyNearBringellyRd	47.05	0.65	1.14
113	StaffordSt	47.34	0.48	1.12
114	JamisonRd	49.55	0.63	1.74
115	StapleySt	50.87	0.57	2.11
116	StapleyStandClemsonSt	50.84	1.22	0.74
117	ClemsonSt	52.31	0.15	2.74
118	LucySt	53.12	0.70	3.04
119	SmithSt	54.26	0.54	0.30
120	OagCresandTentSt	56.98	0.63	0.57
121	TentSt	59.09	0.56	2.61
122	TentStandPiperCl	60.95	0.55	0.54
123	PiperCl	61.20	0.29	0.44
124	BringellyRd	63.84	0.21	0.49
125	BringellyRdandCaddensSt	63.40	0.50	0.70
126	AngophoraAve	67.64	0.27	0.73
127	CaddensRd	64.88	0.24	2.36
128	OagCres	58.49	0.51	0.46
129	TheNorthernRd			
130	ElliottSt	53.12	0.35	0.62
131	GladysSt	55.78	0.55	0.33
132	SomersetNearHargraveSt	49.20	0.19	1.88
133	SomersetStandDerbySt	49.26	0.17	1.79
134	OrthSt	45.58	0.83	0.33
135	SomersetSt	47.21	0.61	0.44
136	GreatWesternHwySomersetSt	48.82	0.33	0.32
137	GreatWesternHwyHospital	48.60	0.33	0.42
138	RailwaynearHospital	49.08	1.20	1.44
139	CoxAve	51.52	1.27	0.33
140	CopelandSt	54.02	0.53	0.53
141	PhillipSt	58.26	0.44	1.13
142	GascoigneSt	59.59	0.45	0.34
143	RichmondRd			
144	SecondAveandJonesSt	41.99	0.37	0.88
145	BadenPowellAve	45.70	0.64	1.81
146	FirstSt	46.15	0.20	0.87
147	BadenPowellAveandFirstSt	46.56	0.28	1.07
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.47	0.57	0.29
150	PeppermintCres	49.98	0.46	1.19
151	PeppermintCresandYeelannaPl	57.21	0.62	0.77
152	AngophoraAveand PeppermintCres	60.80	0.20	0.85
153	ChapmanGardens	40.48	0.41	2.19
154	SecondAveandManningSt	42.21	0.22	2.66
155	EdnaSt	43.29	0.75	0.36
156	EdwardSt	47.54	0.39	0.34
157	ManningSt	51.21	0.34	1.51
158	CasuarinaCircuitandMaculataPl			
159	CasuarinaCircuit	60.59	0.47	1.57
160	CaddensRdandCaddaRidgeDr	75.95	0.31	0.89
161	KearneyAve	58.05	1.17	0.11
162	CaddaRidgeDr	58.33	0.32	3.12
163	BringellyRdandGreatWesternHwy			

Peak PMF Depths, Levels, and Velocities

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
1	DunhevedRdWerringtonCreek	21.87	5.07	2.85
2	JohnOxleyAveWerringtonCreek	25.80	4.83	1.46
3	JohnOxleyAve	25.56	3.15	1.82
4	BurtonSt	28.94	5.16	1.80
5	VictoriaSt	33.94	5.03	1.74
6	Railway	36.93	5.79	1.52
7	GreatWesternHwyCollegeCreek	37.34	3.20	1.33
8	CosgroveCres	38.21	2.22	1.94
9	SecondAve	40.31	4.24	2.56
10	LamrockReserve	43.80	2.88	0.75
11	OConnellSt	45.16	1.55	1.07
12	OConnellStJohnFlakAve	46.86	3.10	1.36
13	CaddaRidgeDrOConnellLn	53.07	2.97	0.84
14	CaddensRdandOConnellLn	54.38	2.17	1.74
15	CastleRd			
16	CastleRdcloseKingswood	63.93	1.34	0.81
17	KingswoodRd	68.35	1.49	1.32
18	WerringtonCreekNearDunheved	22.87	6.28	0.11
19	ParkesAve	22.88	2.40	0.22
20	IrwinSt	22.87	1.67	1.27
21	DunkleyPl	22.88	2.68	0.57
22	PrincessSt	22.88	1.88	0.25
23	AlbertStNearEdwardCl	22.97	0.42	1.83
25	VictoriaStNearLethBridgeAve			
26	ParkesAvenueSportingComplex	22.88	2.55	0.17
27	AlbertSt	22.88	2.30	0.19
28	VictoriaStParkesAve	22.88	1.43	0.51
29	VictoriaStGibsonAve	22.88	1.24	1.00
30	WerringtonStation	25.32	0.73	0.27
31	ChapmanSt	25.23	2.51	0.34
32	WalkerSt	25.24	2.22	1.39
33	HeaveyStandLethbridgeAve	25.28	0.59	0.95
34	HumeCresNearPrinceSt	24.81	0.46	0.26
35	PrinceStandJohnOxleyAve	25.67	1.27	1.38
36	PrinceSt	25.63	0.89	0.98
37	BurkeAve			
38	CharlesSturtDr	26.23	1.11	0.58
39	ChisholmAve	28.05	0.93	0.96
40	HuntPl	29.48	0.83	0.53
41	RugbySt	30.95	0.67	0.70
42	CharlesToddCresandRugbySt	33.67	0.43	0.83
43	DunhevedRdandJohnOxleyAve	35.26	0.86	0.55
44	HumeCres			
45	HeaveySt	27.18	2.74	1.05
46	ArmsteinCresandDannySt	27.99	0.41	0.54
47	ArmsteinCres	30.56	0.28	0.57
48	ArmsteinCresandInnesPl	30.55	0.29	0.37
49	VictoriaStbelowReindeerPl	33.05	0.42	0.88
50	VictoriaStCloseRailway	33.55	0.23	1.13
51	RailwayNearUniversity	34.31	0.36	0.74
52	VictoriaStandBurtonSt			
53	BurtonStLackPl	28.75	1.50	1.12
54	CarleenCl	28.90	0.42	1.59
55	DeslieAve	29.90	0.50	0.24

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
56	ImpalaAve	30.34	0.29	0.41
57	GlencoeAveandBurtonSt	29.21	0.85	1.24
58	ChisholmAveandBurtonSt	30.64	0.26	1.77
59	WerringtonLake	30.08	4.12	3.15
60	FrancisSt	31.45	1.04	1.62
61	GlencoeAve	33.68	0.60	1.33
62	GlencoeAveNearBeverleyPl	34.08	1.22	2.20
63	DunbarAve	35.04	0.88	1.31
64	RugbyStandOrletonPl	36.40	0.81	0.61
65	OrletonPl	37.53	0.92	0.17
66	DunhevedRd	39.92	0.67	0.83
67	FrancisStN	39.58	0.37	0.37
68	BenineDr	34.54	0.55	0.36
69	WilliamSt	31.50	0.70	3.46
70	SuttonRd	35.21	1.15	0.75
71	TwickhenhamAveandNeetaAve	37.06	0.62	2.15
72	WembleyAve	39.02	1.06	0.71
73	RugbyStN	40.94	0.51	0.50
74	SuttonRdandWillamSt	38.56	0.64	0.25
75	TwickenhamAve			
76	WrenchStandWilliamSt	43.09	0.57	1.04
77	JordonSt	45.41	0.48	0.53
78	HarrowRd	31.52	0.95	1.12
79	HerbertSt	35.12	3.57	2.95
80	WeatherbyAveandCamptonAve	38.01	1.10	1.99
81	WrenchStNearDevonRd	39.72	0.65	1.46
82	CambridgeSt	41.67	1.01	0.87
83	LincolnDr	43.90	0.74	0.61
84	CheltenhamAve	47.68	0.38	0.37
85	AberdeenSt	49.21	0.32	0.34
86	StirlingSt	44.91	0.34	0.31
87	DevonRd	41.33	0.53	1.14
88	EppingCl	46.81	0.39	0.90
89	SandringhamAve	51.88	0.78	0.31
90	CottageSt	33.72	0.23	0.57
91	VictoriaStnearParkAve	34.70	0.82	1.18
92	railwayNearVictoriaSt	37.14	4.07	0.60
93	GreatWesternHwy	46.44	1.93	1.10
94	KerranCl	35.04	0.37	1.24
95	WeatherbyAve	38.30	0.47	0.49
96	WrenchSt	41.54	0.26	0.73
97	GreatWesternHwyNearFrenchSt	38.18	0.85	0.60
98	ParkAve	37.87	1.48	1.70
99	AmarooSt	38.88	0.73	1.84
100	JosephSt	40.65	0.44	0.71
101	WalterSt	42.45	0.46	0.22
102	VictoriaStW	51.35	0.21	1.68
103	CollegeSt			
104	WalterStandParkAve	39.94	0.43	2.15
105	GreatWesternHwyNearSantleyCres	38.09	2.13	1.13
106	SantleyCres	39.54	0.85	2.60
107	DougRennieField	39.70	1.24	2.14
108	FirstStN	41.87	1.74	1.97
109	BringellyRdNearFirst	44.02	1.51	1.78
110	HargraveSt	44.70	1.36	1.01

Location	Description	Peak Level (mAHD)	Peak Depth (m)	Peak Velocity (m/s)
111	DerbySy	45.70	1.49	0.24
112	StaffordSyNearBringellyRd	47.31	0.91	1.52
113	StaffordSt	47.70	0.84	1.06
114	JamisonRd	49.89	0.97	1.86
115	StapleySt	51.16	0.87	2.21
116	StapleyStandClemsonSt	50.93	1.31	2.05
117	ClemsonSt			
118	LucySt	53.45	1.03	3.28
119	SmithSt	54.56	0.83	0.67
120	OagCresandTentSt	57.34	0.99	0.78
121	TentSt	59.36	0.84	2.84
122	TentStandPiperCl	61.10	0.71	0.57
123	PiperCl	61.31	0.40	0.52
124	BringellyRd	63.87	0.24	0.54
125	BringellyRdandCaddensSt	63.50	0.59	0.85
126	AngophoraAve	67.68	0.31	0.76
127	CaddensRd	64.91	0.27	2.66
128	OagCres	58.51	0.53	0.58
129	TheNorthernRd			
130	ElliottSt	53.14	0.37	0.74
131	GladysSt	55.82	0.59	0.43
132	SomersetNearHargraveSt	49.26	0.25	2.08
133	SomersetStandDerbySt	49.30	0.21	2.09
134	OrthSt	45.74	1.00	0.51
135	SomersetSt	47.37	0.77	0.72
136	GreatWesternHwySomersetSt	49.08	0.59	0.96
137	GreatWesternHwyHospital	48.69	0.42	0.40
138	RailwaynearHospital	49.18	1.30	1.38
139	CoxAve	51.88	1.63	0.49
140	CopelandSt	54.09	0.59	0.69
141	PhillipSt	58.33	0.51	1.24
142	GascoigneSt	59.62	0.49	0.46
143	RichmondRd			
144	SecondAveandJonesSt	42.15	0.53	1.26
145	BadenPowellAve	45.99	0.93	2.56
146	FirstSt	46.19	0.24	0.97
147	BadenPowellAveandFirstSt	46.66	0.38	1.60
148	BringellyRdNearJamisonRd			
149	FuryStandStockAve	46.84	0.93	0.41
150	PeppermintCres	50.29	0.77	1.58
151	PeppermintCresandYeelannaPl	57.32	0.73	0.68
152	AngophoraAveand PeppermintCres	60.85	0.24	0.95
153	ChapmanGardens	40.63	0.56	2.65
154	SecondAveandManningSt	42.48	0.49	3.62
155	EdnaSt	43.64	1.09	0.50
156	EdwardSt	48.13	0.97	1.01
157	ManningSt	51.38	0.51	2.10
158	CasuarinaCircuitandMaculataPl	54.16	0.19	2.61
159	CasuarinaCircuit	60.64	0.53	1.80
160	CaddensRdandCaddaRidgeDr	75.91	0.26	0.58
161	KearneyAve	58.11	1.22	0.17
162	CaddaRidgeDr	58.40	0.38	3.50
163	BringellyRdandGreatWesternHwy			

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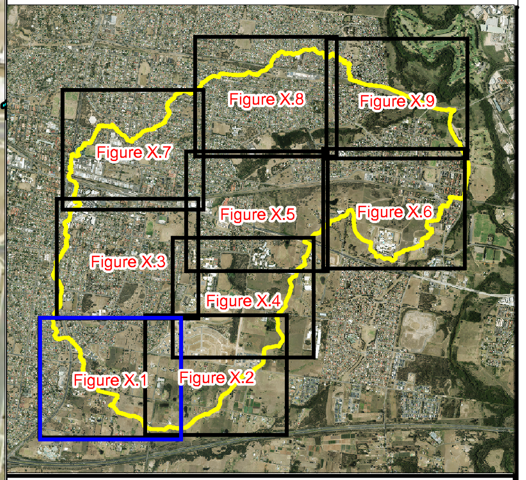


LEGEND

- TUFLOW Model Boundary
- 10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

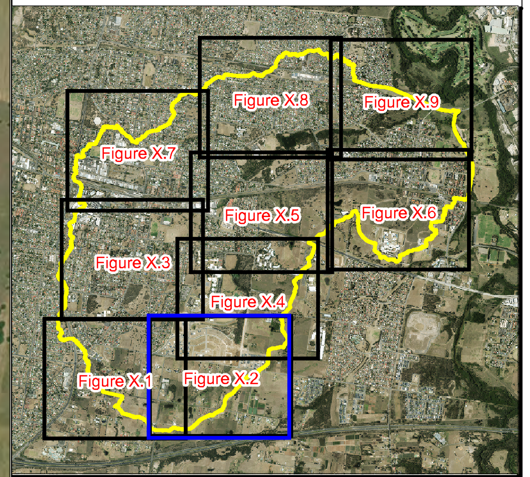
0 0.15 0.3 Km

Figure M1: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.1 Overland Flow Locations.wor



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LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3

Km

Figure M2: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
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File Name: Fig1.2 Overland Flow Locations.wor

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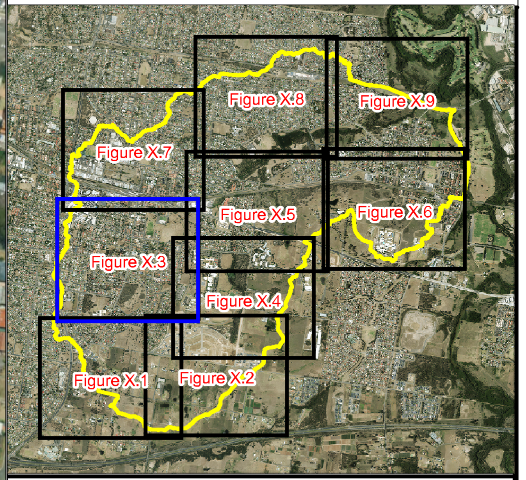


LEGEND

TUFLOW Model Boundary

Peak Discharge Location

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

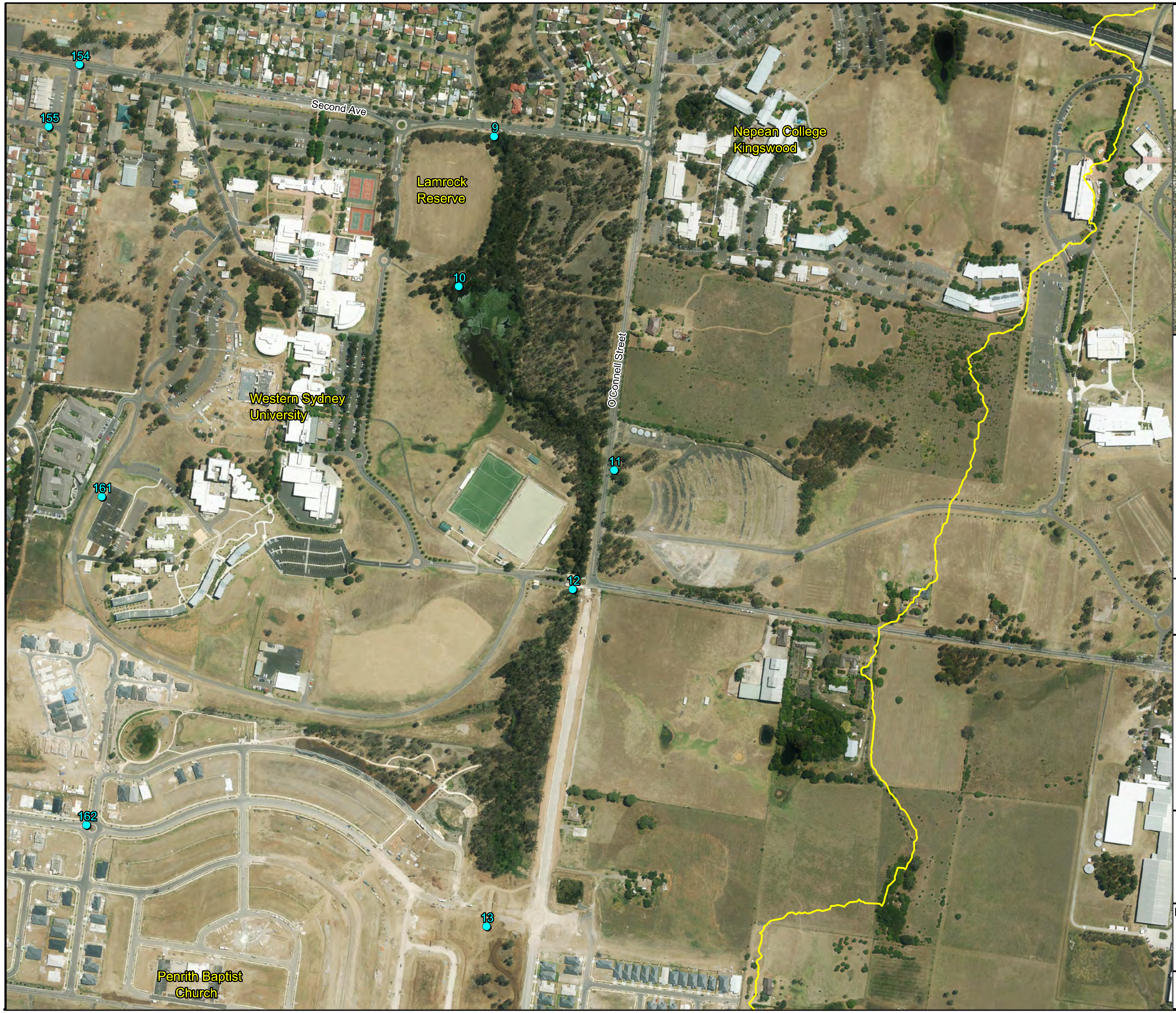
0 0.15 0.3 Km

Figure M3: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.3 Overland Flow Locations.wor



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LEGEND

TUFLOW Model Boundary

Peak Discharge Location

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure M4: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.4 Overland Flow Locations.wor

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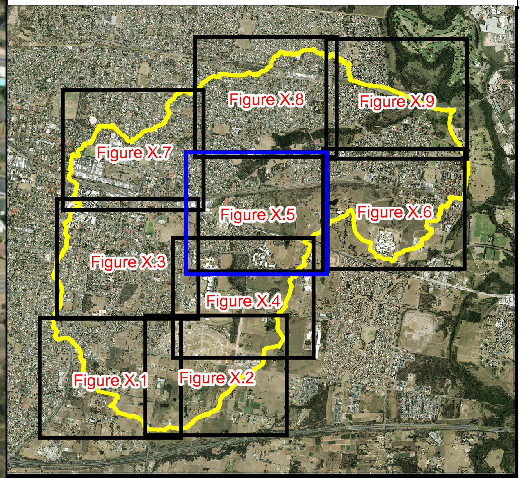

LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3

Km

Figure M5:
Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.5 Overland Flow Locations.wor

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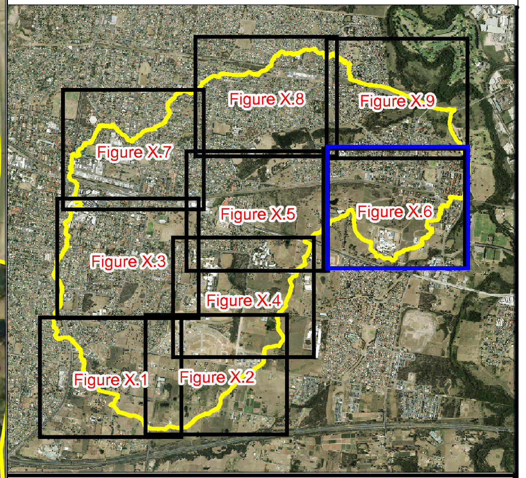

LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3

Km

Figure M6: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.6 Overland Flow Locations.wor

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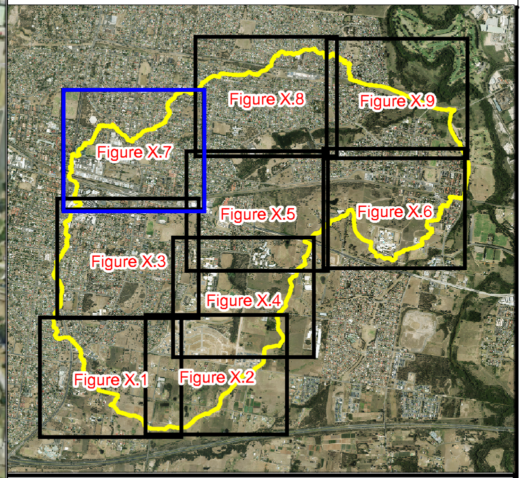

LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure M7: Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.7 Overland Flow Locations.wor

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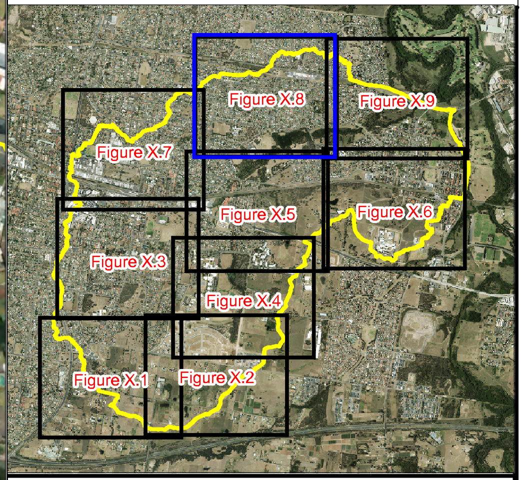

LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3

Km

Figure M8: Hydraulic Modelling Results Locations

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Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.8 Overland Flow Locations.wor

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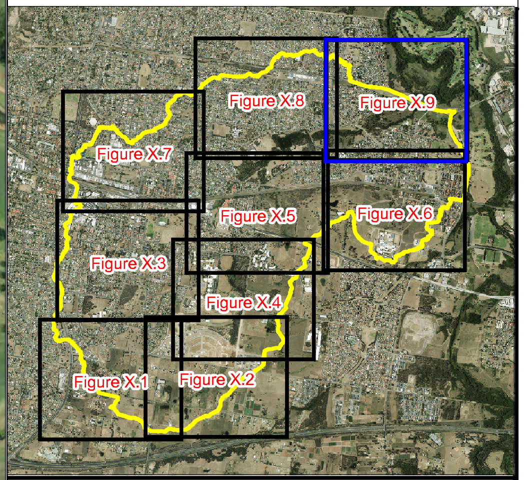


LEGEND

TUFLOW Model Boundary

10 Peak Discharge Location

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure M9:
Hydraulic Modelling Results Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Fig1.9 Overland Flow Locations.wor

Peak 1 in 2 Year ARI Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	40.48	40.48	360mins	3.10
2	JohnOxleyAveWerringtonCreek	0.00	34.90	34.90	360mins	2.93
3	JohnOxleyAve	0.09	0.01	0.11	360mins	2.50
4	BurtonSt	0.00	32.51	32.51	360mins	2.70
5	VictoriaSt	0.00	21.39	21.39	360mins	2.67
6	Railway	0.01	19.44	19.44	360mins	3.07
7	GreatWesternHwyCollegeCreek	0.00	4.48	4.48	360mins	4.03
8	CosgroveCres	0.00	4.29	4.29	360mins	4.03
9	SecondAve	-0.03	4.00	3.98	360mins	4.03
10	LamrockReserve	0.00	3.82	3.82	360mins	3.97
11	OConnellSt	1.38	0.68	2.06	120mins	0.90
12	OConnellStJohnFlakAve	0.08	3.57	3.66	360mins	3.40
13	CaddaRidgeDrOConnellLn	0.29	1.81	2.10	360mins	3.23
14	CaddensRdandOConnellLn	3.19	0.04	3.23	120mins	1.10
15	CastleRd	0.27	0.01	0.29	120mins	0.77
16	CastleRdcloseKingswood	0.08	0.50	0.58	360mins	2.87
17	KingswoodRd	0.06	1.24	1.30	120mins	0.87
18	WerringtonCreekNearDunheved	0.00	3.10	3.10	360mins	3.77
19	ParkesAve	0.00	0.15	0.14	360mins	5.87
20	IrwinSt	0.01	1.11	1.12	120mins	1.53
21	DunkleyPl	0.02	1.02	1.04	120mins	1.67
22	PrincessSt	0.44	0.53	0.98	120mins	1.30
23	AlbertStNearEdwardCl	0.68	0.29	0.97	120mins	1.00
25	VictoriaStNearLethBridgeAve	0.31	0.11	0.42	120mins	0.77
26	ParkesAvenueSportingComplex	0.03	1.68	1.70	360mins	4.37
27	AlbertSt	0.87	1.77	2.64	360mins	3.03
28	VictoriaStParkesAve	0.45	1.97	2.42	360mins	3.13
29	VictoriaStGibsonAve	0.06	0.05	0.10	120mins	0.77
30	WerringtonStation	0.00	2.23	2.23	360mins	3.13
31	ChapmanSt	0.06	1.53	1.58	120mins	2.70
32	WalkerSt	0.01	1.20	1.21	360mins	3.47
33	HeaveyStandLethbridgeAve	-0.01	0.65	0.64	30mins	0.40
34	HumeCresNearPrinceSt	0.13	0.26	0.39	120mins	0.83
35	PrinceStandJohnOxleyAve	0.26	4.57	4.83	120mins	0.80
36	PrinceSt	0.01	0.56	0.57	120mins	0.77
37	BurkeAve	0.18	0.16	0.34	120mins	0.73
38	CharlesSturtDr	0.37	4.27	4.64	120mins	0.80
39	ChisholmAve	0.47	3.73	4.21	120mins	0.80
40	HuntPl	0.55	3.01	3.56	120mins	0.80
41	RugbySt	0.33	2.83	3.16	120mins	0.77
42	CharlesToddCresandRugbySt	0.08	0.49	0.56	120mins	0.77
43	DunhevedRdandJohnOxleyAve	0.00	1.70	1.70	120mins	0.77
44	HumeCres	0.05	0.02	0.08	120mins	0.70
45	HeaveySt	0.00	1.12	1.13	120mins	0.80
46	ArmsteinCresandDannySt	-0.03	0.12	0.09	120mins	0.70
47	ArmsteinCres	0.02	0.61	0.63	120mins	0.80
48	ArmsteinCresandInnesPl	0.08	0.00	0.08	120mins	0.70
49	VictoriaStbelowReindeerPl	0.13	0.08	0.21	120mins	0.87
50	VictoriaStCloseRailway	0.09	0.18	0.27	120mins	0.90
51	RailwayNearUniversity	0.30	0.00	0.30	120mins	0.90
52	VictoriaStandBurtonSt	0.03	0.00	0.03	120mins	0.80

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.00	0.18	0.18	120mins	2.67
54	CarleenCl	0.02	0.33	0.36	120mins	0.80
55	DeslieAve	0.07	0.33	0.40	120mins	0.73
56	ImpalaAve	0.15	0.14	0.29	120mins	0.73
57	GlencoeAveandBurtonSt	0.63	0.68	1.31	120mins	0.77
58	ChisholmAveandBurtonSt	0.62	0.33	0.95	120mins	0.73
59	WerringtonLake	7.91	0.00	7.91	120mins	0.80
60	FrancisSt	0.23	3.09	3.32	120mins	0.77
61	GlencoeAve	0.10	2.09	2.19	120mins	0.97
62	GlencoeAveNearBeverleyPl	0.80	1.74	2.53	120mins	0.80
63	DunbarAve	0.37	1.97	2.34	120mins	0.77
64	RugbyStandOrletonPl	0.14	1.86	2.00	120mins	0.77
65	OrletonPl	0.25	0.86	1.11	120mins	0.83
66	DunhevedRd	0.00	0.82	0.82	120mins	0.77
67	FrancisStN	0.22	0.16	0.38	120mins	0.77
68	BenineDr	0.15	0.35	0.49	120mins	0.73
69	WilliamSt	0.19	3.73	3.92	120mins	0.90
70	SuttonRd	0.83	3.13	3.97	120mins	0.80
71	TwickhenhamAveandNeetaAve	0.39	1.06	1.45	120mins	0.77
72	WembleyAve	0.35	0.83	1.17	120mins	0.77
73	RugbyStN	0.32	0.61	0.93	120mins	0.73
74	SuttonRdandWillamSt	0.34	1.49	1.83	120mins	0.77
75	TwickenhamAve	0.09	0.20	0.29	120mins	0.70
76	WrenchStandWilliamSt	0.57	0.51	1.08	120mins	0.77
77	JordonSt	0.25	0.17	0.42	120mins	0.73
78	HarrowRd	0.31	0.43	0.74	120mins	0.83
79	HerbertSt	0.02	4.05	4.07	120mins	0.80
80	WeatherbyAveandCamptonAve	1.60	2.54	4.14	120mins	0.90
81	WrenchStNearDevonRd	1.87	2.28	4.15	120mins	0.90
82	CambridgeSt	0.22	1.38	1.60	120mins	0.83
83	LincolnDr	0.18	0.91	1.10	120mins	0.77
84	CheltenhamAve	0.18	0.19	0.37	120mins	0.73
85	AberdeenSt	0.11	0.27	0.38	120mins	0.70
86	StirlingSt	0.34	0.11	0.45	120mins	0.77
87	DevonRd	0.22	0.05	0.26	120mins	0.73
88	EppingCl	0.33	0.25	0.58	120mins	0.77
89	SandringhamAve	0.49	0.26	0.75	120mins	0.77
90	CottageSt	0.17	0.02	0.19	120mins	0.90
91	VictoriaStnearParkAve	0.19	2.57	2.76	120mins	1.20
92	railwayNearVictoriaSt	0.00	2.70	2.71	120mins	1.17
93	GreatWesternHwy	0.00	1.16	1.17	120mins	1.00
94	KerranCl	0.30	0.00	0.30	120mins	0.83
95	WeatherbyAve	0.23	0.55	0.79	120mins	0.77
96	WrenchSt	0.39	0.21	0.60	120mins	0.73
97	GreatWesternHwyNearFrenchSt	0.00	0.74	0.74	120mins	0.93
98	ParkAve	1.43	2.74	4.17	120mins	0.87
99	AmarooSt	0.96	2.03	2.99	120mins	0.83
100	JosephSt	1.00	1.84	2.84	120mins	0.83
101	WalterSt	0.77	1.75	2.52	120mins	0.77
102	VictoriaStW	0.25	0.66	0.91	120mins	0.77
103	CollegeSt	0.06	0.23	0.30	120mins	0.70
104	WalterStandParkAve	0.45	0.71	1.16	120mins	0.80
105	GreatWesternHwyNearSantleyCres	0.00	14.37	14.36	360mins	2.93

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	0.34	0.07	0.41	360mins	2.53
107	DougRennieField	4.63	7.60	12.23	360mins	2.70
108	FirstStN	2.59	7.63	10.21	120mins	1.40
109	BringellyRdNearFirst	2.02	7.96	9.98	120mins	1.30
110	HargraveSt	0.90	1.98	2.88	120mins	1.33
111	DerbySy	2.19	4.18	6.38	120mins	1.20
112	StaffordSyNearBringellyRd	0.26	3.42	3.68	120mins	1.17
113	StaffordSt	2.35	0.00	2.35	120mins	1.10
114	JamisonRd	3.34	2.66	6.00	120mins	0.97
115	StapleySt	0.01	2.51	2.52	120mins	0.93
116	StapleyStandClemsonSt	0.48	2.70	3.18	120mins	0.83
117	ClemsonSt	0.24	0.23	0.47	120mins	0.73
118	LucySt	0.36	4.02	4.38	120mins	0.90
119	SmithSt	0.23	3.74	3.97	120mins	0.90
120	OagCresandTentSt	0.31	2.50	2.81	120mins	0.83
121	TentSt	0.13	1.56	1.69	120mins	0.80
122	TentStandPiperCl	0.09	1.12	1.20	360mins	2.30
123	PiperCl	0.02	0.32	0.34	120mins	0.77
124	BringellyRd	0.15	0.21	0.36	120mins	0.77
125	BringellyRdandCaddensSt	0.16	0.89	1.05	360mins	2.53
126	AngophoraAve	0.16	0.03	0.20	120mins	0.73
127	CaddensRd	0.55	0.23	0.78	120mins	0.83
128	OagCres	0.44	0.37	0.81	120mins	0.80
129	TheNorthernRd	0.31	0.14	0.45	120mins	0.77
130	ElliottSt	0.15	0.68	0.82	120mins	0.73
131	GladysSt	0.13	0.56	0.69	120mins	0.70
132	SomersetNearHargraveSt	0.51	0.16	0.67	120mins	0.73
133	SomersetStandDerbySt	0.12	0.02	0.13	120mins	0.77
134	OrthSt	1.47	2.31	3.78	120mins	1.10
135	SomersetSt	1.36	2.15	3.51	120mins	1.00
136	GreatWesternHwySomersetSt	0.84	0.00	0.84	120mins	0.97
137	GreatWesternHwyHospital	0.00	2.19	2.19	120mins	0.93
138	RailwaynearHospital	0.00	2.97	2.97	120mins	0.93
139	CoxAve	1.35	1.75	3.10	120mins	0.83
140	CopelandSt	1.06	0.63	1.69	120mins	0.77
141	PhillipSt	0.11	0.66	0.77	120mins	0.77
142	GascoigneSt	0.03	0.29	0.32	120mins	0.70
143	RichmondRd	0.07	0.02	0.10	120mins	0.67
144	SecondAveandJonesSt	0.36	3.38	3.74	120mins	0.80
145	BadenPowellAve	0.20	2.05	2.24	120mins	0.77
146	FirstSt	0.32	0.64	0.96	120mins	0.83
147	BadenPowellAveandFirstSt	0.54	0.38	0.92	120mins	0.80
148	BringellyRdNearJamisonRd	0.01	0.18	0.20	120mins	0.77
149	FuryStandStockAve	0.23	1.79	2.02	120mins	0.80
150	PeppermintCres	0.15	1.03	1.19	120mins	0.83
151	PeppermintCresandYeelannaPl	0.40	0.54	0.94	120mins	0.77
152	AngophoraAveand PeppermintCres	0.09	0.25	0.34	120mins	0.73
153	ChapmanGardens	0.12	3.61	3.73	120mins	0.87
154	SecondAveandManningSt	0.03	3.55	3.58	120mins	0.87
155	EdnaSt	0.81	2.60	3.42	120mins	0.83
156	EdwardSt	0.10	1.67	1.78	120mins	0.80
157	ManningSt	0.30	1.47	1.76	120mins	0.77
158	CasuarinaCircuitandMaculataPl	0.09	0.05	0.14	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	0.13	1.54	1.67	120mins	0.77
160	CaddensRdandCaddaRidgeDr	0.30	0.04	0.34	120mins	0.80
161	KearneyAve	0.07	0.00	0.07	360mins	4.03
162	CaddaRidgeDr	0.20	2.14	2.35	120mins	0.77
163	BringellyRdandGreatWesternHwy	0.00	0.42	0.42	120mins	0.77

Peak 20% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	51.42	51.42	360mins	3.10
2	JohnOxleyAveWerringtonCreek	0.00	47.10	47.10	360mins	2.93
3	JohnOxleyAve	0.26	0.02	0.28	120mins	0.93
4	BurtonSt	0.00	43.80	43.80	360mins	2.87
5	VictoriaSt	0.00	31.88	31.89	360mins	2.77
6	Railway	0.01	29.29	29.29	360mins	2.80
7	GreatWesternHwyCollegeCreek	0.09	10.04	10.12	360mins	2.87
8	CosgroveCres	0.01	6.95	6.96	360mins	3.50
9	SecondAve	-0.04	6.53	6.49	360mins	3.50
10	LamrockReserve	0.00	6.25	6.25	360mins	3.50
11	OConnellSt	2.75	0.69	3.45	120mins	0.83
12	OConnellStJohnFlakAve	0.20	7.30	7.51	360mins	2.83
13	CaddaRidgeDrOConnellLn	0.00	5.22	5.22	30mins	2.50
14	CaddensRdandOConnellLn	5.08	0.21	5.29	120mins	1.00
15	CastleRd	0.48	0.06	0.54	120mins	0.83
16	CastleRdcloseKingswood	0.26	0.85	1.10	360mins	2.67
17	KingswoodRd	0.44	1.41	1.85	120mins	0.83
18	WerringtonCreekNearDunheved	0.00	3.67	3.66	360mins	5.03
19	ParkesAve	0.00	0.67	0.67	360mins	6.00
20	IrwinSt	0.02	1.30	1.33	120mins	1.63
21	DunkleyPl	0.45	0.93	1.38	120mins	1.40
22	PrincessSt	1.29	0.46	1.74	120mins	1.17
23	AlbertStNearEdwardCl	1.18	0.43	1.61	120mins	0.90
25	VictoriaStNearLethBridgeAve	0.43	0.12	0.55	120mins	0.77
26	ParkesAvenueSportingComplex	1.32	1.57	2.89	360mins	5.43
27	AlbertSt	1.68	1.36	3.03	360mins	5.00
28	VictoriaStParkesAve	0.94	1.86	2.80	360mins	2.97
29	VictoriaStGibsonAve	0.12	0.06	0.18	120mins	0.87
30	WerringtonStation	0.00	2.54	2.54	360mins	3.17
31	ChapmanSt	0.31	2.05	2.36	360mins	3.27
32	WalkerSt	0.20	1.23	1.43	360mins	3.40
33	HeaveyStandLethbridgeAve	0.02	0.86	0.89	30mins	0.37
34	HumeCresNearPrinceSt	0.36	0.26	0.62	120mins	0.80
35	PrinceStandJohnOxleyAve	0.98	5.52	6.50	120mins	0.80
36	PrinceSt	0.15	0.61	0.76	120mins	0.73
37	BurkeAve	0.27	0.22	0.50	120mins	0.73
38	CharlesSturtDr	0.95	5.17	6.12	120mins	0.80
39	ChisholmAve	1.20	4.33	5.53	120mins	0.77
40	HuntPl	1.28	3.34	4.63	120mins	0.77
41	RugbySt	0.86	3.15	4.01	120mins	0.77
42	CharlesToddCresandRugbySt	0.22	0.61	0.83	120mins	0.77
43	DunhevedRdandJohnOxleyAve	0.36	1.73	2.10	120mins	0.83
44	HumeCres	0.10	0.03	0.13	30mins	0.33
45	HeaveySt	0.02	1.40	1.42	120mins	0.77
46	ArmsteinCresandDannySt	-0.03	0.15	0.12	30mins	0.37
47	ArmsteinCres	0.05	0.83	0.87	120mins	0.77
48	ArmsteinCresandInnesPl	0.11	0.00	0.11	120mins	0.70
49	VictoriaStbelowReindeerPl	0.21	0.08	0.29	120mins	0.83
50	VictoriaStCloseRailway	0.08	0.21	0.30	120mins	0.87
51	RailwayNearUniversity	0.34	0.00	0.34	120mins	0.83
52	VictoriaStandBurtonSt	0.08	0.00	0.08	120mins	0.77

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.33	-0.08	0.25	120mins	0.97
54	CarleenCl	0.42	0.32	0.74	120mins	0.77
55	DeslieAve	0.12	0.31	0.43	120mins	0.67
56	ImpalaAve	0.20	0.20	0.39	120mins	0.73
57	GlencoeAveandBurtonSt	1.07	0.90	1.96	120mins	0.73
58	ChisholmAveandBurtonSt	0.91	0.44	1.35	120mins	0.70
59	WerringtonLake	9.42	0.00	9.42	120mins	0.97
60	FrancisSt	0.52	3.33	3.84	120mins	0.77
61	GlencoeAve	0.96	2.05	3.01	120mins	0.87
62	GlencoeAveNearBeverleyPl	1.45	1.62	3.07	120mins	0.80
63	DunbarAve	0.72	2.04	2.76	120mins	0.77
64	RugbyStandOrletonPl	0.48	1.89	2.37	120mins	0.87
65	OrletonPl	0.94	0.74	1.68	120mins	0.83
66	DunhevedRd	0.00	1.10	1.10	120mins	0.77
67	FrancisStN	0.32	0.22	0.54	120mins	0.73
68	BenineDr	0.27	0.38	0.65	120mins	0.73
69	WilliamSt	1.35	4.00	5.35	120mins	0.90
70	SuttonRd	1.81	3.24	5.05	120mins	0.83
71	TwickhenhamAveandNeetaAve	0.92	1.04	1.96	120mins	0.83
72	WembleyAve	0.78	0.91	1.69	120mins	0.77
73	RugbyStN	0.56	0.71	1.26	120mins	0.73
74	SuttonRdandWillamSt	0.83	1.65	2.48	120mins	0.80
75	TwickenhamAve	0.14	0.24	0.38	120mins	0.70
76	WrenchStandWilliamSt	1.01	0.51	1.52	120mins	0.73
77	JordonSt	0.41	0.20	0.61	30mins	0.33
78	HarrowRd	1.02	0.50	1.52	120mins	1.03
79	HerbertSt	0.73	6.08	6.82	120mins	0.90
80	WeatherbyAveandCamptonAve	3.09	3.43	6.52	120mins	0.87
81	WrenchStNearDevonRd	3.40	3.06	6.47	120mins	0.83
82	CambridgeSt	0.74	1.67	2.41	120mins	0.87
83	LincolnDr	0.65	0.96	1.61	120mins	0.80
84	CheltenhamAve	0.25	0.23	0.48	120mins	0.73
85	AberdeenSt	0.27	0.26	0.53	30mins	0.33
86	StirlingSt	0.52	0.11	0.63	120mins	0.77
87	DevonRd	0.27	0.06	0.34	120mins	0.73
88	EppingCl	0.54	0.25	0.79	120mins	0.73
89	SandringhamAve	0.75	0.31	1.06	120mins	0.73
90	CottageSt	0.28	0.04	0.32	120mins	0.83
91	VictoriaStnearParkAve	1.04	2.68	3.72	120mins	1.07
92	railwayNearVictoriaSt	0.00	3.60	3.60	120mins	1.07
93	GreatWesternHwy	0.00	2.12	2.13	120mins	0.93
94	KerranCl	0.66	0.00	0.66	120mins	0.80
95	WeatherbyAve	0.59	0.53	1.12	120mins	0.77
96	WrenchSt	0.63	0.19	0.81	120mins	0.73
97	GreatWesternHwyNearFrenchSt	0.00	0.88	0.88	120mins	0.90
98	ParkAve	2.53	3.52	6.05	120mins	0.83
99	AmarooSt	1.56	2.58	4.14	120mins	0.83
100	JosephSt	1.51	2.39	3.89	120mins	0.80
101	WalterSt	1.13	2.20	3.32	120mins	0.77
102	VictoriaStW	0.61	0.78	1.39	120mins	0.77
103	CollegeSt	0.14	0.26	0.40	30mins	0.33
104	WalterStandParkAve	0.82	0.89	1.70	120mins	0.77
105	GreatWesternHwyNearSantleyCres	2.66	15.13	17.80	120mins	1.50

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	0.77	0.06	0.83	120mins	1.53
107	DougRennieField	9.85	7.81	17.65	120mins	1.37
108	FirstStN	7.40	8.05	15.45	120mins	1.30
109	BringellyRdNearFirst	6.13	8.88	15.01	120mins	1.27
110	HargraveSt	2.62	2.08	4.69	120mins	1.23
111	DerbySy	3.79	5.64	9.43	120mins	1.20
112	StaffordSyNearBringellyRd	0.90	4.52	5.41	120mins	1.13
113	StaffordSt	3.74	0.00	3.74	120mins	1.07
114	JamisonRd	6.16	2.81	8.97	120mins	0.93
115	StapleySt	0.58	3.10	3.68	120mins	0.90
116	StapleyStandClemsonSt	1.81	3.13	4.94	120mins	0.90
117	ClemsonSt	0.35	0.29	0.65	120mins	0.70
118	LucySt	1.72	5.04	6.76	120mins	0.87
119	SmithSt	1.72	4.41	6.13	120mins	0.87
120	OagCresandTentSt	0.74	3.57	4.32	120mins	0.83
121	TentSt	0.36	2.31	2.67	120mins	0.80
122	TentStandPiperCl	0.50	1.42	1.92	120mins	0.83
123	PiperCl	0.04	0.43	0.47	120mins	0.73
124	BringellyRd	0.24	0.29	0.53	120mins	0.73
125	BringellyRdandCaddensSt	0.59	0.98	1.57	120mins	0.80
126	AngophoraAve	0.23	0.06	0.29	30mins	0.33
127	CaddensRd	0.91	0.34	1.25	120mins	0.77
128	OagCres	0.65	0.52	1.17	120mins	0.77
129	TheNorthernRd	0.48	0.18	0.66	120mins	0.73
130	ElliottSt	0.21	0.70	0.92	120mins	0.77
131	GladysSt	0.38	0.50	0.88	120mins	0.73
132	SomersetNearHargraveSt	0.79	0.19	0.97	120mins	0.77
133	SomersetStandDerbySt	0.16	0.03	0.19	120mins	0.77
134	OrthSt	2.78	2.29	5.07	120mins	1.00
135	SomersetSt	2.63	2.17	4.80	120mins	0.90
136	GreatWesternHwySomersetSt	1.75	0.00	1.75	120mins	0.97
137	GreatWesternHwyHospital	0.00	2.26	2.26	120mins	0.97
138	RailwaynearHospital	0.00	3.95	3.96	120mins	0.93
139	CoxAve	3.16	1.66	4.82	120mins	0.80
140	CopelandSt	1.73	0.64	2.37	120mins	0.77
141	PhillipSt	0.42	0.64	1.07	120mins	0.77
142	GascoigneSt	0.05	0.38	0.43	120mins	0.70
143	RichmondRd	0.12	0.02	0.14	30mins	0.33
144	SecondAveandJonesSt	0.91	4.22	5.14	120mins	0.87
145	BadenPowellAve	0.40	2.70	3.10	120mins	0.80
146	FirstSt	0.52	0.71	1.23	120mins	0.80
147	BadenPowellAveandFirstSt	0.74	0.45	1.19	120mins	0.77
148	BringellyRdNearJamisonRd	0.03	0.20	0.23	120mins	0.73
149	FuryStandStockAve	0.40	2.31	2.72	120mins	0.80
150	PeppermintCres	0.28	1.17	1.45	120mins	0.77
151	PeppermintCresandYeelannaPl	0.76	0.56	1.32	120mins	0.73
152	AngophoraAveand PeppermintCres	0.13	0.33	0.45	120mins	0.70
153	ChapmanGardens	0.18	4.31	4.49	120mins	0.87
154	SecondAveandManningSt	0.37	4.06	4.43	120mins	0.87
155	EdnaSt	1.66	2.74	4.40	120mins	0.83
156	EdwardSt	0.24	1.75	1.99	120mins	0.77
157	ManningSt	0.53	1.49	2.02	120mins	0.73
158	CasuarinaCircuitandMaculataPl	0.13	0.09	0.22	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	0.33	2.09	2.42	120mins	0.73
160	CaddensRdandCaddaRidgeDr	0.51	0.06	0.56	120mins	0.77
161	KearneyAve	0.23	0.00	0.23	360mins	2.57
162	CaddaRidgeDr	0.85	2.59	3.44	120mins	0.77
163	BringellyRdandGreatWesternHwy	0.00	0.52	0.52	120mins	0.73

Peak 10% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	60.53	60.53	360mins	3.10
2	JohnOxleyAveWerringtonCreek	0.00	55.86	55.86	360mins	2.93
3	JohnOxleyAve	0.46	0.02	0.48	120mins	0.87
4	BurtonSt	0.00	51.92	51.92	360mins	2.83
5	VictoriaSt	0.01	37.74	37.75	360mins	2.73
6	Railway	0.01	34.58	34.58	360mins	2.77
7	GreatWesternHwyCollegeCreek	0.05	12.97	13.03	360mins	3.13
8	CosgroveCres	0.30	9.58	9.88	360mins	3.27
9	SecondAve	-0.05	9.30	9.26	360mins	3.20
10	LamrockReserve	0.51	6.93	7.44	360mins	3.13
11	OConnellSt	3.47	0.70	4.17	120mins	0.80
12	OConnellStJohnFlakAve	0.26	9.46	9.72	360mins	2.73
13	CaddaRidgeDrOConnellLn	0.02	8.05	8.07	30mins	1.43
14	CaddensRdandOConnellLn	6.35	0.34	6.69	120mins	0.93
15	CastleRd	0.66	0.08	0.74	120mins	0.80
16	CastleRdcloseKingswood	0.55	1.00	1.55	360mins	2.70
17	KingswoodRd	1.10	1.39	2.49	120mins	0.80
18	WerringtonCreekNearDunheved	0.00	5.15	5.15	360mins	5.03
19	ParkesAve	1.29	0.41	1.71	360mins	4.87
20	IrwinSt	0.14	1.25	1.39	120mins	1.50
21	DunkleyPl	0.73	0.88	1.61	120mins	1.20
22	PrincessSt	1.97	0.42	2.39	120mins	1.10
23	AlbertStNearEdwardCl	1.51	0.46	1.98	120mins	0.87
25	VictoriaStNearLethBridgeAve	0.50	0.13	0.62	120mins	0.73
26	ParkesAvenueSportingComplex	3.04	1.22	4.26	360mins	4.03
27	AlbertSt	4.36	1.21	5.57	120mins	2.97
28	VictoriaStParkesAve	1.26	1.79	3.05	360mins	3.33
29	VictoriaStGibsonAve	0.19	0.07	0.27	120mins	0.83
30	WerringtonStation	0.00	2.75	2.75	360mins	3.37
31	ChapmanSt	0.22	2.43	2.65	120mins	2.73
32	WalkerSt	0.66	1.13	1.79	360mins	3.10
33	HeaveyStandLethbridgeAve	-0.01	0.82	0.81	30mins	0.33
34	HumeCresNearPrinceSt	0.51	0.26	0.78	120mins	0.77
35	PrinceStandJohnOxleyAve	1.62	5.83	7.45	120mins	0.80
36	PrinceSt	0.23	0.63	0.86	120mins	0.73
37	BurkeAve	0.33	0.25	0.58	120mins	0.70
38	CharlesSturtDr	1.51	5.45	6.96	120mins	0.80
39	ChisholmAve	1.81	4.47	6.28	120mins	0.77
40	HuntPl	1.76	3.43	5.19	120mins	0.77
41	RugbySt	1.15	3.27	4.42	120mins	0.77
42	CharlesToddCresandRugbySt	0.34	0.65	0.98	120mins	0.73
43	DunhevedRdandJohnOxleyAve	1.08	1.60	2.68	120mins	0.80
44	HumeCres	0.15	0.03	0.18	30mins	0.33
45	HeaveySt	0.06	1.51	1.57	120mins	0.80
46	ArmsteinCresandDannySt	0.01	0.12	0.13	120mins	0.73
47	ArmsteinCres	0.06	0.92	0.98	120mins	0.77
48	ArmsteinCresandInnesPl	0.13	0.00	0.13	120mins	0.70
49	VictoriaStbelowReindeerPl	0.27	0.08	0.36	120mins	0.83
50	VictoriaStCloseRailway	0.07	0.23	0.31	120mins	0.83
51	RailwayNearUniversity	0.36	0.00	0.36	120mins	0.80
52	VictoriaStandBurtonSt	0.10	0.00	0.10	120mins	0.77

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.42	-0.09	0.33	120mins	0.97
54	CarleenCl	0.64	0.32	0.96	120mins	0.77
55	DeslieAve	0.15	0.29	0.44	120mins	0.67
56	ImpalaAve	0.26	0.20	0.46	120mins	0.73
57	GlencoeAveandBurtonSt	1.33	0.99	2.32	120mins	0.73
58	ChisholmAveandBurtonSt	1.08	0.49	1.57	120mins	0.70
59	WerringtonLake	11.59	0.00	11.59	120mins	0.97
60	FrancisSt	1.19	2.97	4.17	120mins	0.97
61	GlencoeAve	1.58	1.98	3.55	120mins	0.93
62	GlencoeAveNearBeverleyPl	1.94	1.55	3.49	120mins	0.90
63	DunbarAve	1.17	2.03	3.20	120mins	0.87
64	RugbyStandOrletonPl	1.10	1.91	3.02	120mins	0.87
65	OrletonPl	1.26	0.74	2.00	120mins	0.80
66	DunhevedRd	0.00	1.21	1.21	120mins	0.77
67	FrancisStN	0.40	0.24	0.64	120mins	0.73
68	BenineDr	0.33	0.40	0.72	120mins	0.73
69	WilliamSt	2.44	3.99	6.43	120mins	0.87
70	SuttonRd	2.85	3.29	6.14	120mins	0.83
71	TwickhenhamAveandNeetaAve	1.34	1.01	2.35	120mins	0.83
72	WembleyAve	1.04	0.91	1.95	120mins	0.77
73	RugbyStN	0.76	0.69	1.45	120mins	0.73
74	SuttonRdandWillamSt	1.31	1.65	2.97	120mins	0.77
75	TwickenhamAve	0.20	0.25	0.46	30mins	0.33
76	WrenchStandWilliamSt	1.29	0.51	1.80	120mins	0.73
77	JordonSt	0.54	0.21	0.75	30mins	0.33
78	HarrowRd	1.54	0.47	2.01	120mins	0.97
79	HerbertSt	1.20	7.16	8.36	120mins	0.90
80	WeatherbyAveandCamptonAve	4.29	3.65	7.93	120mins	0.87
81	WrenchStNearDevonRd	4.73	3.10	7.83	120mins	0.87
82	CambridgeSt	1.37	1.74	3.11	120mins	0.83
83	LincolnDr	1.17	0.99	2.17	120mins	0.80
84	CheltenhamAve	0.34	0.22	0.55	120mins	0.70
85	AberdeenSt	0.40	0.24	0.64	30mins	0.33
86	StirlingSt	0.62	0.11	0.73	120mins	0.77
87	DevonRd	0.33	0.07	0.40	120mins	0.73
88	EppingCl	0.68	0.25	0.93	120mins	0.73
89	SandringhamAve	0.90	0.32	1.22	120mins	0.70
90	CottageSt	0.36	0.05	0.41	120mins	0.80
91	VictoriaStnearParkAve	1.23	2.95	4.18	120mins	1.20
92	railwayNearVictoriaSt	0.00	4.06	4.06	120mins	1.20
93	GreatWesternHwy	0.00	2.85	2.85	120mins	0.87
94	KerranCl	0.89	0.00	0.89	120mins	0.77
95	WeatherbyAve	0.76	0.53	1.30	120mins	0.77
96	WrenchSt	0.74	0.19	0.93	120mins	0.73
97	GreatWesternHwyNearFrenchSt	0.00	0.92	0.92	120mins	0.87
98	ParkAve	3.19	3.67	6.86	120mins	0.83
99	AmarooSt	1.94	2.64	4.58	120mins	0.80
100	JosephSt	1.89	2.41	4.30	120mins	0.80
101	WalterSt	1.39	2.21	3.60	120mins	0.77
102	VictoriaStW	0.81	0.78	1.59	120mins	0.77
103	CollegeSt	0.23	0.27	0.50	30mins	0.33
104	WalterStandParkAve	1.09	0.95	2.04	120mins	0.77
105	GreatWesternHwyNearSantleyCres	5.67	15.33	21.00	120mins	1.43

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	1.47	0.07	1.54	120mins	1.40
107	DougRennieField	12.49	7.88	20.38	120mins	1.33
108	FirstStN	10.13	8.14	18.27	120mins	1.30
109	BringellyRdNearFirst	8.59	9.16	17.75	120mins	1.27
110	HargraveSt	4.32	2.03	6.34	120mins	1.23
111	DerbySy	5.50	6.30	11.80	120mins	1.17
112	StaffordSyNearBringellyRd	1.79	4.87	6.66	120mins	1.10
113	StaffordSt	4.53	0.00	4.53	120mins	1.03
114	JamisonRd	7.94	2.86	10.80	120mins	0.93
115	StapleySt	1.14	3.28	4.42	120mins	0.87
116	StapleyStandClemsonSt	2.82	3.32	6.13	120mins	0.90
117	ClemsonSt	0.42	0.31	0.73	120mins	0.73
118	LucySt	2.71	5.37	8.08	120mins	0.87
119	SmithSt	2.69	4.67	7.36	120mins	0.87
120	OagCresandTentSt	1.24	4.02	5.26	120mins	0.87
121	TentSt	0.77	2.59	3.35	120mins	0.87
122	TentStandPiperCl	0.74	1.75	2.49	120mins	0.87
123	PiperCl	0.07	0.44	0.51	120mins	0.73
124	BringellyRd	0.33	0.32	0.65	120mins	0.77
125	BringellyRdandCaddensSt	0.84	1.09	1.93	120mins	0.77
126	AngophoraAve	0.29	0.07	0.37	120mins	0.73
127	CaddensRd	1.06	0.39	1.45	120mins	0.73
128	OagCres	0.75	0.59	1.35	120mins	0.77
129	TheNorthernRd	0.57	0.20	0.77	120mins	0.73
130	ElliottSt	0.31	0.71	1.02	120mins	0.77
131	GladysSt	0.52	0.52	1.04	120mins	0.70
132	SomersetNearHargraveSt	0.96	0.19	1.15	120mins	0.77
133	SomersetStandDerbySt	0.19	0.04	0.24	120mins	0.77
134	OrthSt	3.55	2.29	5.84	120mins	0.93
135	SomersetSt	3.26	2.17	5.43	120mins	0.87
136	GreatWesternHwySomersetSt	2.04	0.00	2.04	120mins	0.90
137	GreatWesternHwyHospital	0.00	2.28	2.28	120mins	0.97
138	RailwaynearHospital	0.00	4.25	4.25	120mins	0.93
139	CoxAve	4.39	1.49	5.88	120mins	0.80
140	CopelandSt	2.19	0.65	2.83	120mins	0.77
141	PhillipSt	0.63	0.60	1.23	120mins	0.73
142	GascoigneSt	0.07	0.44	0.50	120mins	0.70
143	RichmondRd	0.14	0.03	0.17	30mins	0.33
144	SecondAveandJonesSt	1.64	4.32	5.96	120mins	0.87
145	BadenPowellAve	0.55	2.92	3.47	120mins	0.77
146	FirstSt	0.60	0.74	1.35	120mins	0.77
147	BadenPowellAveandFirstSt	0.80	0.47	1.27	120mins	0.77
148	BringellyRdNearJamisonRd	0.03	0.21	0.24	120mins	0.70
149	FuryStandStockAve	0.53	2.44	2.97	120mins	0.77
150	PeppermintCres	0.33	1.19	1.52	120mins	0.73
151	PeppermintCresandYeelannaPl	0.99	0.53	1.52	120mins	0.73
152	AngophoraAveand PeppermintCres	0.16	0.39	0.55	30mins	0.33
153	ChapmanGardens	0.77	4.60	5.37	120mins	0.90
154	SecondAveandManningSt	0.99	4.33	5.32	120mins	0.83
155	EdnaSt	2.28	2.91	5.19	120mins	0.80
156	EdwardSt	0.31	1.79	2.09	120mins	0.77
157	ManningSt	0.60	1.51	2.12	120mins	0.73
158	CasuarinaCircuitandMaculataPl	0.14	0.11	0.25	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	0.51	2.36	2.86	120mins	0.73
160	CaddensRdandCaddaRidgeDr	0.61	0.07	0.68	120mins	0.77
161	KearneyAve	0.29	0.00	0.29	360mins	2.50
162	CaddaRidgeDr	1.52	2.62	4.14	120mins	0.77
163	BringellyRdandGreatWesternHwy	0.00	0.58	0.58	120mins	0.73

Peak 5% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	72.41	72.41	360mins	3.10
2	JohnOxleyAveWerringtonCreek	0.00	64.78	64.78	360mins	2.90
3	JohnOxleyAve	1.69	0.01	1.70	360mins	2.97
4	BurtonSt	0.00	61.64	61.64	360mins	2.77
5	VictoriaSt	1.39	43.79	45.18	360mins	2.67
6	Railway	0.01	42.06	42.07	360mins	2.97
7	GreatWesternHwyCollegeCreek	0.21	18.86	19.07	360mins	3.07
8	CosgroveCres	5.42	9.17	14.60	360mins	3.03
9	SecondAve	1.02	13.01	14.03	360mins	2.93
10	LamrockReserve	2.27	7.24	9.51	360mins	2.87
11	OConnellSt	4.44	0.70	5.14	120mins	0.80
12	OConnellStJohnFlakAve	3.54	8.89	12.44	360mins	2.67
13	CaddaRidgeDrOConnellLn	0.08	11.73	11.81	30mins	1.03
14	CaddensRdandOConnellLn	8.27	0.30	8.57	120mins	0.93
15	CastleRd	0.93	0.11	1.04	120mins	0.77
16	CastleRdcloseKingswood	1.22	0.97	2.18	360mins	2.53
17	KingswoodRd	1.86	1.38	3.25	120mins	0.77
18	WerringtonCreekNearDunheved	0.00	5.91	5.91	360mins	4.90
19	ParkesAve	2.20	0.00	2.20	360mins	5.10
20	IrwinSt	0.33	1.05	1.38	360mins	2.57
21	DunkleyPl	1.12	0.85	1.98	360mins	3.10
22	PrincessSt	2.85	0.37	3.21	120mins	1.00
23	AlbertStNearEdwardCl	1.91	0.51	2.42	120mins	0.83
25	VictoriaStNearLethBridgeAve	0.57	0.13	0.71	120mins	0.73
26	ParkesAvenueSportingComplex	3.81	0.77	4.58	360mins	5.43
27	AlbertSt	5.57	1.02	6.59	360mins	2.30
28	VictoriaStParkesAve	1.68	1.71	3.40	360mins	3.47
29	VictoriaStGibsonAve	0.30	0.10	0.40	120mins	0.80
30	WerringtonStation	0.00	3.09	3.09	360mins	3.50
31	ChapmanSt	0.79	2.57	3.35	120mins	2.03
32	WalkerSt	1.33	1.11	2.44	360mins	2.87
33	HeaveyStandLethbridgeAve	0.09	0.74	0.83	30mins	0.33
34	HumeCresNearPrinceSt	0.69	0.30	1.00	120mins	0.77
35	PrinceStandJohnOxleyAve	2.67	6.00	8.66	120mins	0.80
36	PrinceSt	0.32	0.66	0.97	120mins	0.70
37	BurkeAve	0.43	0.26	0.68	30mins	0.33
38	CharlesSturtDr	2.40	5.58	7.98	120mins	0.80
39	ChisholmAve	2.71	4.53	7.24	120mins	0.77
40	HuntPl	2.69	3.49	6.18	120mins	0.83
41	RugbySt	2.07	3.37	5.44	120mins	0.83
42	CharlesToddCresandRugbySt	0.51	0.69	1.19	120mins	0.73
43	DunhevedRdandJohnOxleyAve	1.84	1.41	3.25	120mins	0.80
44	HumeCres	0.20	0.03	0.24	30mins	0.33
45	HeaveySt	0.14	1.62	1.76	120mins	0.83
46	ArmsteinCresandDannySt	0.04	0.13	0.17	120mins	0.70
47	ArmsteinCres	0.08	0.98	1.06	120mins	0.77
48	ArmsteinCresandInnesPl	0.19	0.00	0.19	120mins	0.83
49	VictoriaStbelowReindeerPl	0.37	0.08	0.45	120mins	0.80
50	VictoriaStCloseRailway	0.05	0.26	0.31	120mins	0.80
51	RailwayNearUniversity	0.39	0.00	0.39	120mins	0.77
52	VictoriaStandBurtonSt	0.13	0.00	0.13	120mins	0.77

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.59	-0.12	0.47	120mins	0.87
54	CarleenCl	0.87	0.32	1.19	120mins	0.77
55	DeslieAve	0.15	0.28	0.43	120mins	0.67
56	ImpalaAve	0.32	0.20	0.52	120mins	0.70
57	GlencoeAveandBurtonSt	1.75	1.10	2.85	30mins	0.37
58	ChisholmAveandBurtonSt	1.35	0.56	1.91	30mins	0.33
59	WerringtonLake	14.37	0.00	14.37	120mins	0.90
60	FrancisSt	2.02	3.42	5.43	120mins	0.90
61	GlencoeAve	2.61	1.96	4.56	120mins	0.90
62	GlencoeAveNearBeverleyPl	2.98	1.54	4.52	120mins	0.87
63	DunbarAve	2.12	2.04	4.16	120mins	0.83
64	RugbyStandOrletonPl	1.87	2.01	3.88	120mins	0.83
65	OrletonPl	1.66	0.73	2.39	120mins	0.80
66	DunhevedRd	0.13	1.25	1.38	120mins	0.77
67	FrancisStN	0.53	0.24	0.76	120mins	0.73
68	BenineDr	0.41	0.42	0.83	30mins	0.33
69	WilliamSt	4.02	4.06	8.08	120mins	0.83
70	SuttonRd	4.26	3.33	7.59	120mins	0.80
71	TwickhenhamAveandNeetaAve	1.93	1.00	2.92	120mins	0.80
72	WembleyAve	1.46	0.91	2.37	120mins	0.77
73	RugbyStN	1.05	0.71	1.76	120mins	0.70
74	SuttonRdandWillamSt	1.95	1.65	3.60	120mins	0.77
75	TwickenhamAve	0.25	0.26	0.51	30mins	0.33
76	WrenchStandWilliamSt	1.65	0.52	2.16	30mins	0.37
77	JordonSt	0.71	0.22	0.92	30mins	0.33
78	HarrowRd	2.32	0.47	2.79	120mins	0.93
79	HerbertSt	2.09	8.06	10.15	120mins	0.87
80	WeatherbyAveandCamptonAve	5.74	3.96	9.70	120mins	0.83
81	WrenchStNearDevonRd	6.50	3.27	9.77	120mins	0.83
82	CambridgeSt	2.15	1.76	3.90	120mins	0.83
83	LincolnDr	1.79	1.02	2.82	120mins	0.77
84	CheltenhamAve	0.46	0.21	0.67	30mins	0.33
85	AberdeenSt	0.57	0.21	0.78	30mins	0.33
86	StirlingSt	0.78	0.11	0.88	120mins	0.77
87	DevonRd	0.45	0.07	0.52	30mins	0.33
88	EppingCl	0.88	0.25	1.12	120mins	0.73
89	SandringhamAve	1.13	0.33	1.46	30mins	0.33
90	CottageSt	0.45	0.06	0.52	120mins	0.77
91	VictoriaStnearParkAve	1.80	2.96	4.76	120mins	1.13
92	railwayNearVictoriaSt	0.00	4.61	4.61	120mins	1.13
93	GreatWesternHwy	0.01	3.80	3.81	120mins	0.83
94	KerranCl	1.22	0.00	1.22	120mins	0.77
95	WeatherbyAve	1.03	0.53	1.57	120mins	0.73
96	WrenchSt	0.97	0.19	1.16	30mins	0.33
97	GreatWesternHwyNearFrenchSt	0.01	0.92	0.93	120mins	0.87
98	ParkAve	4.19	3.81	8.00	120mins	0.83
99	AmarooSt	2.50	2.70	5.21	120mins	0.80
100	JosephSt	2.43	2.41	4.84	120mins	0.77
101	WalterSt	1.78	2.18	3.96	120mins	0.77
102	VictoriaStW	1.21	0.79	2.00	120mins	0.77
103	CollegeSt	0.33	0.27	0.60	30mins	0.33
104	WalterStandParkAve	1.44	0.99	2.43	120mins	0.77
105	GreatWesternHwyNearSantleyCres	9.50	15.45	24.95	120mins	1.40

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	2.60	0.08	2.68	120mins	1.37
107	DougRennieField	15.27	7.97	23.24	120mins	1.27
108	FirstStN	13.34	8.25	21.60	120mins	1.27
109	BringellyRdNearFirst	11.62	9.35	20.96	120mins	1.23
110	HargraveSt	6.60	1.96	8.56	120mins	1.17
111	DerbySy	7.58	6.72	14.30	120mins	1.13
112	StaffordSyNearBringellyRd	2.93	5.20	8.14	120mins	1.03
113	StaffordSt	5.68	0.00	5.68	120mins	1.03
114	JamisonRd	10.70	2.89	13.59	120mins	0.93
115	StapleySt	1.85	3.40	5.24	120mins	0.87
116	StapleyStandClemsonSt	4.02	3.54	7.56	120mins	0.87
117	ClemsonSt	0.53	0.33	0.85	120mins	0.73
118	LucySt	4.12	5.78	9.90	120mins	0.87
119	SmithSt	4.15	4.90	9.05	120mins	0.87
120	OagCresandTentSt	2.29	4.23	6.51	120mins	0.83
121	TentSt	1.36	2.84	4.20	120mins	0.83
122	TentStandPiperCl	1.23	1.98	3.21	120mins	0.83
123	PiperCl	0.11	0.44	0.55	30mins	0.37
124	BringellyRd	0.53	0.31	0.84	120mins	0.77
125	BringellyRdandCaddensSt	1.22	1.25	2.47	360mins	2.37
126	AngophoraAve	0.39	0.10	0.49	120mins	0.73
127	CaddensRd	1.22	0.45	1.68	120mins	0.73
128	OagCres	0.96	0.59	1.55	120mins	0.77
129	TheNorthernRd	0.69	0.22	0.91	120mins	0.70
130	ElliottSt	0.46	0.71	1.17	120mins	0.73
131	GladysSt	0.79	0.54	1.32	30mins	0.33
132	SomersetNearHargraveSt	1.20	0.21	1.41	120mins	0.73
133	SomersetStandDerbySt	0.27	0.06	0.33	120mins	0.77
134	OrthSt	4.55	2.31	6.85	120mins	0.87
135	SomersetSt	4.01	2.17	6.18	120mins	0.83
136	GreatWesternHwySomersetSt	2.25	0.00	2.25	120mins	0.83
137	GreatWesternHwyHospital	0.00	2.29	2.29	120mins	1.00
138	RailwaynearHospital	0.00	4.42	4.42	120mins	0.93
139	CoxAve	5.81	1.40	7.22	120mins	0.77
140	CopelandSt	2.77	0.66	3.44	120mins	0.77
141	PhillipSt	0.85	0.57	1.43	120mins	0.73
142	GascoigneSt	0.17	0.41	0.58	30mins	0.33
143	RichmondRd	0.17	0.03	0.20	30mins	0.33
144	SecondAveandJonesSt	2.52	4.38	6.90	120mins	0.83
145	BadenPowellAve	0.81	3.06	3.87	120mins	0.77
146	FirstSt	0.69	0.77	1.46	120mins	0.77
147	BadenPowellAveandFirstSt	0.90	0.49	1.39	120mins	0.77
148	BringellyRdNearJamisonRd	0.04	0.22	0.26	120mins	0.70
149	FuryStandStockAve	0.70	2.50	3.21	120mins	0.77
150	PeppermintCres	0.39	1.19	1.58	120mins	0.77
151	PeppermintCresandYeelannaPl	1.31	0.50	1.82	120mins	0.73
152	AngophoraAveand PeppermintCres	0.21	0.45	0.66	30mins	0.33
153	ChapmanGardens	1.82	4.64	6.46	120mins	0.87
154	SecondAveandManningSt	2.02	4.33	6.35	120mins	0.80
155	EdnaSt	2.92	3.14	6.06	120mins	0.77
156	EdwardSt	0.39	1.82	2.22	120mins	0.73
157	ManningSt	0.77	1.54	2.31	120mins	0.73
158	CasuarinaCircuitandMaculataPl	0.17	0.14	0.32	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	0.94	2.47	3.41	120mins	0.73
160	CaddensRdandCaddaRidgeDr	0.78	0.07	0.86	120mins	0.73
161	KearneyAve	0.40	0.00	0.40	360mins	2.13
162	CaddaRidgeDr	2.30	2.67	4.97	120mins	0.73
163	BringellyRdandGreatWesternHwy	0.00	0.66	0.66	120mins	0.73

Peak 2% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	83.92	83.92	120mins	1.90
2	JohnOxleyAveWerringtonCreek	0.00	70.89	70.89	120mins	1.63
3	JohnOxleyAve	7.55	0.02	7.57	120mins	1.70
4	BurtonSt	0.02	73.64	73.66	120mins	1.57
5	VictoriaSt	6.89	47.25	54.14	120mins	1.60
6	Railway	0.01	50.90	50.91	360mins	2.87
7	GreatWesternHwyCollegeCreek	3.38	21.73	25.12	360mins	2.90
8	CosgroveCres	11.82	7.86	19.68	360mins	2.83
9	SecondAve	5.42	13.44	18.86	360mins	2.73
10	LamrockReserve	4.16	7.43	11.59	360mins	2.70
11	OConnellSt	5.32	0.70	6.01	120mins	0.80
12	OConnellStJohnFlakAve	6.46	9.05	15.51	360mins	2.57
13	CaddaRidgeDrOConnellLn	3.27	5.70	8.97	360mins	2.53
14	CaddensRdandOConnellLn	10.18	0.41	10.58	120mins	0.90
15	CastleRd	1.13	0.15	1.28	120mins	0.77
16	CastleRdcloseKingswood	1.91	0.92	2.82	360mins	2.30
17	KingswoodRd	2.37	1.39	3.76	120mins	0.77
18	WerringtonCreekNearDunheved	-0.01	6.82	6.81	360mins	5.03
19	ParkesAve	2.54	0.00	2.55	360mins	4.90
20	IrwinSt	0.35	1.07	1.42	360mins	2.43
21	DunkleyPl	1.75	0.87	2.62	120mins	1.17
22	PrincessSt	3.56	0.38	3.93	120mins	0.93
23	AlbertStNearEdwardCl	2.32	0.53	2.85	120mins	0.83
25	VictoriaStNearLethBridgeAve	0.64	0.13	0.78	120mins	0.73
26	ParkesAvenueSportingComplex	7.55	0.77	8.31	360mins	4.63
27	AlbertSt	6.28	0.96	7.24	360mins	5.07
28	VictoriaStParkesAve	2.08	1.74	3.82	360mins	3.43
29	VictoriaStGibsonAve	0.41	0.12	0.54	120mins	0.77
30	WerringtonStation	0.00	3.62	3.62	360mins	3.73
31	ChapmanSt	3.07	0.61	3.68	360mins	3.57
32	WalkerSt	2.15	1.01	3.16	360mins	2.77
33	HeaveyStandLethbridgeAve	0.39	0.49	0.88	30mins	0.37
34	HumeCresNearPrinceSt	0.86	0.30	1.16	120mins	0.77
35	PrinceStandJohnOxleyAve	3.72	6.12	9.83	120mins	0.83
36	PrinceSt	0.36	0.67	1.03	120mins	0.70
37	BurkeAve	0.50	0.26	0.75	30mins	0.33
38	CharlesSturtDr	3.58	5.67	9.25	120mins	0.83
39	ChisholmAve	3.87	4.57	8.44	120mins	0.80
40	HuntPl	3.85	3.52	7.37	120mins	0.80
41	RugbySt	3.06	3.39	6.45	120mins	0.80
42	CharlesToddCresandRugbySt	0.64	0.71	1.35	120mins	0.73
43	DunhevedRdandJohnOxleyAve	2.35	1.39	3.74	120mins	0.80
44	HumeCres	0.23	0.04	0.27	30mins	0.33
45	HeaveySt	0.22	1.74	1.96	120mins	0.80
46	ArmsteinCresandDannySt	0.05	0.15	0.20	30mins	0.33
47	ArmsteinCres	0.11	1.03	1.14	120mins	0.77
48	ArmsteinCresandInnesPl	0.33	0.00	0.33	120mins	0.80
49	VictoriaStbelowReindeerPl	0.47	0.08	0.55	120mins	0.77
50	VictoriaStCloseRailway	0.06	0.27	0.33	120mins	0.83
51	RailwayNearUniversity	0.41	0.00	0.41	120mins	0.73
52	VictoriaStandBurtonSt	0.16	0.00	0.16	120mins	0.73

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.74	-0.12	0.62	120mins	0.83
54	CarleenCl	1.08	0.32	1.39	120mins	0.77
55	DeslieAve	0.14	0.28	0.43	120mins	0.63
56	ImpalaAve	0.38	0.20	0.58	30mins	0.33
57	GlencoeAveandBurtonSt	2.09	1.16	3.25	30mins	0.37
58	ChisholmAveandBurtonSt	1.56	0.62	2.18	30mins	0.33
59	WerringtonLake	17.05	0.00	17.05	120mins	0.90
60	FrancisSt	3.23	3.55	6.78	120mins	0.90
61	GlencoeAve	3.66	1.94	5.60	120mins	0.87
62	GlencoeAveNearBeverleyPl	3.98	1.53	5.50	120mins	0.83
63	DunbarAve	3.07	2.03	5.10	120mins	0.83
64	RugbyStandOrletonPl	2.60	2.08	4.68	120mins	0.80
65	OrletonPl	2.06	0.73	2.79	120mins	0.80
66	DunhevedRd	0.44	1.20	1.63	120mins	0.77
67	FrancisStN	0.63	0.23	0.86	120mins	0.73
68	BenineDr	0.52	0.42	0.94	30mins	0.33
69	WilliamSt	5.36	4.09	9.44	120mins	0.83
70	SuttonRd	5.40	3.34	8.73	120mins	0.80
71	TwickhenhamAveandNeetaAve	2.42	0.99	3.41	120mins	0.80
72	WembleyAve	1.80	0.90	2.69	120mins	0.77
73	RugbyStN	1.26	0.73	1.99	30mins	0.33
74	SuttonRdandWillamSt	2.38	1.65	4.03	120mins	0.77
75	TwickenhamAve	0.28	0.26	0.54	30mins	0.33
76	WrenchStandWilliamSt	1.92	0.52	2.44	30mins	0.37
77	JordonSt	0.76	0.22	0.98	30mins	0.33
78	HarrowRd	3.08	0.48	3.56	120mins	0.90
79	HerbertSt	3.66	8.15	11.81	120mins	0.87
80	WeatherbyAveandCamptonAve	7.22	4.13	11.35	120mins	0.83
81	WrenchStNearDevonRd	7.99	3.32	11.31	120mins	0.83
82	CambridgeSt	2.82	1.76	4.58	120mins	0.80
83	LincolnDr	2.22	1.03	3.25	120mins	0.77
84	CheltenhamAve	0.57	0.20	0.77	30mins	0.33
85	AberdeenSt	0.67	0.19	0.87	30mins	0.33
86	StirlingSt	0.90	0.11	1.01	120mins	0.73
87	DevonRd	0.51	0.08	0.60	30mins	0.33
88	EppingCl	1.03	0.25	1.27	30mins	0.37
89	SandringhamAve	1.36	0.35	1.71	30mins	0.33
90	CottageSt	0.53	0.08	0.61	120mins	0.77
91	VictoriaStnearParkAve	2.03	2.96	4.99	120mins	1.07
92	railwayNearVictoriaSt	0.00	4.80	4.81	120mins	1.07
93	GreatWesternHwy	0.01	4.53	4.54	120mins	0.83
94	KerranCl	1.48	0.00	1.48	120mins	0.77
95	WeatherbyAve	1.25	0.53	1.78	120mins	0.73
96	WrenchSt	1.09	0.19	1.28	30mins	0.33
97	GreatWesternHwyNearFrenchSt	0.19	0.85	1.04	120mins	0.83
98	ParkAve	5.12	3.88	9.00	120mins	0.83
99	AmarooSt	3.02	2.73	5.76	120mins	0.80
100	JosephSt	2.73	2.43	5.16	120mins	0.77
101	WalterSt	2.15	2.15	4.30	120mins	0.77
102	VictoriaStW	1.50	0.80	2.29	120mins	0.77
103	CollegeSt	0.39	0.27	0.66	30mins	0.33
104	WalterStandParkAve	1.77	1.01	2.78	120mins	0.77
105	GreatWesternHwyNearSantleyCres	13.47	16.12	29.60	120mins	1.37

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	3.91	0.08	3.99	120mins	1.33
107	DougRennieField	18.62	8.04	26.66	120mins	1.27
108	FirstStN	16.91	8.33	25.24	120mins	1.23
109	BringellyRdNearFirst	15.01	9.46	24.47	120mins	1.20
110	HargraveSt	9.09	1.91	11.00	120mins	1.17
111	DerbySy	9.89	7.06	16.94	120mins	1.10
112	StaffordSyNearBringellyRd	4.09	5.46	9.55	120mins	1.00
113	StaffordSt	6.93	0.00	6.93	120mins	1.03
114	JamisonRd	12.68	2.93	15.61	120mins	0.90
115	StapleySt	2.67	3.49	6.16	120mins	0.87
116	StapleyStandClemsonSt	5.22	3.65	8.87	120mins	0.87
117	ClemsonSt	0.63	0.35	0.98	30mins	0.33
118	LucySt	5.47	6.25	11.72	120mins	0.87
119	SmithSt	5.49	5.23	10.72	120mins	0.87
120	OagCresandTentSt	3.39	4.23	7.62	120mins	0.83
121	TentSt	1.83	2.97	4.80	120mins	0.83
122	TentStandPiperCl	1.68	2.16	3.83	120mins	0.80
123	PiperCl	0.14	0.42	0.56	120mins	0.80
124	BringellyRd	0.67	0.31	0.98	120mins	0.77
125	BringellyRdandCaddensSt	2.15	1.34	3.49	120mins	1.00
126	AngophoraAve	0.46	0.12	0.58	120mins	0.73
127	CaddensRd	1.35	0.50	1.85	120mins	0.73
128	OagCres	1.16	0.60	1.76	120mins	0.77
129	TheNorthernRd	0.78	0.23	1.02	120mins	0.70
130	ElliottSt	0.57	0.71	1.28	120mins	0.73
131	GladysSt	0.95	0.54	1.50	30mins	0.33
132	SomersetNearHargraveSt	1.42	0.22	1.64	120mins	0.73
133	SomersetStandDerbySt	0.35	0.08	0.43	120mins	0.73
134	OrthSt	5.55	2.31	7.87	120mins	0.83
135	SomersetSt	4.73	2.18	6.91	120mins	0.77
136	GreatWesternHwySomersetSt	2.43	0.00	2.43	120mins	0.80
137	GreatWesternHwyHospital	0.00	2.30	2.30	120mins	1.00
138	RailwaynearHospital	0.00	4.55	4.55	120mins	0.97
139	CoxAve	7.06	1.07	8.13	120mins	0.77
140	CopelandSt	3.26	0.67	3.93	120mins	0.77
141	PhillipSt	1.04	0.56	1.61	120mins	0.73
142	GascoigneSt	0.31	0.35	0.66	30mins	0.33
143	RichmondRd	0.19	0.03	0.22	30mins	0.33
144	SecondAveandJonesSt	3.34	4.40	7.75	120mins	0.83
145	BadenPowellAve	1.01	3.17	4.19	120mins	0.77
146	FirstSt	0.77	0.80	1.57	120mins	0.77
147	BadenPowellAveandFirstSt	1.00	0.51	1.51	120mins	0.77
148	BringellyRdNearJamisonRd	0.05	0.23	0.28	30mins	0.33
149	FuryStandStockAve	0.92	2.53	3.44	120mins	0.83
150	PeppermintCres	0.48	1.15	1.64	120mins	0.73
151	PeppermintCresandYeelannaPl	1.61	0.48	2.09	120mins	0.73
152	AngophoraAveand PeppermintCres	0.23	0.48	0.71	30mins	0.33
153	ChapmanGardens	2.83	4.66	7.49	120mins	0.83
154	SecondAveandManningSt	3.04	4.27	7.30	120mins	0.80
155	EdnaSt	3.64	3.31	6.95	120mins	0.77
156	EdwardSt	0.47	1.87	2.34	120mins	0.73
157	ManningSt	0.88	1.56	2.44	120mins	0.73
158	CasuarinaCircuitandMaculataPl	0.21	0.18	0.39	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	1.29	2.51	3.81	120mins	0.73
160	CaddensRdandCaddaRidgeDr	0.89	0.07	0.97	120mins	0.73
161	KearneyAve	0.55	0.00	0.55	360mins	2.03
162	CaddaRidgeDr	3.06	2.69	5.75	120mins	0.73
163	BringellyRdandGreatWesternHwy	0.00	0.74	0.74	120mins	0.73

Peak 1% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	94.50	94.50	120mins	1.83
2	JohnOxleyAveWerringtonCreek	0.00	75.40	75.40	120mins	1.57
3	JohnOxleyAve	13.31	0.01	13.33	120mins	1.63
4	BurtonSt	0.10	81.97	82.07	120mins	1.57
5	VictoriaSt	13.77	50.82	64.59	120mins	1.67
6	Railway	0.01	61.22	61.23	120mins	1.67
7	GreatWesternHwyCollegeCreek	9.98	22.14	32.12	360mins	2.73
8	CosgroveCres	16.68	7.89	24.57	360mins	2.67
9	SecondAve	9.59	13.77	23.36	360mins	2.63
10	LamrockReserve	6.08	7.57	13.65	360mins	2.57
11	OConnellSt	6.44	0.69	7.14	120mins	0.77
12	OConnellStJohnFlakAve	9.41	9.17	18.58	360mins	2.43
13	CaddaRidgeDrOConnellLn	4.31	6.83	11.14	120mins	1.17
14	CaddensRdandOConnellLn	12.19	0.48	12.67	120mins	0.87
15	CastleRd	1.39	0.17	1.56	120mins	0.77
16	CastleRdcloseKingswood	2.88	0.81	3.69	360mins	2.17
17	KingswoodRd	2.95	1.41	4.36	120mins	0.73
18	WerringtonCreekNearDunheved	0.02	7.54	7.56	360mins	5.13
19	ParkesAve	2.70	0.00	2.70	360mins	5.47
20	IrwinSt	0.36	1.08	1.44	360mins	2.23
21	DunkleyPl	1.37	0.81	2.19	360mins	3.27
22	PrincessSt	4.21	0.37	4.58	120mins	0.90
23	AlbertStNearEdwardCl	2.74	0.54	3.28	120mins	0.80
25	VictoriaStNearLethBridgeAve	0.72	0.13	0.85	120mins	0.73
26	ParkesAvenueSportingComplex	6.29	0.73	7.02	360mins	5.93
27	AlbertSt	9.05	0.94	9.99	360mins	5.30
28	VictoriaStParkesAve	2.40	1.72	4.12	360mins	3.73
29	VictoriaStGibsonAve	0.53	0.14	0.67	120mins	0.77
30	WerringtonStation	0.00	3.91	3.91	360mins	3.67
31	ChapmanSt	5.41	0.70	6.11	360mins	3.23
32	WalkerSt	3.16	0.82	3.98	360mins	2.97
33	HeaveyStandLethbridgeAve	0.12	0.87	0.99	30mins	0.30
34	HumeCresNearPrinceSt	1.05	0.30	1.34	120mins	0.73
35	PrinceStandJohnOxleyAve	5.37	6.21	11.58	120mins	0.80
36	PrinceSt	0.48	0.70	1.18	30mins	0.33
37	BurkeAve	0.59	0.27	0.87	30mins	0.33
38	CharlesSturtDr	5.19	5.74	10.93	120mins	0.80
39	ChisholmAve	5.41	4.58	9.99	120mins	0.80
40	HuntPl	5.05	3.53	8.58	120mins	0.77
41	RugbySt	4.04	3.39	7.43	120mins	0.77
42	CharlesToddCresandRugbySt	0.81	0.74	1.54	120mins	0.73
43	DunhevedRdandJohnOxleyAve	2.93	1.38	4.31	120mins	0.77
44	HumeCres	0.29	0.04	0.33	30mins	0.33
45	HeaveySt	0.30	1.83	2.13	120mins	0.80
46	ArmsteinCresandDannySt	0.09	0.14	0.23	30mins	0.33
47	ArmsteinCres	0.17	1.09	1.26	120mins	0.77
48	ArmsteinCresandInnesPl	0.51	0.00	0.51	120mins	0.80
49	VictoriaStbelowReindeerPl	0.57	0.08	0.65	120mins	0.77
50	VictoriaStCloseRailway	0.07	0.27	0.33	120mins	0.87
51	RailwayNearUniversity	0.44	0.00	0.44	120mins	0.77
52	VictoriaStandBurtonSt	0.17	0.00	0.17	120mins	0.73

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	0.86	-0.12	0.74	120mins	0.80
54	CarleenCl	1.31	0.32	1.62	120mins	0.73
55	DeslieAve	0.16	0.28	0.44	120mins	0.63
56	ImpalaAve	0.43	0.21	0.64	30mins	0.33
57	GlencoeAveandBurtonSt	2.57	1.23	3.80	30mins	0.33
58	ChisholmAveandBurtonSt	1.86	0.65	2.51	30mins	0.33
59	WerringtonLake	19.64	0.00	19.64	120mins	0.87
60	FrancisSt	4.21	3.68	7.89	120mins	0.87
61	GlencoeAve	4.65	1.93	6.58	120mins	0.87
62	GlencoeAveNearBeverleyPl	4.93	1.53	6.46	120mins	0.80
63	DunbarAve	3.97	2.03	6.01	120mins	0.80
64	RugbyStandOrletonPl	3.35	2.08	5.43	120mins	0.80
65	OrletonPl	2.50	0.73	3.23	120mins	0.80
66	DunhevedRd	0.76	1.14	1.91	120mins	0.77
67	FrancisStN	0.74	0.24	0.98	120mins	0.70
68	BenineDr	0.65	0.42	1.06	30mins	0.33
69	WilliamSt	6.62	4.11	10.74	120mins	0.80
70	SuttonRd	6.62	3.36	9.98	120mins	0.77
71	TwickhenhamAveandNeetaAve	2.98	0.99	3.97	120mins	0.77
72	WembleyAve	2.18	0.89	3.08	120mins	0.73
73	RugbyStN	1.56	0.73	2.29	30mins	0.33
74	SuttonRdandWillamSt	3.02	1.64	4.66	30mins	0.37
75	TwickenhamAve	0.32	0.27	0.59	30mins	0.33
76	WrenchStandWilliamSt	2.27	0.54	2.80	30mins	0.33
77	JordonSt	0.86	0.22	1.08	30mins	0.33
78	HarrowRd	3.76	0.49	4.25	120mins	0.87
79	HerbertSt	5.42	8.09	13.50	120mins	0.87
80	WeatherbyAveandCamptonAve	8.70	4.30	13.00	120mins	0.83
81	WrenchStNearDevonRd	9.64	3.44	13.08	120mins	0.80
82	CambridgeSt	3.55	1.77	5.32	120mins	0.80
83	LincolnDr	2.71	1.03	3.74	120mins	0.73
84	CheltenhamAve	0.68	0.20	0.88	30mins	0.33
85	AberdeenSt	0.79	0.19	0.99	30mins	0.33
86	StirlingSt	1.04	0.11	1.15	30mins	0.37
87	DevonRd	0.63	0.10	0.73	30mins	0.33
88	EppingCl	1.22	0.25	1.47	30mins	0.37
89	SandringhamAve	1.62	0.36	1.98	30mins	0.33
90	CottageSt	0.61	0.09	0.70	120mins	0.77
91	VictoriaStnearParkAve	2.19	2.97	5.16	120mins	1.00
92	railwayNearVictoriaSt	0.01	4.94	4.94	120mins	1.03
93	GreatWesternHwy	0.01	5.30	5.32	120mins	0.83
94	KerranCl	1.76	0.00	1.76	120mins	0.77
95	WeatherbyAve	1.50	0.54	2.03	120mins	0.73
96	WrenchSt	1.36	0.19	1.55	30mins	0.33
97	GreatWesternHwyNearFrenchSt	0.48	0.79	1.27	120mins	0.80
98	ParkAve	6.19	3.93	10.11	120mins	0.80
99	AmarooSt	3.70	2.73	6.42	120mins	0.83
100	JosephSt	3.02	2.43	5.46	120mins	0.77
101	WalterSt	2.74	2.11	4.85	120mins	0.77
102	VictoriaStW	1.79	0.80	2.59	120mins	0.73
103	CollegeSt	0.47	0.27	0.74	30mins	0.33
104	WalterStandParkAve	2.14	1.03	3.16	120mins	0.77
105	GreatWesternHwyNearSantleyCres	16.38	16.07	32.45	120mins	1.20

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	5.24	0.08	5.32	120mins	1.27
107	DougRennieField	21.33	8.12	29.45	120mins	1.13
108	FirstStN	20.12	8.39	28.51	120mins	1.23
109	BringellyRdNearFirst	18.43	9.52	27.95	120mins	1.20
110	HargraveSt	11.76	1.86	13.63	120mins	1.17
111	DerbySy	12.56	7.30	19.86	120mins	1.10
112	StaffordSyNearBringellyRd	5.38	5.67	11.06	120mins	1.00
113	StaffordSt	8.00	0.00	8.00	120mins	1.00
114	JamisonRd	15.21	2.93	18.14	120mins	0.90
115	StapleySt	3.59	3.55	7.13	120mins	0.87
116	StapleyStandClemsonSt	6.39	3.75	10.14	120mins	0.87
117	ClemsonSt	0.73	0.36	1.09	30mins	0.33
118	LucySt	7.14	6.47	13.61	120mins	0.87
119	SmithSt	7.22	5.31	12.53	120mins	0.83
120	OagCresandTentSt	4.59	4.23	8.81	120mins	0.83
121	TentSt	2.51	3.12	5.63	120mins	0.80
122	TentStandPiperCl	3.00	2.13	5.12	120mins	0.97
123	PiperCl	0.18	0.41	0.59	120mins	0.80
124	BringellyRd	0.80	0.30	1.11	120mins	0.73
125	BringellyRdandCaddensSt	3.57	1.43	5.01	120mins	0.93
126	AngophoraAve	0.55	0.13	0.68	120mins	0.70
127	CaddensRd	1.50	0.63	2.14	120mins	0.73
128	OagCres	1.39	0.61	2.00	120mins	0.77
129	TheNorthernRd	0.87	0.24	1.12	120mins	0.73
130	ElliottSt	0.74	0.71	1.45	30mins	0.37
131	GladysSt	1.16	0.55	1.71	30mins	0.33
132	SomersetNearHargraveSt	1.58	0.22	1.80	120mins	0.73
133	SomersetStandDerbySt	0.45	0.10	0.55	120mins	0.73
134	OrthSt	6.56	2.30	8.86	120mins	0.83
135	SomersetSt	5.43	2.18	7.61	120mins	0.77
136	GreatWesternHwySomersetSt	2.62	0.00	2.62	120mins	0.77
137	GreatWesternHwyHospital	0.00	2.30	2.31	120mins	0.97
138	RailwaynearHospital	0.00	4.65	4.66	120mins	0.97
139	CoxAve	7.99	1.10	9.09	120mins	0.73
140	CopelandSt	3.77	0.67	4.44	120mins	0.73
141	PhillipSt	1.26	0.56	1.82	30mins	0.37
142	GascoigneSt	0.42	0.31	0.72	30mins	0.33
143	RichmondRd	0.22	0.03	0.25	30mins	0.33
144	SecondAveandJonesSt	3.95	4.47	8.42	120mins	0.80
145	BadenPowellAve	1.27	3.25	4.53	120mins	0.77
146	FirstSt	0.85	0.83	1.68	120mins	0.73
147	BadenPowellAveandFirstSt	1.10	0.54	1.64	120mins	0.77
148	BringellyRdNearJamisonRd	0.08	0.24	0.31	30mins	0.33
149	FuryStandStockAve	1.25	2.56	3.81	120mins	0.83
150	PeppermintCres	0.56	1.14	1.70	120mins	0.73
151	PeppermintCresandYeelannaPl	1.92	0.46	2.38	120mins	0.73
152	AngophoraAveand PeppermintCres	0.26	0.53	0.79	30mins	0.33
153	ChapmanGardens	3.75	4.67	8.42	120mins	0.83
154	SecondAveandManningSt	3.97	4.27	8.24	120mins	0.77
155	EdnaSt	4.29	3.48	7.78	120mins	0.77
156	EdwardSt	0.54	1.90	2.44	120mins	0.73
157	ManningSt	1.05	1.55	2.59	120mins	0.70
158	CasuarinaCircuitandMaculataPl	0.25	0.20	0.45	120mins	0.70

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	1.72	2.54	4.26	120mins	0.73
160	CaddensRdandCaddaRidgeDr	1.02	0.08	1.10	120mins	0.70
161	KearneyAve	0.81	0.00	0.81	120mins	0.80
162	CaddaRidgeDr	3.96	2.68	6.64	120mins	0.73
163	BringellyRdandGreatWesternHwy	0.00	0.86	0.86	30mins	0.37

Peak 0.5% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	140.00	140.00	30mins	1.13
2	JohnOxleyAveWerringtonCreek	0.00	92.57	92.57	30mins	0.90
3	JohnOxleyAve	48.05	0.02	48.07	30mins	0.93
4	BurtonSt	9.20	122.70	131.90	30mins	0.80
5	VictoriaSt	67.31	63.20	130.50	30mins	1.07
6	Railway	48.38	83.59	131.97	30mins	1.00
7	GreatWesternHwyCollegeCreek	59.97	23.79	83.76	30mins	0.87
8	CosgroveCres	50.15	7.87	58.02	30mins	0.80
9	SecondAve	44.53	15.56	60.08	30mins	0.77
10	LamrockReserve	23.30	8.37	31.67	30mins	0.73
11	OConnellSt	16.68	0.59	17.27	30mins	0.40
12	OConnellStJohnFlakAve	45.53	8.91	54.43	30mins	0.67
13	CaddaRidgeDrOConnellLn	17.07	19.13	36.20	30mins	0.60
14	CaddensRdandOConnellLn	31.27	0.86	32.13	30mins	0.57
15	CastleRd	4.07	0.38	4.44	30mins	0.33
16	CastleRdcloseKingswood	13.91	0.28	14.19	30mins	0.43
17	KingswoodRd	9.55	1.58	11.13	30mins	0.33
18	WerringtonCreekNearDunheved	-0.01	8.19	8.18	30mins	2.50
19	ParkesAve	4.72	0.02	4.74	30mins	0.40
20	IrwinSt	1.94	1.22	3.17	30mins	0.73
21	DunkleyPl	3.63	1.08	4.71	30mins	0.67
22	PrincessSt	9.62	0.36	9.98	30mins	0.63
23	AlbertStNearEdwardCl	6.13	0.52	6.66	30mins	0.40
25	VictoriaStNearLethBridgeAve	1.58	0.12	1.70	30mins	0.33
26	ParkesAvenueSportingComplex	7.19	0.68	7.87	30mins	1.87
27	AlbertSt	8.45	1.01	9.46	30mins	0.60
28	VictoriaStParkesAve	3.10	1.76	4.86	30mins	1.40
29	VictoriaStGibsonAve	1.48	0.23	1.71	30mins	0.33
30	WerringtonStation	0.00	4.60	4.60	30mins	1.00
31	ChapmanSt	8.53	-0.08	8.45	30mins	1.20
32	WalkerSt	9.56	0.80	10.36	30mins	0.70
33	HeaveyStandLethbridgeAve	1.36	0.59	1.95	30mins	0.33
34	HumeCresNearPrinceSt	3.00	0.30	3.30	30mins	0.33
35	PrinceStandJohnOxleyAve	20.18	6.51	26.69	30mins	0.37
36	PrinceSt	2.05	0.86	2.91	30mins	0.33
37	BurkeAve	1.76	0.25	2.01	30mins	0.33
38	CharlesSturtDr	19.22	5.95	25.17	30mins	0.37
39	ChisholmAve	19.05	4.61	23.66	30mins	0.37
40	HuntPl	16.57	3.48	20.05	30mins	0.37
41	RugbySt	13.38	3.36	16.74	30mins	0.37
42	CharlesToddCresandRugbySt	3.24	0.75	3.99	30mins	0.33
43	DunhevedRdandJohnOxleyAve	8.78	1.25	10.04	30mins	0.37
44	HumeCres	0.77	0.10	0.88	30mins	0.33
45	HeaveySt	1.91	2.19	4.10	30mins	0.43
46	ArmsteinCresandDannySt	0.34	0.14	0.48	30mins	0.33
47	ArmsteinCres	1.51	1.40	2.92	30mins	0.33
48	ArmsteinCresandInnesPl	2.13	0.00	2.13	30mins	0.33
49	VictoriaStbelowReindeerPl	1.45	0.08	1.52	30mins	0.33
50	VictoriaStCloseRailway	0.01	0.42	0.43	30mins	0.33
51	RailwayNearUniversity	0.66	0.00	0.66	30mins	0.33
52	VictoriaStandBurtonSt	0.30	0.00	0.30	30mins	0.33

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	1.46	-0.12	1.34	30mins	0.37
54	CarleenCl	3.78	0.31	4.09	30mins	0.33
55	DeslieAve	0.12	0.30	0.42	120mins	0.70
56	ImpalaAve	1.32	0.22	1.54	30mins	0.33
57	GlencoeAveandBurtonSt	8.28	1.30	9.58	30mins	0.33
58	ChisholmAveandBurtonSt	4.96	0.68	5.64	30mins	0.33
59	WerringtonLake	40.19	0.00	40.19	30mins	0.43
60	FrancisSt	13.53	3.83	17.36	30mins	0.53
61	GlencoeAve	11.92	1.88	13.81	30mins	0.43
62	GlencoeAveNearBeverleyPl	12.34	1.48	13.82	30mins	0.40
63	DunbarAve	11.59	1.98	13.57	30mins	0.40
64	RugbyStandOrletonPl	9.96	2.15	12.11	30mins	0.37
65	OrletonPl	7.17	0.72	7.89	30mins	0.37
66	DunhevedRd	3.92	0.95	4.87	30mins	0.33
67	FrancisStN	2.21	0.24	2.45	30mins	0.33
68	BenineDr	1.85	0.36	2.21	30mins	0.33
69	WilliamSt	20.82	4.24	25.06	30mins	0.40
70	SuttonRd	19.97	3.36	23.33	30mins	0.37
71	TwickhenhamAveandNeetaAve	8.45	0.96	9.41	30mins	0.37
72	WembleyAve	6.47	0.86	7.33	30mins	0.33
73	RugbyStN	3.81	0.70	4.51	30mins	0.33
74	SuttonRdandWillamSt	9.41	1.62	11.03	30mins	0.33
75	TwickenhamAve	0.78	0.24	1.02	30mins	0.33
76	WrenchStandWilliamSt	5.77	0.56	6.33	30mins	0.33
77	JordonSt	2.15	0.21	2.36	30mins	0.33
78	HarrowRd	8.83	0.53	9.35	30mins	0.50
79	HerbertSt	24.16	10.05	34.22	30mins	0.47
80	WeatherbyAveandCamptonAve	23.94	4.95	28.90	30mins	0.40
81	WrenchStNearDevonRd	26.41	3.89	30.30	30mins	0.37
82	CambridgeSt	10.37	1.77	12.14	30mins	0.40
83	LincolnDr	8.41	1.01	9.41	30mins	0.33
84	CheltenhamAve	1.89	0.19	2.08	30mins	0.33
85	AberdeenSt	1.96	0.18	2.14	30mins	0.33
86	StirlingSt	2.52	0.11	2.62	30mins	0.33
87	DevonRd	1.77	0.20	1.98	30mins	0.33
88	EppingCl	3.36	0.22	3.58	30mins	0.33
89	SandringhamAve	4.02	0.43	4.45	30mins	0.33
90	CottageSt	1.71	0.14	1.85	30mins	0.33
91	VictoriaStnearParkAve	13.80	2.69	16.50	30mins	0.57
92	railwayNearVictoriaSt	10.38	5.13	15.50	30mins	0.47
93	GreatWesternHwy	4.66	8.13	12.79	30mins	0.40
94	KerranCl	4.87	0.00	4.87	30mins	0.33
95	WeatherbyAve	4.60	0.54	5.14	30mins	0.33
96	WrenchSt	3.34	0.20	3.55	30mins	0.33
97	GreatWesternHwyNearFrenchSt	3.88	0.57	4.45	30mins	0.37
98	ParkAve	17.22	4.08	21.29	30mins	0.40
99	AmarooSt	11.02	2.86	13.87	30mins	0.43
100	JosephSt	8.21	2.49	10.70	30mins	0.40
101	WalterSt	8.59	1.88	10.47	30mins	0.37
102	VictoriaStW	5.94	0.79	6.73	30mins	0.33
103	CollegeSt	1.22	0.25	1.47	30mins	0.33
104	WalterStandParkAve	6.15	0.91	7.06	30mins	0.33
105	GreatWesternHwyNearSantleyCres	37.61	17.12	54.72	30mins	0.80

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	15.84	0.07	15.90	30mins	0.83
107	DougRennieField	39.52	8.48	48.00	30mins	0.77
108	FirstStN	41.25	8.64	49.89	30mins	0.80
109	BringellyRdNearFirst	40.61	9.98	50.59	30mins	0.77
110	HargraveSt	32.20	1.68	33.88	30mins	0.67
111	DerbySy	33.13	8.28	41.41	30mins	0.67
112	StaffordSyNearBringellyRd	16.03	6.65	22.68	30mins	0.60
113	StaffordSt	17.99	0.00	17.99	30mins	0.60
114	JamisonRd	35.80	2.98	38.78	30mins	0.50
115	StapleySt	11.79	3.82	15.61	30mins	0.47
116	StapleyStandClemsonSt	16.97	4.22	21.19	30mins	0.57
117	ClemsonSt	2.12	0.30	2.42	30mins	0.33
118	LucySt	22.13	7.49	29.62	30mins	0.57
119	SmithSt	22.20	5.80	27.99	30mins	0.57
120	OagCresandTentSt	18.02	4.14	22.16	30mins	0.53
121	TentSt	13.60	3.69	17.29	30mins	0.50
122	TentStandPiperCl	13.18	2.84	16.02	30mins	0.50
123	PiperCl	0.97	0.40	1.36	30mins	0.37
124	BringellyRd	2.73	0.30	3.03	30mins	0.33
125	BringellyRdandCaddensSt	13.80	1.90	15.70	30mins	0.43
126	AngophoraAve	1.89	0.12	2.01	30mins	0.33
127	CaddensRd	3.89	0.70	4.59	30mins	0.33
128	OagCres	3.88	0.66	4.54	30mins	0.33
129	TheNorthernRd	2.25	0.25	2.51	30mins	0.33
130	ElliottSt	1.99	0.68	2.67	30mins	0.33
131	GladysSt	3.04	0.54	3.58	30mins	0.33
132	SomersetNearHargraveSt	3.61	0.29	3.90	30mins	0.33
133	SomersetStandDerbySt	1.29	0.07	1.36	30mins	0.33
134	OrthSt	13.05	2.35	15.40	30mins	0.40
135	SomersetSt	10.02	2.24	12.25	30mins	0.37
136	GreatWesternHwySomersetSt	4.09	0.00	4.09	30mins	0.33
137	GreatWesternHwyHospital	0.00	2.37	2.37	30mins	0.97
138	RailwaynearHospital	0.00	5.13	5.13	30mins	0.63
139	CoxAve	18.99	0.94	19.93	30mins	0.37
140	CopelandSt	9.47	0.64	10.11	30mins	0.33
141	PhillipSt	3.78	0.54	4.32	30mins	0.33
142	GascoigneSt	1.50	0.27	1.77	30mins	0.33
143	RichmondRd	0.48	0.05	0.53	30mins	0.33
144	SecondAveandJonesSt	11.34	4.74	16.09	30mins	0.43
145	BadenPowellAve	6.33	3.51	9.84	30mins	0.67
146	FirstSt	2.04	0.82	2.87	30mins	0.33
147	BadenPowellAveandFirstSt	2.43	0.67	3.10	30mins	0.33
148	BringellyRdNearJamisonRd	0.29	0.32	0.61	30mins	0.33
149	FuryStandStockAve	6.24	2.60	8.83	30mins	0.63
150	PeppermintCres	8.71	1.33	10.03	30mins	0.50
151	PeppermintCresandYeelannaPl	5.85	0.32	6.16	30mins	0.33
152	AngophoraAveand PeppermintCres	1.01	0.51	1.52	30mins	0.33
153	ChapmanGardens	12.57	4.75	17.32	30mins	0.40
154	SecondAveandManningSt	13.21	4.27	17.48	30mins	0.37
155	EdnaSt	11.66	4.03	15.69	30mins	0.37
156	EdwardSt	2.57	2.14	4.71	30mins	0.67
157	ManningSt	10.06	2.04	12.09	30mins	0.47
158	CasuarinaCircuitandMaculataPl	0.90	0.22	1.12	30mins	0.33

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	8.53	2.50	11.03	30mins	0.33
160	CaddensRdandCaddaRidgeDr	2.70	0.17	2.87	30mins	0.33
161	KearneyAve	2.81	0.00	2.81	30mins	0.33
162	CaddaRidgeDr	13.66	2.67	16.33	30mins	0.33
163	BringellyRdandGreatWesternHwy	-0.01	1.18	1.17	30mins	0.33

Peak 0.2% AEP Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	0.00	165.82	165.82	30mins	1.47
2	JohnOxleyAveWerringtonCreek	0.01	99.52	99.53	30mins	0.83
3	JohnOxleyAve	66.84	0.02	66.87	30mins	0.87
4	BurtonSt	17.99	137.96	155.95	30mins	1.17
5	VictoriaSt	100.20	67.06	167.26	30mins	1.03
6	Railway	91.53	85.08	176.61	30mins	0.97
7	GreatWesternHwyCollegeCreek	88.71	23.71	112.43	30mins	0.83
8	CosgroveCres	66.82	8.05	74.87	30mins	0.77
9	SecondAve	62.43	16.19	78.62	30mins	0.70
10	LamrockReserve	32.44	8.63	41.06	30mins	0.67
11	OConnellSt	23.21	0.48	23.69	30mins	0.63
12	OConnellStJohnFlakAve	61.65	8.74	70.40	30mins	0.63
13	CaddaRidgeDrOConnellLn	22.51	23.44	45.94	30mins	0.57
14	CaddensRdandOConnellLn	40.54	0.94	41.48	30mins	0.53
15	CastleRd	5.02	0.39	5.40	30mins	0.33
16	CastleRdcloseKingswood	19.40	0.24	19.64	30mins	0.40
17	KingswoodRd	13.80	1.66	15.46	30mins	0.37
18	WerringtonCreekNearDunheved	0.01	9.10	9.11	30mins	2.50
19	ParkesAve	5.86	0.03	5.88	30mins	0.37
20	IrwinSt	3.45	1.25	4.70	30mins	0.67
21	DunkleyPl	5.89	1.04	6.94	30mins	0.73
22	PrincessSt	13.53	0.35	13.88	30mins	0.60
23	AlbertStNearEdwardCl	7.53	0.52	8.05	30mins	0.40
25	VictoriaStNearLethBridgeAve	1.86	0.11	1.97	30mins	0.33
26	ParkesAvenueSportingComplex	6.43	0.70	7.13	30mins	2.10
27	AlbertSt	8.90	0.98	9.88	30mins	0.50
28	VictoriaStParkesAve	3.87	1.52	5.39	30mins	0.33
29	VictoriaStGibsonAve	1.91	0.24	2.15	30mins	0.33
30	WerringtonStation	0.00	4.88	4.88	30mins	1.10
31	ChapmanSt	18.34	-0.15	18.20	30mins	1.33
32	WalkerSt	15.91	0.19	16.09	30mins	1.10
33	HeaveyStandLethbridgeAve	1.73	0.60	2.32	30mins	0.33
34	HumeCresNearPrinceSt	3.53	0.30	3.83	30mins	0.33
35	PrinceStandJohnOxleyAve	24.92	6.57	31.49	30mins	0.37
36	PrinceSt	2.56	0.80	3.37	30mins	0.33
37	BurkeAve	2.07	0.24	2.32	30mins	0.33
38	CharlesSturtDr	24.23	6.01	30.25	30mins	0.37
39	ChisholmAve	23.60	4.61	28.21	30mins	0.37
40	HuntPl	20.60	3.47	24.07	30mins	0.37
41	RugbySt	16.71	3.34	20.05	30mins	0.37
42	CharlesToddCresandRugbySt	3.84	0.76	4.60	30mins	0.33
43	DunhevedRdandJohnOxleyAve	10.71	1.24	11.94	30mins	0.37
44	HumeCres	0.96	0.12	1.08	30mins	0.33
45	HeaveySt	2.75	2.21	4.96	30mins	0.43
46	ArmsteinCresandDannySt	0.39	0.13	0.53	30mins	0.33
47	ArmsteinCres	2.05	1.46	3.51	30mins	0.33
48	ArmsteinCresandInnesPl	2.79	0.00	2.79	30mins	0.33
49	VictoriaStbelowReindeerPl	1.73	0.08	1.80	30mins	0.33
50	VictoriaStCloseRailway	0.03	0.46	0.50	30mins	0.33
51	RailwayNearUniversity	0.73	0.00	0.73	30mins	0.33
52	VictoriaStandBurtonSt	0.33	0.00	0.33	30mins	0.33

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	1.62	-0.12	1.51	30mins	0.50
54	CarleenCl	4.63	0.30	4.93	30mins	0.33
55	DeslieAve	0.22	0.28	0.50	30mins	0.20
56	ImpalaAve	1.55	0.21	1.77	30mins	0.33
57	GlencoeAveandBurtonSt	9.86	1.30	11.16	30mins	0.33
58	ChisholmAveandBurtonSt	5.85	0.70	6.54	30mins	0.33
59	WerringtonLake	46.66	0.00	46.66	30mins	0.43
60	FrancisSt	17.01	3.82	20.82	30mins	0.47
61	GlencoeAve	13.82	1.89	15.71	30mins	0.43
62	GlencoeAveNearBeverleyPl	14.67	1.45	16.13	30mins	0.40
63	DunbarAve	14.15	1.97	16.12	30mins	0.40
64	RugbyStandOrletonPl	12.37	2.15	14.52	30mins	0.37
65	OrletonPl	8.60	0.72	9.32	30mins	0.37
66	DunhevedRd	4.79	0.96	5.75	30mins	0.33
67	FrancisStN	2.61	0.24	2.86	30mins	0.33
68	BenineDr	2.18	0.36	2.54	30mins	0.33
69	WilliamSt	24.97	4.26	29.23	30mins	0.40
70	SuttonRd	23.98	3.33	27.31	30mins	0.37
71	TwickhenhamAveandNeetaAve	10.31	0.96	11.27	30mins	0.37
72	WembleyAve	7.85	0.85	8.71	30mins	0.33
73	RugbyStN	4.52	0.69	5.21	30mins	0.33
74	SuttonRdandWillamSt	11.05	1.61	12.66	30mins	0.33
75	TwickenhamAve	0.85	0.23	1.09	30mins	0.33
76	WrenchStandWilliamSt	6.76	0.57	7.33	30mins	0.33
77	JordonSt	2.52	0.21	2.73	30mins	0.33
78	HarrowRd	10.73	0.52	11.26	30mins	0.50
79	HerbertSt	29.90	10.45	40.35	30mins	0.43
80	WeatherbyAveandCamptonAve	28.06	4.98	33.04	30mins	0.40
81	WrenchStNearDevonRd	32.06	3.96	36.01	30mins	0.37
82	CambridgeSt	12.08	1.75	13.83	30mins	0.37
83	LincolnDr	9.64	1.00	10.64	30mins	0.33
84	CheltenhamAve	2.23	0.19	2.42	30mins	0.33
85	AberdeenSt	2.29	0.18	2.48	30mins	0.33
86	StirlingSt	2.97	0.10	3.08	30mins	0.33
87	DevonRd	2.08	0.23	2.31	30mins	0.33
88	EppingCl	3.95	0.22	4.17	30mins	0.33
89	SandringhamAve	4.53	0.42	4.95	30mins	0.33
90	CottageSt	2.05	0.14	2.19	30mins	0.33
91	VictoriaStnearParkAve	19.55	2.66	22.21	30mins	0.50
92	railwayNearVictoriaSt	15.48	5.15	20.63	30mins	0.43
93	GreatWesternHwy	8.06	8.86	16.93	30mins	0.37
94	KerranCl	5.74	0.00	5.74	30mins	0.33
95	WeatherbyAve	5.54	0.54	6.08	30mins	0.33
96	WrenchSt	3.91	0.21	4.12	30mins	0.33
97	GreatWesternHwyNearFrenchSt	5.06	0.52	5.58	30mins	0.37
98	ParkAve	20.84	4.12	24.96	30mins	0.40
99	AmarooSt	13.20	2.87	16.06	30mins	0.43
100	JosephSt	9.96	2.51	12.47	30mins	0.40
101	WalterSt	10.86	1.85	12.71	30mins	0.37
102	VictoriaStW	7.07	0.77	7.84	30mins	0.33
103	CollegeSt	1.43	0.24	1.67	30mins	0.33
104	WalterStandParkAve	7.46	0.89	8.35	30mins	0.33
105	GreatWesternHwyNearSantleyCres	48.49	15.71	64.20	30mins	0.80

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	21.70	0.06	21.77	30mins	0.80
107	DougRennieField	47.87	8.55	56.42	30mins	0.73
108	FirstStN	49.90	8.70	58.60	30mins	0.80
109	BringellyRdNearFirst	49.55	9.93	59.48	30mins	0.63
110	HargraveSt	41.24	1.67	42.91	30mins	0.70
111	DerbySy	41.84	8.44	50.29	30mins	0.67
112	StaffordSyNearBringellyRd	19.78	6.91	26.70	30mins	0.60
113	StaffordSt	21.44	0.00	21.44	30mins	0.60
114	JamisonRd	43.05	3.00	46.05	30mins	0.50
115	StapleySt	15.23	3.86	19.09	30mins	0.50
116	StapleyStandClemsonSt	20.91	4.36	25.26	30mins	0.50
117	ClemsonSt	2.51	0.29	2.81	30mins	0.33
118	LucySt	28.16	7.86	36.02	30mins	0.53
119	SmithSt	28.11	6.06	34.17	30mins	0.53
120	OagCresandTentSt	22.67	4.15	26.82	30mins	0.50
121	TentSt	18.07	3.74	21.81	30mins	0.50
122	TentStandPiperCl	16.96	3.01	19.97	30mins	0.47
123	PiperCl	1.32	0.39	1.71	30mins	0.37
124	BringellyRd	3.37	0.30	3.66	30mins	0.33
125	BringellyRdandCaddensSt	17.31	2.01	19.32	30mins	0.40
126	AngophoraAve	2.35	0.12	2.47	30mins	0.33
127	CaddensRd	4.86	0.71	5.57	30mins	0.33
128	OagCres	4.22	0.65	4.88	30mins	0.33
129	TheNorthernRd	2.60	0.26	2.86	30mins	0.33
130	ElliottSt	2.32	0.68	2.99	30mins	0.33
131	GladysSt	3.53	0.53	4.07	30mins	0.33
132	SomersetNearHargraveSt	4.37	0.29	4.66	30mins	0.33
133	SomersetStandDerbySt	1.45	0.06	1.52	30mins	0.33
134	OrthSt	15.15	2.33	17.48	30mins	0.40
135	SomersetSt	11.97	2.26	14.23	30mins	0.33
136	GreatWesternHwySomersetSt	4.55	0.00	4.55	30mins	0.33
137	GreatWesternHwyHospital	0.00	2.35	2.35	30mins	1.00
138	RailwaynearHospital	0.00	5.24	5.24	30mins	0.63
139	CoxAve	22.56	1.00	23.56	30mins	0.33
140	CopelandSt	11.82	0.61	12.43	30mins	0.33
141	PhillipSt	4.62	0.54	5.15	30mins	0.33
142	GascoigneSt	1.77	0.27	2.04	30mins	0.33
143	RichmondRd	0.56	0.05	0.61	30mins	0.33
144	SecondAveandJonesSt	13.85	4.77	18.62	30mins	0.43
145	BadenPowellAve	10.15	3.47	13.62	30mins	0.60
146	FirstSt	2.43	0.80	3.23	30mins	0.33
147	BadenPowellAveandFirstSt	2.91	0.68	3.59	30mins	0.33
148	BringellyRdNearJamisonRd	0.37	0.34	0.71	30mins	0.33
149	FuryStandStockAve	9.05	2.57	11.62	30mins	0.57
150	PeppermintCres	12.08	1.25	13.32	30mins	0.47
151	PeppermintCresandYeelannaPl	6.93	0.31	7.24	30mins	0.33
152	AngophoraAveand PeppermintCres	1.18	0.49	1.68	30mins	0.33
153	ChapmanGardens	15.45	4.76	20.21	30mins	0.37
154	SecondAveandManningSt	16.09	4.29	20.38	30mins	0.37
155	EdnaSt	14.28	4.08	18.37	30mins	0.33
156	EdwardSt	5.40	2.12	7.52	30mins	0.63
157	ManningSt	14.45	2.01	16.46	30mins	0.43
158	CasuarinaCircuitandMaculataPl	1.09	0.21	1.29	30mins	0.33

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	10.90	2.37	13.27	30mins	0.33
160	CaddensRdandCaddaRidgeDr	3.16	0.18	3.34	30mins	0.33
161	KearneyAve	4.06	0.00	4.06	30mins	0.33
162	CaddaRidgeDr	16.49	2.67	19.16	30mins	0.33
163	BringellyRdandGreatWesternHwy	-0.01	1.19	1.18	30mins	0.33

Peak PMF Discharges

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
1	DunhevedRdWerringtonCreek	8.61	541.39	549.99	120mins	1.63
2	JohnOxleyAveWerringtonCreek	40.87	127.40	168.27	120mins	1.27
3	JohnOxleyAve	423.85	0.01	423.86	120mins	1.30
4	BurtonSt	221.85	230.50	452.34	120mins	1.27
5	VictoriaSt	504.93	55.74	560.66	120mins	1.17
6	Railway	452.26	75.57	527.83	120mins	1.07
7	GreatWesternHwyCollegeCreek	241.47	17.14	258.61	120mins	1.00
8	CosgroveCres	167.81	6.02	173.83	30mins	0.53
9	SecondAve	210.17	8.10	218.27	30mins	0.50
10	LamrockReserve	101.81	9.77	111.59	30mins	0.47
11	OConnellSt	75.57	0.24	75.82	30mins	0.43
12	OConnellStJohnFlakAve	189.12	0.07	189.18	30mins	0.43
13	CaddaRidgeDrOConnellLn	85.26	28.17	113.43	30mins	0.40
14	CaddensRdandOConnellLn	98.69	1.05	99.74	30mins	0.37
15	CastleRd	7.63	0.34	7.97	30mins	0.20
16	CastleRdcloseKingswood	38.74	0.48	39.22	30mins	0.30
17	KingswoodRd	24.57	1.66	26.22	30mins	0.27
18	WerringtonCreekNearDunheved	48.78	11.06	59.85	360mins	3.87
19	ParkesAve	8.32	0.00	8.32	360mins	4.03
20	IrwinSt	13.17	1.30	14.47	30mins	0.47
21	DunkleyPl	18.03	1.04	19.07	30mins	0.47
22	PrincessSt	30.44	0.37	30.81	30mins	0.43
23	AlbertStNearEdwardCl	16.59	0.41	17.00	30mins	0.40
25	VictoriaStNearLethBridgeAve	2.69	0.11	2.80	30mins	0.20
26	ParkesAvenueSportingComplex	43.84	0.47	44.31	120mins	1.73
27	AlbertSt	47.70	0.65	48.36	120mins	1.63
28	VictoriaStParkesAve	28.19	1.55	29.74	120mins	1.17
29	VictoriaStGibsonAve	26.34	-0.03	26.30	120mins	1.63
30	WerringtonStation	48.17	4.76	52.93	120mins	1.50
31	ChapmanSt	31.58	0.07	31.65	120mins	1.53
32	WalkerSt	39.62	0.47	40.10	30mins	0.40
33	HeaveyStandLethbridgeAve	3.16	0.61	3.77	30mins	0.23
34	HumeCresNearPrinceSt	4.65	0.29	4.94	30mins	0.23
35	PrinceStandJohnOxleyAve	102.46	3.28	105.74	120mins	1.27
36	PrinceSt	5.87	0.52	6.38	120mins	1.30
37	BurkeAve	2.88	0.23	3.11	30mins	0.20
38	CharlesSturtDr	45.54	5.78	51.32	30mins	0.30
39	ChisholmAve	43.23	4.60	47.83	30mins	0.27
40	HuntPl	37.96	3.45	41.41	30mins	0.27
41	RugbySt	31.31	3.27	34.58	30mins	0.27
42	CharlesToddCresandRugbySt	5.72	0.76	6.48	30mins	0.20
43	DunhevedRdandJohnOxleyAve	19.20	1.17	20.37	30mins	0.27
44	HumeCres	1.42	0.14	1.57	30mins	0.20
45	HeaveySt	22.46	1.10	23.57	120mins	1.23
46	ArmsteinCresandDannySt	0.51	0.15	0.65	30mins	0.17
47	ArmsteinCres	3.91	1.60	5.51	30mins	0.37
48	ArmsteinCresandInnesPl	6.80	0.00	6.80	30mins	0.37
49	VictoriaStbelowReindeerPl	4.18	0.08	4.26	30mins	0.33
50	VictoriaStCloseRailway	1.24	0.69	1.92	30mins	0.33
51	RailwayNearUniversity	4.09	0.00	4.09	30mins	0.33
52	VictoriaStandBurtonSt	0.30	0.00	0.30	30mins	0.20

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
53	BurtonStLackPl	2.39	-0.12	2.27	30mins	0.20
54	CarleenCl	16.65	0.15	16.80	120mins	1.23
55	DeslieAve	0.24	0.28	0.52	120mins	0.23
56	ImpalaAve	2.14	0.21	2.35	30mins	0.20
57	GlencoeAveandBurtonSt	14.88	1.31	16.19	30mins	0.20
58	ChisholmAveandBurtonSt	8.50	0.70	9.21	30mins	0.17
59	WerringtonLake	159.71	0.00	159.71	120mins	1.17
60	FrancisSt	39.60	3.80	43.40	30mins	0.33
61	GlencoeAve	23.00	2.03	25.03	30mins	0.33
62	GlencoeAveNearBeverleyPl	27.65	1.46	29.11	30mins	0.30
63	DunbarAve	28.39	1.94	30.33	30mins	0.27
64	RugbyStandOrletonPl	24.17	2.15	26.32	30mins	0.27
65	OrletonPl	14.84	0.70	15.54	30mins	0.23
66	DunhevedRd	7.82	0.93	8.75	30mins	0.20
67	FrancisStN	3.81	0.24	4.06	30mins	0.20
68	BenineDr	3.11	0.36	3.47	30mins	0.17
69	WilliamSt	43.31	4.32	47.63	30mins	0.27
70	SuttonRd	39.33	3.27	42.60	30mins	0.23
71	TwickhenhamAveandNeetaAve	17.35	0.95	18.30	30mins	0.23
72	WembleyAve	11.96	0.84	12.80	30mins	0.23
73	RugbyStN	6.85	0.68	7.53	30mins	0.20
74	SuttonRdandWillamSt	17.53	1.64	19.17	30mins	0.20
75	TwickenhamAve	1.06	0.23	1.29	30mins	0.17
76	WrenchStandWilliamSt	10.18	0.54	10.72	30mins	0.20
77	JordonSt	3.53	0.19	3.72	30mins	0.20
78	HarrowRd	22.77	0.53	23.31	30mins	0.37
79	HerbertSt	55.01	10.17	65.18	30mins	0.30
80	WeatherbyAveandCamptonAve	47.43	5.11	52.54	30mins	0.27
81	WrenchStNearDevonRd	56.28	3.98	60.26	30mins	0.23
82	CambridgeSt	22.07	1.64	23.71	30mins	0.23
83	LincolnDr	14.34	0.99	15.33	30mins	0.20
84	CheltenhamAve	3.37	0.19	3.56	30mins	0.20
85	AberdeenSt	3.25	0.18	3.43	30mins	0.17
86	StirlingSt	4.98	0.10	5.08	30mins	0.20
87	DevonRd	2.95	0.37	3.32	30mins	0.20
88	EppingCl	5.60	0.21	5.82	30mins	0.20
89	SandringhamAve	7.09	0.42	7.52	30mins	0.20
90	CottageSt	6.86	0.13	6.99	30mins	0.33
91	VictoriaStnearParkAve	53.31	1.92	55.23	30mins	0.33
92	railwayNearVictoriaSt	40.30	3.33	43.63	30mins	0.30
93	GreatWesternHwy	19.75	9.24	28.99	30mins	0.23
94	KerranCl	8.46	0.00	8.46	30mins	0.20
95	WeatherbyAve	8.06	0.50	8.56	30mins	0.20
96	WrenchSt	5.54	0.20	5.74	30mins	0.20
97	GreatWesternHwyNearFrenchSt	19.03	0.40	19.44	120mins	1.00
98	ParkAve	47.89	4.38	52.26	30mins	0.30
99	AmarooSt	28.38	2.90	31.28	30mins	0.30
100	JosephSt	20.34	2.49	22.82	30mins	0.27
101	WalterSt	21.58	1.84	23.42	30mins	0.27
102	VictoriaStW	10.40	0.76	11.15	30mins	0.20
103	CollegeSt	1.98	0.23	2.20	30mins	0.20
104	WalterStandParkAve	11.95	0.81	12.77	30mins	0.27
105	GreatWesternHwyNearSantleyCres	194.93	12.31	207.23	120mins	1.03

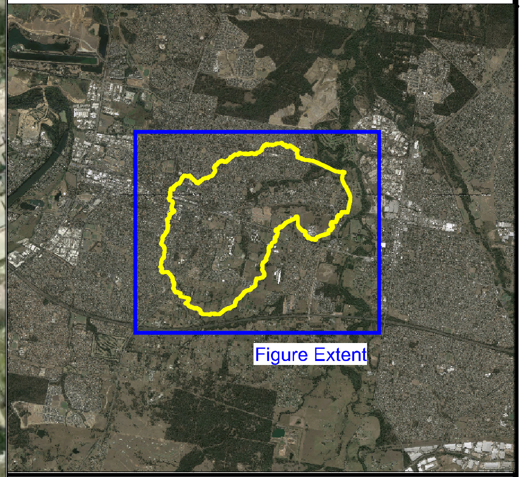
Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
106	SantleyCres	74.18	-0.04	74.15	120mins	1.07
107	DougRennieField	133.11	8.36	141.46	30mins	0.47
108	FirstStN	126.54	8.95	135.49	120mins	1.03
109	BringellyRdNearFirst	135.13	10.21	145.35	30mins	0.57
110	HargraveSt	97.34	1.46	98.80	30mins	0.53
111	DerbySy	105.40	9.21	114.61	30mins	0.50
112	StaffordSyNearBringellyRd	51.41	8.26	59.68	30mins	0.47
113	StaffordSt	48.49	0.00	48.49	30mins	0.50
114	JamisonRd	98.89	2.96	101.85	30mins	0.43
115	StapleySt	36.14	4.00	40.14	30mins	0.40
116	StapleyStandClemsonSt	52.54	4.26	56.80	30mins	0.43
117	ClemsonSt	3.68	0.31	3.99	30mins	0.17
118	LucySt	72.75	8.62	81.37	30mins	0.40
119	SmithSt	69.37	6.59	75.96	30mins	0.40
120	OagCresandTentSt	54.25	4.13	58.39	30mins	0.37
121	TentSt	41.95	3.88	45.83	30mins	0.37
122	TentStandPiperCl	35.64	3.22	38.85	30mins	0.33
123	PiperCl	4.55	0.36	4.91	30mins	0.30
124	BringellyRd	4.75	0.30	5.05	30mins	0.23
125	BringellyRdandCaddensSt	34.13	2.22	36.35	30mins	0.30
126	AngophoraAve	3.27	0.12	3.38	30mins	0.20
127	CaddensRd	7.27	0.81	8.08	30mins	0.20
128	OagCres	6.31	0.69	7.00	30mins	0.20
129	TheNorthernRd	3.41	0.25	3.66	30mins	0.20
130	ElliottSt	3.26	0.73	3.99	30mins	0.17
131	GladysSt	5.01	0.52	5.52	30mins	0.20
132	SomersetNearHargraveSt	6.91	0.22	7.14	30mins	0.27
133	SomersetStandDerbySt	1.92	0.06	1.98	30mins	0.23
134	OrthSt	28.34	2.25	30.59	120mins	1.00
135	SomersetSt	24.41	2.44	26.85	30mins	0.47
136	GreatWesternHwySomersetSt	17.46	0.00	17.46	30mins	0.43
137	GreatWesternHwyHospital	0.05	2.19	2.24	30mins	0.47
138	RailwaynearHospital	3.31	3.66	6.98	30mins	0.43
139	CoxAve	32.59	0.65	33.24	30mins	0.20
140	CopelandSt	17.87	0.57	18.43	30mins	0.23
141	PhillipSt	6.54	0.53	7.07	30mins	0.23
142	GascoigneSt	2.64	0.26	2.90	30mins	0.20
143	RichmondRd	0.79	0.06	0.84	30mins	0.20
144	SecondAveandJonesSt	51.47	4.71	56.17	30mins	0.40
145	BadenPowellAve	37.88	3.38	41.26	30mins	0.37
146	FirstSt	3.53	0.71	4.24	30mins	0.37
147	BadenPowellAveandFirstSt	6.93	0.67	7.60	30mins	0.37
148	BringellyRdNearJamisonRd	0.63	0.36	0.99	30mins	0.20
149	FuryStandStockAve	29.98	2.50	32.48	30mins	0.37
150	PeppermintCres	31.90	1.17	33.07	30mins	0.30
151	PeppermintCresandYeelannaPl	11.36	0.30	11.66	30mins	0.20
152	AngophoraAveand PeppermintCres	1.83	0.44	2.27	30mins	0.13
153	ChapmanGardens	52.76	4.66	57.42	30mins	0.43
154	SecondAveandManningSt	61.58	4.52	66.09	30mins	0.43
155	EdnaSt	62.66	4.38	67.04	30mins	0.40
156	EdwardSt	37.38	2.13	39.51	30mins	0.37
157	ManningSt	35.40	1.94	37.33	30mins	0.27
158	CasuarinaCircuitandMaculataPl	3.63	0.03	3.65	30mins	0.27

Location	Description	Peak Discharge (m^3/s)			Critical Duration (minutes)	Time of Peak Discharge (hours)
		Overland	Structure	Total		
159	CasuarinaCircuit	17.10	2.25	19.35	30mins	0.20
160	CaddensRdandCaddaRidgeDr	4.51	0.18	4.70	30mins	0.20
161	KearneyAve	6.59	0.00	6.59	30mins	0.20
162	CaddaRidgeDr	25.01	2.62	27.63	30mins	0.20
163	BringellyRdandGreatWesternHwy	0.11	1.22	1.33	120mins	1.00

Appendix N

Stage Hydrographs

PENRITH CITY COUNCIL



LEGEND

- Stage Hydrographs Locations
- College, Orth and Werrington Creeks Catchment

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:18,000 (at A3)

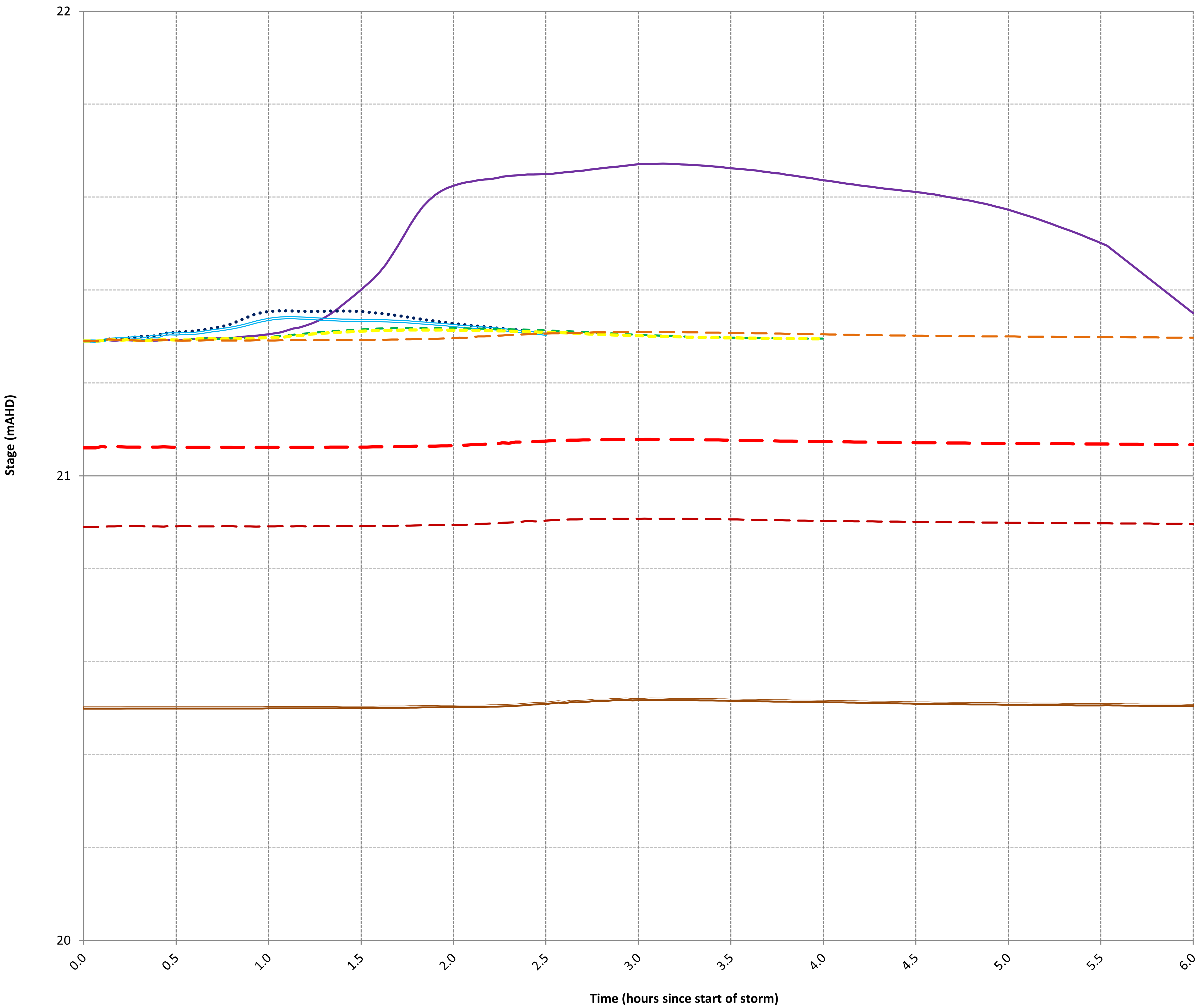
0 0.5 1.0 Km

Stage Hydrograph Locations

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: Stage Hydrograph Locations.wor



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

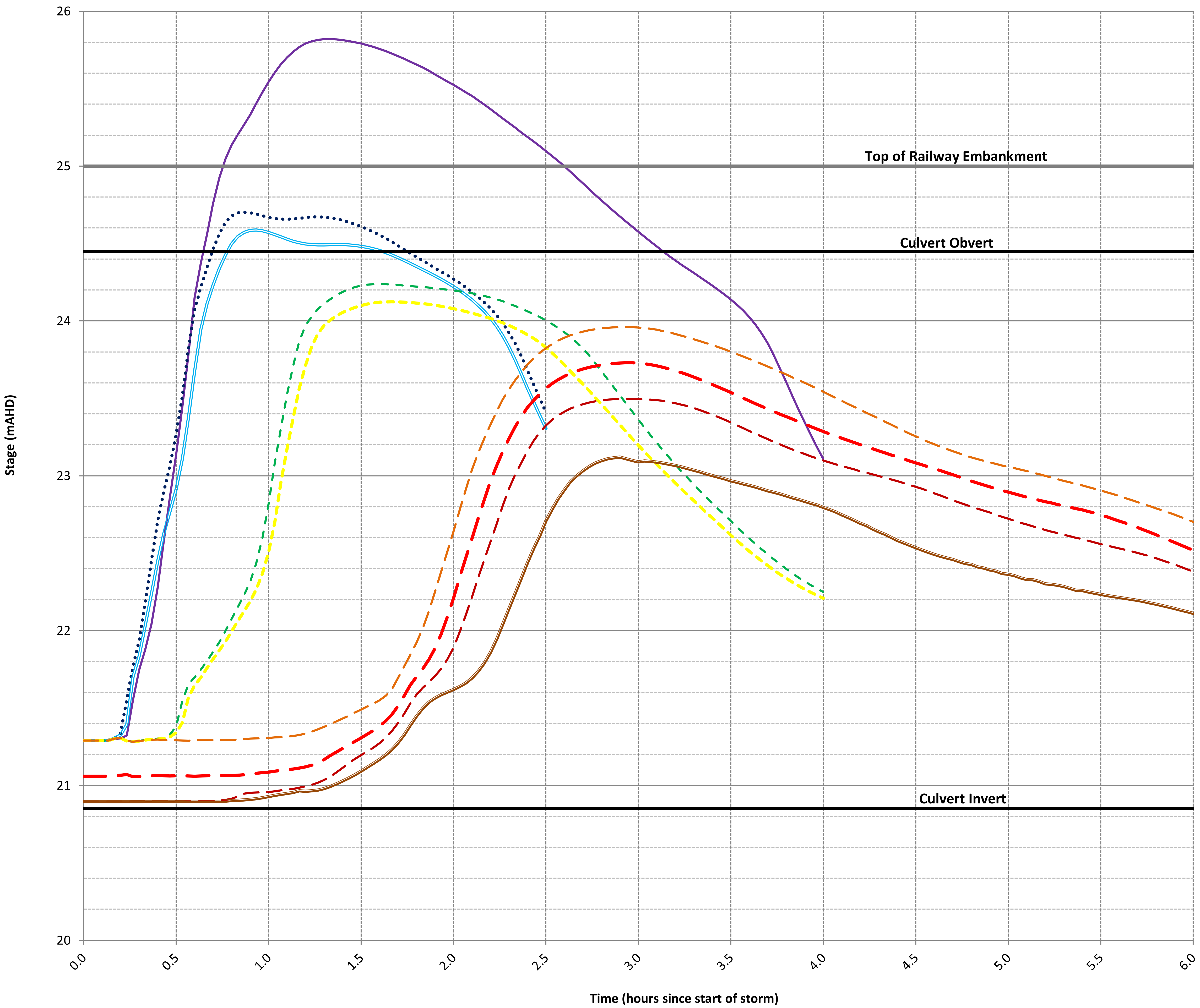
Bottom of bridge deck has an elevation of 22.6 mAHD.

Stage hydrographs at this location are dominated by South Creek backwater water flooding.

Figure N.1 Design Stage Hydrographs at Location #1 (South Creek at Dunheved Rd)

Prepared By:
CatchmentSimulationSolutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

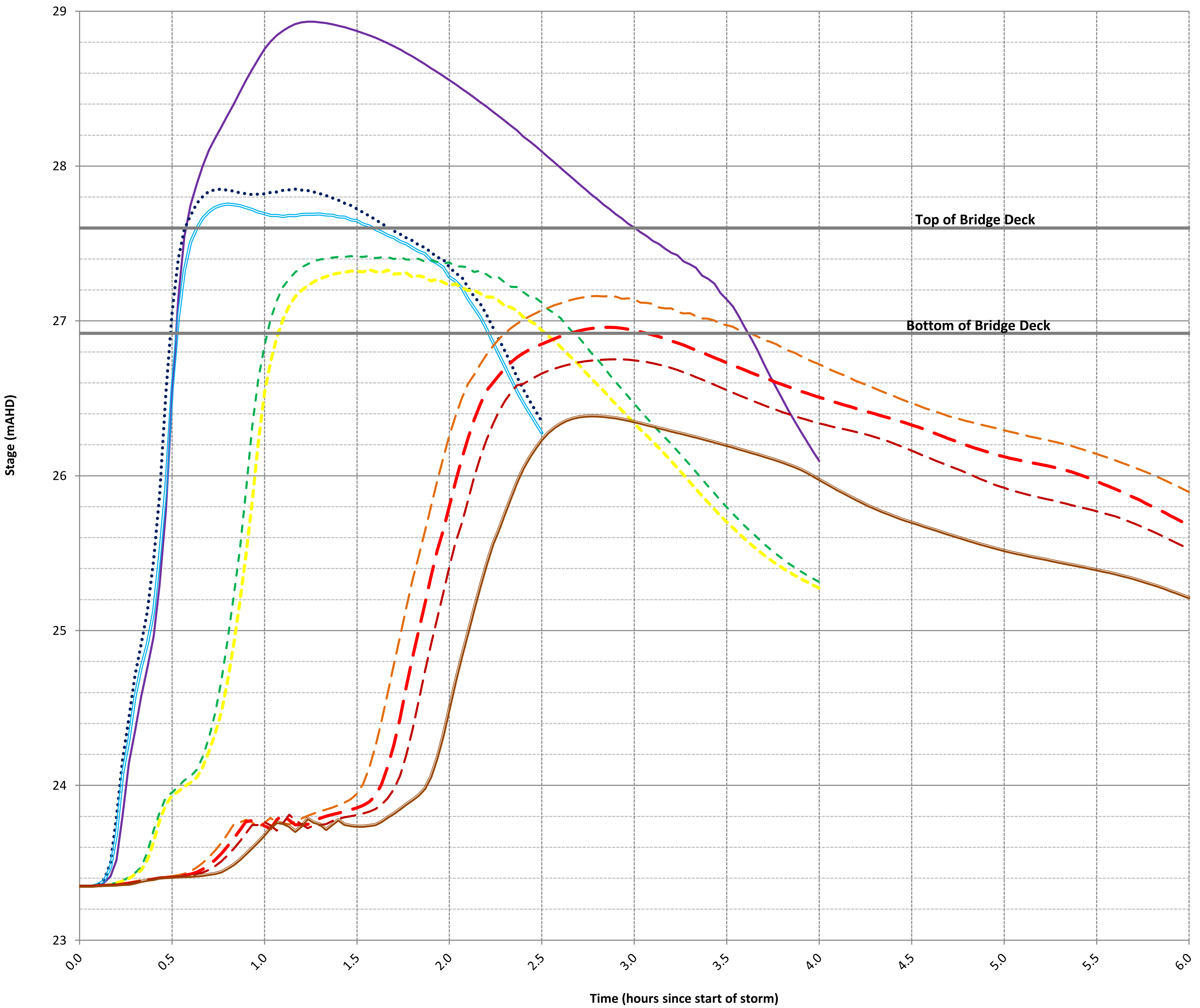
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.2 Design Stage Hydrographs at Location #2 (Werrington Creek at John Oxley Ave)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

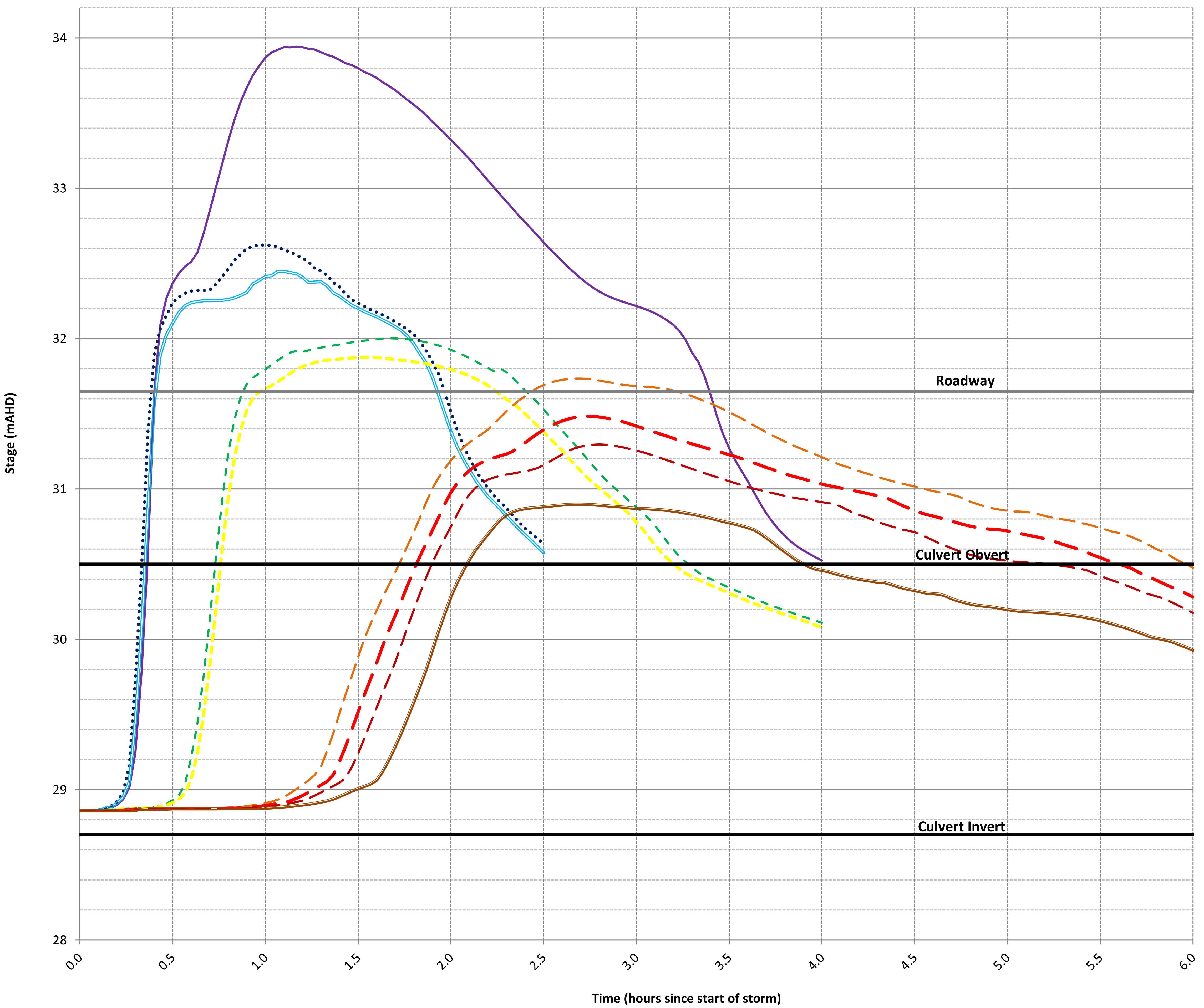
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.3 Design Stage Hydrographs at Location #3 (Werrington Creek at Burton St)

Prepared By:
CatchmentSimulationSolutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

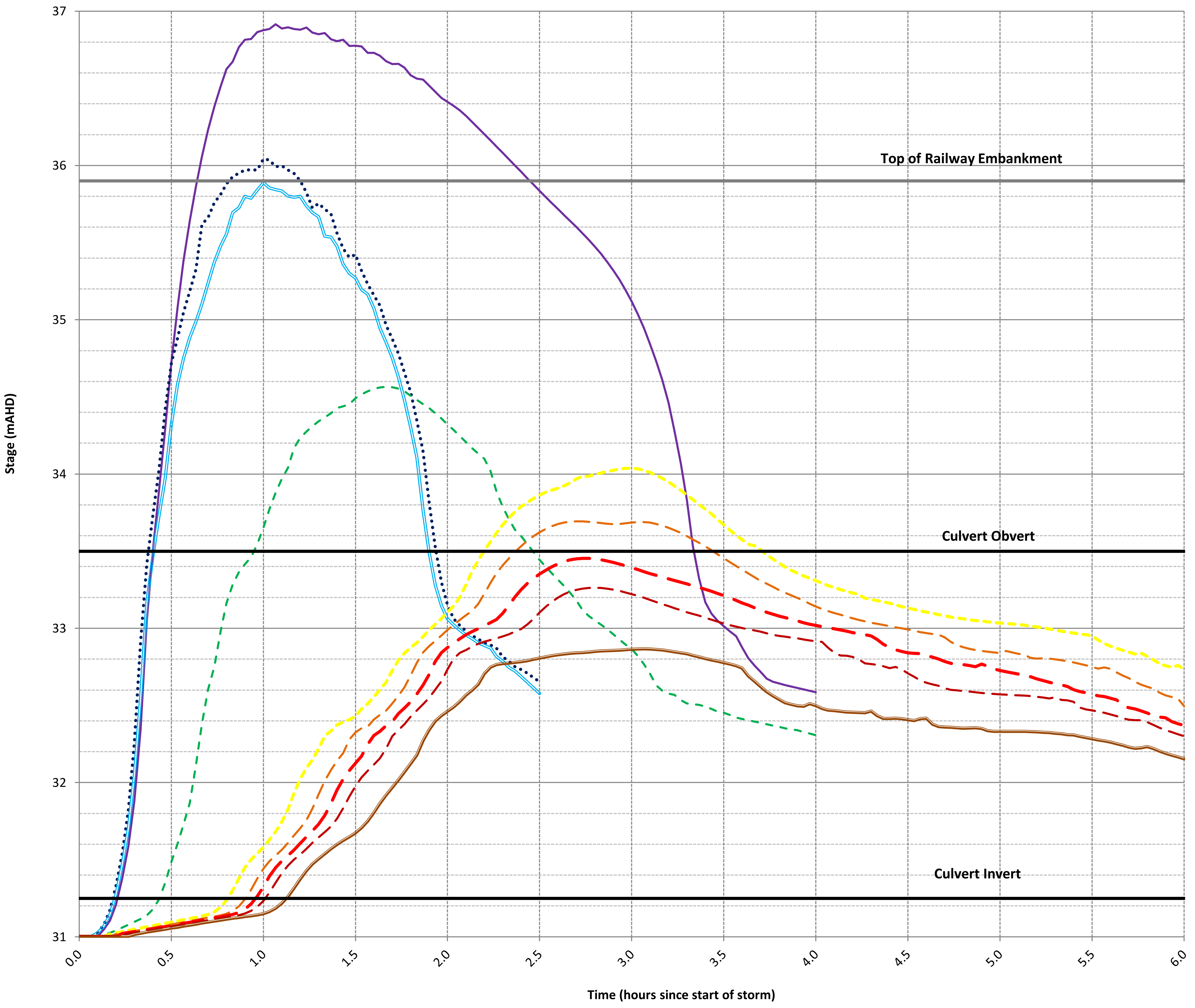
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.4 Design Stage Hydrographs at Location #4 (Werrington Creek at Victoria St)

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.5
Design Stage Hydrographs at Location #5 (Werrington Creek at Railway)

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Catchment Simulation Solutions
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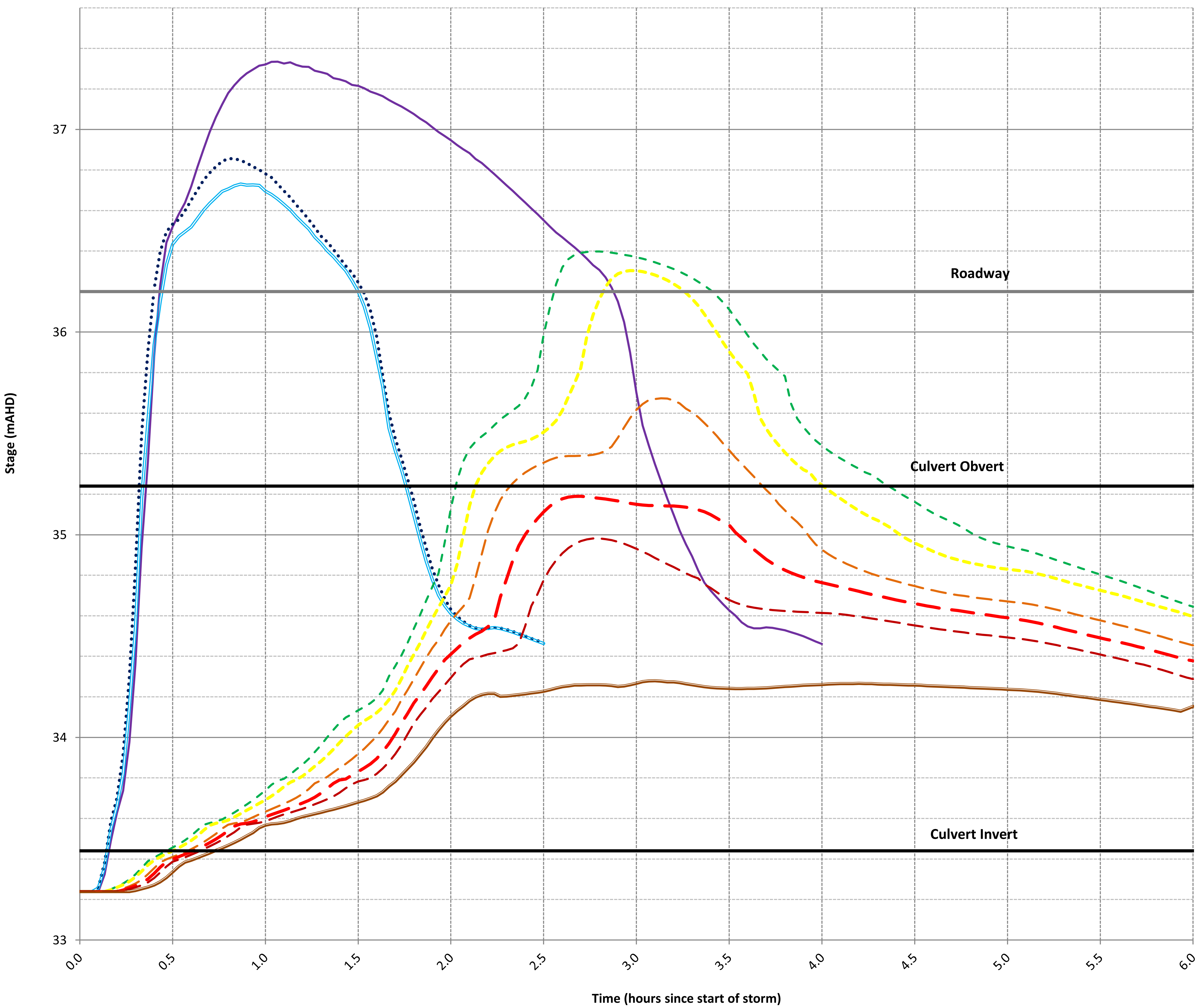
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

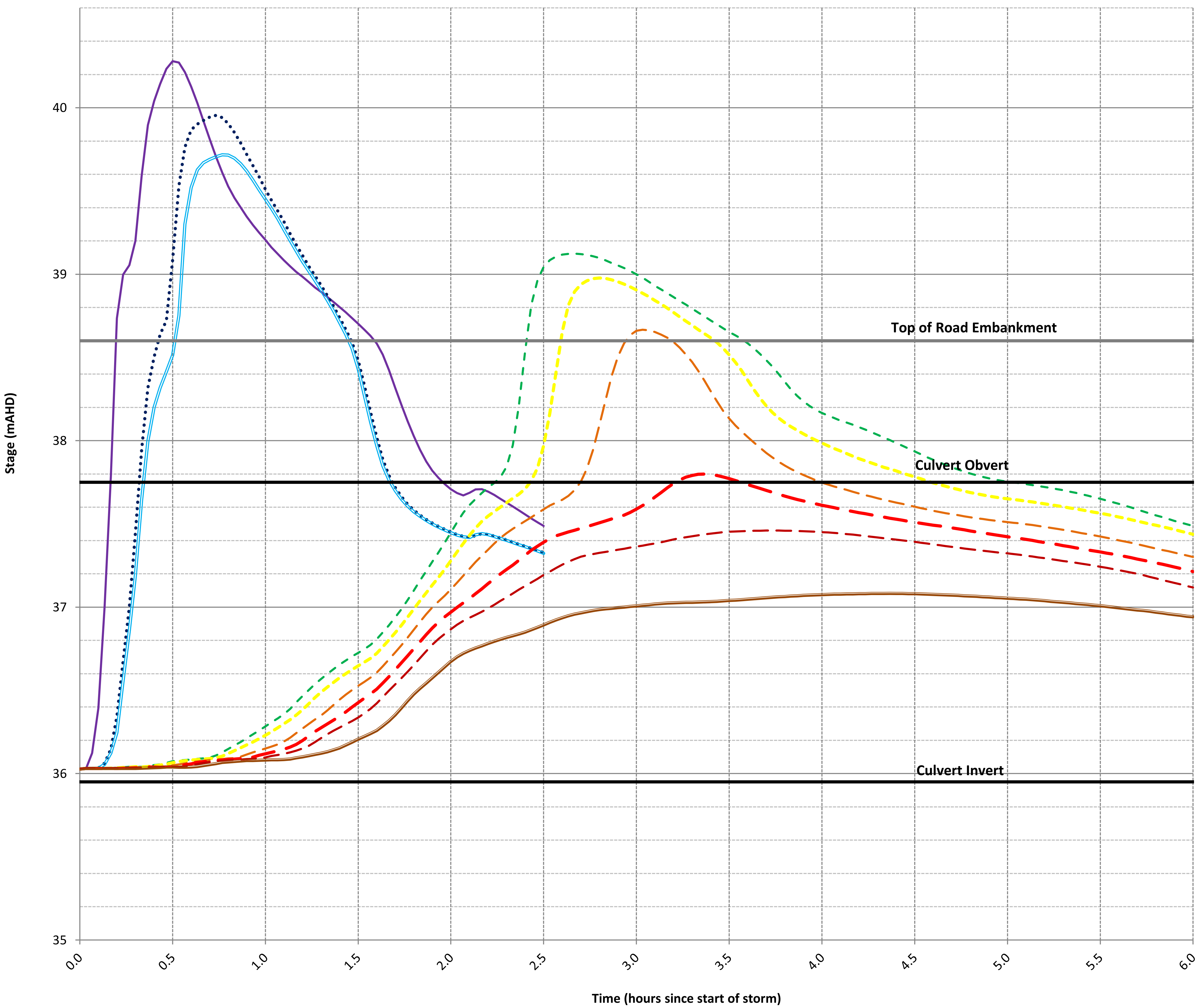
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.6 Design Stage Hydrographs at Location #6 (College Creek at Great Western Highway)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.7
Design Stage Hydrographs at Location #7 (College Creek at Second Ave)

Prepared By:
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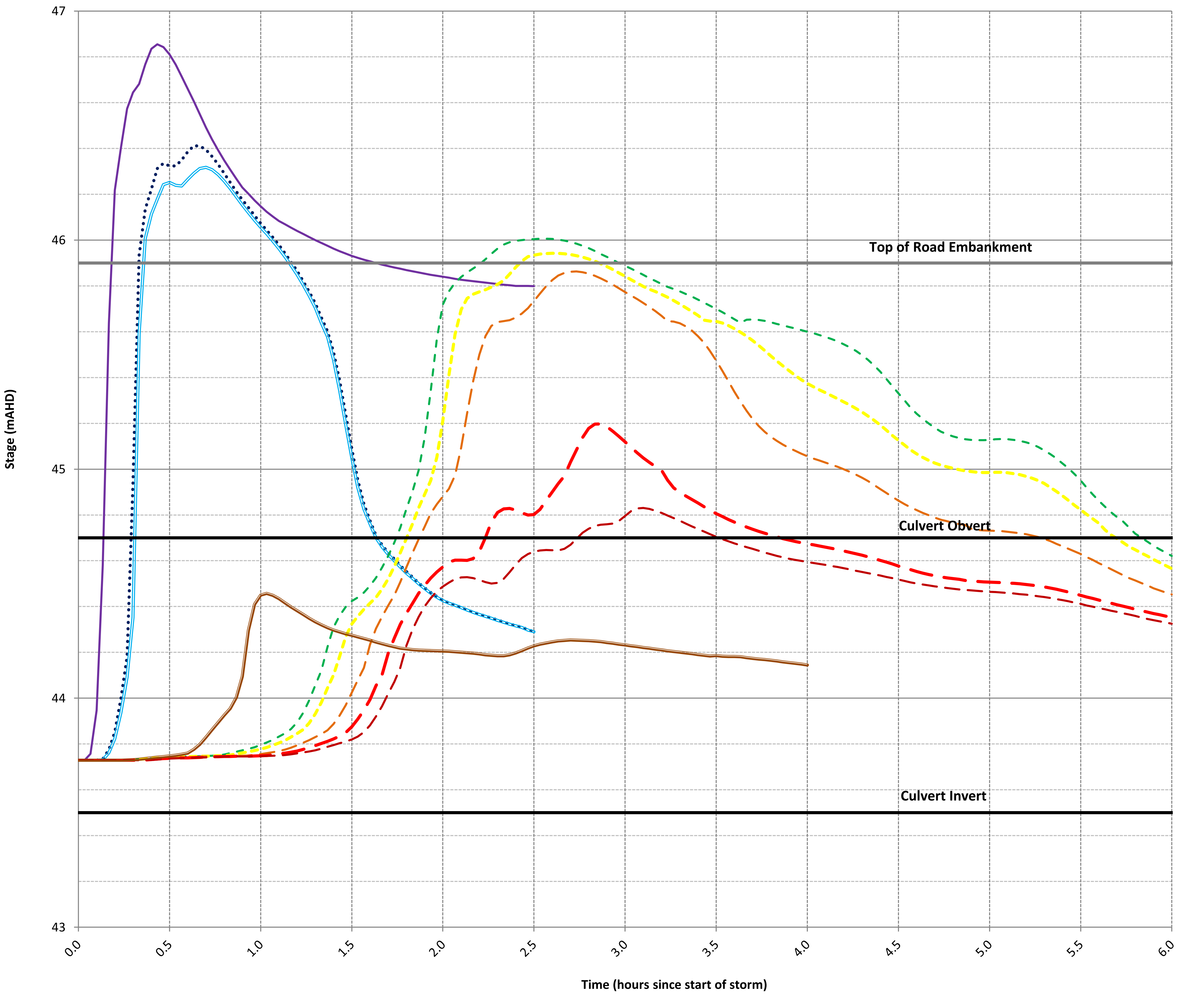
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

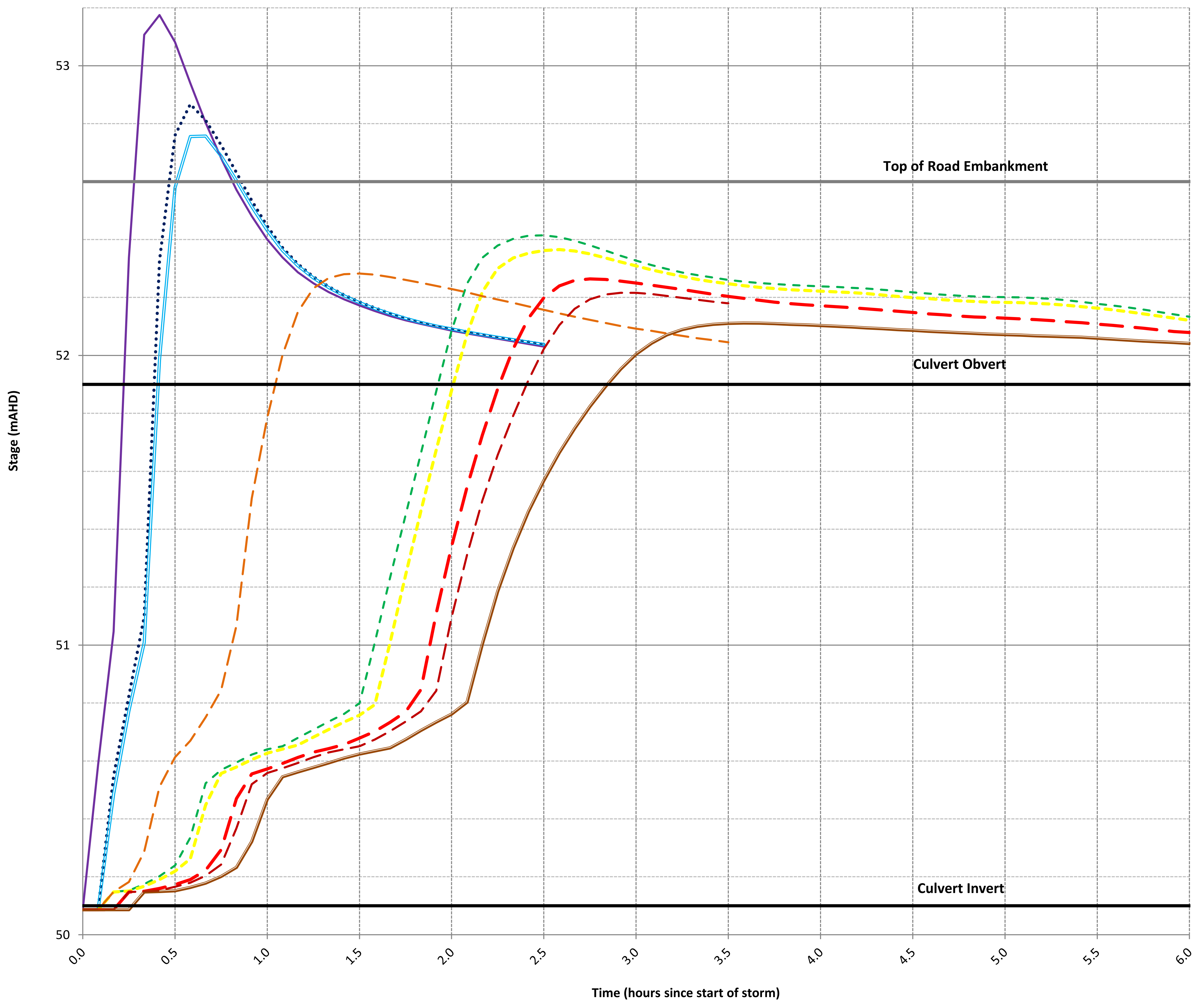
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.8 Design Stage Hydrographs at Location #8 (College Creek at O'Connell St)

Prepared By:

CatchmentSimulationSolutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH
CITY COUNCIL

LEGEND:

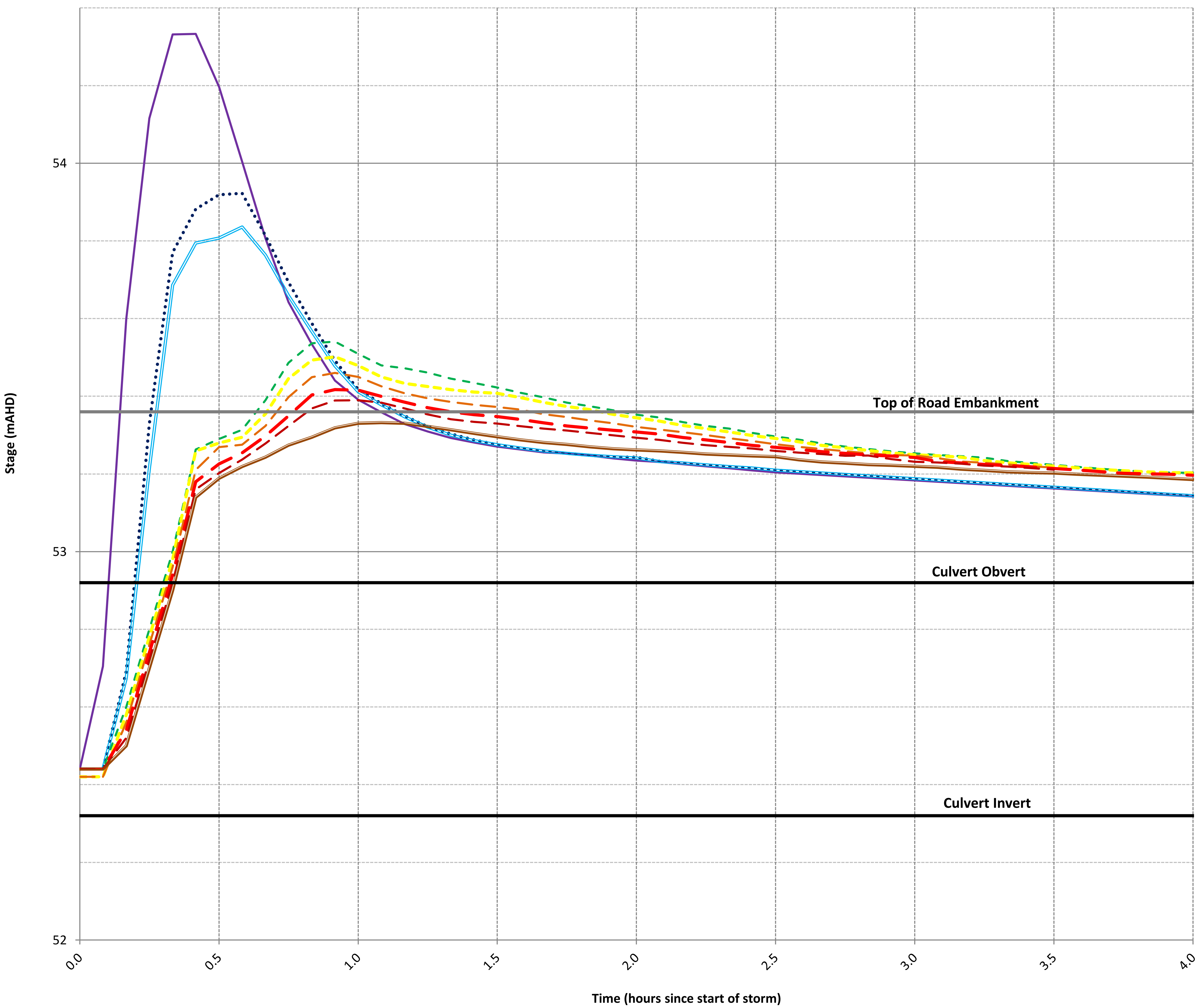
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.9
Design Stage Hydrographs at Location #9 (College Creek at Cadda Ridge Dr)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

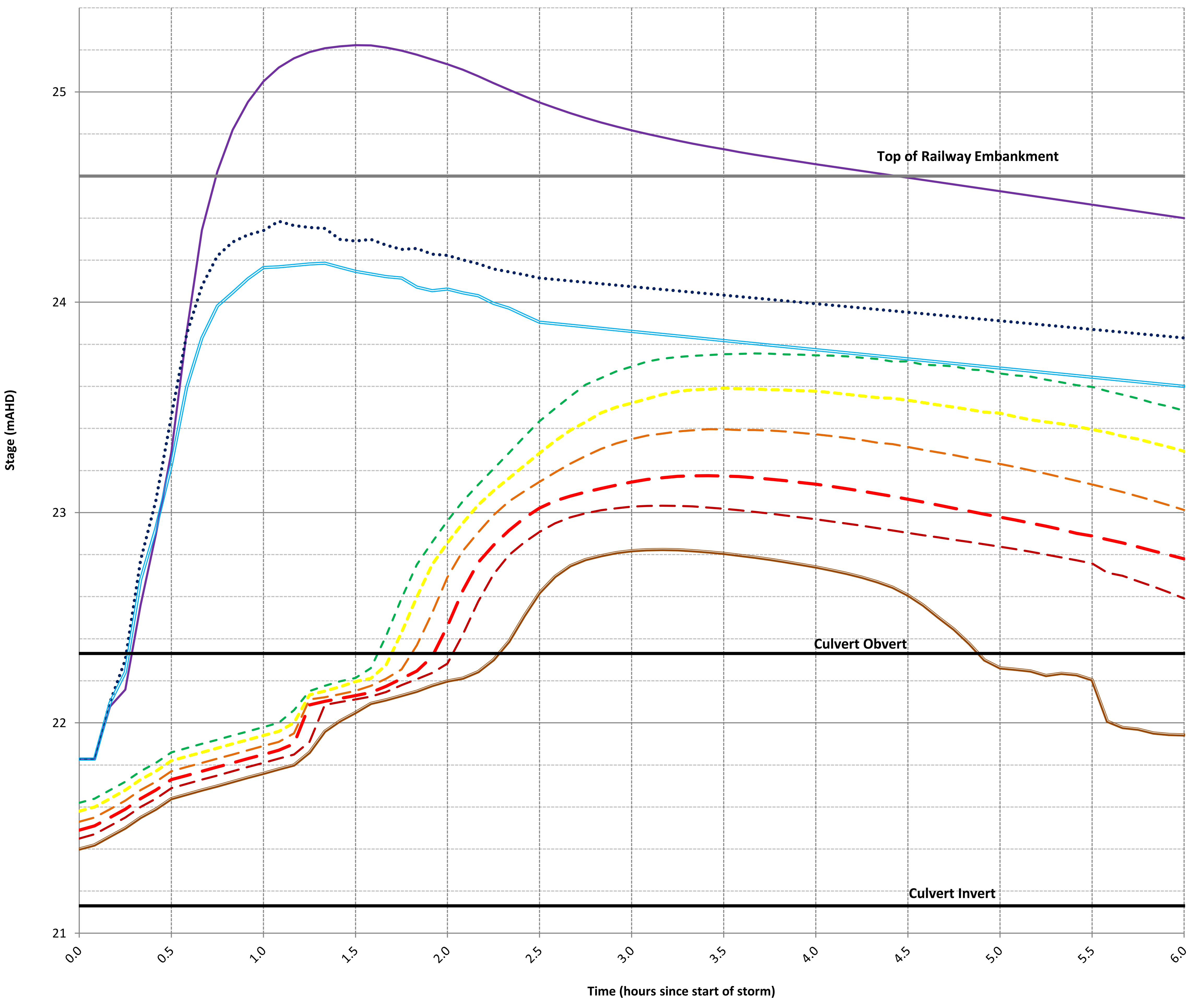
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.10
Design Stage Hydrographs at Location #10 (College Creek at Caddens Rd)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

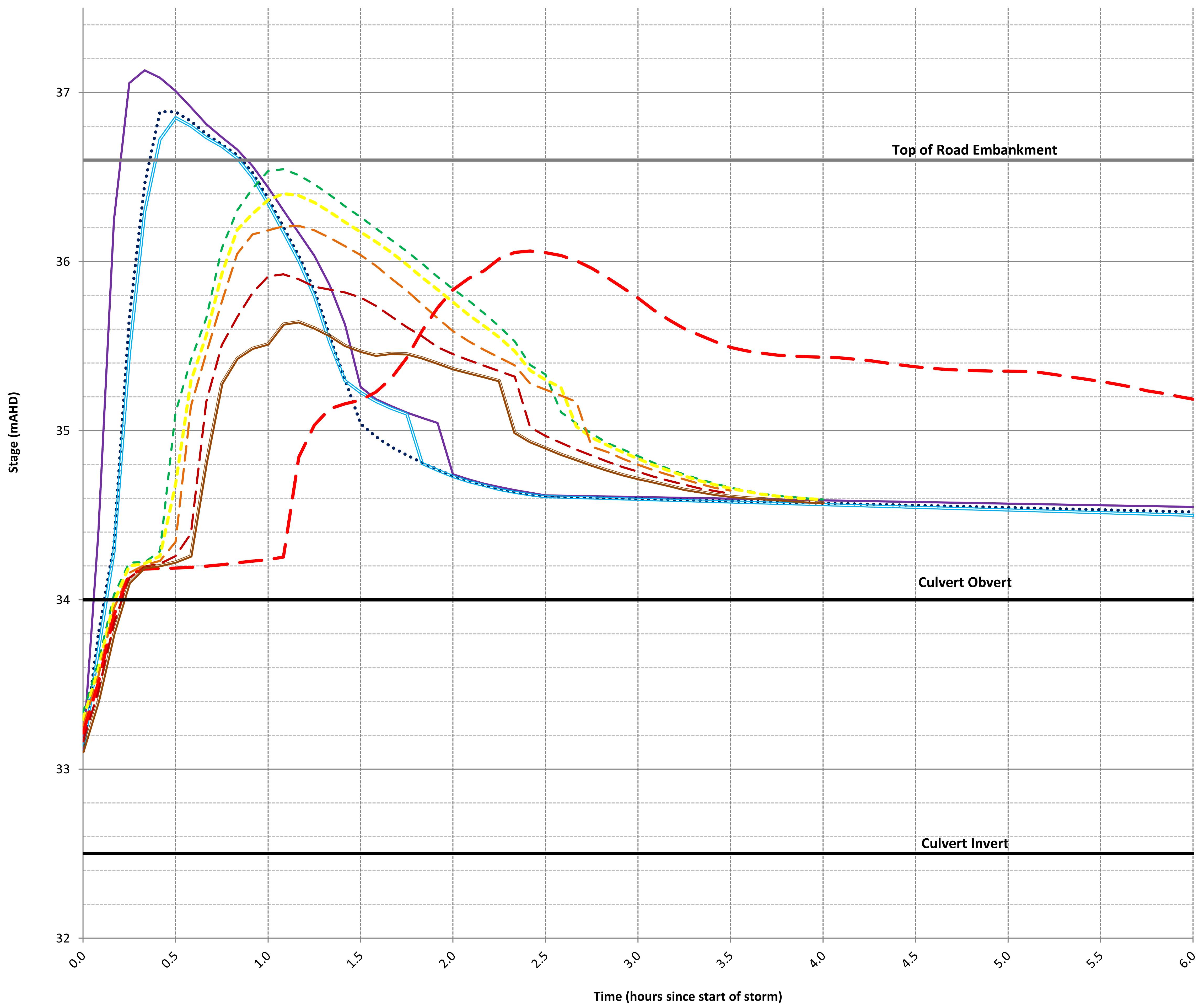
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.12 Design Stage Hydrographs at Location #12 (Upstream of Railway at Werrington Station)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

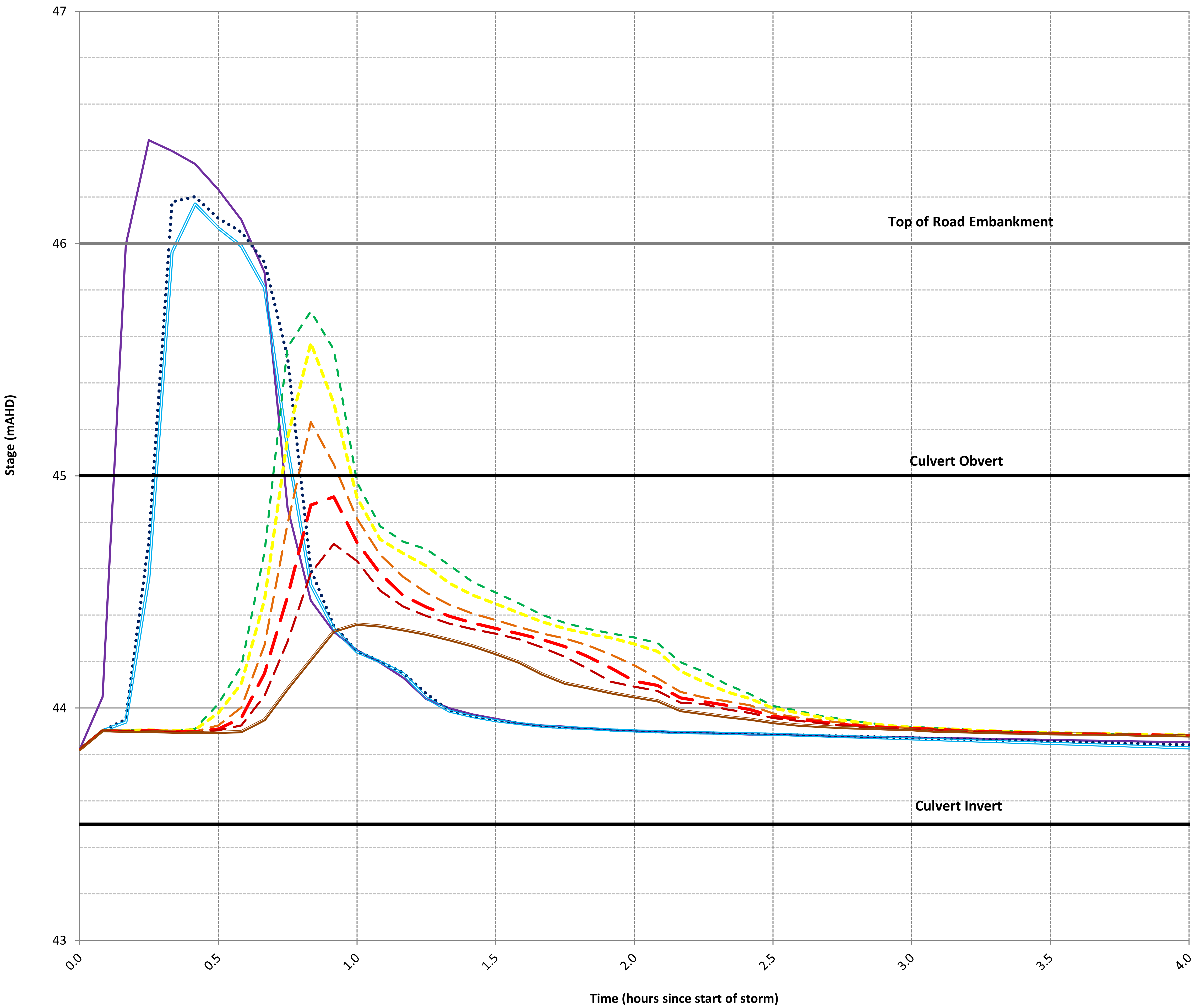
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.13 Design Stage Hydrographs at Location #13 (Railway north of French St Subdivision)

Prepared By:
CatchmentSimulationSolutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

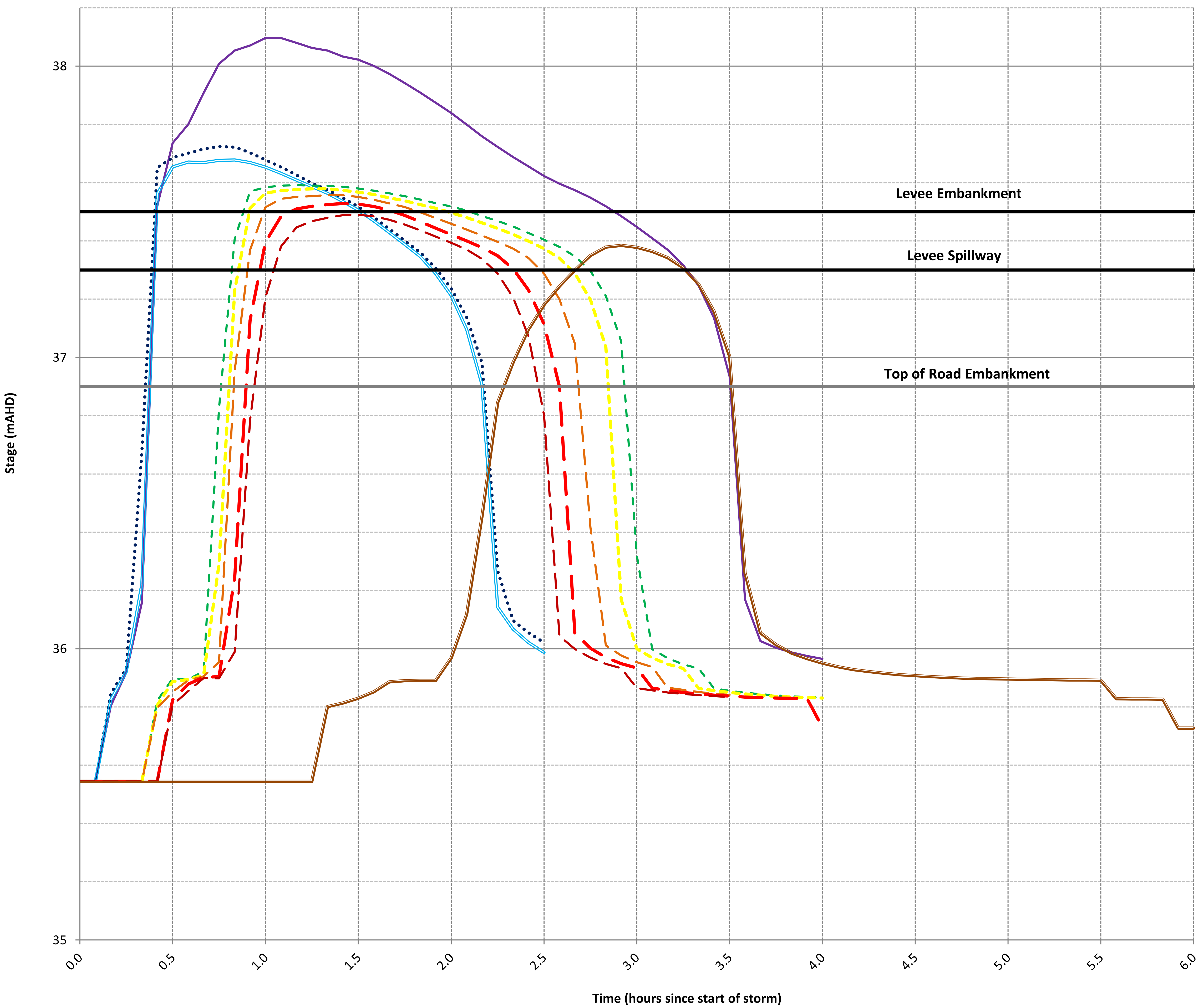
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.14 Design Stage Hydrographs at Location #14 (Great Western Hwy north of Nepean College)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

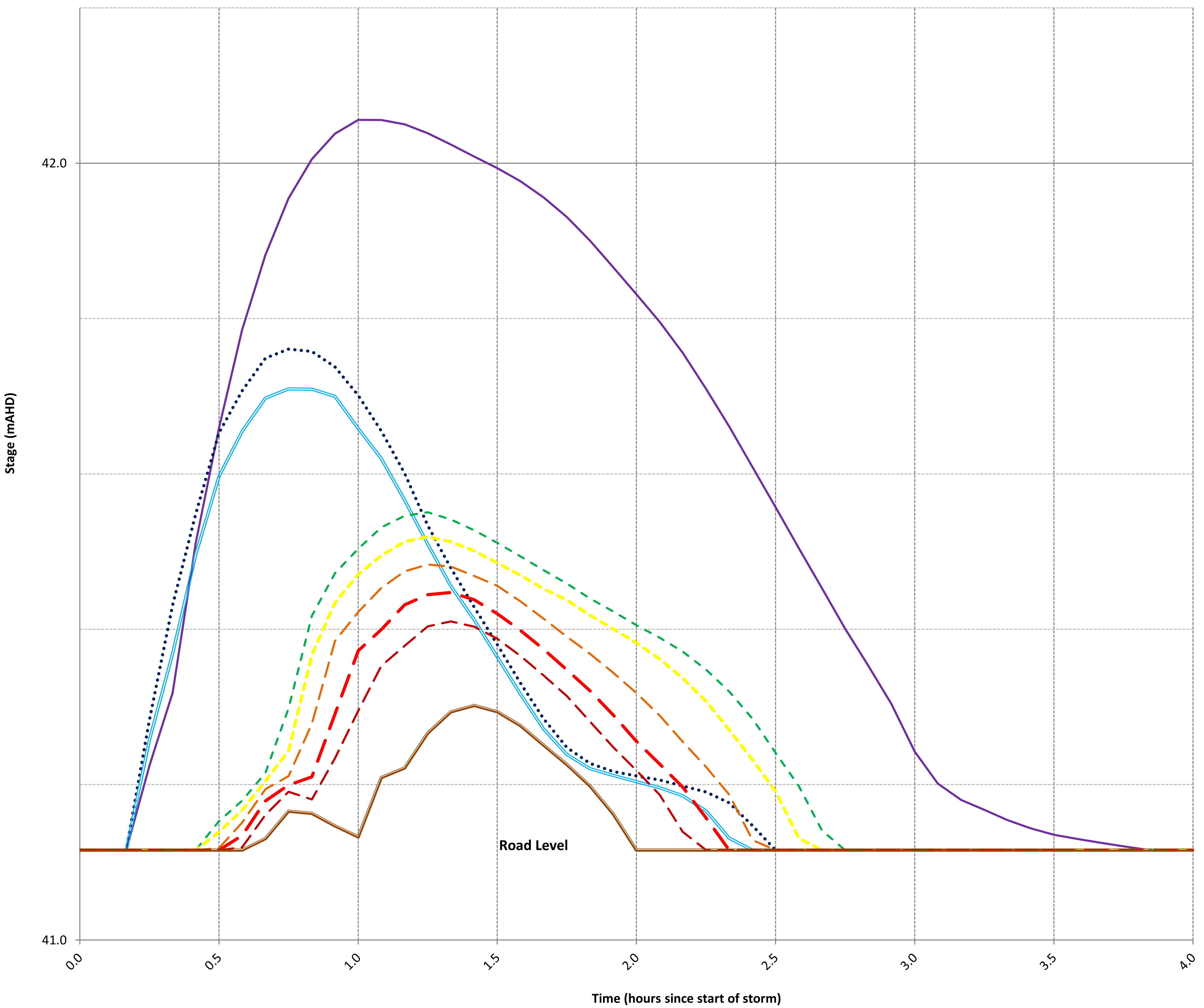
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.15 Design Stage Hydrographs at Location #15 (Chapman Gardens at Great Western Highway)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

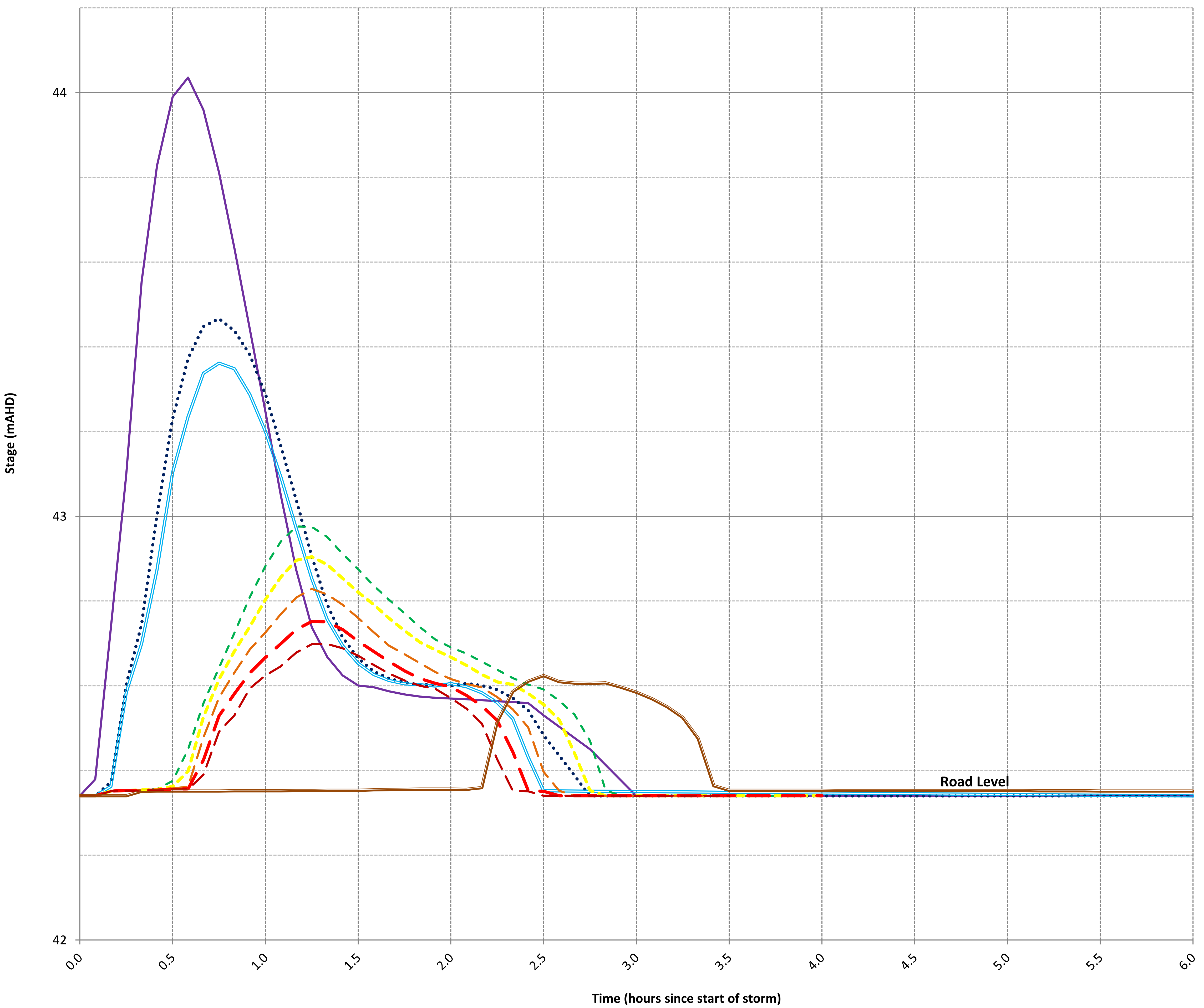
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.16 Design Stage Hydrographs at Location #16 (First Street)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

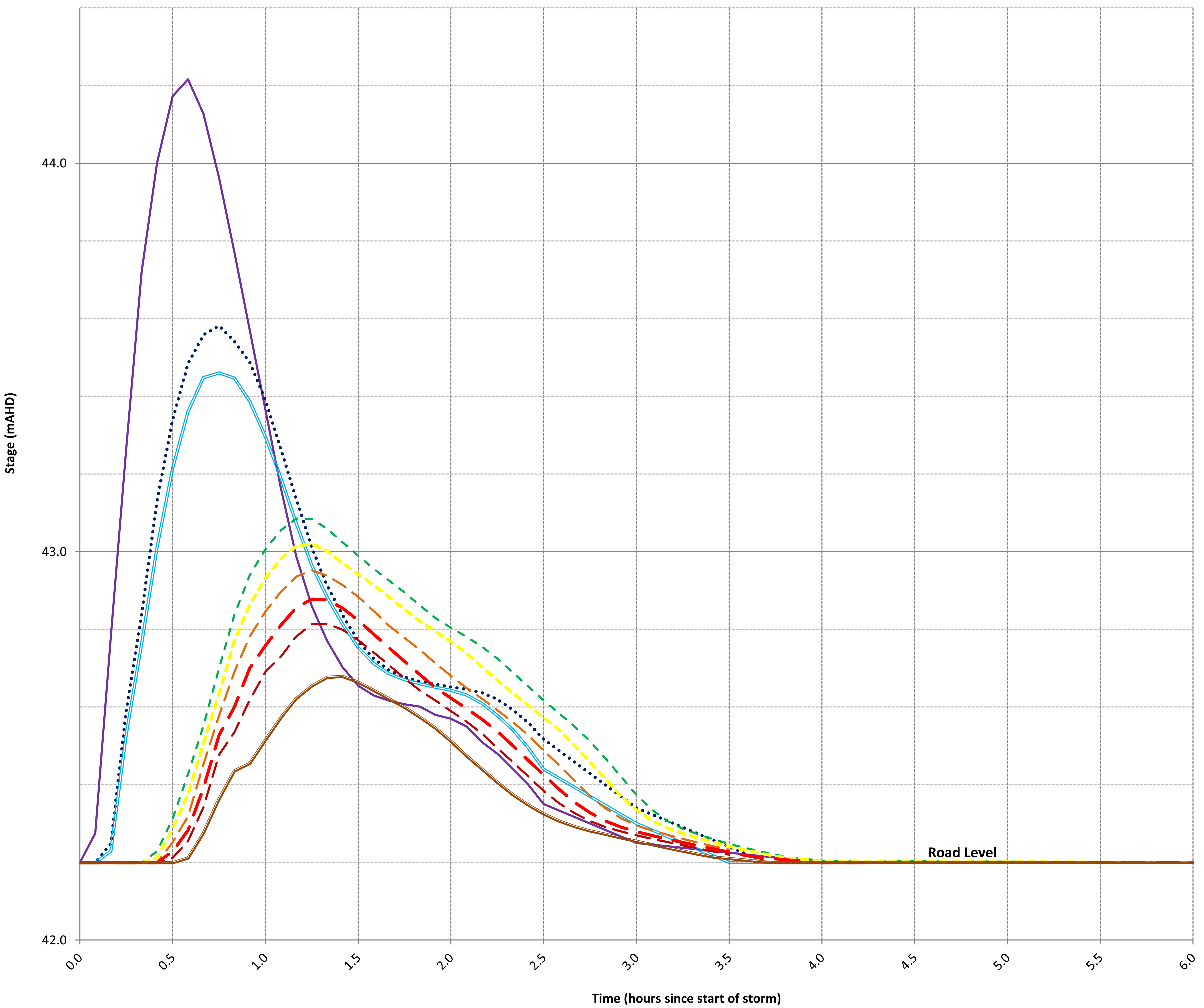
Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.17 Design Stage Hydrographs at Location #17 (Bringelly Road)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH
CITY COUNCIL

LEGEND:

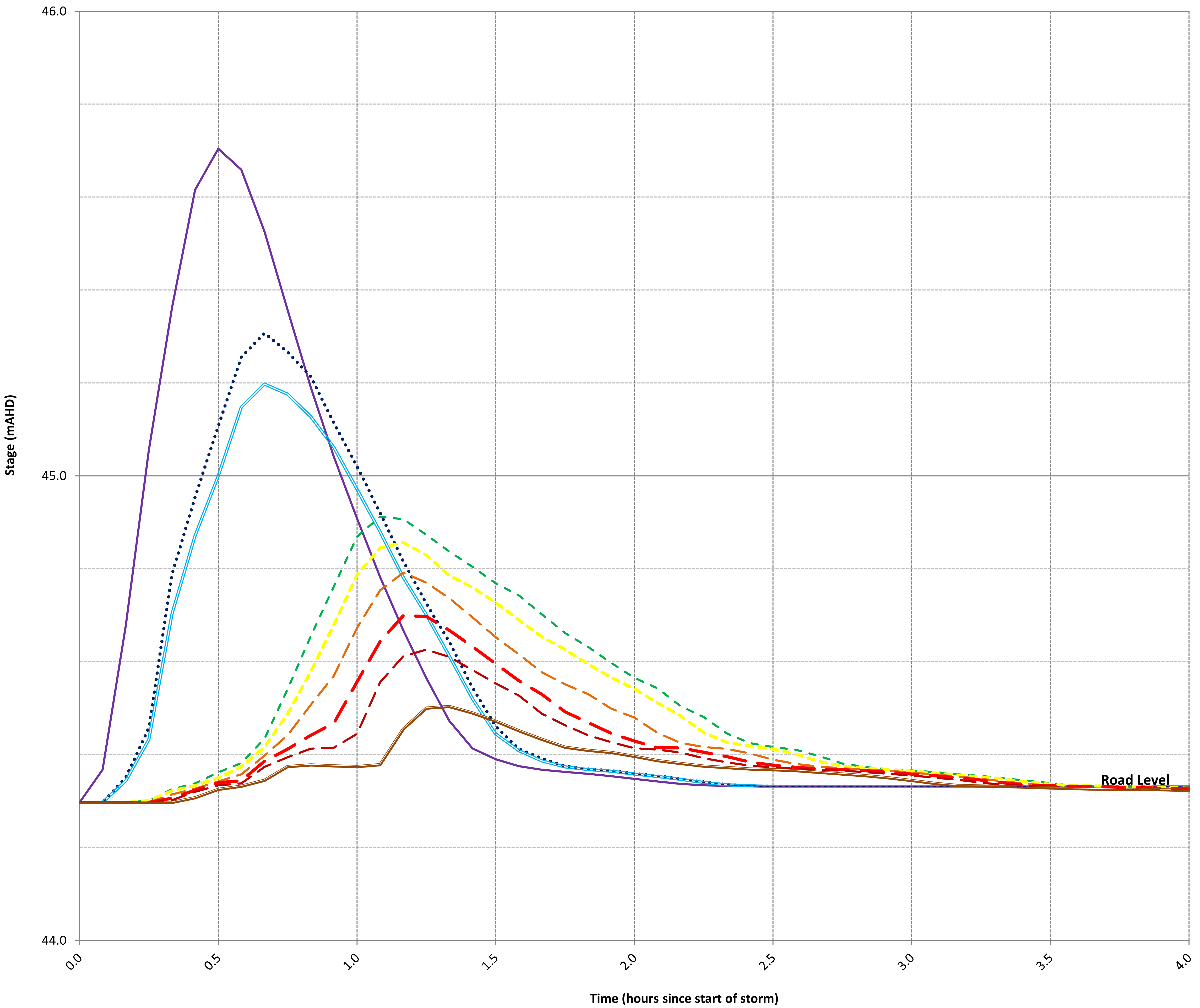
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.18
Design Stage Hydrographs at Location #18 (Orth Street)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

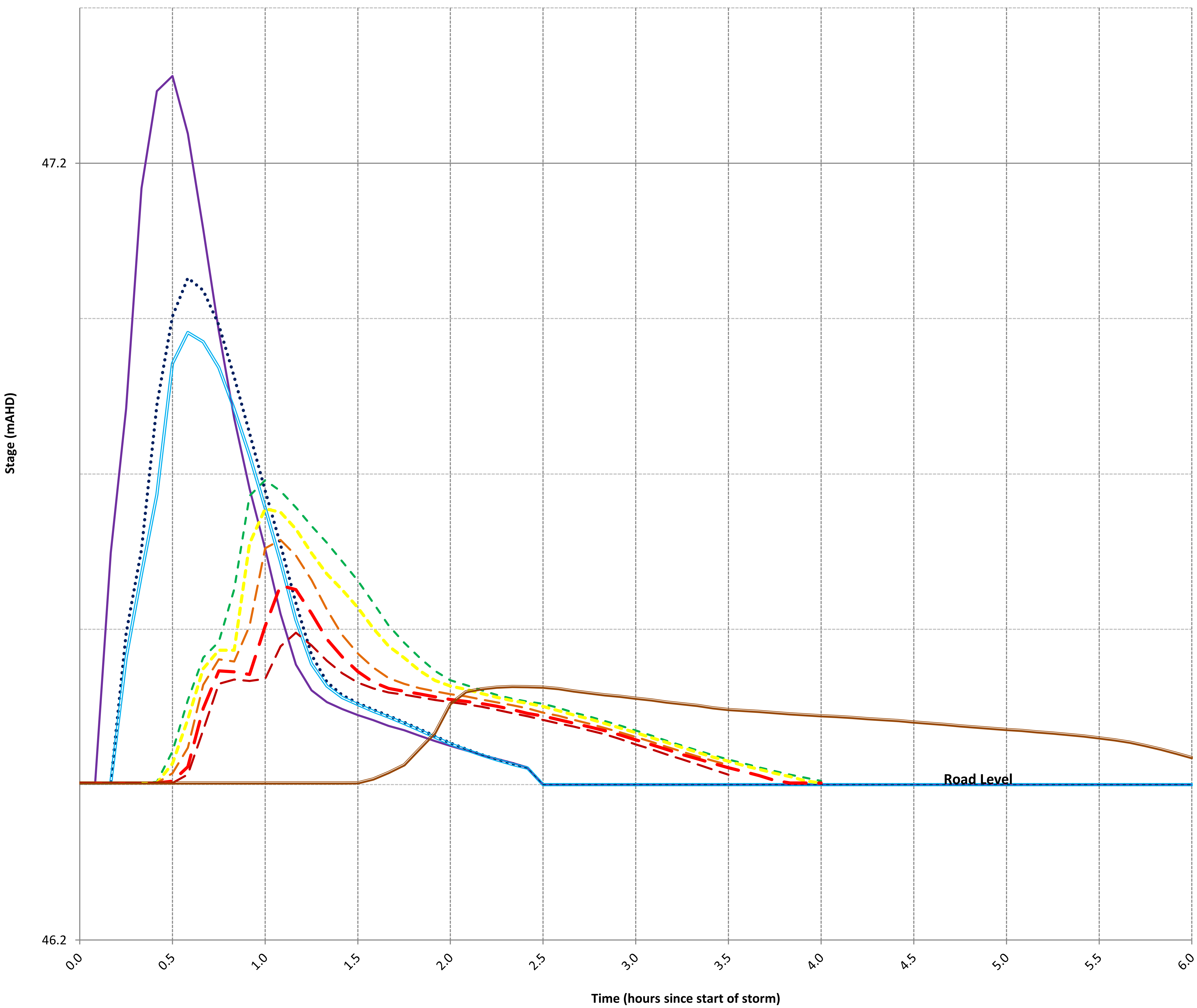
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.19
Design Stage Hydrographs at Location #19 (Derby Street)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

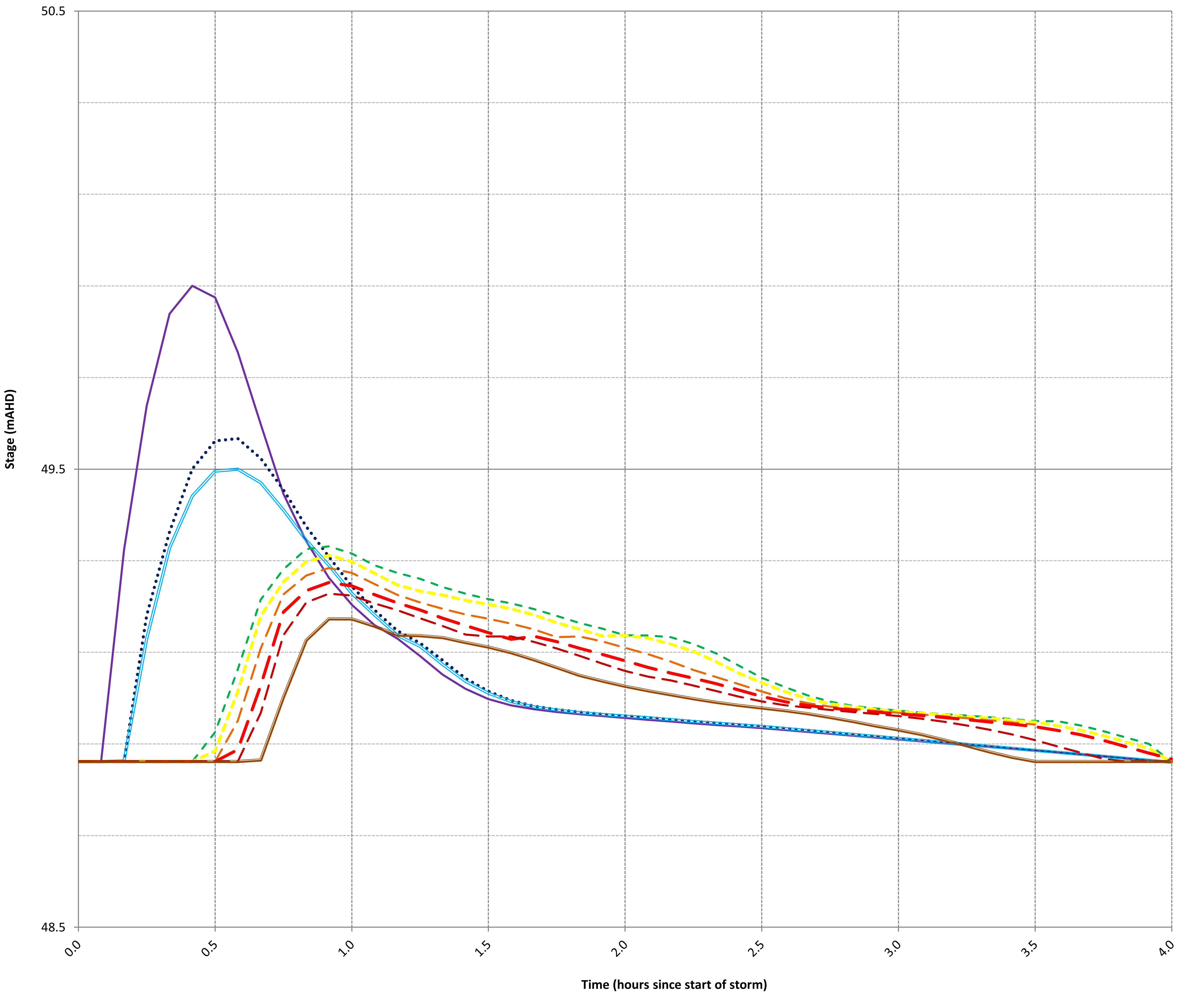
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.20 Design Stage Hydrographs at Location #20 (Roadway on Stafford Street)

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

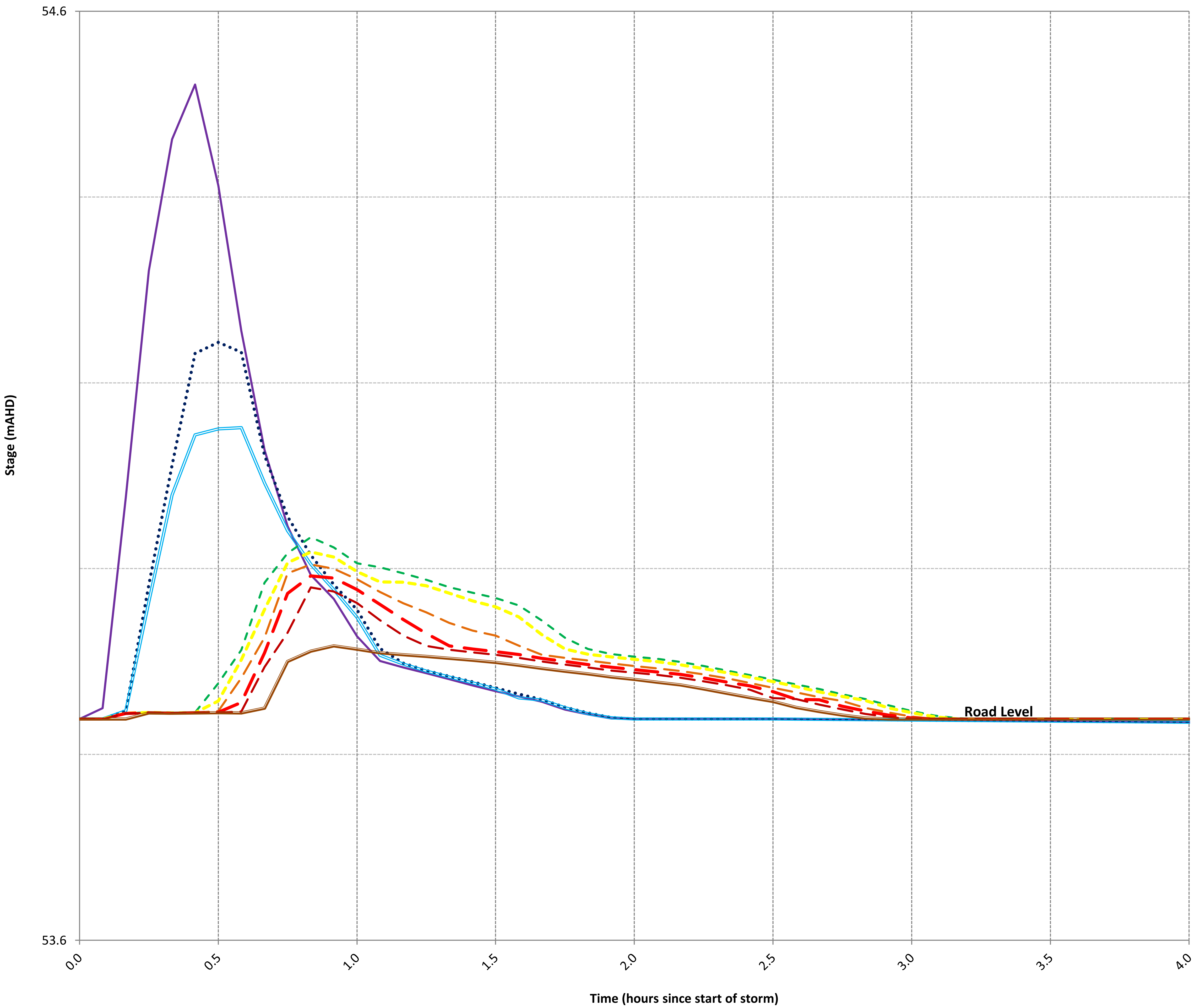
- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:
A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.21 Design Stage Hydrographs at Location #21 (Roadway Jamison Road)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx



PENRITH CITY COUNCIL

LEGEND:

- PMF Stage Hydrograph
- 0.2% AEP Stage Hydrograph
- 0.5% AEP Stage Hydrograph
- 1% AEP Stage Hydrograph
- 2% AEP Stage Hydrograph
- 5% AEP Stage Hydrograph
- 10% AEP Stage Hydrograph
- 20% AEP Stage Hydrograph
- 1 in 2 Year ARI Stage Hydrograph

Notes:

A number of different storm durations were simulated for each design flood. The stage hydrograph presented in this figure represents the storm duration that produces the highest peak design flood level at this location.

Figure N.22 Design Stage Hydrographs at Location #22 (Roadway on Smith Street)

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Design Stage Hydrographs.xlsx

Appendix O

XP-RAFTS Verification Model

XP-RAFTS Verification Model

General

The XP-RAFTS software was used to develop a hydrologic computer model of the College, Orth and Werrington Creeks catchment to assist with the verification of the TUFLOW computer model. XP-RAFTS is a lumped hydrologic software product that is developed by XP Software (XP Software, 2009) and is used extensively across Australia for simulating rainfall-runoff processes and producing design discharge estimates. The following sections provide a summary of the XP-RAFTS model development process and the outcomes of the model verification.

Hydrologic Model Development

Subcatchment Parameterisation

The College, Orth and Werrington Creeks catchment was subdivided into 204 subcatchments based on the alignment of major flow paths and topographic divides. The subcatchments were delineated with the assistance of the CatchmentSIM software (Catchment Simulation Solutions, 2011) using a 1 metre Digital Elevation Model (DEM). The subcatchment layout is presented in **Figure O1** through **Figure O9**.

The College, Orth and Werrington Creeks catchment incorporates significant urban areas that are relatively impervious. Urbanisation effectively separates the catchment into two hydrologic systems, i.e.,:

- rapid rainfall response and low infiltration potential across impervious areas; and,
- slower rainfall response and high infiltration potential across pervious areas.

In recognition of the differing characteristics of the two hydrologic systems, each XP-RAFTS subcatchment was subdivided into two sub-areas. The first sub-area was used to represent the pervious sections of the subcatchment and the second sub-area was used to represent the impervious sections of the subcatchment. The division of each subcatchment into pervious and impervious sub-areas allows different rainfall losses and roughness coefficients to be specified, thereby providing a more realistic representation of rainfall-runoff processes from the two different hydrologic systems.

Key hydrologic properties including area and average vectored slope were calculated automatically for each subcatchment using CatchmentSIM. The adopted subcatchment slopes and areas are provided in **Table O1**.

The catchment was also subdivided into different land use types based on the remote sensing outputs that were used for assigning material types in the TUFLOW model. Percentage impervious and Manning's 'n' values were assigned to each land use and are summarised in **Table O2**. The percentage impervious and Manning's 'n' values were subsequently used to calculate weighted average percentage impervious and 'n' values for each subcatchment.

Table O1 - XP-RAFTS INPUT PARAMETERS

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
1.01	1	5.55	2.14	0	0.030
	2	0.26	2.14	100	0.015
1.02	1	10.06	3.00	0	0.033
	2	1.63	3.00	100	0.015
1.03	1	6.42	1.99	0	0.032
	2	1.04	1.99	100	0.015
1.04	1	1.91	6.30	0	0.031
	2	0.46	6.30	100	0.015
1.05	1	6.97	2.52	0	0.045
	2	1.67	2.52	100	0.015
1.06	1	3.97	3.61	0	0.032
	2	0.44	3.61	100	0.015
1.07	1	25.83	1.74	0	0.033
	2	3.07	1.74	100	0.015
1.08	1	8.06	2.33	0	0.029
	2	10.12	2.33	100	0.015
1.09	1	26.82	1.98	0	0.041
	2	7.25	1.98	100	0.015
1.1	1	1.79	1.90	0	0.085
	2	0.18	1.90	100	0.015
1.11	1	14.39	1.90	0	0.049
	2	3.49	1.90	100	0.015
1.12	1	7.90	3.03	0	0.069
	2	1.95	3.03	100	0.015
1.13	1	7.68	2.30	0	0.050
	2	7.28	2.30	100	0.015
1.14	1	2.24	2.02	0	0.051
	2	2.20	2.02	100	0.015
1.15	1	4.41	1.22	0	0.038
	2	6.82	1.22	100	0.015
1.16	1	2.13	1.39	0	0.046
	2	2.62	1.39	100	0.015
1.17	1	2.00	0.48	0	0.040
	2	8.27	0.48	100	0.015
1.18	1	5.31	1.87	0	0.040
	2	6.51	1.87	100	0.015
1.19	1	25.98	0.81	0	0.063
	2	6.61	0.81	100	0.015
1.2	1	4.83	0.20	0	0.067
	2	0.08	0.20	100	0.015
1.21	1	8.08	1.65	0	0.059
	2	3.73	1.65	100	0.015
1.22	1	17.01	0.86	0	0.056
	2	7.03	0.86	100	0.015
1.23	1	2.89	1.84	0	0.073
	2	0.94	1.84	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
1.24	1	1.82	1.03	0	0.071
	2	0.57	1.03	100	0.015
1.25	1	16.54	1.32	0	0.063
	2	2.02	1.32	100	0.015
1.26	1	1.58	2.89	0	0.050
	2	0.16	2.89	100	0.015
2.01	1	0.41	4.97	0	0.031
	2	0.08	4.97	100	0.015
3.01	1	3.92	2.30	0	0.032
	2	0.72	2.30	100	0.015
3.02	1	1.67	6.86	0	0.031
	2	0.61	6.86	100	0.015
4.01	1	0.59	2.52	0	0.031
	2	0.02	2.52	100	0.015
5.01	1	9.41	4.05	0	0.031
	2	7.87	4.05	100	0.015
5.02	1	2.63	2.70	0	0.030
	2	3.91	2.70	100	0.015
6.01	1	1.92	4.46	0	0.071
	2	0.39	4.46	100	0.015
6.02	1	6.95	3.27	0	0.032
	2	0.23	3.27	100	0.015
7.01	1	15.99	3.36	0	0.039
	2	3.32	3.36	100	0.015
8.01	1	4.04	2.51	0	0.049
	2	3.01	2.51	100	0.015
9.01	1	14.61	2.30	0	0.041
	2	3.93	2.30	100	0.015
9.02	1	1.11	2.14	0	0.036
	2	1.00	2.14	100	0.015
9.03	1	0.81	1.04	0	0.048
	2	1.11	1.04	100	0.015
9.04	1	0.94	0.93	0	0.044
	2	0.96	0.93	100	0.015
9.05	1	2.18	1.67	0	0.040
	2	1.71	1.67	100	0.015
9.06	1	11.38	2.29	0	0.053
	2	4.55	2.29	100	0.015
9.07	1	1.84	9.99	0	0.043
	2	3.07	9.99	100	0.015
9.08	1	1.88	4.42	0	0.049
	2	2.28	4.42	100	0.015
9.09	1	2.71	5.39	0	0.043
	2	3.48	5.39	100	0.015
9.1	1	2.45	3.41	0	0.049
	2	2.74	3.41	100	0.015
9.11	1	3.09	3.08	0	0.054
	2	3.01	3.08	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
9.12	1	4.17	2.22	0	0.048
	2	4.67	2.22	100	0.015
9.13	1	1.40	2.32	0	0.050
	2	2.09	2.32	100	0.015
9.14	1	3.57	2.13	0	0.046
	2	4.59	2.13	100	0.015
9.15	1	1.87	1.96	0	0.050
	2	4.04	1.96	100	0.015
9.16	1	8.82	1.30	0	0.040
	2	3.61	1.30	100	0.015
9.17	1	12.11	1.91	0	0.052
	2	2.52	1.91	100	0.015
9.18	1	1.46	1.74	0	0.033
	2	2.73	1.74	100	0.015
9.19	1	1.34	1.48	0	0.038
	2	3.54	1.48	100	0.015
10.01	1	4.74	4.12	0	0.034
	2	1.48	4.12	100	0.015
11.01	1	0.89	6.42	0	0.029
	2	1.43	6.42	100	0.015
11.02	1	0.44	2.48	0	0.041
	2	0.49	2.48	100	0.015
11.03	1	0.53	3.16	0	0.045
	2	0.57	3.16	100	0.015
12.01	1	1.68	2.56	0	0.043
	2	1.33	2.56	100	0.015
12.02	1	1.40	2.29	0	0.043
	2	1.80	2.29	100	0.015
13.01	1	1.94	3.02	0	0.040
	2	2.80	3.02	100	0.015
13.02	1	0.63	2.86	0	0.042
	2	1.17	2.86	100	0.015
14.01	1	1.44	3.12	0	0.040
	2	1.97	3.12	100	0.015
15.01	1	1.02	7.07	0	0.041
	2	1.73	7.07	100	0.015
16.01	1	2.20	2.33	0	0.063
	2	3.73	2.33	100	0.015
17.01	1	0.41	3.75	0	0.059
	2	0.55	3.75	100	0.015
18.01	1	0.18	3.27	0	0.035
	2	0.33	3.27	100	0.015
19.01	1	0.22	3.93	0	0.043
	2	0.40	3.93	100	0.015
19.02	1	1.84	2.86	0	0.052
	2	3.00	2.86	100	0.015
19.03	1	4.40	2.58	0	0.039
	2	4.43	2.58	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
19.04	1	7.57	1.46	0	0.044
	2	7.59	1.46	100	0.015
19.05	1	1.01	0.30	0	0.048
	2	3.14	0.30	100	0.015
19.06	1	1.19	3.21	0	0.028
	2	0.99	3.21	100	0.015
19.07	1	3.25	1.07	0	0.056
	2	7.00	1.07	100	0.015
19.08	1	2.45	0.97	0	0.047
	2	3.01	0.97	100	0.015
20.01	1	0.77	5.54	0	0.044
	2	0.91	5.54	100	0.015
21.01	1	0.00	1.07	0	0.014
	2	0.02	1.07	100	0.015
22.01	1	3.81	1.99	0	0.042
	2	4.82	1.99	100	0.015
23.01	1	0.97	7.95	0	0.037
	2	1.52	7.95	100	0.015
23.02	1	3.47	3.82	0	0.041
	2	4.90	3.82	100	0.015
23.03	1	1.85	4.92	0	0.072
	2	0.01	4.92	100	0.015
23.04	1	1.26	5.15	0	0.060
	2	0.00	5.15	100	0.015
23.05	1	2.85	5.01	0	0.070
	2	0.82	5.01	100	0.015
23.06	1	1.59	4.39	0	0.069
	2	0.41	4.39	100	0.015
23.07	1	0.67	6.72	0	0.087
	2	0.00	6.72	100	0.015
23.08	1	1.48	3.23	0	0.055
	2	1.13	3.23	100	0.015
23.09	1	2.07	2.09	0	0.045
	2	2.39	2.09	100	0.015
23.1	1	0.51	3.33	0	0.052
	2	0.73	3.33	100	0.015
23.11	1	2.70	2.51	0	0.050
	2	3.14	2.51	100	0.015
24.01	1	1.21	1.70	0	0.045
	2	1.58	1.70	100	0.015
24.02	1	3.17	1.97	0	0.044
	2	4.24	1.97	100	0.015
26.01	1	1.41	9.34	0	0.032
	2	0.11	9.34	100	0.015
26.02	1	1.41	5.64	0	0.028
	2	0.64	5.64	100	0.015
26.03	1	3.10	3.83	0	0.038
	2	4.47	3.83	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
26.04	1	2.49	5.17	0	0.038
	2	2.55	5.17	100	0.015
26.05	1	1.53	6.90	0	0.046
	2	1.46	6.90	100	0.015
26.06	1	0.55	6.80	0	0.047
	2	0.48	6.80	100	0.015
26.07	1	0.50	6.92	0	0.042
	2	0.55	6.92	100	0.015
26.08	1	0.38	6.74	0	0.046
	2	0.34	6.74	100	0.015
26.09	1	1.03	4.40	0	0.042
	2	1.62	4.40	100	0.015
26.1	1	1.46	4.60	0	0.042
	2	0.47	4.60	100	0.015
26.11	1	0.62	5.22	0	0.043
	2	0.71	5.22	100	0.015
26.12	1	8.22	2.31	0	0.048
	2	7.36	2.31	100	0.015
26.13	1	0.64	5.14	0	0.048
	2	1.01	5.14	100	0.015
26.14	1	1.33	1.77	0	0.049
	2	0.22	1.77	100	0.015
27.01	1	0.64	3.47	0	0.046
	2	0.89	3.47	100	0.015
28.01	1	2.54	3.14	0	0.042
	2	1.47	3.14	100	0.015
28.02	1	2.21	2.96	0	0.048
	2	1.95	2.96	100	0.015
29.01	1	1.24	0.85	0	0.051
	2	1.30	0.85	100	0.015
30.01	1	12.57	2.93	0	0.039
	2	2.67	2.93	100	0.015
30.02	1	1.84	3.80	0	0.043
	2	0.78	3.80	100	0.015
30.03	1	8.89	1.87	0	0.037
	2	2.02	1.87	100	0.015
30.04	1	17.40	0.48	0	0.060
	2	2.00	0.48	100	0.015
31.01	1	3.48	5.64	0	0.034
	2	0.49	5.64	100	0.015
32.01	1	0.07	5.71	0	0.024
	2	0.08	5.71	100	0.015
33.01	1	0.87	2.94	0	0.042
	2	1.23	2.94	100	0.015
33.02	1	3.82	4.71	0	0.052
	2	2.22	4.71	100	0.015
33.03	1	5.08	4.16	0	0.045
	2	7.66	4.16	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
33.04	1	1.12	3.71	0	0.041
	2	1.80	3.71	100	0.015
33.05	1	0.69	1.46	0	0.041
	2	0.73	1.46	100	0.015
33.06	1	1.55	2.53	0	0.036
	2	1.49	2.53	100	0.015
34.01	1	3.66	2.61	0	0.054
	2	4.23	2.61	100	0.015
35.01	1	2.35	4.56	0	0.043
	2	3.17	4.56	100	0.015
35.02	1	6.85	1.64	0	0.050
	2	5.83	1.64	100	0.015
35.03	1	0.48	3.28	0	0.045
	2	0.56	3.28	100	0.015
35.04	1	1.85	0.27	0	0.041
	2	3.14	0.27	100	0.015
36.01	1	1.33	3.35	0	0.051
	2	1.66	3.35	100	0.015
36.02	1	3.06	3.21	0	0.046
	2	0.61	3.21	100	0.015
36.03	1	1.65	2.97	0	0.045
	2	1.75	2.97	100	0.015
37.01	1	0.79	4.17	0	0.043
	2	1.18	4.17	100	0.015
38.01	1	1.30	3.21	0	0.047
	2	1.75	3.21	100	0.015
39.01	1	1.35	3.94	0	0.046
	2	1.95	3.94	100	0.015
40.01	1	1.06	3.93	0	0.040
	2	1.68	3.93	100	0.015
41.01	1	1.46	3.10	0	0.040
	2	2.02	3.10	100	0.015
41.02	1	0.65	2.50	0	0.040
	2	1.05	2.50	100	0.015
42.01	1	0.42	2.64	0	0.039
	2	0.87	2.64	100	0.015
43.01	1	1.84	0.78	0	0.040
	2	0.95	0.78	100	0.015
44.01	1	1.24	0.58	0	0.043
	2	0.11	0.58	100	0.015
45.01	1	2.41	1.31	0	0.047
	2	3.18	1.31	100	0.015
45.02	1	2.51	2.54	0	0.044
	2	2.37	2.54	100	0.015
45.03	1	2.50	2.39	0	0.042
	2	3.16	2.39	100	0.015
45.04	1	0.73	2.28	0	0.046
	2	1.16	2.28	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
45.05	1	1.00	0.75	0	0.043
	2	1.70	0.75	100	0.015
45.06	1	0.59	4.18	0	0.042
	2	0.87	4.18	100	0.015
45.07	1	1.81	2.25	0	0.043
	2	3.07	2.25	100	0.015
45.08	1	1.96	3.42	0	0.057
	2	0.88	3.42	100	0.015
46.01	1	1.74	4.15	0	0.048
	2	0.99	4.15	100	0.015
47.01	1	1.44	1.54	0	0.044
	2	2.00	1.54	100	0.015
48.01	1	0.90	4.69	0	0.041
	2	1.47	4.69	100	0.015
48.02	1	1.98	1.98	0	0.040
	2	2.82	1.98	100	0.015
48.03	1	1.80	2.90	0	0.041
	2	3.08	2.90	100	0.015
48.04	1	2.30	0.93	0	0.047
	2	2.84	0.93	100	0.015
48.05	1	1.00	2.15	0	0.043
	2	1.70	2.15	100	0.015
49.01	1	2.42	3.80	0	0.042
	2	3.34	3.80	100	0.015
49.02	1	1.00	3.34	0	0.044
	2	1.25	3.34	100	0.015
49.03	1	0.77	3.34	0	0.040
	2	1.13	3.34	100	0.015
50.01	1	0.71	3.27	0	0.043
	2	1.01	3.27	100	0.015
51.01	1	8.39	1.63	0	0.058
	2	4.39	1.63	100	0.015
52.01	1	2.41	2.30	0	0.039
	2	1.30	2.30	100	0.015
52.02	1	0.54	2.31	0	0.040
	2	0.77	2.31	100	0.015
53.01	1	2.48	3.62	0	0.042
	2	3.19	3.62	100	0.015
53.02	1	1.92	1.55	0	0.043
	2	2.71	1.55	100	0.015
54.01	1	0.56	1.92	0	0.043
	2	1.10	1.92	100	0.015
55.01	1	0.62	1.66	0	0.053
	2	0.62	1.66	100	0.015
56.01	1	0.11	4.48	0	0.112
	2	0.00	4.48	100	0.015
57.01	1	5.46	2.33	0	0.039
	2	1.50	2.33	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
57.02	1	5.29	3.49	0	0.060
	2	0.52	3.49	100	0.015
57.03	1	0.29	1.13	0	0.030
	2	0.12	1.13	100	0.015
57.04	1	1.70	2.36	0	0.042
	2	2.33	2.36	100	0.015
57.05	1	1.78	0.74	0	0.048
	2	1.42	0.74	100	0.015
58.01	1	2.81	3.57	0	0.061
	2	0.22	3.57	100	0.015
59.01	1	0.71	1.74	0	0.029
	2	0.43	1.74	100	0.015
60.01	1	0.07	1.61	0	0.056
	2	0.03	1.61	100	0.015
61.01	1	0.39	2.14	0	0.041
	2	0.39	2.14	100	0.015
62.01	1	5.55	3.02	0	0.044
	2	7.50	3.02	100	0.015
62.02	1	3.66	2.25	0	0.039
	2	3.41	2.25	100	0.015
62.03	1	1.43	4.63	0	0.049
	2	1.34	4.63	100	0.015
62.04	1	2.60	1.31	0	0.042
	2	1.55	1.31	100	0.015
62.05	1	0.72	0.36	0	0.044
	2	1.05	0.36	100	0.015
62.06	1	0.55	3.36	0	0.034
	2	0.50	3.36	100	0.015
63.01	1	1.89	3.19	0	0.043
	2	2.34	3.19	100	0.015
64.01	1	0.61	4.77	0	0.042
	2	0.90	4.77	100	0.015
65.01	1	3.97	1.56	0	0.042
	2	4.08	1.56	100	0.015
66.01	1	0.88	1.83	0	0.035
	2	0.80	1.83	100	0.015
67.01	1	1.23	4.55	0	0.045
	2	1.46	4.55	100	0.015
67.02	1	1.72	1.98	0	0.045
	2	1.98	1.98	100	0.015
67.03	1	3.16	2.12	0	0.073
	2	0.55	2.12	100	0.015
68.01	1	1.46	2.24	0	0.048
	2	1.84	2.24	100	0.015
69.01	1	36.79	0.72	0	0.038
	2	4.89	0.72	100	0.015
69.02	1	21.66	1.52	0	0.051
	2	3.61	1.52	100	0.015

Subcatchment ID	Sub-Area	Area [ha]	Catchment Slope [%]	Percentage Impervious [%]	Mannings 'n'
69.03	1	2.01	1.35	0	0.040
	2	1.85	1.35	100	0.015
69.04	1	2.18	1.57	0	0.045
	2	3.29	1.57	100	0.015
69.05	1	4.85	0.88	0	0.044
	2	3.58	0.88	100	0.015
69.06	1	4.97	0.92	0	0.041
	2	2.81	0.92	100	0.015
69.07	1	12.90	0.83	0	0.045
	2	2.92	0.83	100	0.015
70.01	1	0.55	2.67	0	0.034
	2	0.61	2.67	100	0.015
71.01	1	2.00	1.35	0	0.043
	2	2.05	1.35	100	0.015
71.02	1	3.19	1.22	0	0.046
	2	3.84	1.22	100	0.015
71.03	1	3.45	1.13	0	0.043
	2	5.29	1.13	100	0.015
71.04	1	2.87	1.34	0	0.044
	2	3.25	1.34	100	0.015
71.05	1	1.24	2.38	0	0.044
	2	1.58	2.38	100	0.015
72.01	1	0.51	1.12	0	0.070
	2	1.20	1.12	100	0.015
73.01	1	4.03	0.30	0	0.046
	2	2.34	0.30	100	0.015

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LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Appendix O.1: XP - RAFTS Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.1.wor

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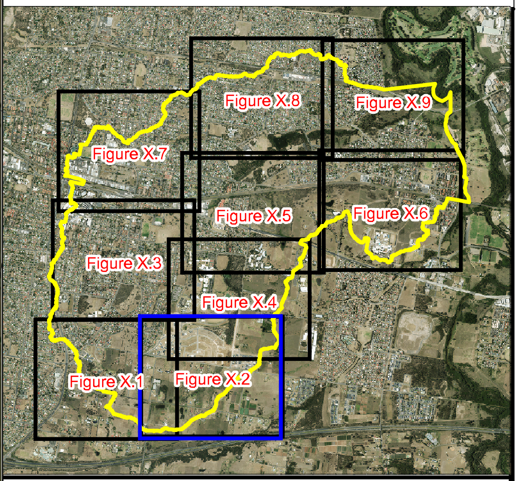


LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:
Aerial photograph date: 2014

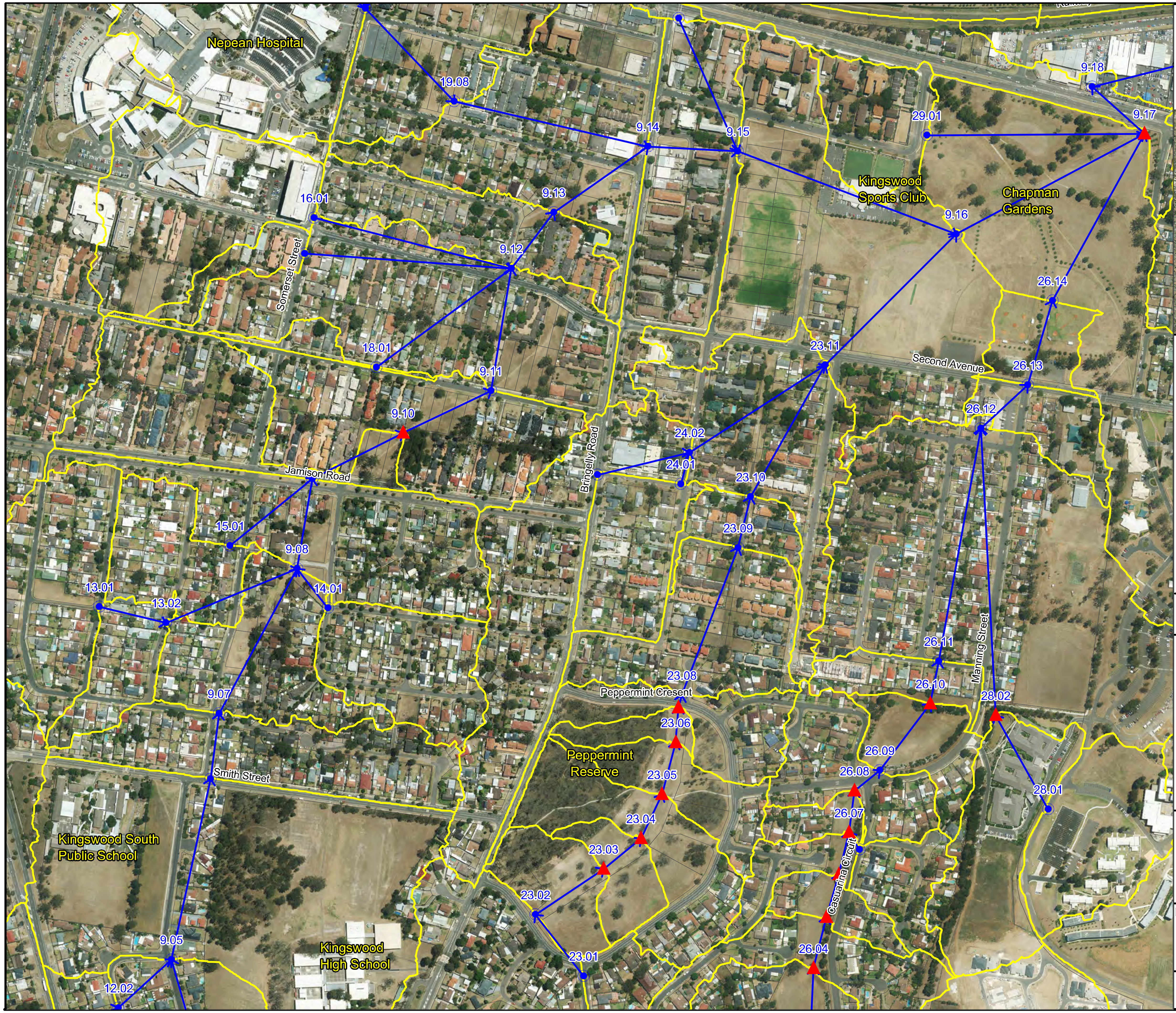
N
W E
S

Scale 1:5,000 (at A3)
0 0.15 0.3
Km

Appendix O.2:
XP - RAFTS
Subcatchment Layout

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.2.wor



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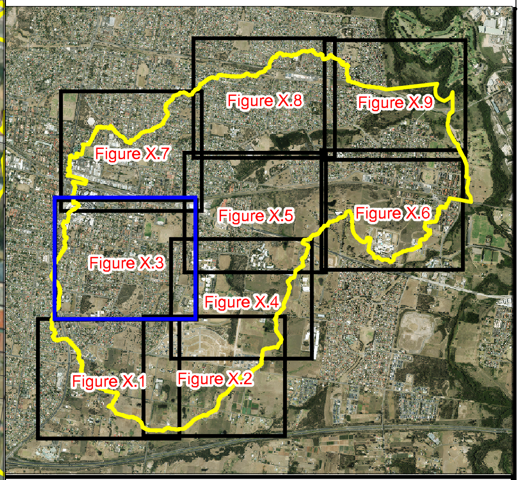


LEGEND

●	XP - RAFTS Subcatchment Node
▲	Detention Basin Node
→	XP - RAFTS Routing Link
▭	XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

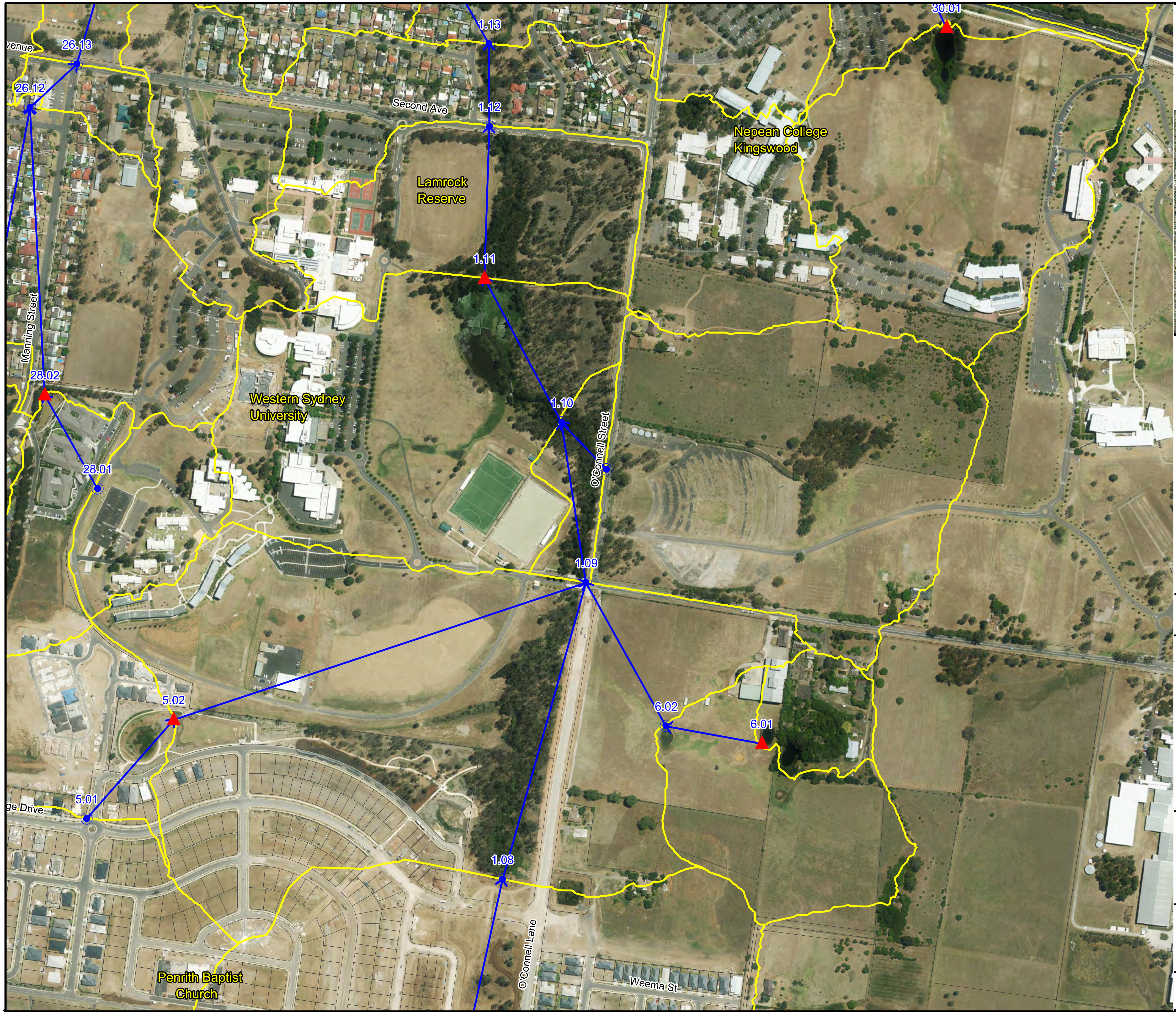
0 0.15 0.3
Km

Appendix O.3: XP - RAFTS Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.3.wor



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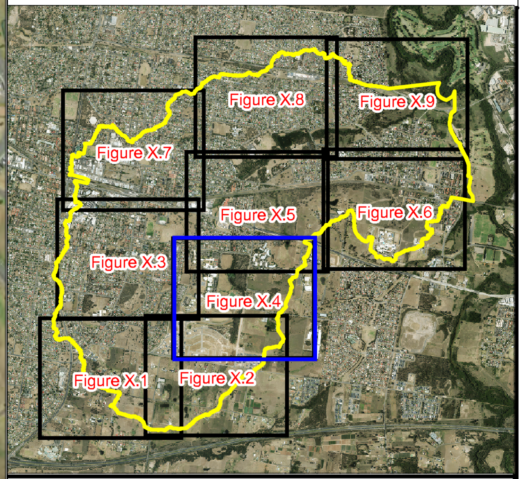


LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:
Aerial photograph date: 2014

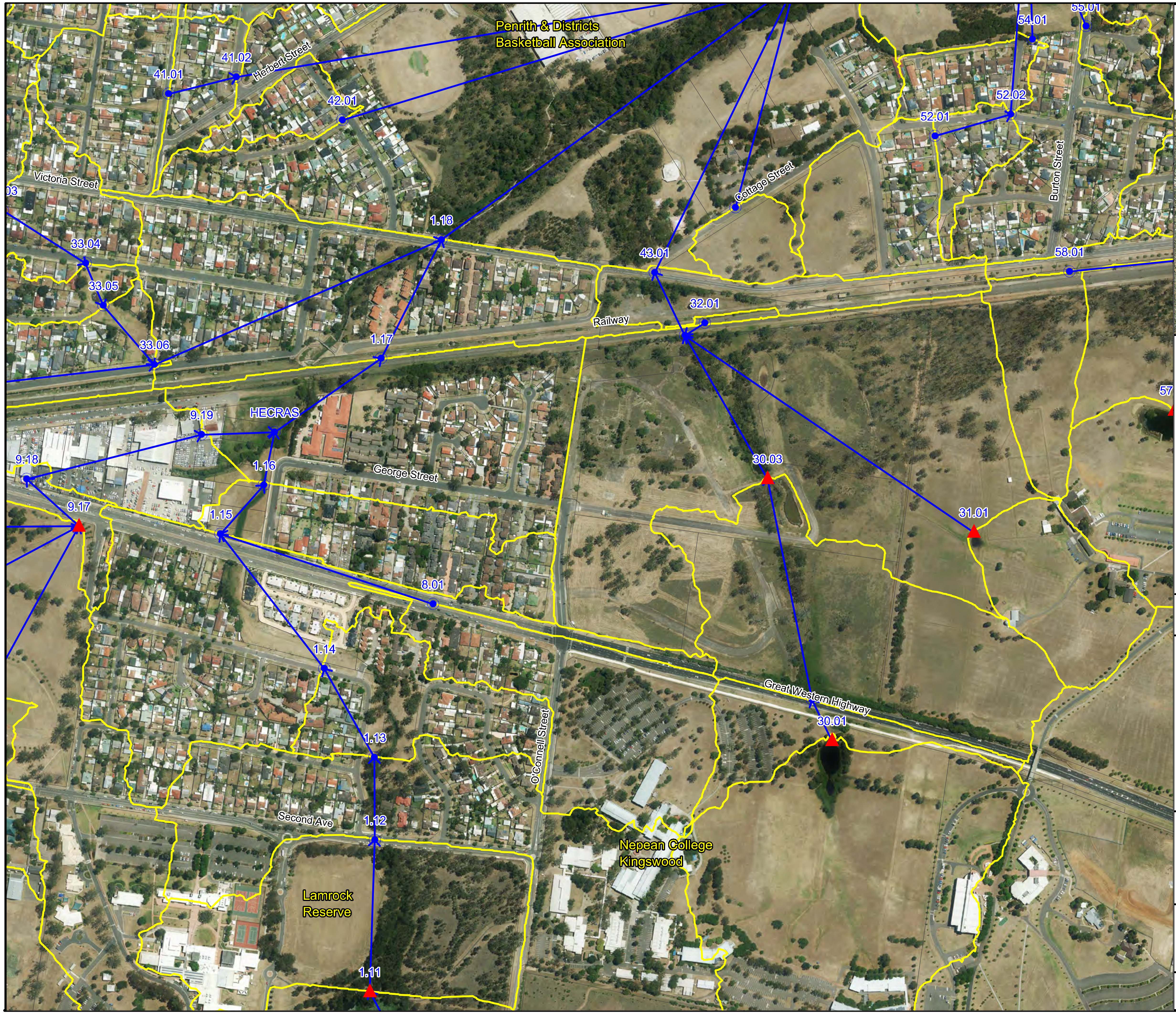
N
W E
S

Scale 1:5,000 (at A3)
0 0.15 0.3
Km

Appendix O.4: XP - RAFTS Subcatchment Layout

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.4.wor



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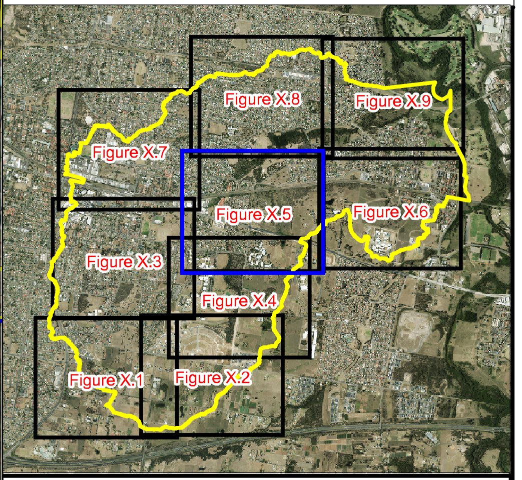

LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Appendix O.5: XP - RAFTS Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.5.wor

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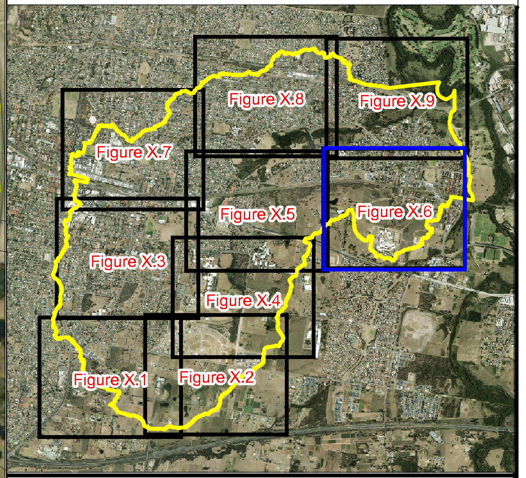


LEGEND

XP - RAFTS Subcatchment Node

Detention Basin Node

XP - RAFTS Routing Link

XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3

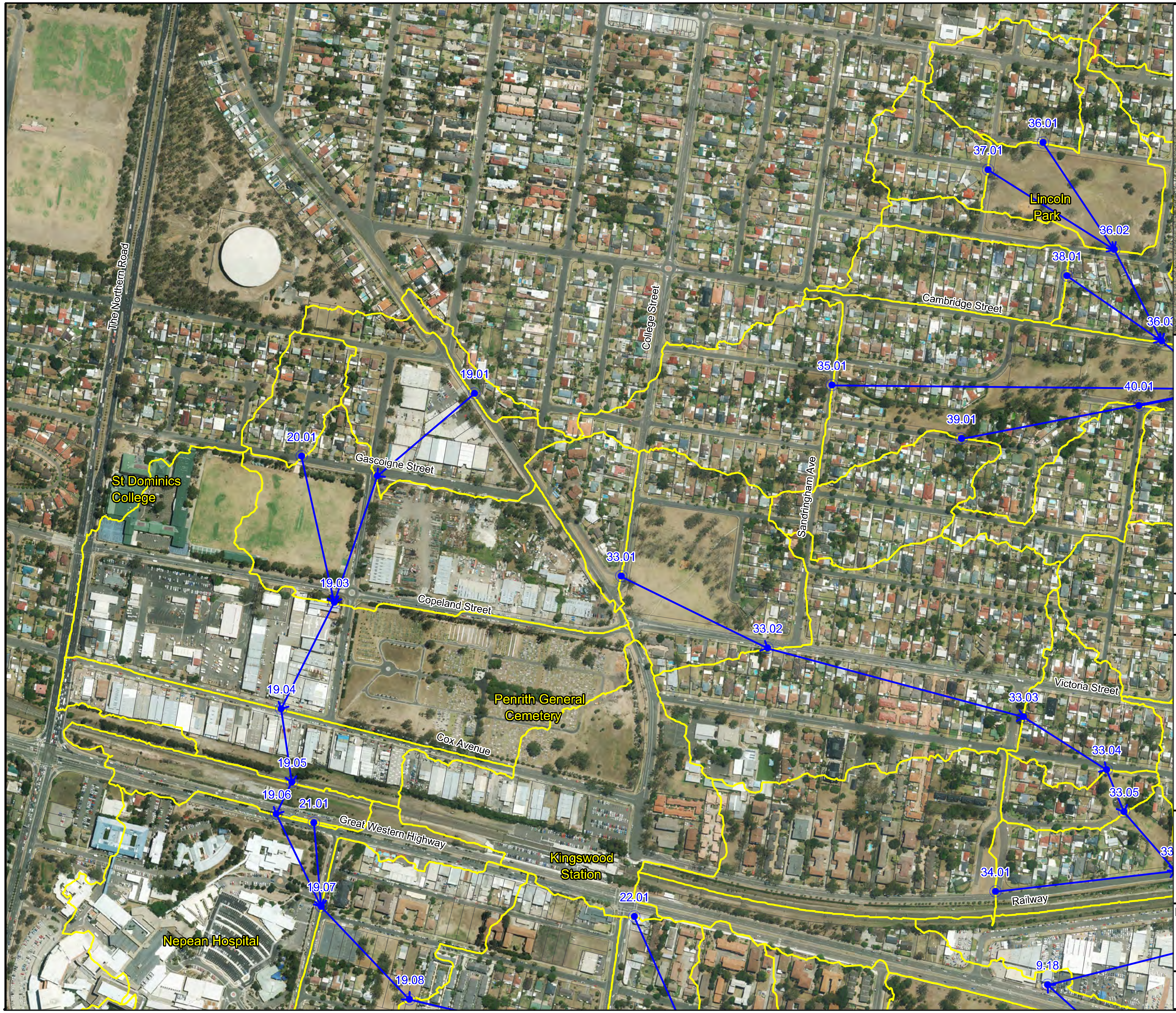
Km

Appendix O.6:
XP - RAFTS
Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.6.wor



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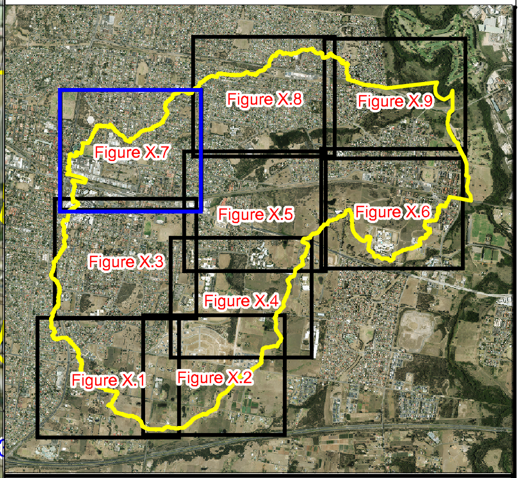

LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Appendix O.7:
XP - RAFTS
Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.7.wor

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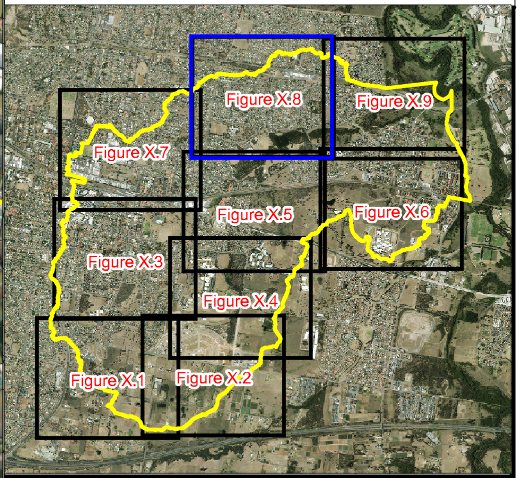

LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:

Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Appendix O.8: XP - RAFTS Subcatchment Layout

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.8.wor

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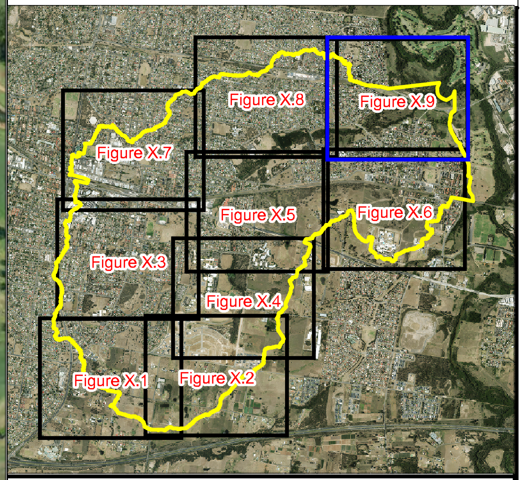


LEGEND

- XP - RAFTS Subcatchment Node
- Detention Basin Node
- XP - RAFTS Routing Link
- XP - RAFTS Subcatchment Boundaries

Notes:
Aerial photograph date: 2014

N W E S

Scale 1:5,000 (at A3)
0 0.15 0.3
Km

Appendix O.9: XP - RAFTS Subcatchment Layout

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: XP-RAFTS layout figure X.9.wor

The adopted pervious and impervious areas and weighted 'n' values for each subcatchment are also provided in **Table O1**.

Table O2 Adopted Impervious Percentage and Manning's 'n' Values for Hydrologic Model

Land Use Description	Manning's 'n'	Impervious (%)
Buildings	0.100	100
Water	0.035	100
Trees	0.133	0
Grass	0.031	0
Impervious Surfaces (Roads, Footpaths, etc)	0.015	100
Area currently under construction	0.024	60

Detention Basins

There are a number of detention basins located within the College, Orth and Werrington Creeks catchment. These include both formal and informal storages that have the potential to attenuate downstream flows during storm events by temporarily storing runoff from the upstream catchment. Due to the potential for the storages to impact on downstream flows, each significant storage was incorporated in the XP-RAFTS model.

The representation of basins in XP-RAFTS requires the outflow and storage characteristics of the basin to be defined. The outflow characteristics were specified using the surveyed outlet pipe characteristics and the storage characteristics were defined using a stage-storage relationship derived from the LiDAR information.

The location of the basins included within the XP-RAFTS model is shown on **Figure O1** to **Figure O9** as red triangles.

Stream Routing

In addition to local subcatchment runoff, most subcatchments will also carry flow from upstream catchments along the main flow path / watercourse. The flow along these flowpaths in XP-RAFTS is represented using a "link" between successive subcatchment "nodes".

For this study, time delay lag routing was employed to represent the routing of runoff along the main watercourses into downstream subcatchments. The time delay value for each subcatchment was calculated using a modified version of the Bransby-Williams formula (Queensland Government, 2007).

Rainfall Loss Model

During a typical rainfall event, not all of the rain falling on a catchment is converted to runoff. Some of the rainfall may be intercepted and stored by vegetation, some may be stored in small depressions and some may infiltrate into the underlying soils.

To account for rainfall "losses" of this nature, the hydrologic model incorporates a rainfall loss model. For this study, the "Initial-Continuing" loss model was adopted, which is recommended in *"Australian Rainfall and Runoff – A Guide to Flood Estimation"* (Engineers Australia, 1987) for eastern NSW.

Initial and continuing losses were applied to each material type based on standard design values documented in *'Australian Rainfall and Runoff – A Guide to Flood Estimation' (Engineers Australia, 1987)* and are summarised in **Table O3**. All rainfall losses are consistent with those adopted in the TUFLOW model.

Table O3 Adopted XP-RAFTS Rainfall Loss Values

Material Description	Rainfall Losses	
	Initial Loss *(mm)*	Continuing Loss Rate *(mm/hr)*
Buildings	1.0	0.0
Water	0.0	0.0
Trees	10.0	2.5
Grass	10.0	2.5
Impervious Surfaces (Roads, Footpaths, etc)	1.0	0.0
Current construction area	1.0	1.0

Results

The XP-RAFTS hydrologic model was then used to simulate the 1% AEP storm for a range of design storm durations. Peak 1% AEP discharges were extracted from the model and compared to the TUFLOW hydraulic model at common locations. A summary of the flow comparison results is provided in **Table O4**, and complete results for all subcatchments in the College, Orth and Werrington Creeks catchment is contained in **Table O5**.

The comparison provided in **Tables N4** shows the TUFLOW model produces peak flows that are typically within 15% of the XP-RAFTS model.

Full discharge hydrographs showing the time variation in flows at discreet locations throughout the catchment were also extracted from the XP-RAFTS and TUFLOW model results and are included in **Figures N10** to **N12**. The hydrograph comparison shows that the overall hydrograph shapes, time of peak flow and volume of runoff (represented by the area under the hydrograph) generally compare well. It was noted that the TUFLOW shows are greater delay before the hydrograph begins to rise relative to the XP-RAFTS model. This is again likely to be associated with the TUFLOW model providing a more comprehensive presentation of "micro" storage across the catchment (e.g., small depressions) that are difficult to represent in a lumped hydrologic model such as XP-RAFTS model. Consequently, each of these micro storage areas must be filled before runoff can commence.

Overall, it is considered that a good level of agreement has been achieved and indicates that the TUFLOW model is providing a reasonable representation of hydrologic processes across the College, Orth and Werrington Creeks catchment.

Table O4 Comparison between XP-RAFTS and TUFLOW 1%AEP peak discharges in the College, Orth and Werrington Creeks Study Area

Location/XP-RAFTS Subcatchment ID	Peak 1% AEP Flow (m^3/s)		
	XP-RAFTS	TUFLOW	Difference
Piper Close	3.3	3.8	13%
Jamison Street	13.7	16.4	16%
Stafford Street	14.1	17.3	18%
Bringelly Road	26.2	27.9	6%
First Street	27.6	28.8	4%
Peppermint Crescent	3.3	2.9	-14%
Edward Street	2.4	2.4	0%
DougRennieField	32.8	29.4	-12%
Caddens Road	9.2	10.7	14%
O'Connell St	19.3	17.6	-10%
CosgroveCres	20.9	22.0	5%
College Creek @ GWH	21.7	20.9	-4%
Werrington Ck @ Railway	60.7	62.2	2%
Park Ave	9.0	7.9	-14%
Werrington Ck @ Victoria Rd	64.4	66.1	3%
Herbert St	11.6	13.7	15%
Dunheved Rd / South Creek	92.1	98.4	6%

Table O5 - PEAK DESIGN FLOOD DISCHARGES - 1% AEP

Subcatchment ID	Peak Discharge (m^3/s)						
	30 min	60 min	90 min	120 min	180 min	270 min	360 min
1.01	0.79	1.06	1.06	**1.11**	0.88	1.02	0.87
1.02	2.22	3.01	3.02	**3.11**	2.57	3.06	2.63
1.03	2.56	3.68	3.76	**3.93**	3.35	3.72	3.41
1.04	2.60	3.84	3.98	**4.16**	3.62	3.91	3.67
1.05	3.17	4.78	5.01	**5.23**	4.65	4.90	4.75
1.06	3.34	5.03	5.34	**5.58**	5.07	5.22	5.21
1.07	5.94	8.41	8.79	**9.25**	8.65	8.70	9.06
1.08	6.82	9.05	10.29	**10.90**	10.00	10.05	10.75
1.09	14.85	18.33	**19.34**	19.34	17.79	18.07	17.93
1.1	17.08	21.27	22.31	**22.67**	19.90	20.35	20.41
1.11	14.25	17.62	18.77	19.51	18.89	18.56	**19.52**
1.12	14.64	18.07	19.16	20.07	19.57	19.31	**20.15**
1.13	14.96	18.42	19.70	20.78	20.49	20.42	**21.00**
1.14	15.01	18.47	19.81	20.91	20.73	20.73	**21.23**
1.15	15.24	18.73	20.35	21.68	21.80	21.96	**22.23**
1.16	15.28	18.78	20.43	21.89	22.04	22.26	**22.47**
1.17	41.50	53.15	57.52	**60.70**	57.15	55.97	57.47
1.18	42.24	54.67	60.14	**63.65**	60.97	59.58	60.77
1.19	44.73	59.46	68.90	**72.03**	71.37	69.54	70.50
1.2	44.36	60.59	72.25	75.90	**77.24**	75.09	75.84
1.21	44.60	61.19	72.89	77.42	**79.07**	76.78	77.55
1.22	47.67	65.29	76.17	82.93	**85.03**	82.29	83.29
1.23	48.04	65.68	76.41	83.51	**85.76**	83.06	84.11
1.24	48.10	65.76	76.47	83.59	**85.89**	83.20	84.27
1.25	48.95	67.01	77.33	84.93	**87.82**	85.03	86.30
1.26	53.32	74.76	85.94	93.08	**98.44**	94.80	97.35
2.01	0.00	0.00	0.00	0.01	0.03	**0.03**	0.03
3.01	0.78	0.98	1.07	**1.08**	0.87	0.86	0.76
3.02	1.29	1.63	**1.92**	1.86	1.44	1.35	1.15
4.01	0.00	0.00	0.00	0.01	0.03	**0.03**	0.03
5.01	4.83	5.22	**6.04**	5.34	3.99	3.63	2.95
5.02	5.65	6.36	6.83	**6.87**	4.83	4.77	3.99
6.01	0.31	0.41	0.41	**0.42**	0.33	0.41	0.35
6.02	1.54	1.92	1.94	**2.09**	1.61	1.73	1.51
7.01	2.56	3.18	**3.68**	3.52	2.89	3.35	2.95
8.01	1.71	1.80	**2.06**	1.83	1.31	1.26	1.13
9.01	0.88	1.74	2.01	2.15	1.99	1.88	**2.16**
9.02	2.31	2.70	2.99	3.00	2.80	2.58	**3.08**
9.03	2.52	2.97	3.27	**3.28**	2.98	2.78	3.26
9.04	3.98	4.74	5.04	**5.08**	3.85	3.96	3.91
9.05	5.40	6.49	6.65	**6.70**	5.19	5.71	4.90
9.06	6.33	8.25	8.67	**8.78**	7.09	7.64	6.86
9.07	6.96	8.70	9.24	**9.38**	7.72	8.30	7.44
9.08	8.82	10.39	**11.54**	11.01	9.59	10.04	9.14
9.09	10.41	12.15	**13.01**	12.77	10.58	10.76	10.22
9.1	10.38	12.26	**12.92**	12.89	11.03	11.09	10.75
9.11	10.76	13.11	13.72	**13.77**	11.64	11.64	11.47
9.12	11.45	14.94	15.65	**16.01**	13.50	13.45	13.42
9.13	11.56	15.25	16.01	**16.42**	13.93	13.78	13.78
9.14	21.06	24.87	24.90	**26.15**	22.20	22.77	21.64
9.15	21.65	26.46	26.35	**27.56**	24.11	24.09	23.28
9.16	24.26	31.19	31.41	**32.80**	29.34	28.56	29.35
9.17	27.83	36.79	37.51	**38.96**	35.70	34.30	35.16
9.18	27.87	36.84	37.71	**39.15**	36.01	34.51	35.42
9.19	27.90	36.89	37.93	**39.49**	36.36	34.87	35.73
10.01	1.27	1.53	**1.88**	1.80	1.42	1.27	1.05
11.01	0.96	1.02	**1.10**	1.01	0.62	0.55	0.40
11.02	1.12	1.24	**1.32**	**1.32**	0.85	0.75	0.56
11.03	1.34	1.50	1.55	**1.64**	1.11	0.97	0.75
12.01	0.81	0.87	**0.99**	0.89	0.64	0.60	0.51
12.02	1.75	1.86	**2.08**	1.89	1.33	1.25	1.04
13.01	1.59	1.65	**1.86**	1.68	1.14	1.03	0.81
13.02	2.14	2.28	**2.53**	2.35	1.53	1.40	1.12
14.01	1.14	1.19	**1.35**	1.23	0.83	0.75	0.59
15.01	1.07	1.14	**1.25**	1.15	0.73	0.65	0.48
16.01	1.96	1.98	**2.15**	2.02	1.23	1.14	0.96
17.01	0.32	0.33	**0.40**	0.34	0.24	0.21	0.17
18.01	0.20	0.22	**0.24**	0.22	0.14	0.12	0.09

Subcatchment ID	Peak Discharge (m^3/s)						
	30 min	60 min	90 min	120 min	180 min	270 min	360 min
19.01	0.24	0.25	**0.29**	0.26	0.16	0.15	0.11
19.02	1.80	1.80	**1.98**	1.79	1.24	1.15	0.93
19.03	4.18	4.05	4.32	**4.73**	3.40	3.18	2.67
19.04	6.77	6.81	**6.89**	6.71	5.51	5.33	4.80
19.05	7.35	7.64	**7.92**	7.40	5.92	5.95	5.25
19.06	7.78	8.20	**8.42**	8.05	6.26	6.31	5.58
19.07	9.33	**9.84**	9.67	9.38	7.45	7.85	6.78
19.08	9.67	**10.50**	10.31	9.96	7.96	8.39	7.42
20.01	0.60	0.65	**0.72**	0.65	0.44	0.39	0.29
21.01	0.01	0.01	0.01	**0.01**	0.01	0.01	0.00
22.01	2.60	2.65	**2.95**	2.70	1.77	1.68	1.42
23.01	0.99	1.07	**1.16**	1.06	0.67	0.59	0.43
23.02	3.65	3.88	**4.32**	3.93	2.66	2.40	1.87
23.03	2.15	2.61	2.80	**2.91**	2.26	2.28	2.02
23.04	2.21	2.71	2.75	**2.88**	2.24	2.45	2.13
23.05	2.21	2.96	3.02	**3.11**	2.52	2.80	2.50
23.06	2.15	3.06	3.14	**3.24**	2.70	2.95	2.70
23.07	2.12	3.09	3.18	**3.28**	2.76	2.99	2.77
23.08	2.17	3.20	3.41	**3.53**	3.03	3.17	3.07
23.09	2.23	3.34	3.78	**3.98**	3.48	3.45	3.49
23.1	2.23	3.37	3.86	**4.07**	3.59	3.55	3.59
23.11	6.11	6.47	**6.94**	6.50	5.06	5.01	5.22
24.01	0.86	0.90	**1.00**	0.93	0.60	0.56	0.47
24.02	3.11	3.18	**3.51**	3.24	2.12	1.99	1.69
26.01	0.00	0.00	0.00	0.02	0.07	**0.08**	0.08
26.02	0.65	0.78	**0.87**	0.75	0.54	0.48	0.35
26.03	2.82	2.93	**3.40**	2.99	2.33	2.07	1.66
26.04	2.96	3.28	3.39	**3.49**	2.87	2.76	2.42
26.05	3.43	3.81	3.86	**3.96**	3.26	3.28	2.84
26.06	3.50	3.92	3.94	**4.03**	3.33	3.42	2.95
26.07	3.73	4.26	4.25	**4.31**	3.60	3.78	3.26
26.08	3.56	4.26	4.25	**4.35**	3.64	3.77	3.33
26.09	3.62	4.50	4.56	**4.67**	3.98	4.01	3.64
26.1	1.37	1.79	2.16	**2.32**	2.19	1.95	2.10
26.11	1.42	1.80	2.18	**2.39**	2.27	2.06	2.17
26.12	4.59	5.42	**6.31**	5.59	4.75	5.07	4.64
26.13	4.87	5.80	**6.76**	6.13	4.98	5.29	4.93
26.14	5.04	6.03	**7.00**	6.41	5.19	5.53	5.15
27.01	0.52	0.57	**0.63**	0.58	0.39	0.35	0.27
28.01	0.95	1.05	**1.27**	1.09	0.87	0.80	0.67
28.02	1.16	1.55	1.58	**1.72**	1.14	1.44	1.14
29.01	0.68	0.69	**0.77**	0.71	0.45	0.43	0.38
30.01	1.77	2.43	2.43	2.48	2.11	**2.52**	2.17
30.02	2.08	2.79	2.79	2.87	2.44	**2.89**	2.55
30.03	3.03	4.30	4.40	**4.56**	3.91	4.43	4.02
30.04	4.11	5.65	5.74	**6.01**	5.31	5.94	5.51
31.01	0.88	1.10	1.25	**1.28**	0.97	0.84	0.68
32.01	0.07	0.07	**0.07**	0.07	0.04	0.04	0.03
33.01	0.73	0.77	**0.86**	0.78	0.52	0.47	0.36
33.02	1.91	1.94	2.24	**2.36**	1.74	1.62	1.37
33.03	4.86	5.38	**5.84**	5.28	3.97	3.91	3.42
33.04	5.37	6.07	**6.41**	6.25	4.38	4.37	3.80
33.05	5.61	6.36	**6.66**	6.51	4.57	4.56	3.99
33.06	7.31	8.31	8.36	**8.93**	6.31	6.34	5.66
34.01	2.30	2.34	**2.60**	2.38	1.55	1.48	1.28
35.01	1.84	1.95	**2.23**	2.00	1.38	1.23	0.95
35.02	7.56	8.49	8.70	**9.01**	6.62	7.14	6.12
35.03	7.73	8.65	8.85	**9.14**	6.75	7.27	6.25
35.04	7.84	9.05	9.34	**9.68**	7.25	7.62	6.77
36.01	0.95	0.99	**1.11**	1.03	0.69	0.64	0.51
36.02	2.06	2.38	**2.64**	2.59	1.79	1.74	1.44
36.03	3.19	3.75	3.81	**4.19**	2.97	2.94	2.50
37.01	0.71	0.75	**0.85**	0.77	0.51	0.45	0.34
38.01	1.00	1.05	**1.17**	1.08	0.72	0.66	0.52
39.01	1.13	1.18	**1.33**	1.21	0.82	0.73	0.57
40.01	0.99	1.04	**1.17**	1.07	0.71	0.63	0.48
41.01	1.17	1.22	**1.37**	1.26	0.85	0.76	0.60
41.02	1.68	1.81	**2.03**	1.88	1.23	1.12	0.89
42.01	0.49	0.52	**0.58**	0.53	0.34	0.30	0.22
43.01	4.29	5.96	6.08	**6.37**	5.62	6.26	5.86

Subcatchment ID	Peak Discharge (m^3/s)						
	30 min	60 min	90 min	120 min	180 min	270 min	360 min
44.01	0.12	0.16	0.17	**0.18**	0.16	0.18	0.17
45.01	1.68	1.71	**1.86**	1.76	1.08	1.01	0.87
45.02	2.64	2.62	2.67	**3.05**	2.03	1.91	1.65
45.03	4.05	4.36	4.26	**4.83**	3.61	3.43	2.99
45.04	4.47	4.68	4.60	**5.17**	3.91	3.77	3.28
45.05	4.80	5.06	4.97	**5.48**	4.19	4.21	3.61
45.06	5.10	5.42	5.19	**5.66**	4.38	4.47	3.80
45.07	6.33	6.81	6.44	**6.83**	5.39	5.91	4.97
45.08	14.95	15.99	16.05	**16.23**	12.73	13.93	11.68
46.01	0.68	0.75	**0.88**	0.80	0.62	0.56	0.46
47.01	1.08	1.11	**1.21**	1.14	0.73	0.68	0.57
48.01	0.89	0.94	**1.04**	0.96	0.62	0.55	0.41
48.02	2.16	2.03	2.28	**2.31**	1.64	1.51	1.22
48.03	3.23	3.09	3.18	**3.43**	2.66	2.47	2.04
48.04	7.15	7.46	**7.78**	7.76	5.68	5.63	4.64
48.05	7.47	7.89	**8.16**	8.14	6.00	6.11	4.99
49.01	1.90	2.00	**2.28**	2.04	1.41	1.26	0.99
49.02	2.53	2.69	**3.02**	2.78	1.86	1.70	1.37
49.03	2.89	3.17	**3.43**	3.41	2.18	2.06	1.69
50.01	0.60	0.64	**0.71**	0.65	0.44	0.39	0.30
51.01	2.39	2.45	**2.75**	2.48	1.68	1.68	1.56
52.01	0.84	0.92	**1.08**	0.96	0.74	0.70	0.61
52.02	1.07	1.23	1.35	**1.36**	0.97	0.95	0.82
53.01	1.82	1.92	**2.20**	1.97	1.37	1.23	0.97
53.02	3.17	3.31	**3.67**	3.40	2.23	2.07	1.73
54.01	0.60	0.62	**0.70**	0.63	0.41	0.37	0.29
55.01	0.35	0.36	**0.41**	0.36	0.26	0.25	0.21
56.01	0.02	0.02	0.02	**0.03**	0.02	0.02	0.02
57.01	0.69	0.94	0.96	**1.00**	0.88	0.95	0.89
57.02	1.62	2.27	2.29	**2.37**	2.05	2.33	2.08
57.03	1.66	2.33	2.34	**2.43**	2.11	2.39	2.13
57.04	2.26	2.97	3.01	**3.14**	2.78	**3.14**	2.78
57.05	2.48	3.38	3.48	**3.67**	3.26	3.56	3.27
58.01	0.41	0.54	0.54	**0.57**	0.44	0.54	0.47
59.01	0.30	0.35	**0.41**	0.36	0.28	0.25	0.20
60.01	0.02	0.03	**0.03**	0.03	0.02	0.02	0.02
61.01	0.23	0.25	**0.31**	0.27	0.20	0.17	0.13
62.01	4.07	4.20	**4.64**	4.29	2.80	2.62	2.18
62.02	5.92	6.49	6.82	**7.09**	4.80	4.64	3.98
62.03	6.47	7.12	7.37	**7.69**	5.24	5.16	4.37
62.04	7.31	8.07	8.26	**8.76**	6.09	6.12	5.17
62.05	7.51	8.25	8.44	**8.92**	6.25	6.31	5.37
62.06	7.66	8.37	8.56	**9.04**	6.36	6.49	5.49
63.01	1.04	1.07	**1.17**	1.14	0.89	0.83	0.71
64.01	0.57	0.60	**0.67**	0.61	0.40	0.35	0.26
65.01	2.21	2.25	**2.48**	2.29	1.50	1.43	1.27
66.01	0.48	0.53	**0.60**	0.54	0.39	0.36	0.29
67.01	0.89	0.95	**1.09**	0.98	0.68	0.60	0.47
67.02	1.92	2.00	**2.25**	2.05	1.43	1.32	1.08
67.03	2.71	3.01	3.16	**3.35**	2.25	2.33	2.02
68.01	1.03	1.06	**1.17**	1.09	0.71	0.67	0.55
69.01	2.98	3.20	3.69	3.45	3.54	3.48	**3.72**
69.02	4.76	5.10	5.87	6.02	5.79	5.75	**6.45**
69.03	5.48	6.05	6.64	6.48	6.23	6.17	**6.91**
69.04	6.35	7.01	**7.44**	7.34	6.66	6.70	7.34
69.05	7.08	8.22	8.57	**8.60**	7.58	7.56	8.20
69.06	7.44	9.01	9.50	**9.58**	8.28	8.22	8.88
69.07	11.84	14.47	14.90	**15.28**	13.00	13.76	14.10
70.01	0.39	0.44	**0.49**	0.44	0.30	0.27	0.20
71.01	1.12	1.15	**1.27**	1.18	0.77	0.73	0.64
71.02	**2.85**	2.61	**2.85**	2.83	1.99	1.89	1.68
71.03	4.48	4.55	**4.62**	4.45	3.46	3.23	2.90
71.04	5.20	5.56	5.34	**5.57**	4.22	4.24	3.71
71.05	5.70	6.13	6.00	**6.25**	4.59	4.69	4.08
72.01	0.62	0.61	**0.66**	0.63	0.36	0.33	0.27
73.01	1.21	1.21	**1.33**	1.24	0.75	0.70	0.60

APPENDIX P

HEC-RAS VERIFICATION MODEL

HEC-RAS Verification Model

General

The HEC-RAS software was used to develop a hydraulic computer model of the section of Werrington Creek between Millen Street and Park Avenue to assist in verifying the TUFLOW model results. The following sections provide a summary of the model development process and the outcomes of the model verification.

Model Development

A HEC-RAS model was developed using the HEC-GeoRAS tools for ArcGIS. The HEC-GeoRAS tools allow HEC-RAS models to be developed in an automated manner from within ArcGIS.

Plate P1 shows the HEC-RAS cross-section layout superimposed on a Digital Elevation Model (DEM) for the study area. The DEM was developed based on the TUFLOW hydraulic model terrain representation to ensure consistency between the models. **Plate P2** shows the same cross sections on an aerial background.

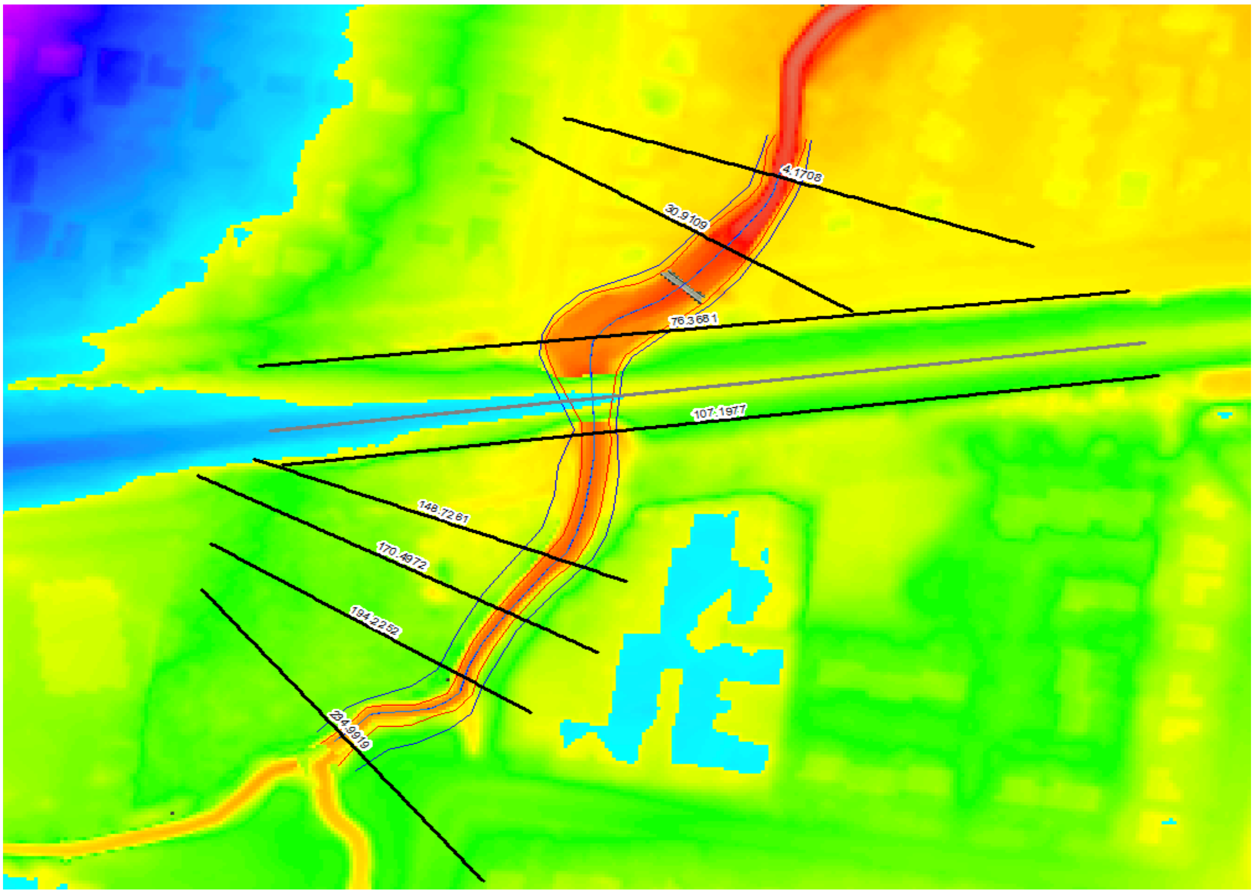


Plate P1: HEC-RAS model cross section layout and DEM in the vicinity of the railway culverts and embankment

Plate P2: HEC-RAS model cross section layout in the vicinity of the railway culverts and embankment

The resulting HEC-RAS model layout is also shown below in **Plate P3**.

The railway culverts and embankment were also included within the HEC-RAS model using surveyed structure data. No blockage was assigned to the culverts in accordance with the "design" blockage calculations that were prepared and implemented in the TUFLOW model.

To maintain consistency, land use classifications used within the TUFLOW model was also used as the basis for defining the Manning's 'n' values assigned to each HEC-RAS model cross-section. As HEC-RAS is a steady state model, Manning's 'n' values used within TUFLOW for depths greater than 0.5 metres were used within the HEC-RAS cross sections.

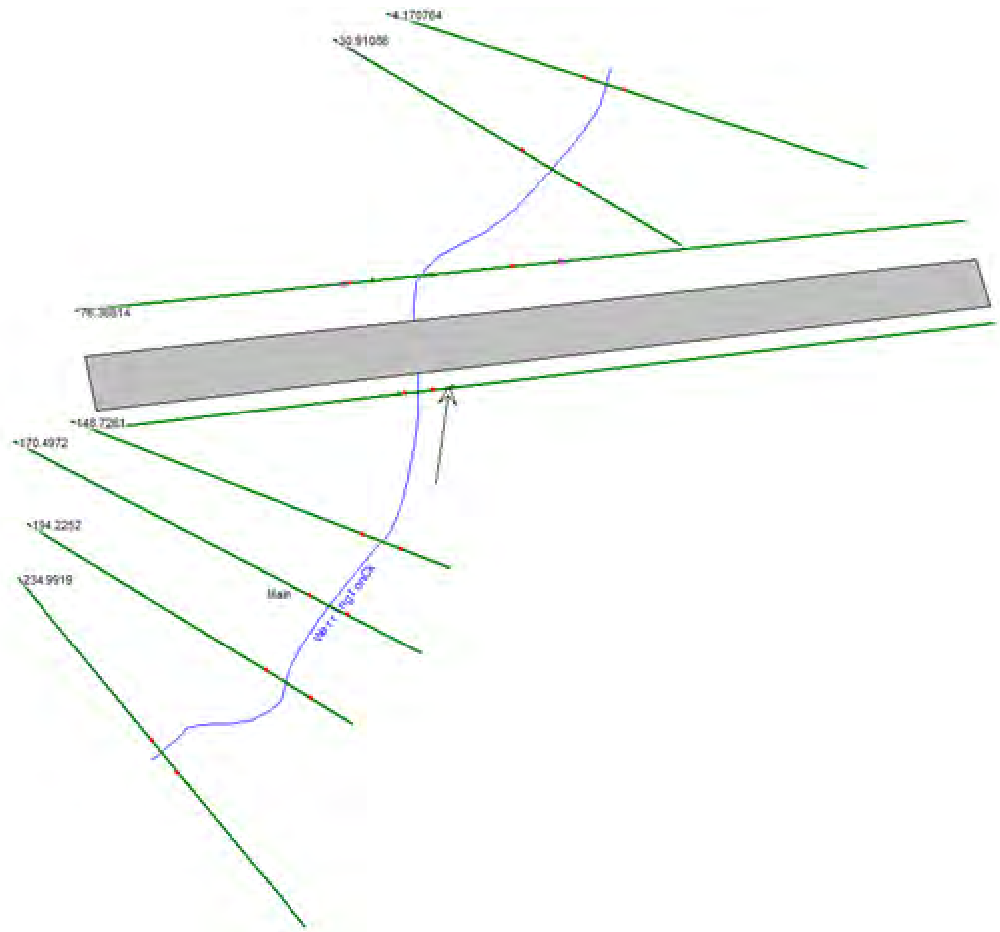


Plate P3: HEC-RAS model layout for the railway culverts and embankment

Boundary Conditions

The upstream inflow boundary condition was based upon the peak 1% AEP discharge extracted from the TUFLOW model. This was determined to be 58.4 m^3/s. The downstream boundary condition was assigned as a static water level of 32.79 mAHD, which was extracted directly from the TUFLOW model results.

Model Results

The HEC-RAS model was used to simulate the 1% AEP flood. Peak 1% AEP water levels extracted from the HEC-RAS simulations are provided in **Table P1**. Peak 1% AEP water levels extracted from the TUFLOW model are also included in **Table P1** for comparison. A peak 1% AEP HEC-RAS water surface profile is also provided in **Plate P4**.

Table O1: Peak 1% AEP Stages for the Railway culverts on Werrington Creek

Location	**HEC-RAS Stage** (mAHD)	**TUFLOW Stage** (mAHD)
Upstream extent of HEC-RAS model	34.73	34.71
Upstream of Railway culverts	34.49	34.56
Downstream of Railway culverts	33.25	33.23
Downstream extent of HEC-RAS model	32.79	32.79

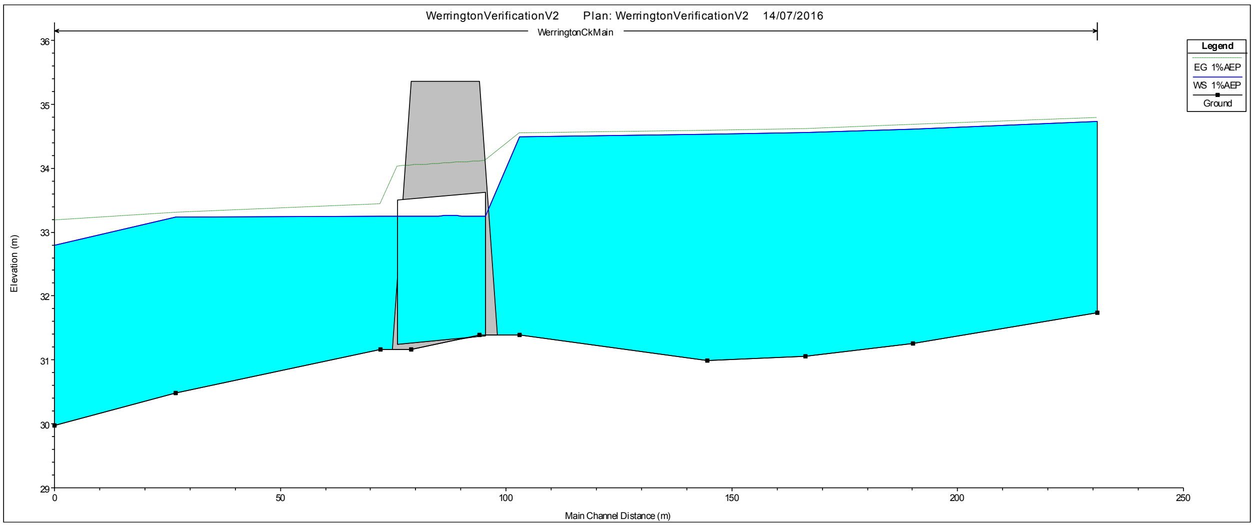


Plate P4: Peak 1% AEP Stages for the Railway culverts on Werrington Creek

As shown in **Table P1**, there is generally a good agreement between the HEC-RAS and TUFLOW results with peak 1% AEP water levels agreeing to better than 0.07 metres at all locations.

As noted in the main report, this location has demonstrated significant variability in modelling results. Therefore, additional simulations were completed with a 10% increase and decrease in flow to quantify the sensitivity of the results to changes in flow. The peak flood levels from the sensitivity simulations are provided in **Table O2**.

Table P1: Peak 1% AEP Stages for the Railway culverts on Werrington Creek

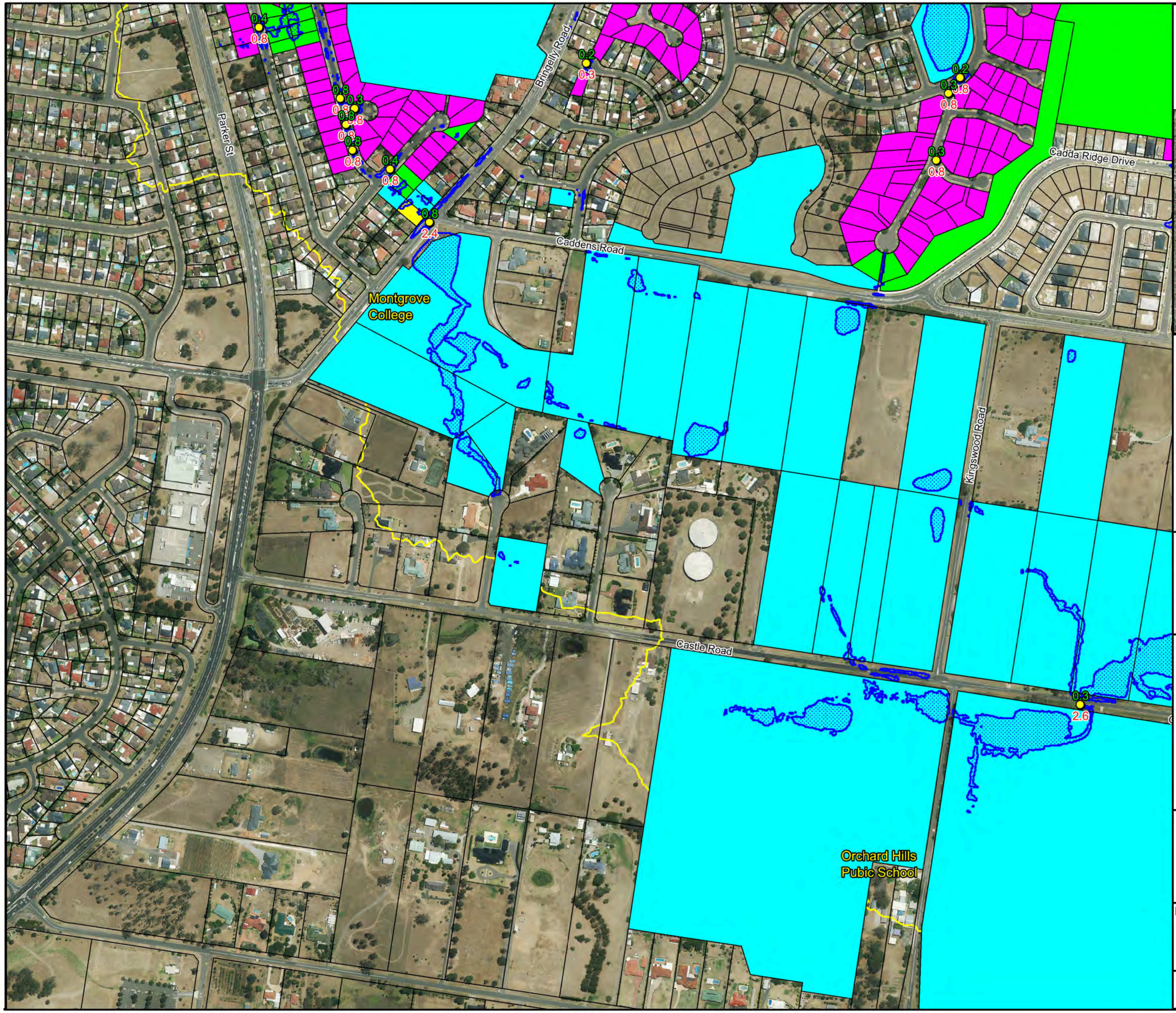
Location	**HEC-RAS Stage** (mAHD)		
	Existing Flow	**10% Increase in Flow**	**10% Decrease in Flow**
Upstream extent of HEC-RAS model	34.73	34.89	34.66
Upstream of Railway culverts	34.49	34.73	34.28
Downstream of Railway culverts	33.25	33.19	33.32
Downstream extent of HEC-RAS model	32.79	32.79	32.79

The comparison provided in **Table P2** indicates that the area immediately upstream of railway s sensitive to variations in flow. More specifically, changing the peak flow approaching the culverts by 10% is predicted to change peak 1% AEP water levels by over 0.2 metre.

Overall, the outcomes of the HEC-RAS verification indicate that the TUFLOW model is providing a reasonable representation of culvert hydraulics in the vicinity of the railway line. It also confirms that this location is sensitive to changes in model input parameter, in particular, flows.

Appendix Q

Alternate Emergency Response Classifications



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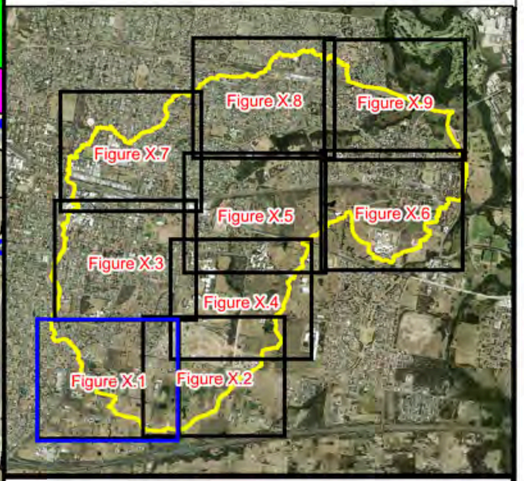


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

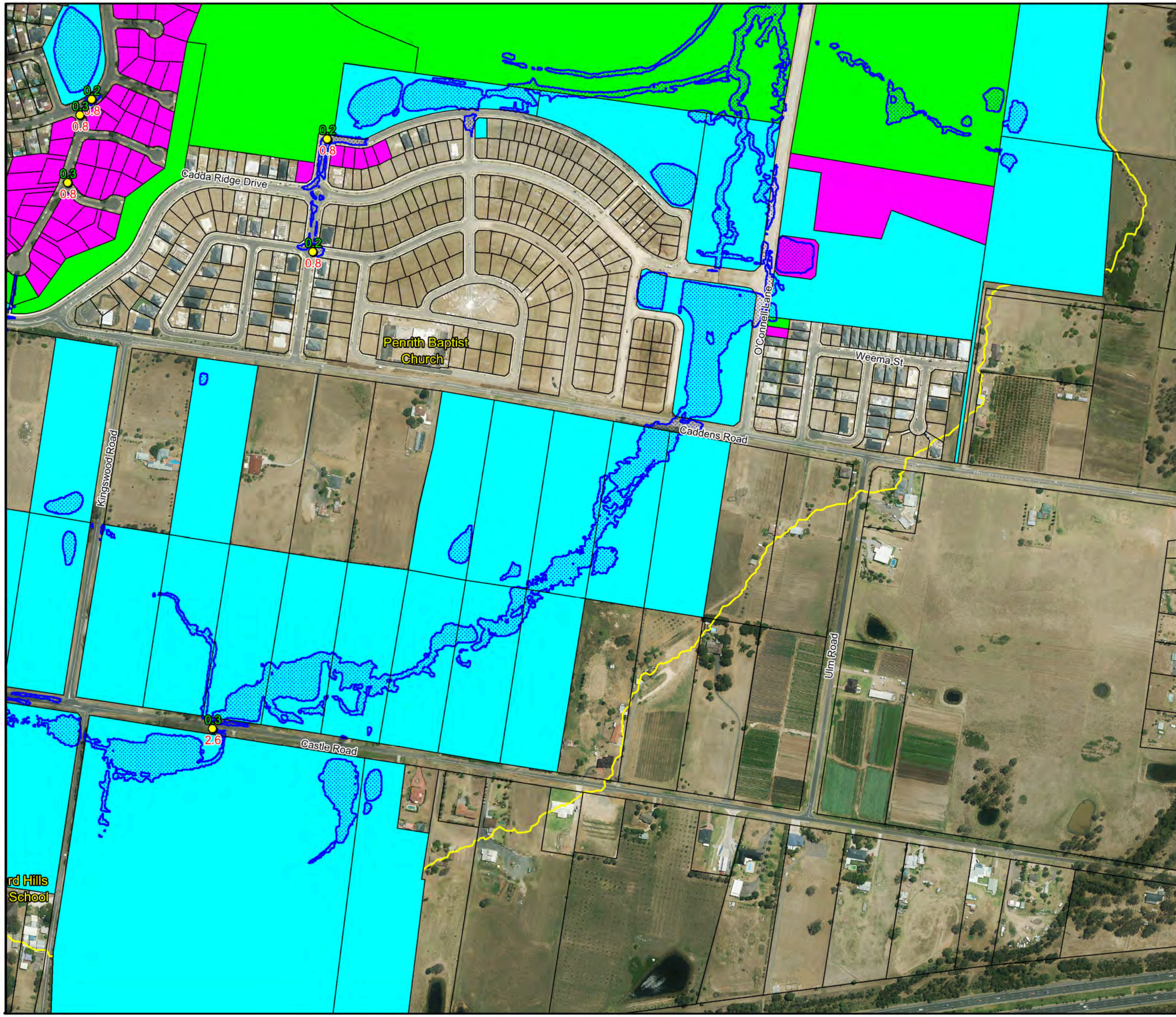
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q1.1: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.1 ERC for the 5% AEP Flood.wor



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LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

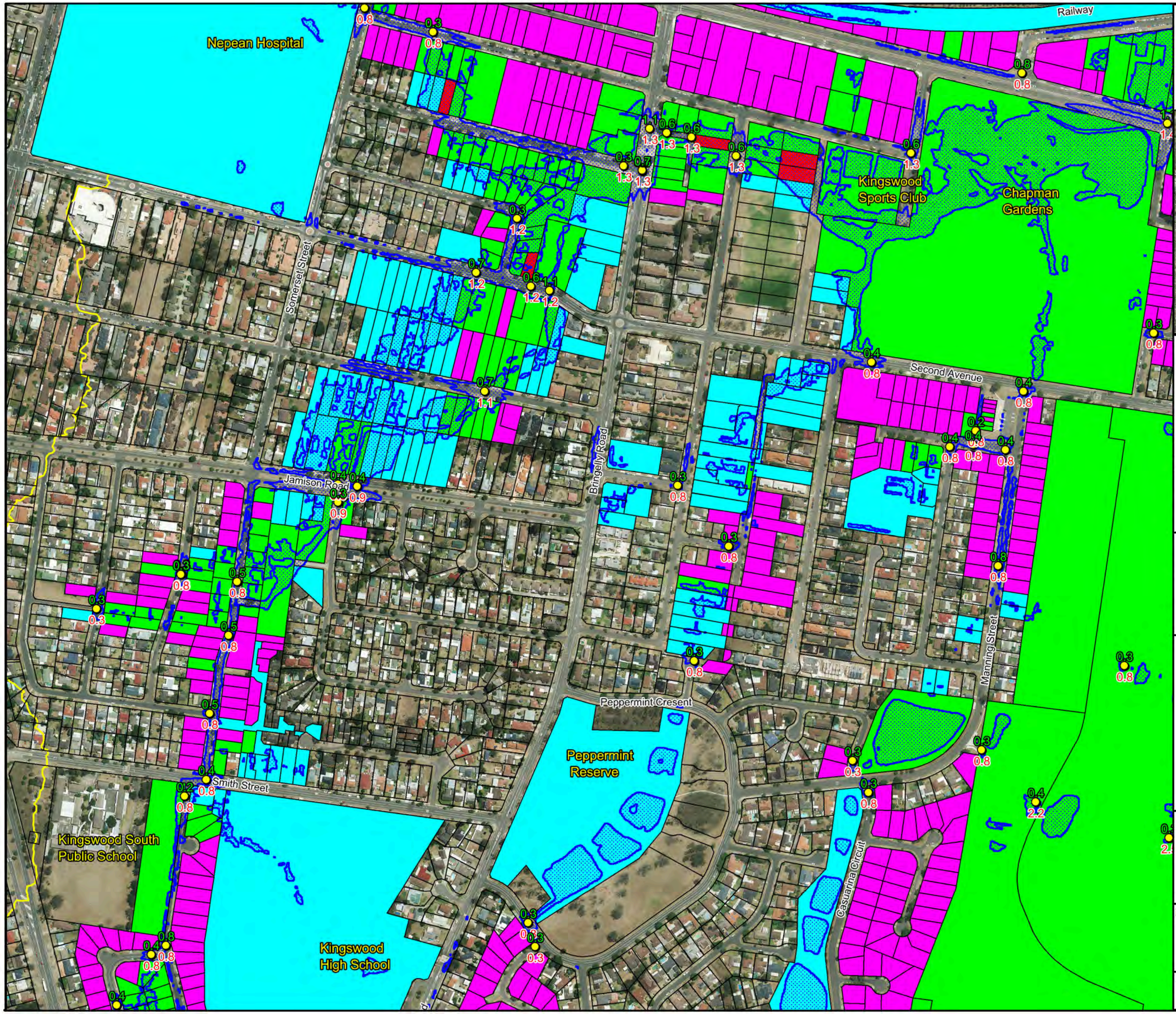
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q1.2: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.2 ERC for the 5% AEP Flood.wor



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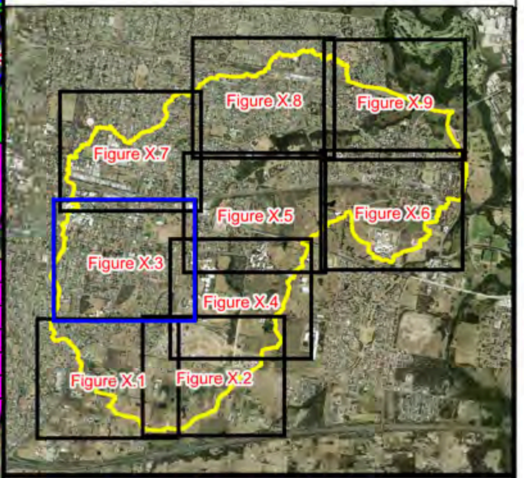


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

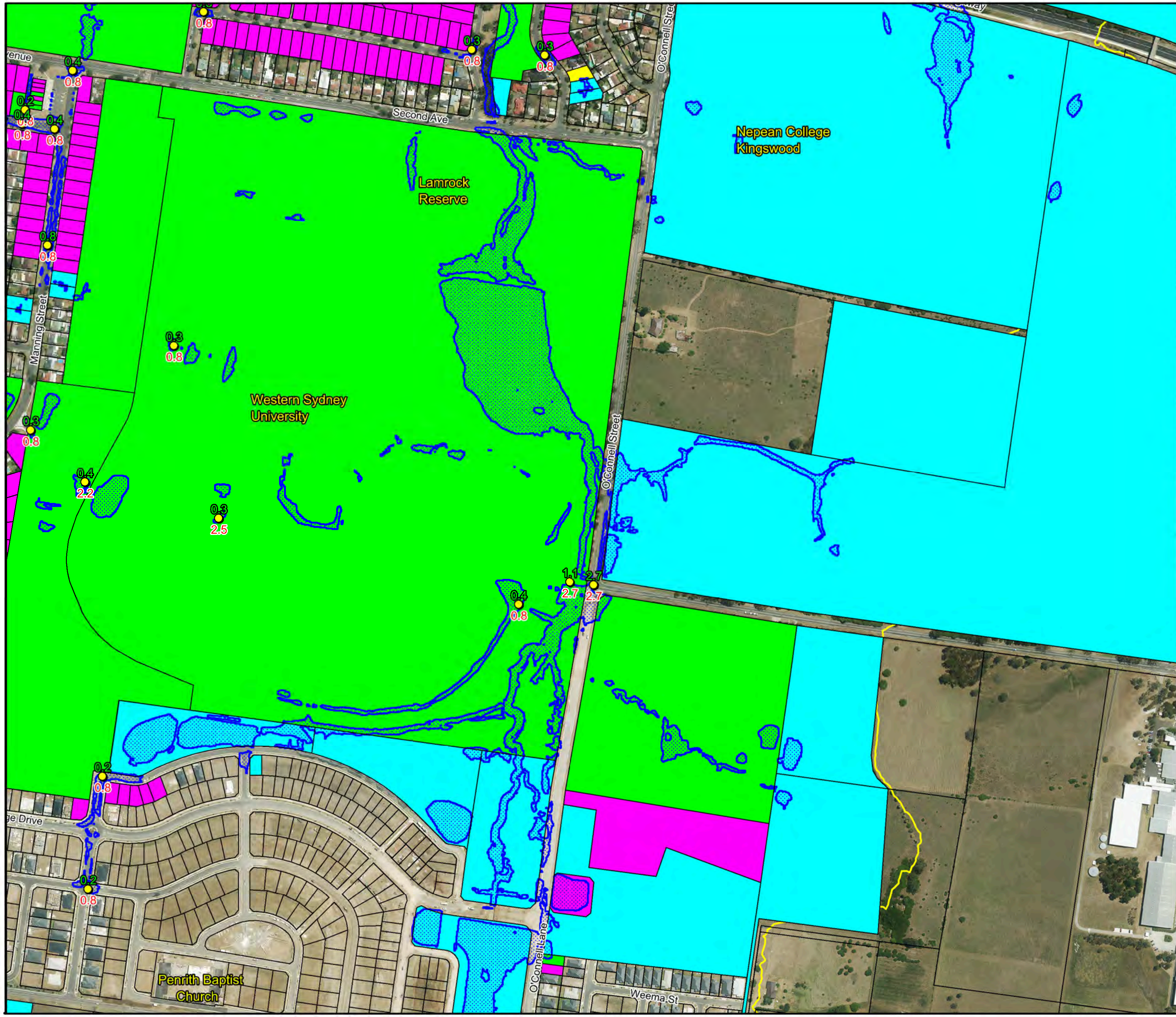
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q1.3: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.3 ERC for the 5% AEP Flood.wor



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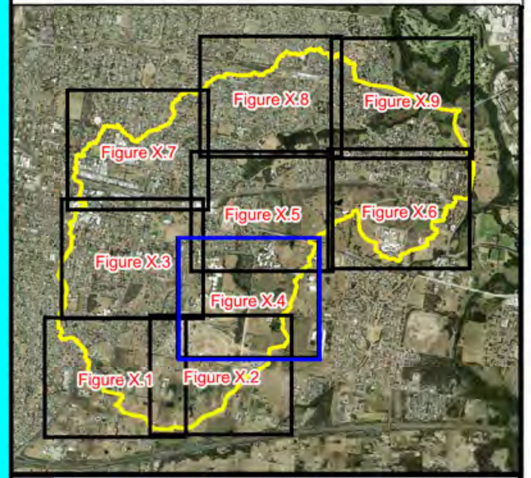

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
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Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q1.4: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.4 ERC for the 5% AEP Flood.wor

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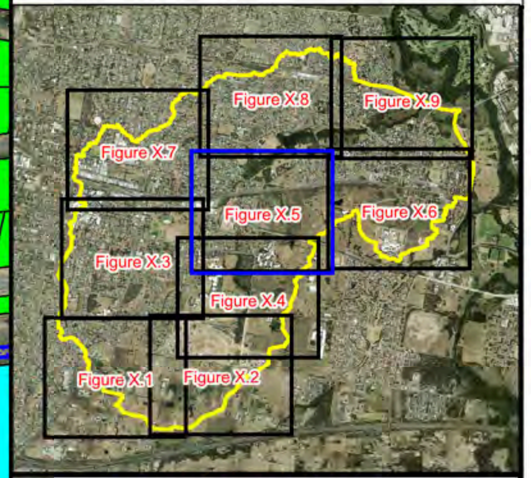


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

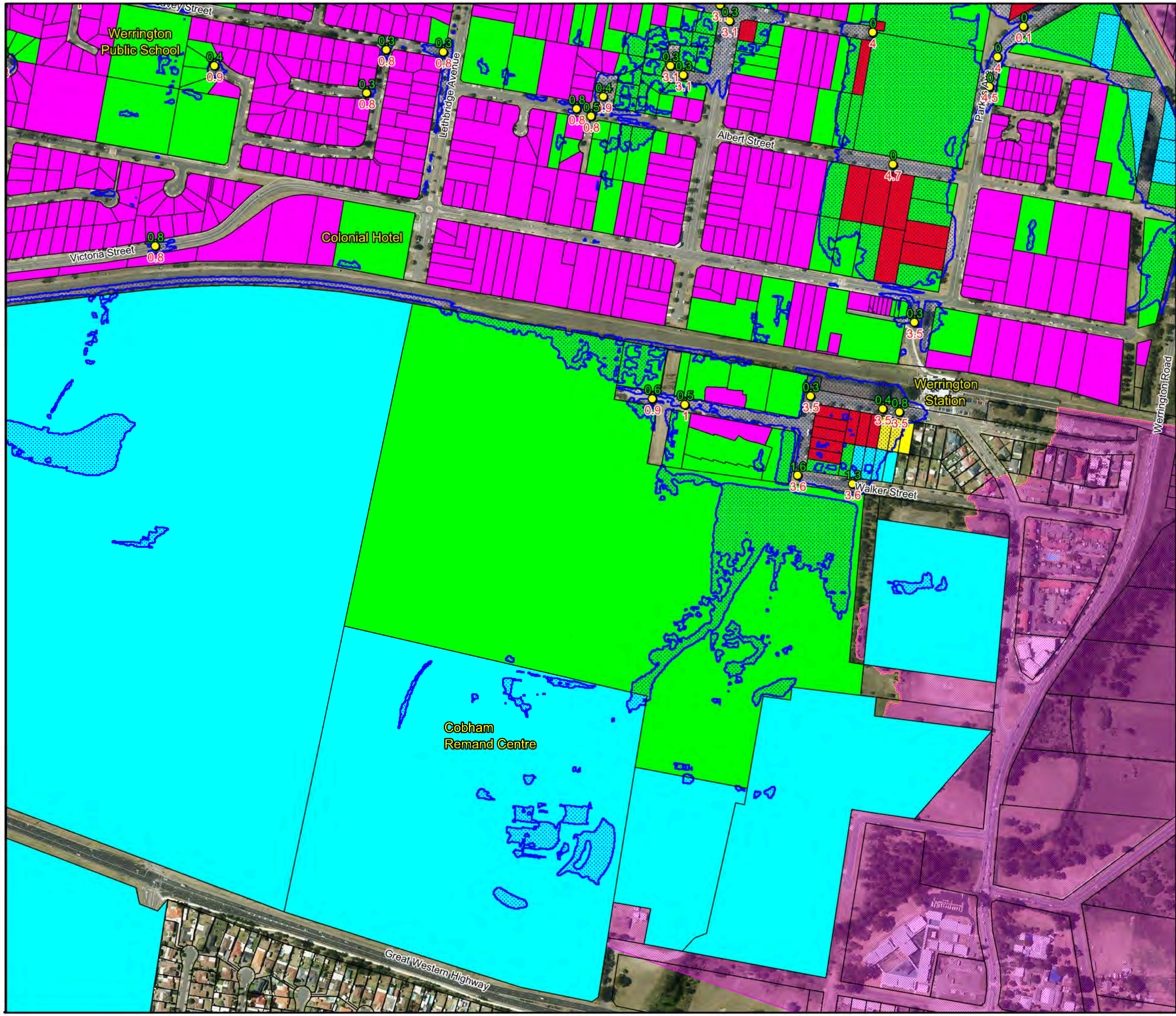
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q1.5: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.5 ERC for the 5% AEP Flood.wor



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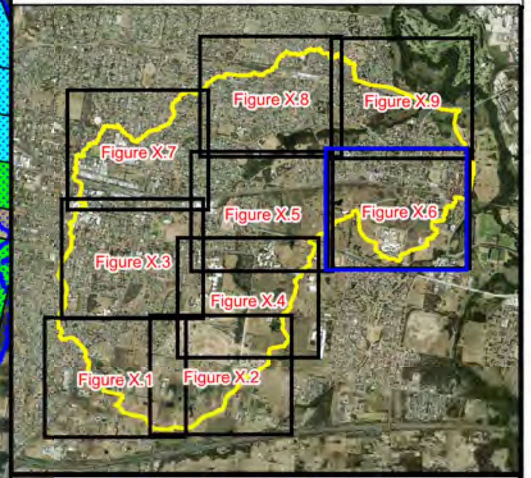


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Inundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

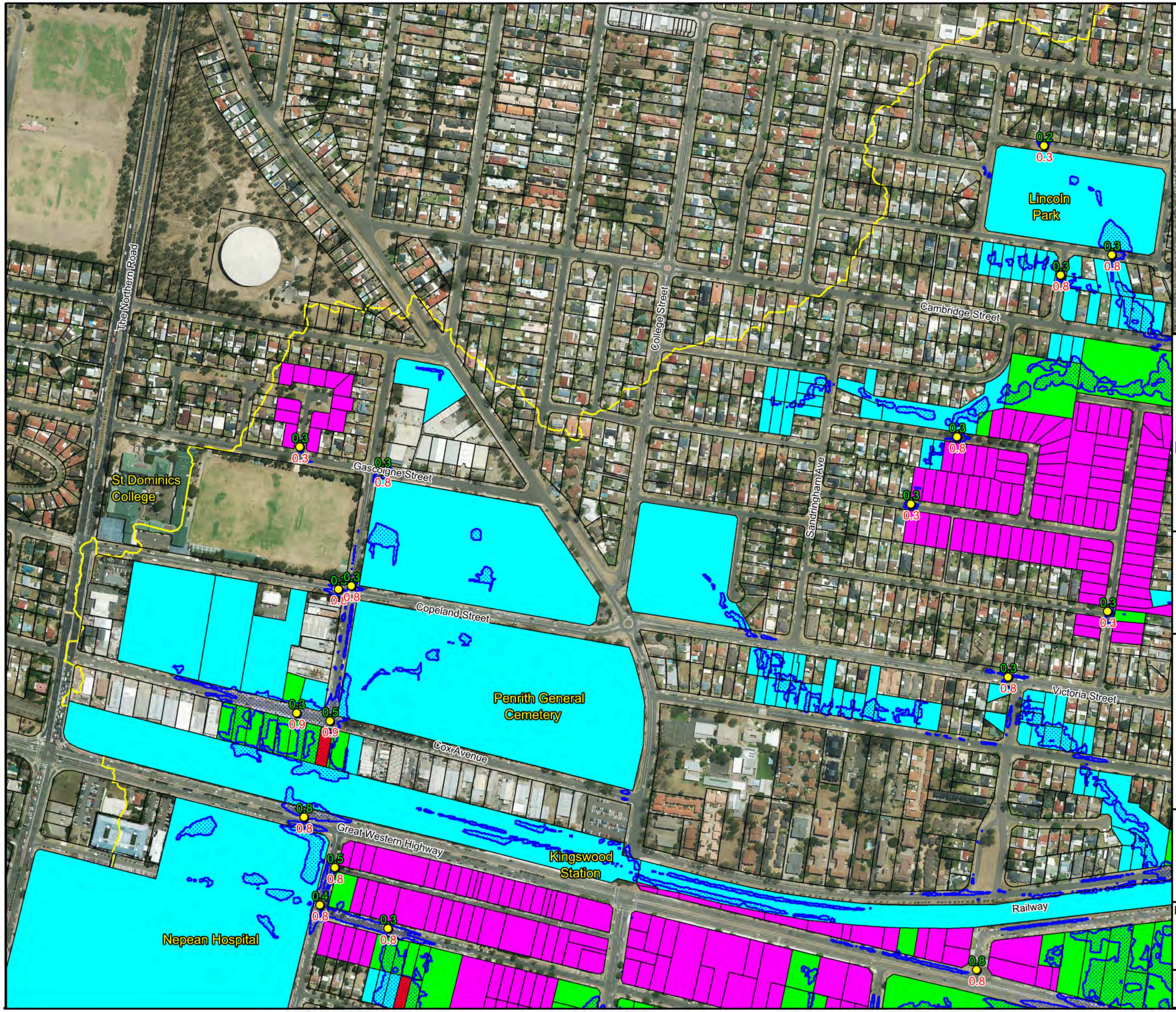
0 0.15 0.3 Km

Figure Q1.6: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.6 ERC for the 5% AEP Flood.wor



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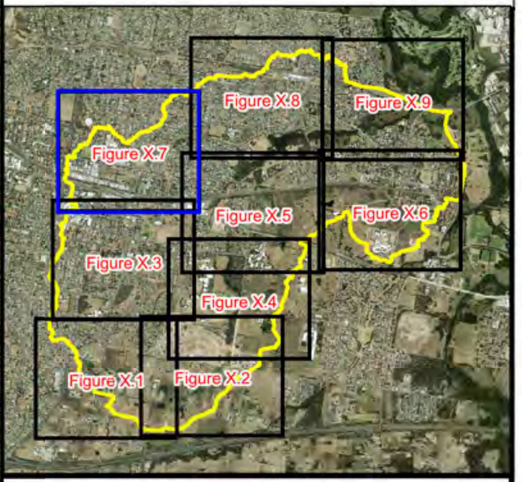


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

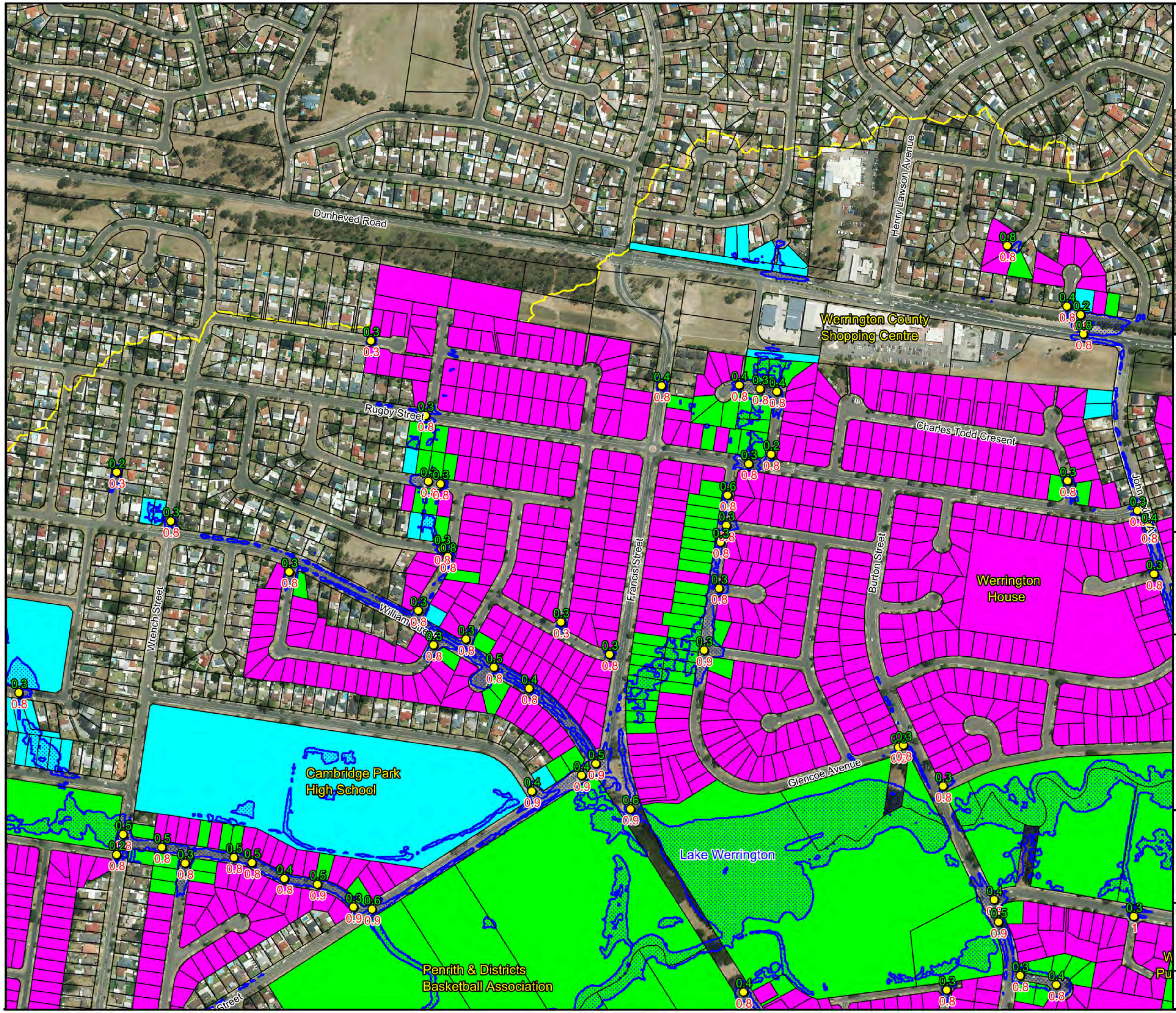
0 0.15 0.3 Km

Figure Q1.7: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.7 ERC for the 5% AEP Flood.wor



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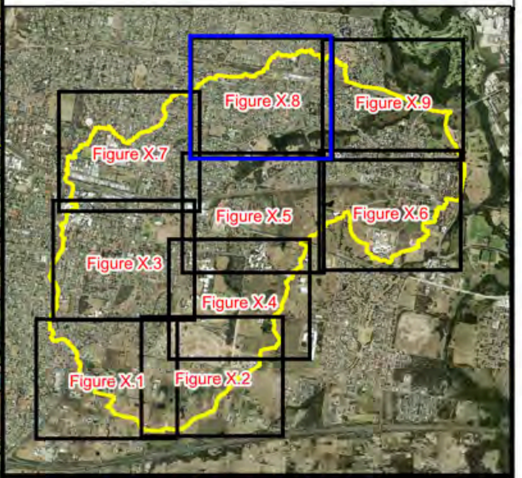

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- Time of Road First Overtopping (hours)
- Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q1.8: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.8 ERC for the 5% AEP Flood.wor

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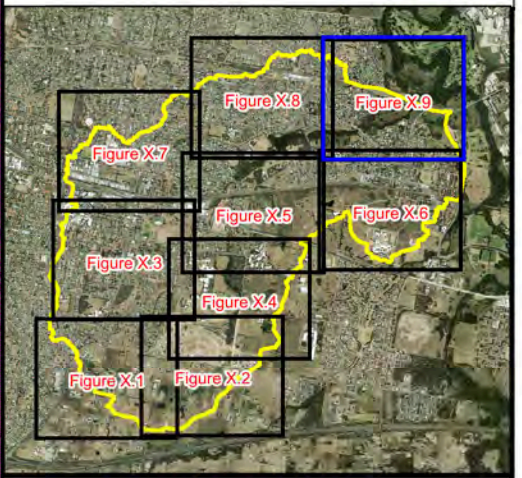


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 5% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
S

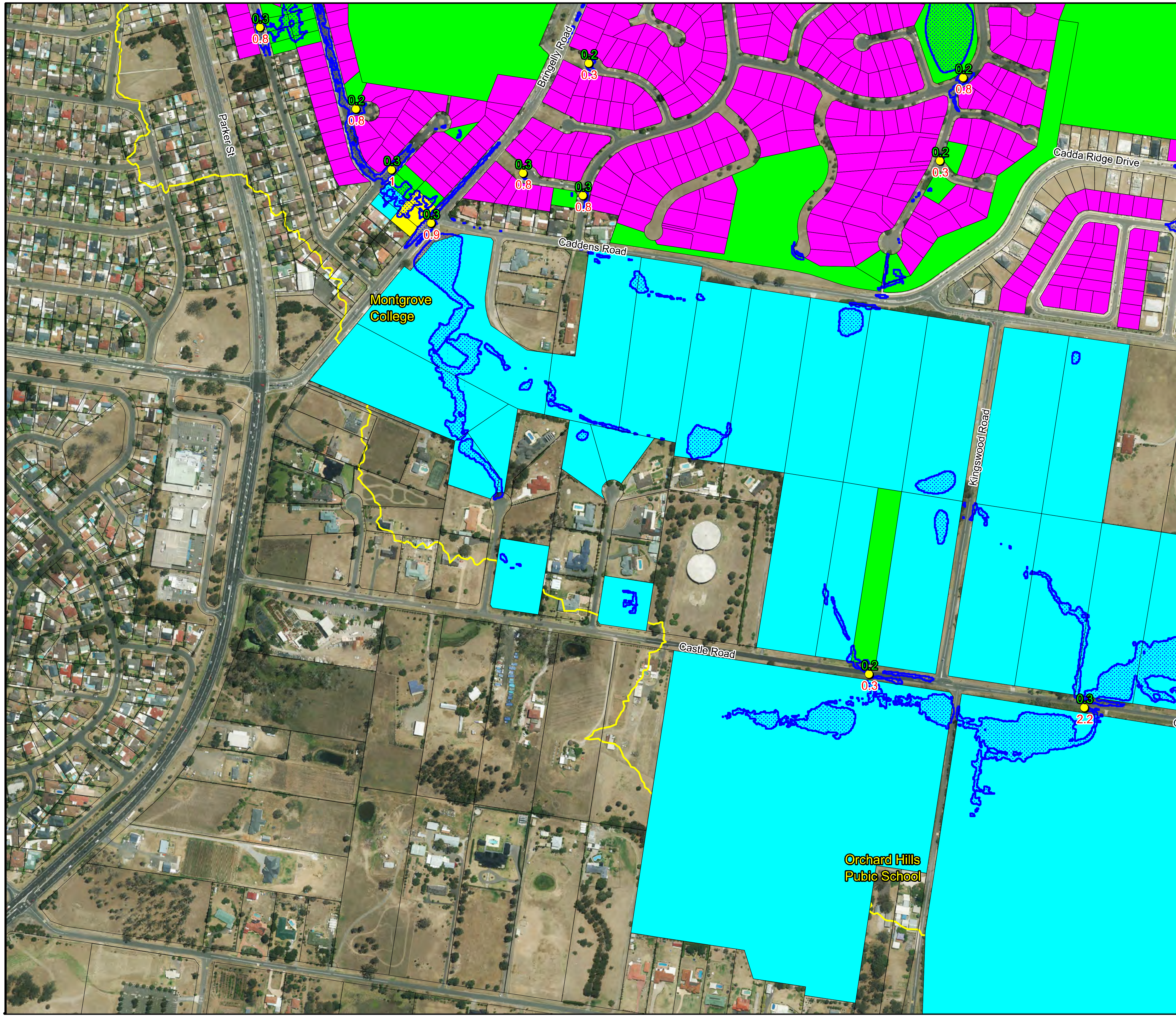
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q1.9: Emergency Response Precinct Classifications for the 5% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ1.9 ERC for the 5% AEP Flood.wor



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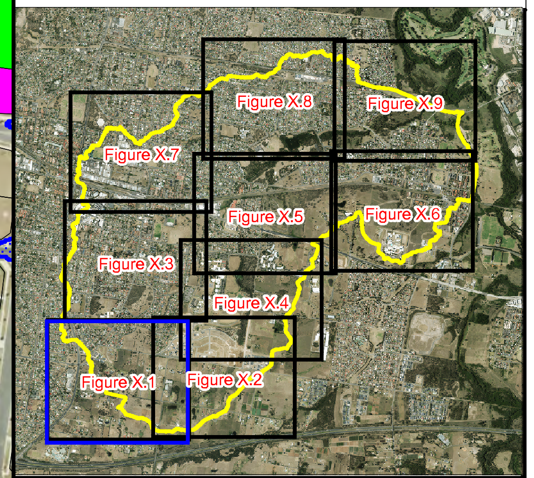


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

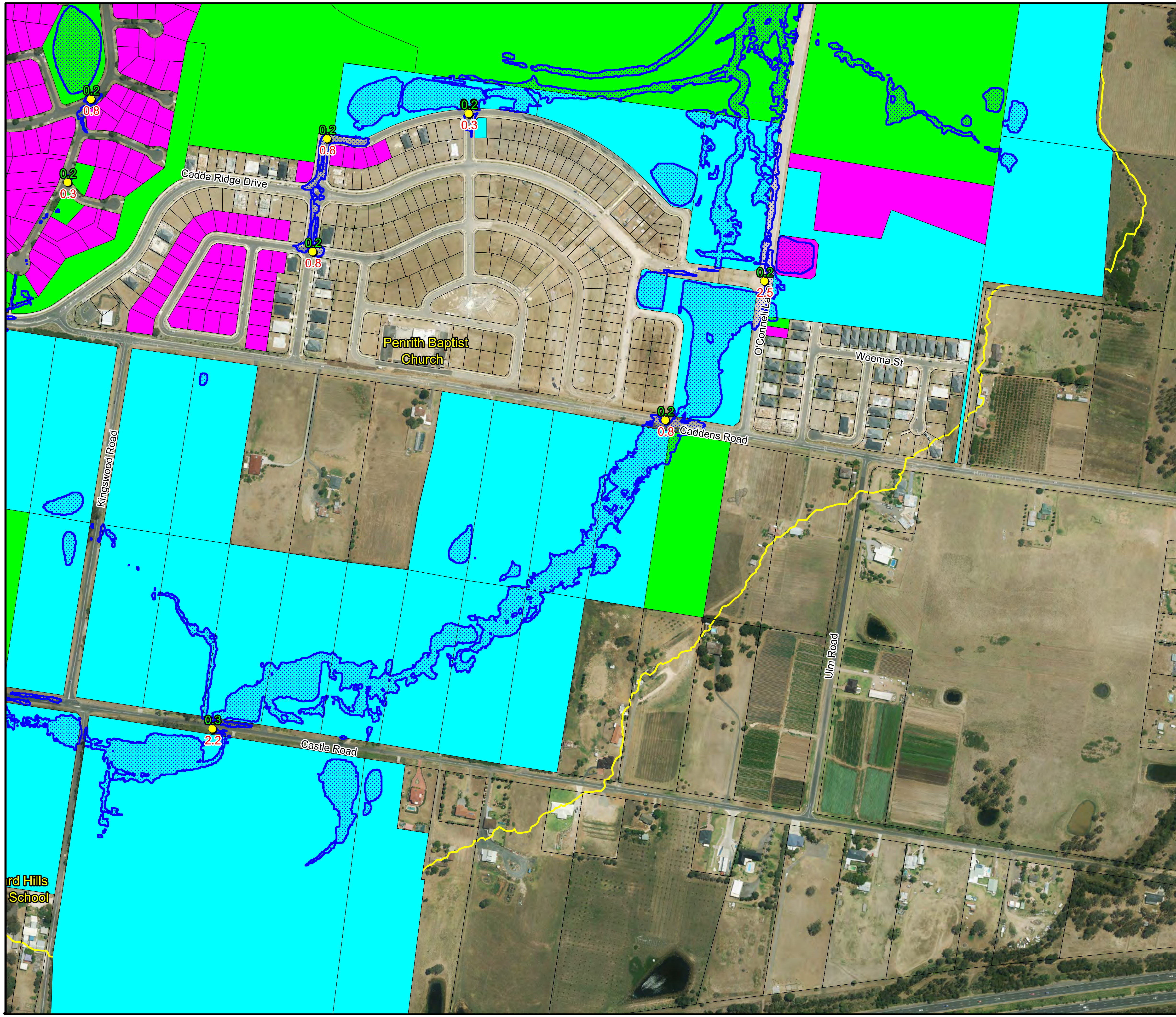
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q2.1: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.1 ERC for the 1% AEP Flood.wor



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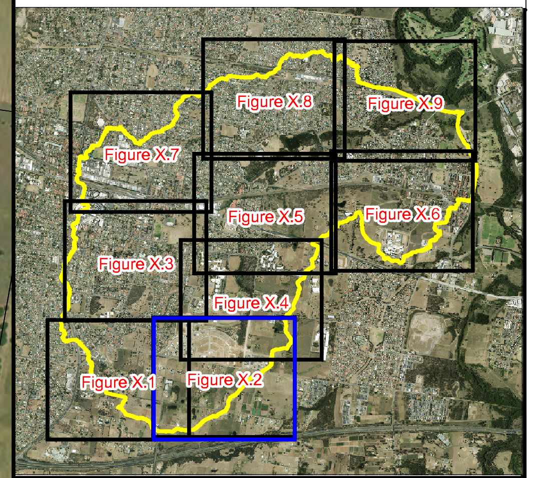


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
S

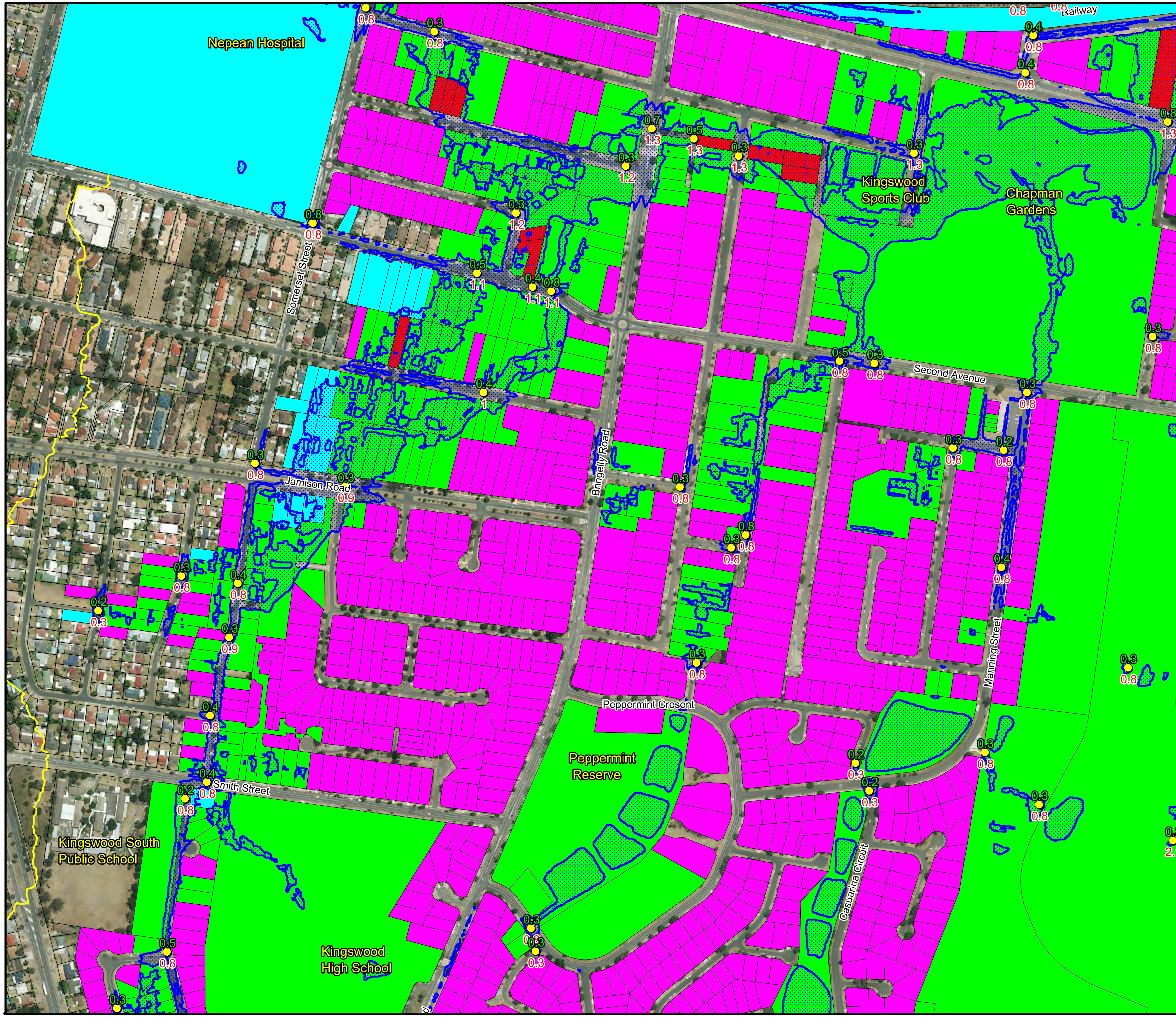
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q2.2: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.2 ERC for the 1% AEP Flood.wor



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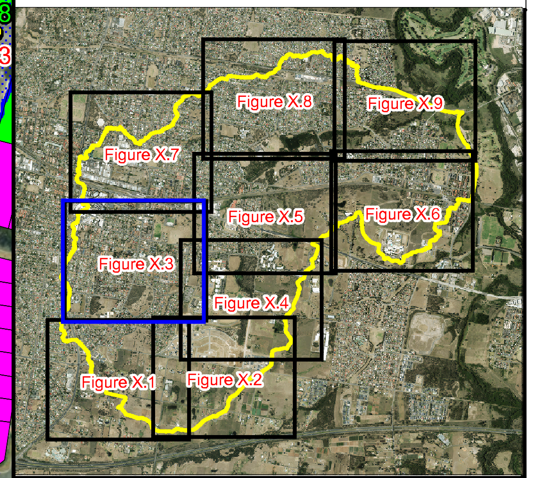

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
S

Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q2.3: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.3 ERC for the 1% AEP Flood.wor

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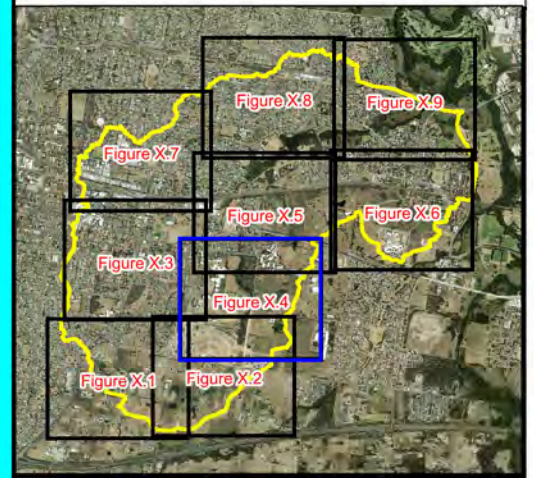

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q2.4: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.4 ERC for the 1% AEP Flood.wor

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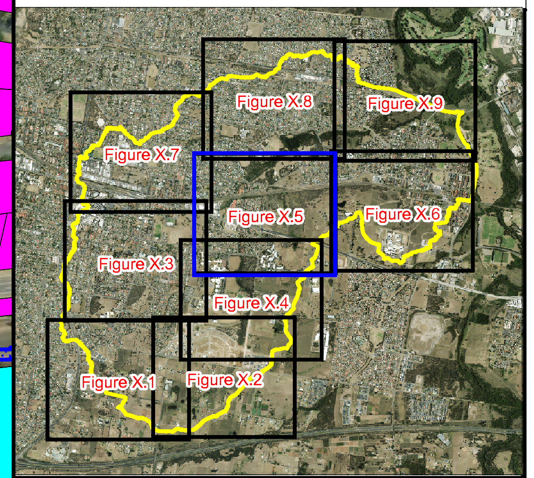

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
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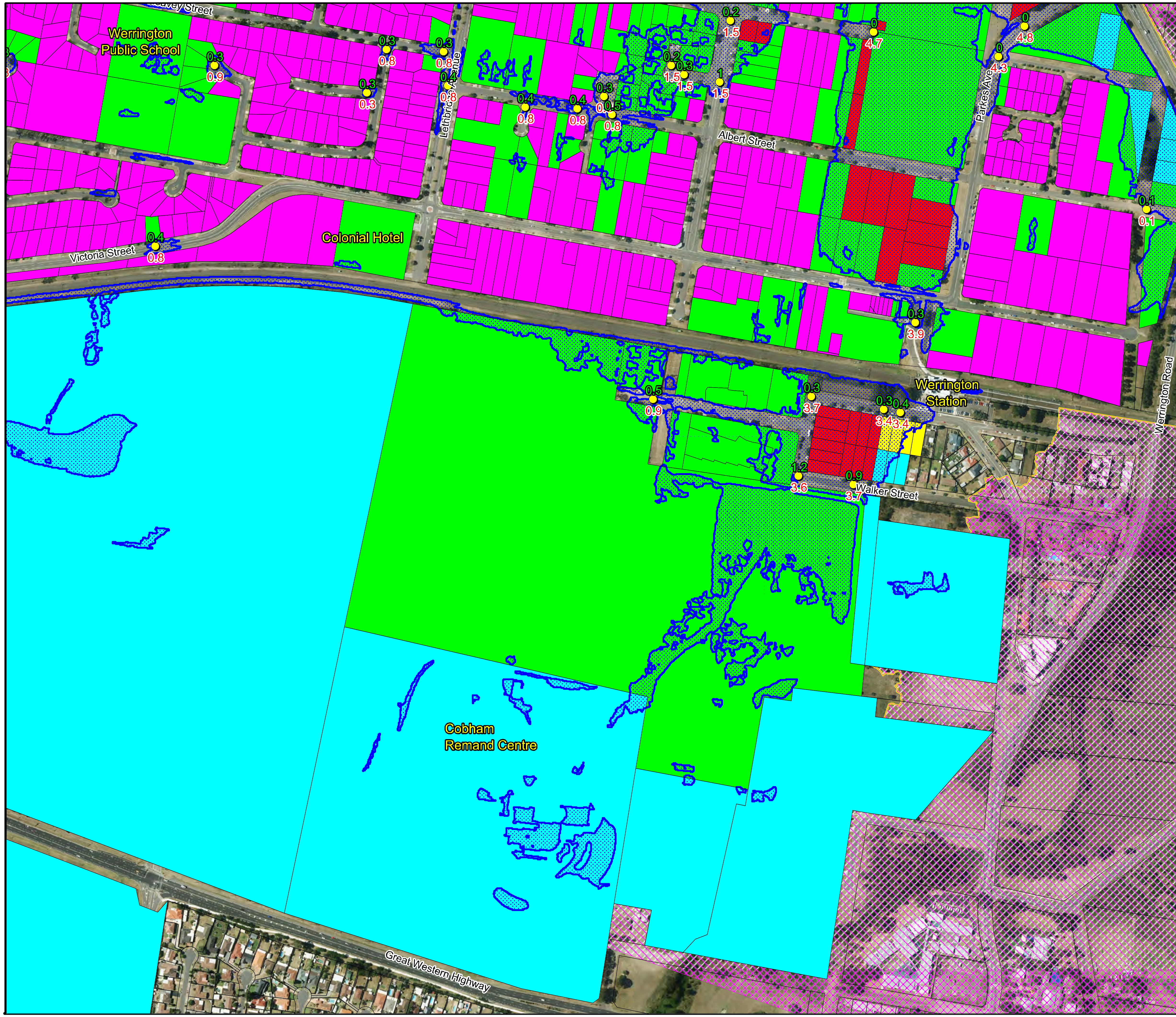
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q2.5: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.5 ERC for the 1% AEP Flood.wor



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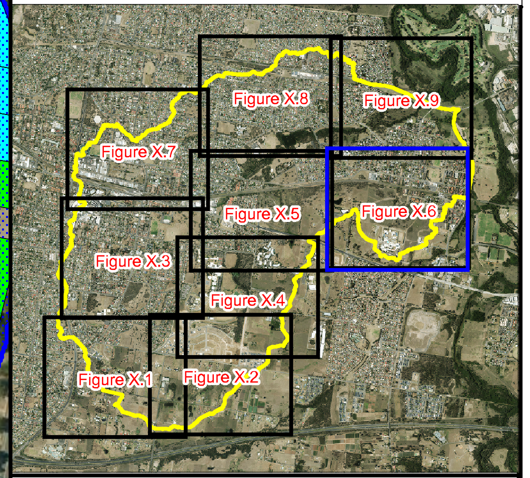


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

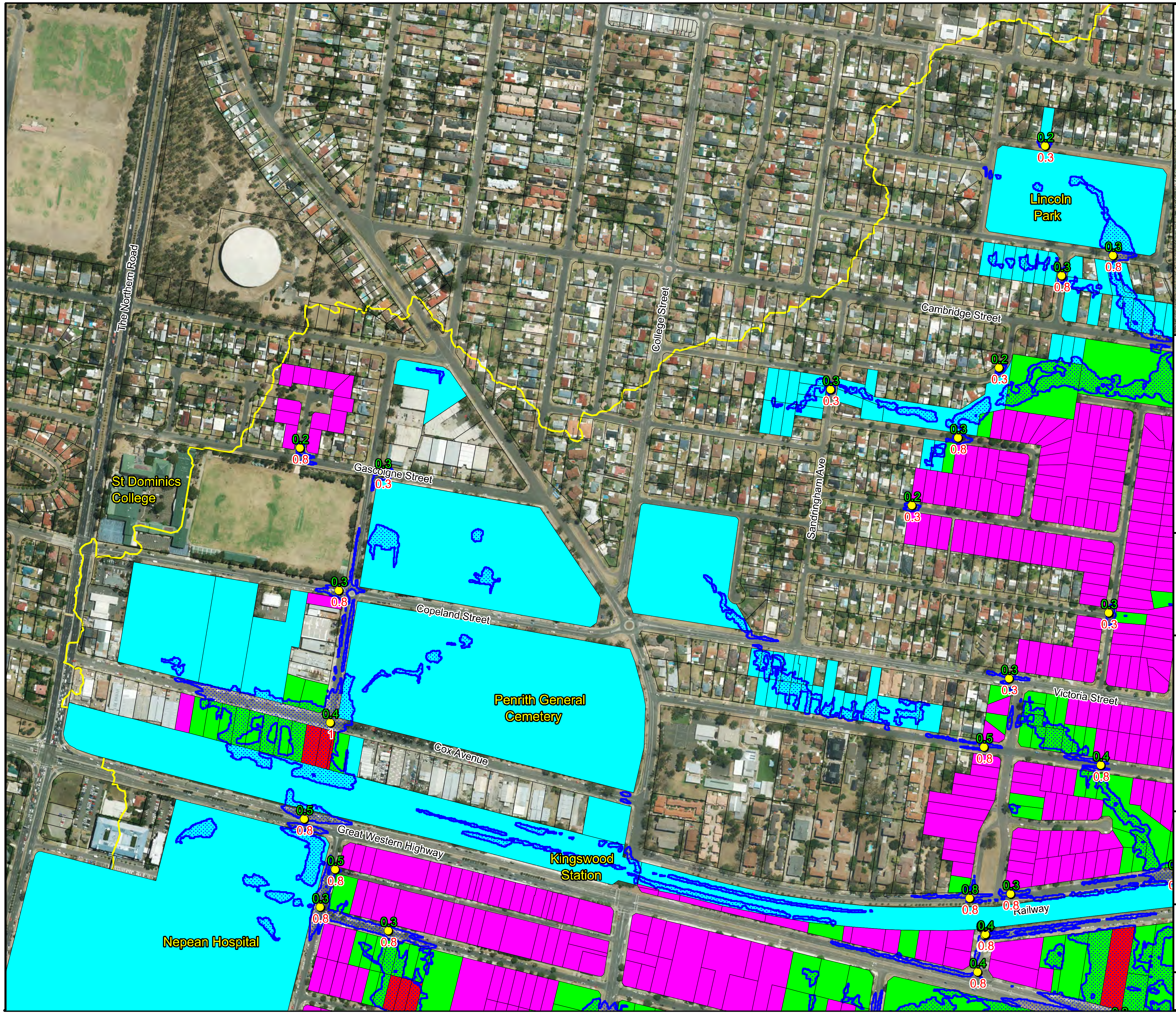
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

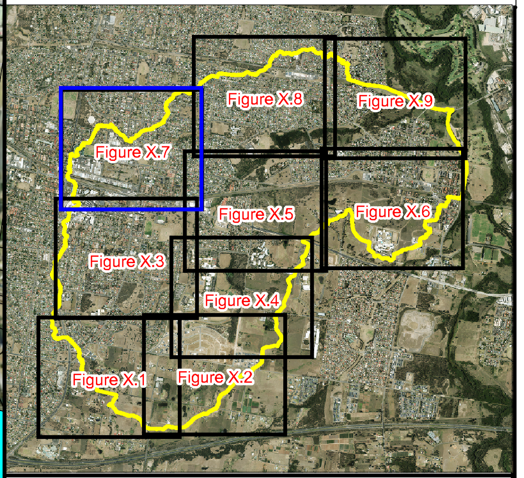
Figure Q2.6: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.6 ERC for the 1% AEP Flood.wor



PENRITH CITY COUNCIL



LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q2.7: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.7 ERC for the 1% AEP Flood.wor

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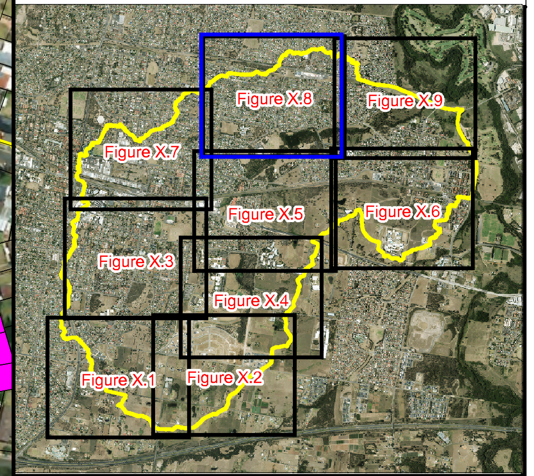


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
S

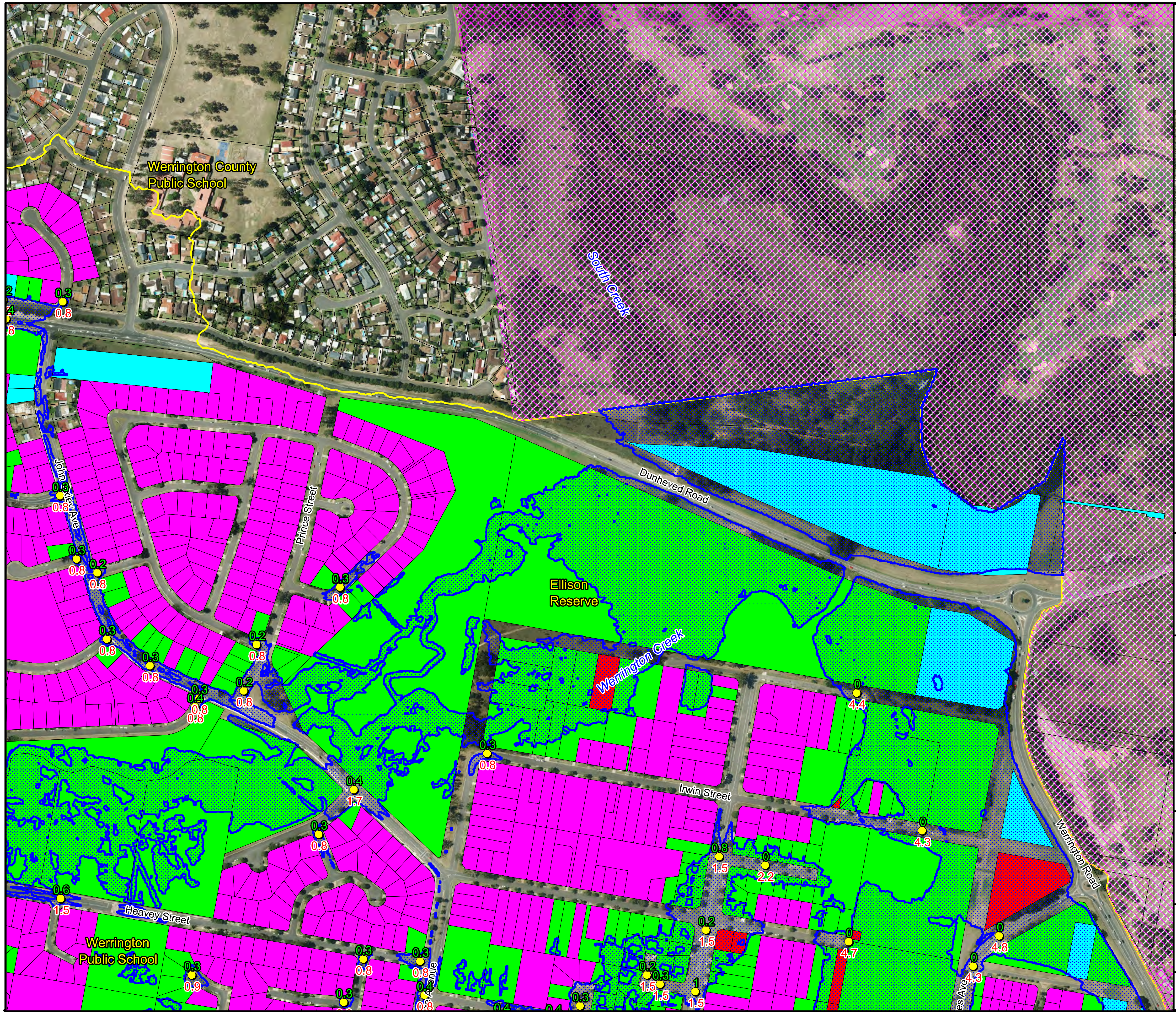
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

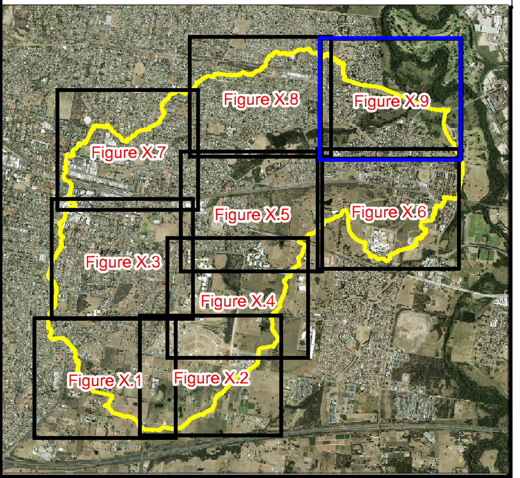
Figure Q2.8: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.8 ERC for the 1% AEP Flood.wor



PENRITH CITY COUNCIL



LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- 1% AEP Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

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Scale 1:5,000 (at A3)

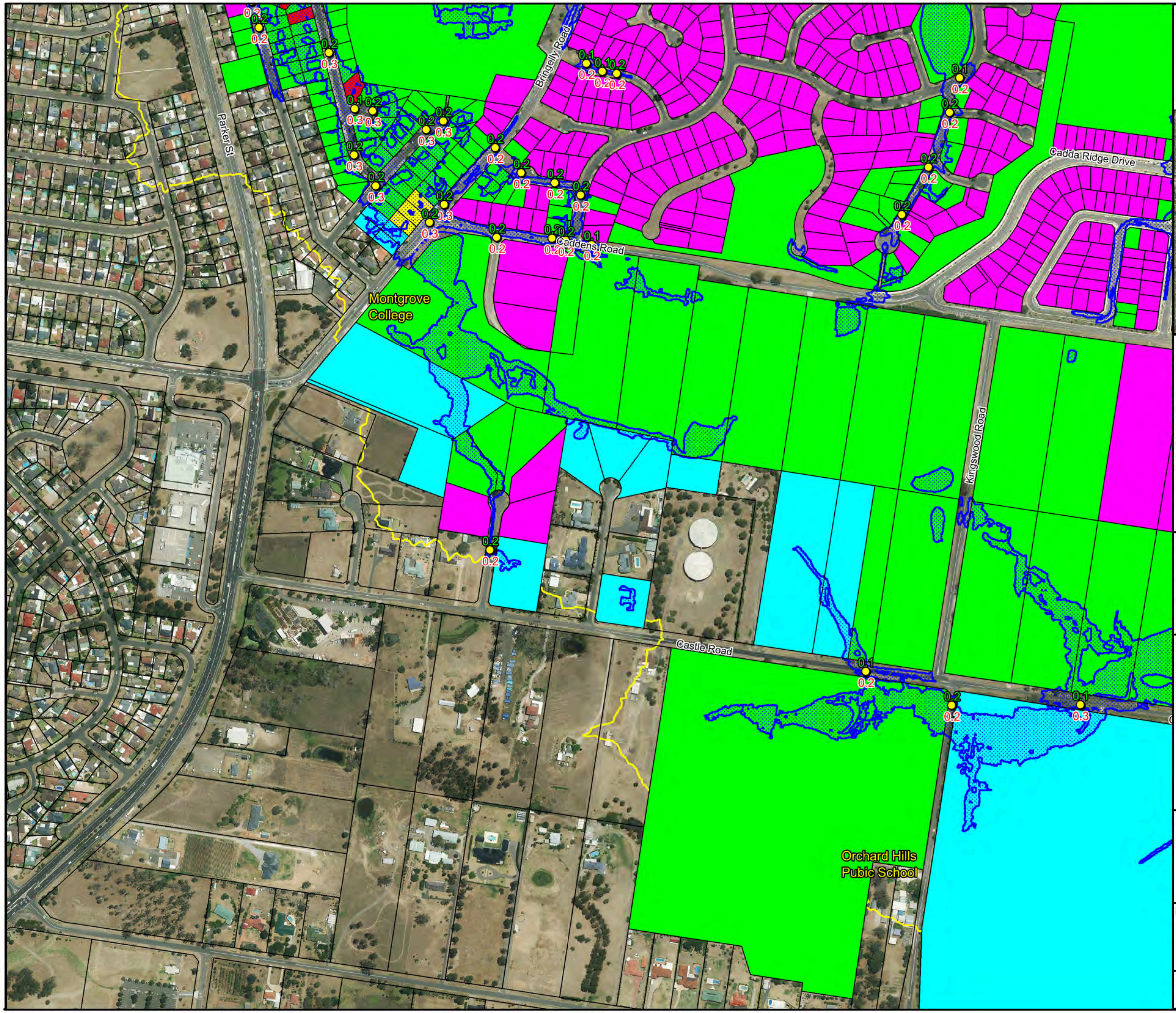
0 0.15 0.3 Km

Figure Q2.9: Emergency Response Precinct Classifications for the 1% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ2.9 ERC for the 1% AEP Flood.wor



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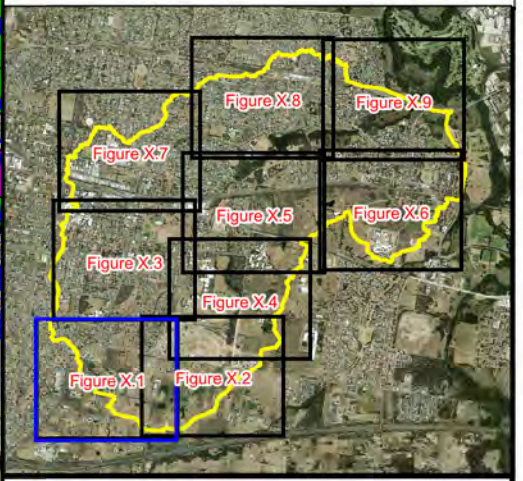

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Inundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
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Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q3.1: Emergency Response Precinct Classifications for the PMF

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.1 ERC for the PMF Flood.wor

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LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

1.5 Time of Road First Overtopping (hours)

0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

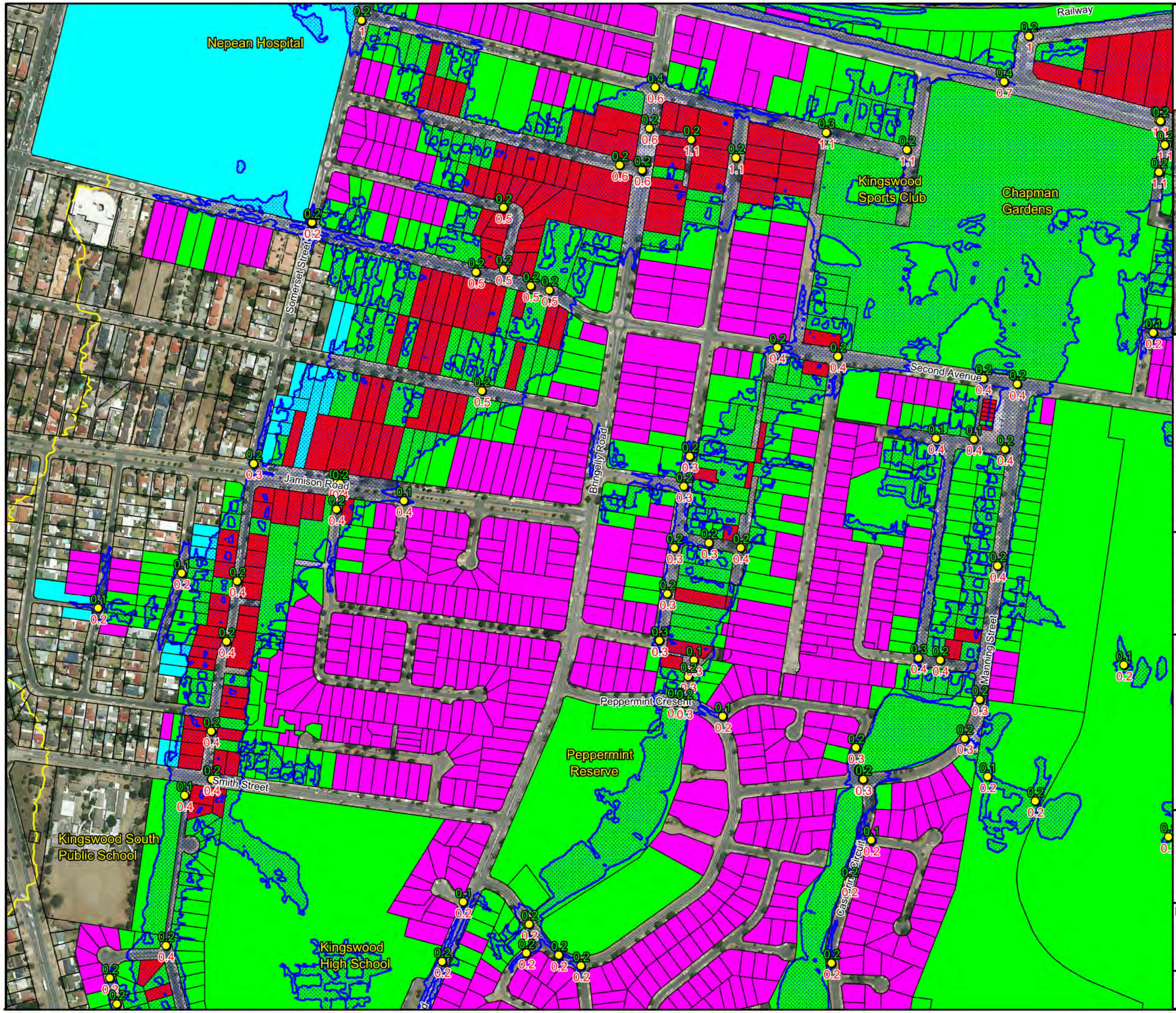
0 0.15 0.3 Km

Figure Q3.2: Emergency Response Precinct Classifications for the PMF

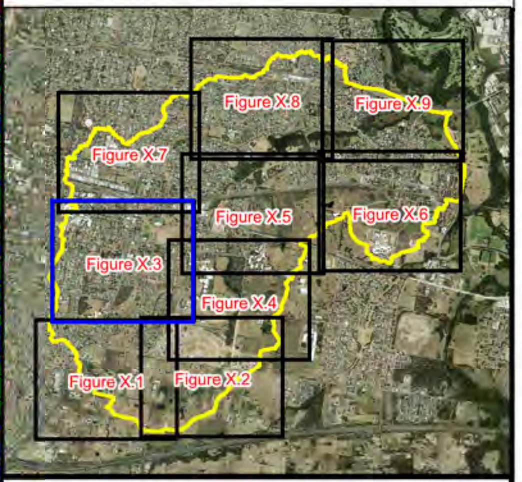
Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.2 ERC for the PMF Flood.wor



PENRITH CITY COUNCIL



LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- Time of Road First Overtopping (hours)
- Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

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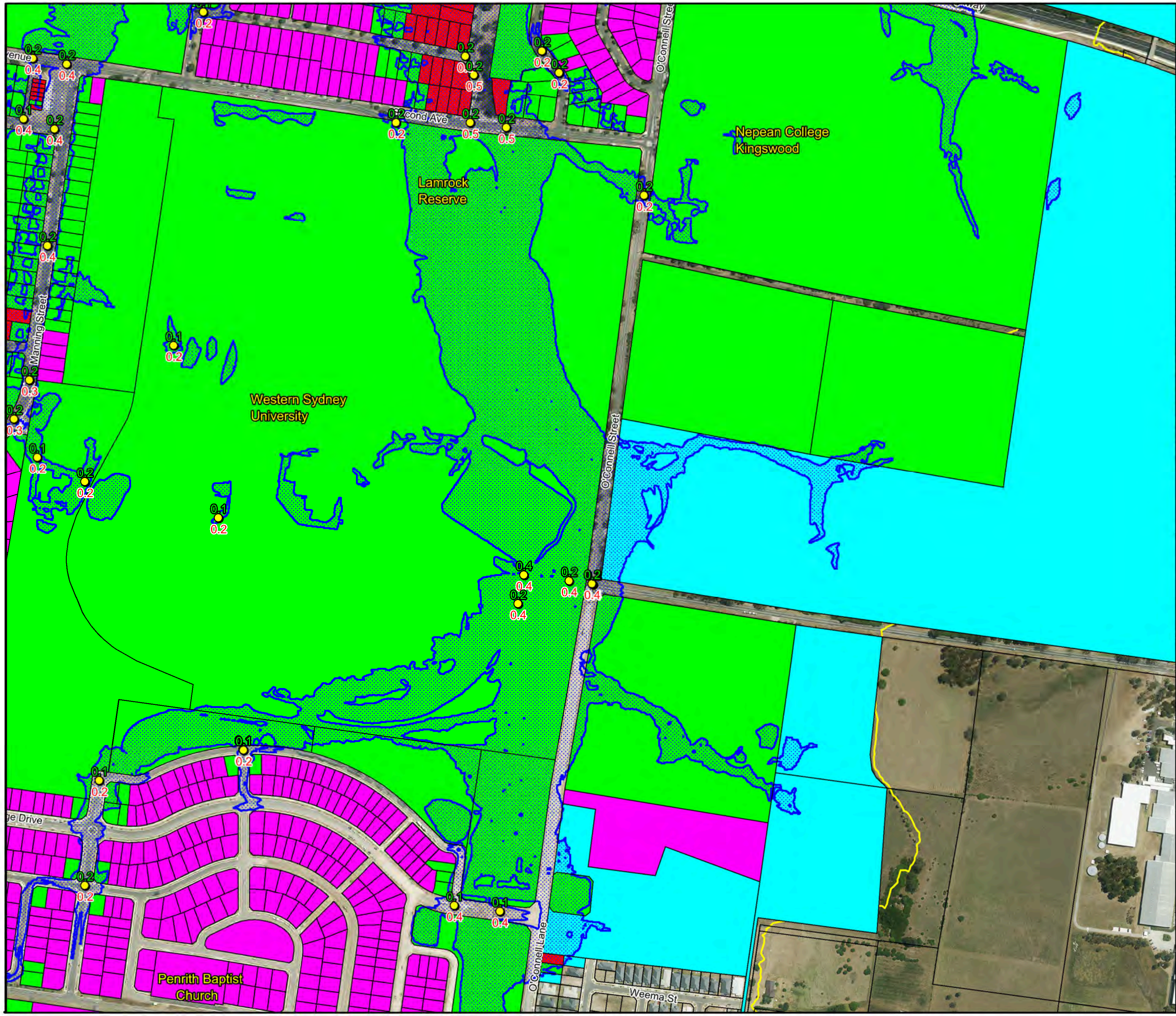
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q3.3: Emergency Response Precinct Classifications for the PMF

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.3 ERC for the PMF Flood.wor



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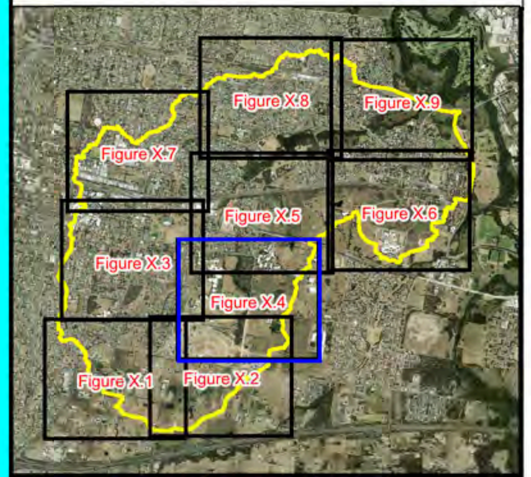


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

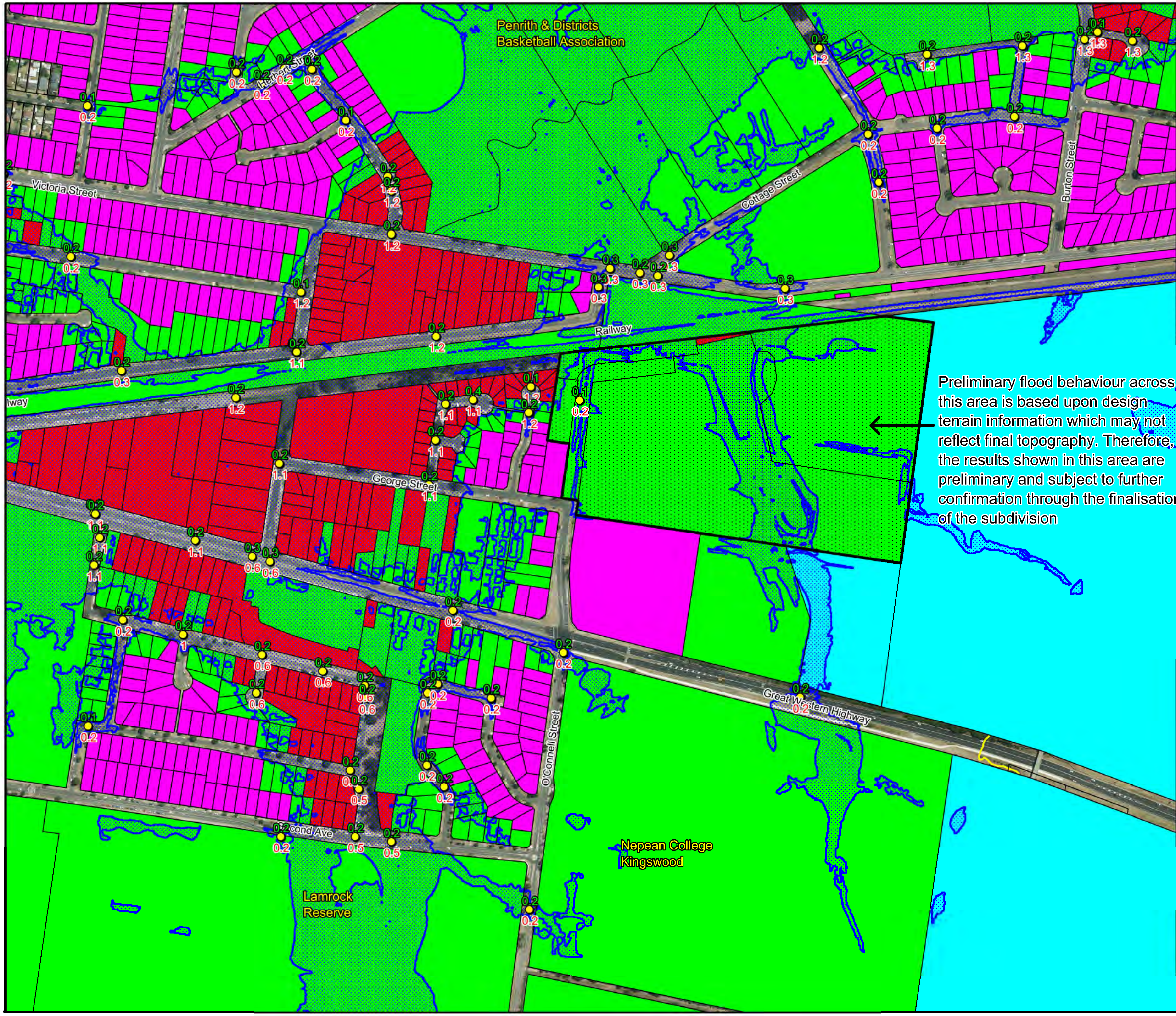
0 0.15 0.3 Km

Figure Q3.4: Emergency Response Precinct Classifications for the PMF

Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.4 ERC for the PMF Flood.wor



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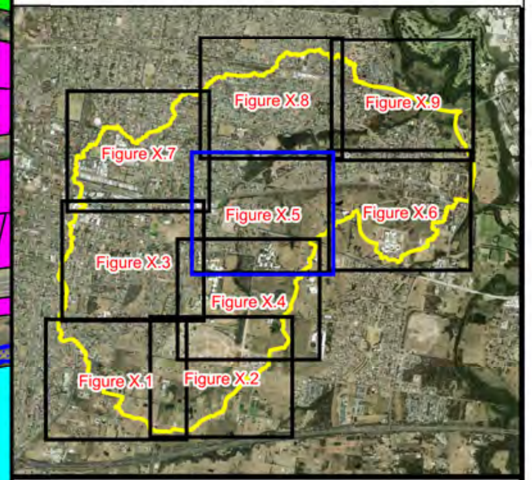

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- Time of Road First Overtopping (hours)
- Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
W E
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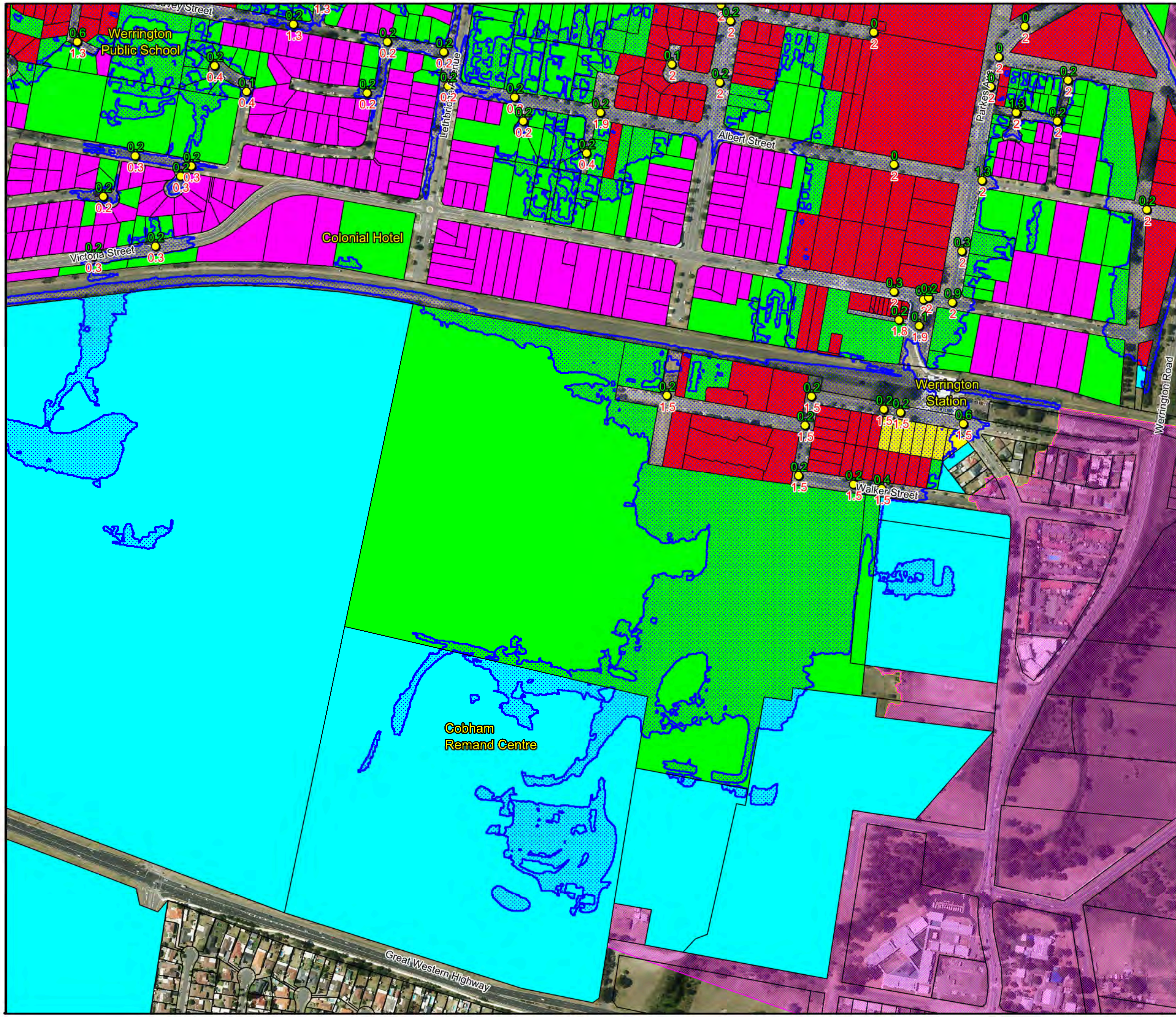
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q3.5: Emergency Response Precinct Classifications for the PMF

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.5 ERC for the PMF Flood.wor



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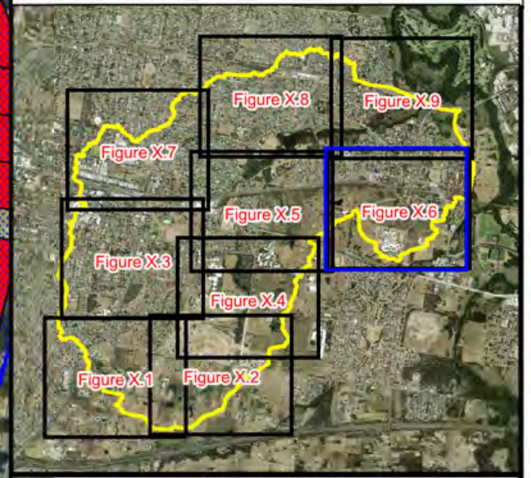


LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

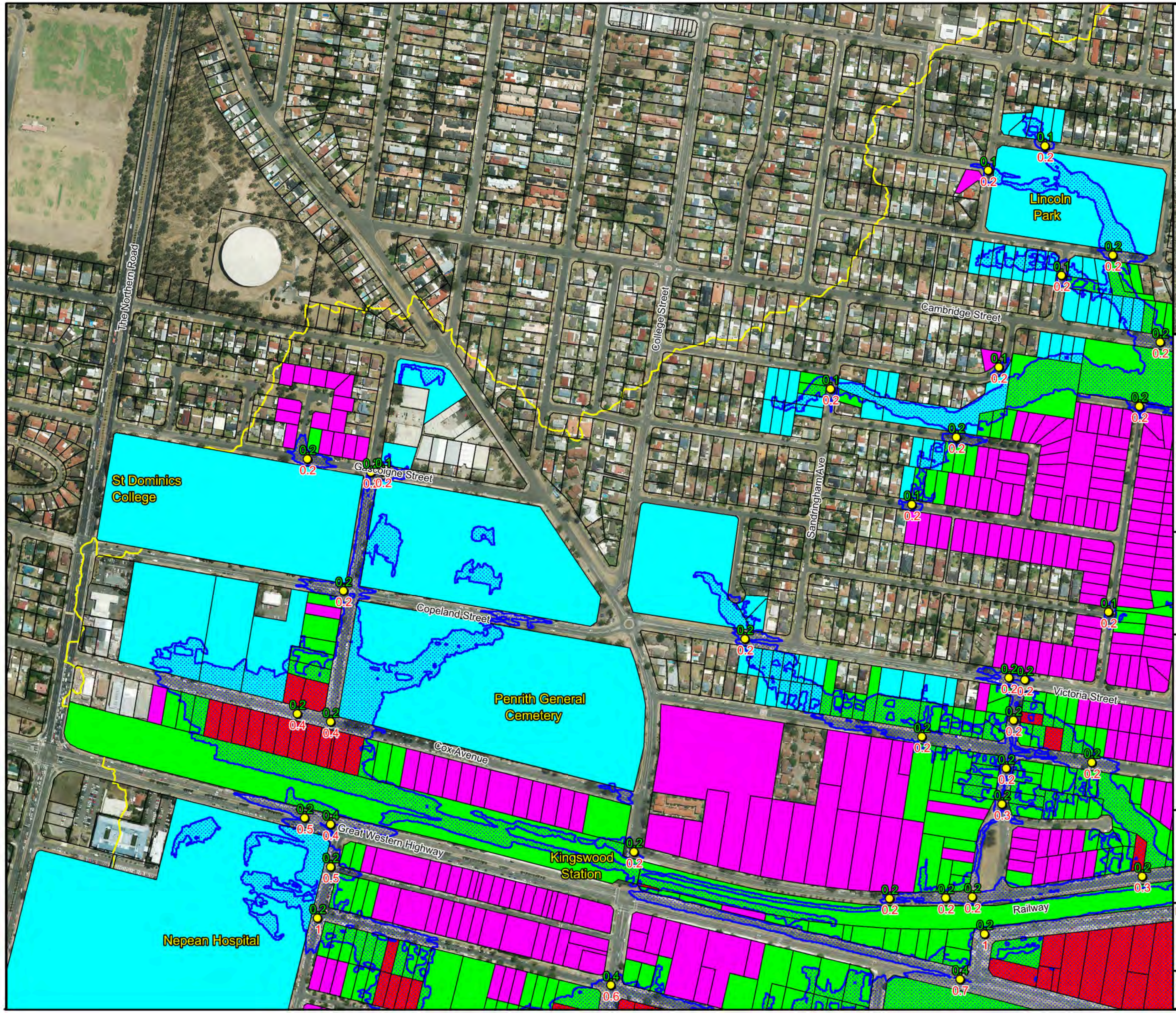
Scale 1:5,000 (at A3)

0 0.15 0.3 Km

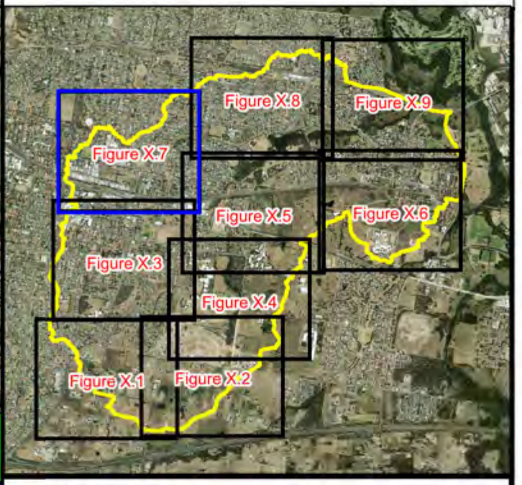
Figure Q3.6: Emergency Response Precinct Classifications for the PMF

Prepared By:
CatchmentSimulationSolutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.6 ERC for the PMF Flood.wor



PENRITH
CITY COUNCIL



LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N
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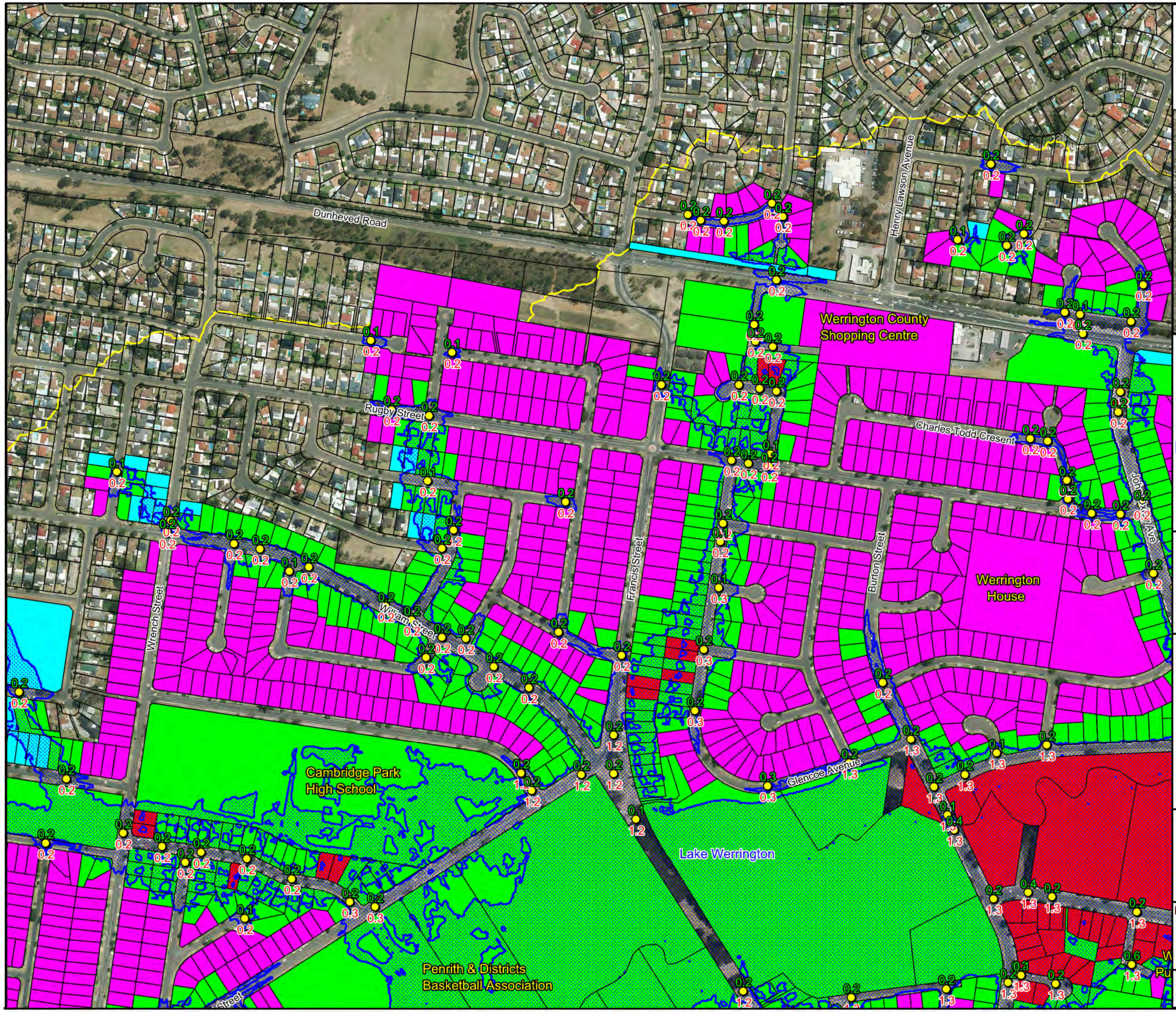
Scale 1:5,000 (at A3)

0 0.15 0.3
Km

Figure Q3.7: Emergency Response Precinct Classifications for the PMF

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.7 ERC for the PMF Flood.wor



PENRITH CITY COUNCIL

LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N E S W

Scale 1:5,000 (at A3)

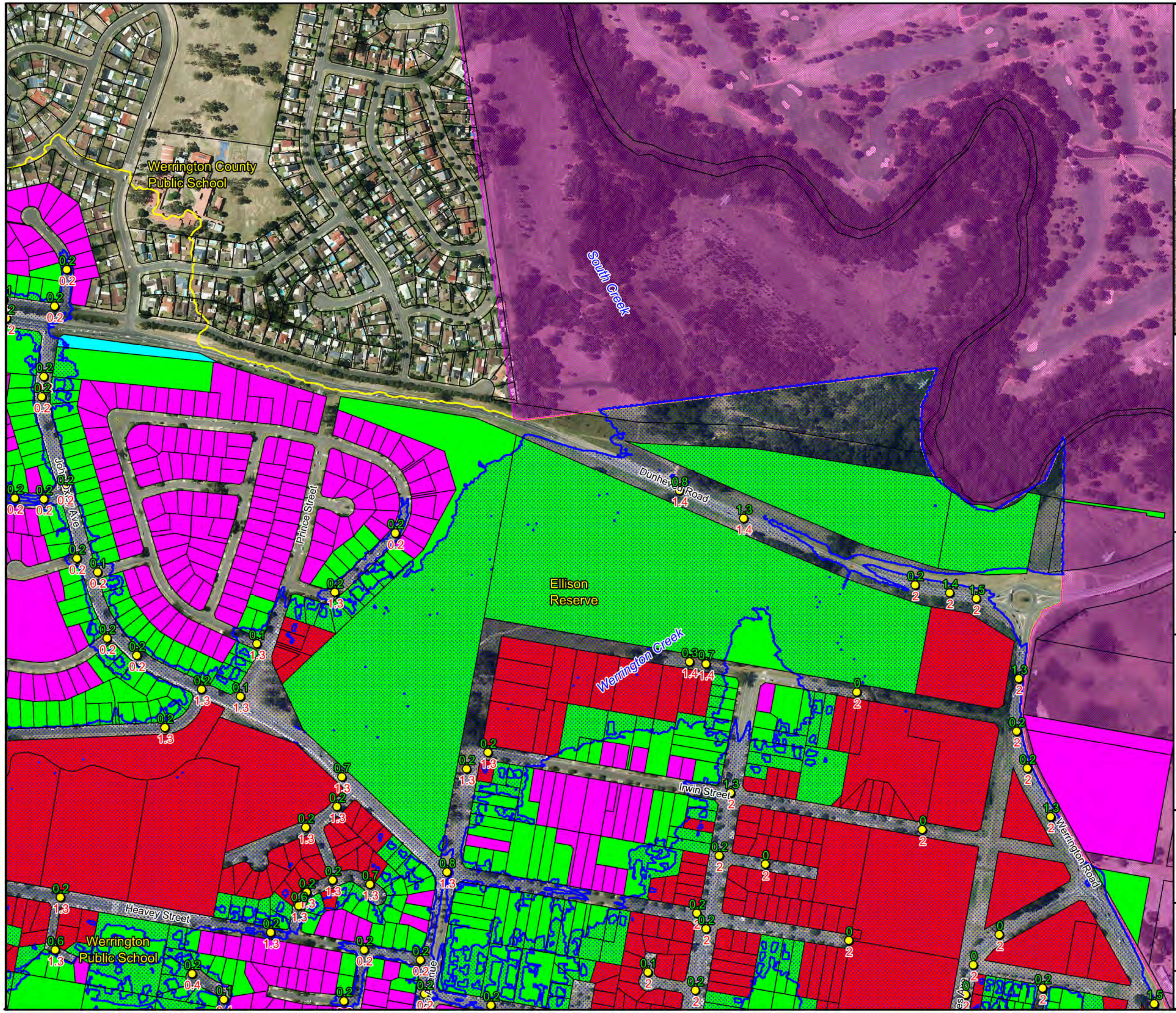
0 0.15 0.3 Km

Figure Q3.8: Emergency Response Precinct Classifications for the PMF

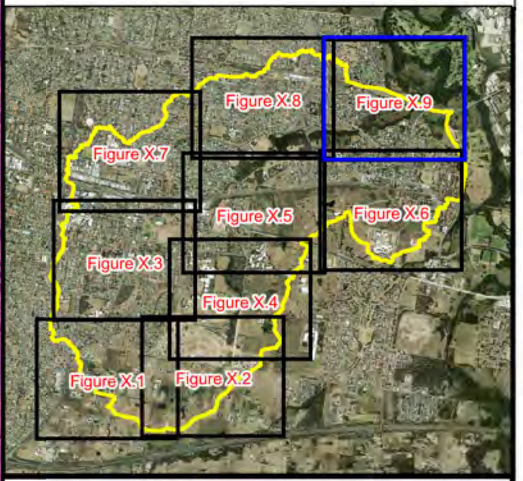
Prepared By:

Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.8 ERC for the PMF Flood.wor



PENRITH CITY COUNCIL



LEGEND

- Flooded Isolated Submerged
- Flooded Exit Route Overland Escape
- Flooded Isolated Elevated
- Flooded Exit Route Rising Road
- Indirect Consequences
- No Flood Impacts
- PMF Extent

Road Overtopping Location

- 1.5 Time of Road First Overtopping (hours)
- 0.5 Duration of Overtopping (hours)

Notes:

Water depths less than 0.15m not displayed.
Aerial photograph date: 2014.

Innundation across this area not mapped. Please refer to "Updated South Creek Flood Study" - (Worley Parsons, 2015)

N W E S

Scale 1:5,000 (at A3)

0 0.15 0.3 Km

Figure Q3.9: Emergency Response Precinct Classifications for the PMF

Prepared By:

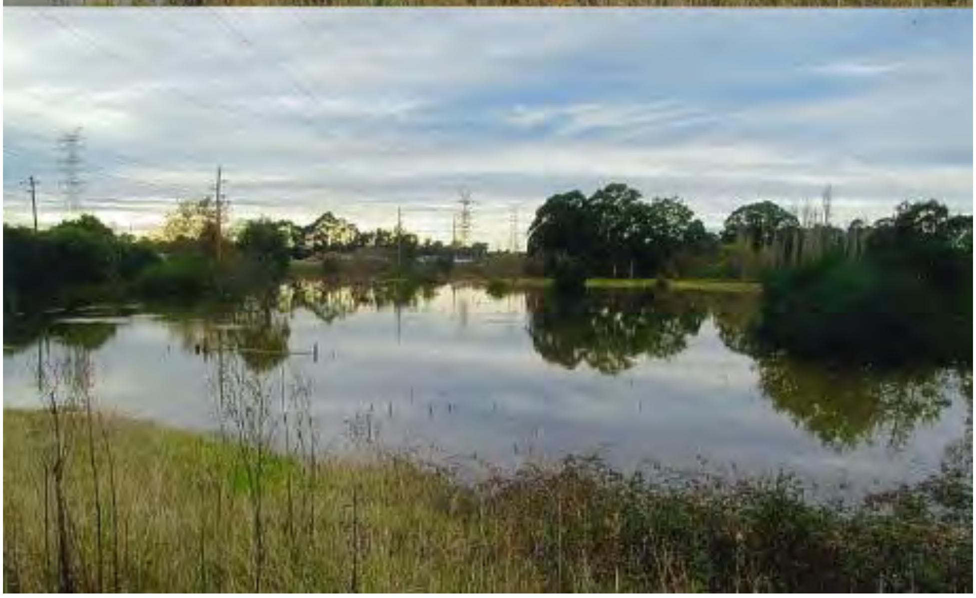
Catchment Simulation Solutions
Suite 2.01, 210 George St
Sydney, NSW 2000

File Name: FigQ3.9 ERC for the PMF Flood.wor

APPENDIX R

PUBLIC EXHIBITION SUBMISSION

February 2016 Flood Photos for Werrington area located North of Railway Line and west of Werrington Road.



FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

February 2016 Flood Photos for Werrington area located North of Railway Line and west of Werrington Road.

February 2016 Flood Photos for Werrington area located North of Railway Line and west of Werrington Road.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

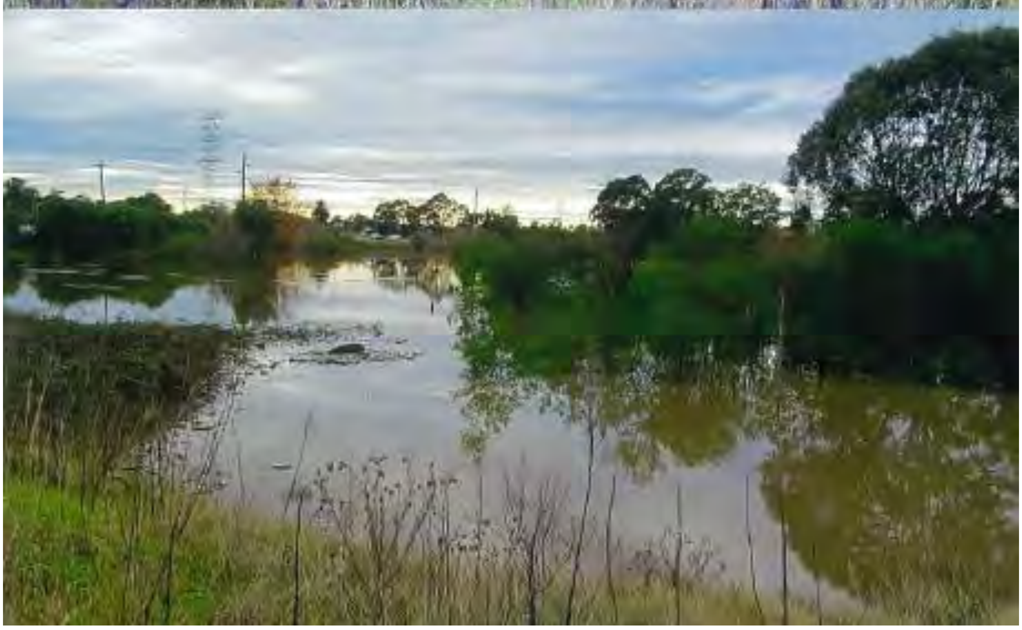
FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

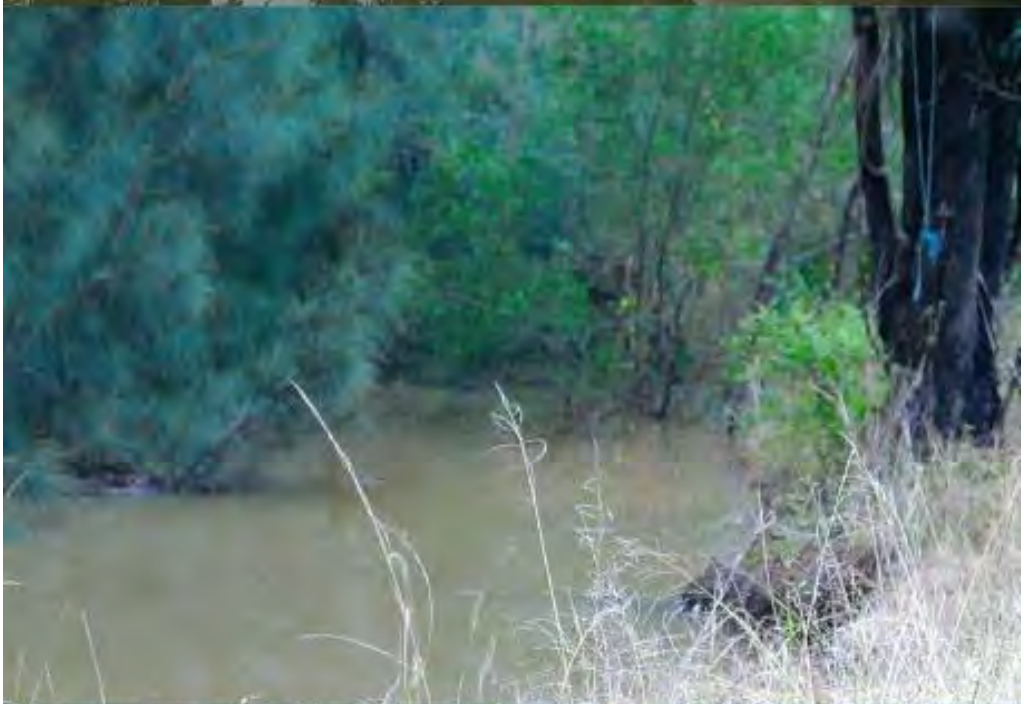
February 2016 Flood Photos for Werrington area located North of Railway Line and west of Werrington Road.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.

FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.



FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.



FEBRUARY 2016 FLOOD PHOTOS FOR WERRINGTON AREA LOCATED NORTH OF RAILWAY LINE AND WEST OF WERRINGTON ROAD.