Flood Mapping of Gardiners Creek

Part 1

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PROJECT DETAILS

Project Name	Flood Mapping of Gardiners Creek – Part 1
Client	Water Technology
Client Project Manager	Farid Ahmed
Water Technology Project Manager	Luke Cunningham
Report Authors	LJC/SHM/ADV
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15 Business Park Drive
Notting Hill VIC 3168

Telephone (03) 9558 9366
Fax (03) 9558 9365

ABN No. 60 093 377 283

ACN No. 093 377 283

Executive Summary

Investigation Objectives

The project scope was prepared in line with the Melbourne Water Technical Specifications document (*MWC , 2009a*) and the Gardiners Creek Flood Mapping project brief (*MWC, 2009b*). The project objectives are as follows:

1) Develop a new RORB model for the Gardiners Creek local catchments incorporating available Redevelopment Services Scheme (RSS) catchment and Flood Mapping (FM) RORB models to form a RORB model covering the entire Gardiners Creek catchment.
2) Determine the 5 year, 10 year, 20 year, 50 year, 100 year average recurrence interval (ARI) events and Probable Maximum Precipitation (PMP) flows from the Gardiners Creek RORB model for hydrograph inputs to the unsteady flow hydraulic model.
3) Review the existing hydraulic model (*Water Technology, 2004*) and update the model as appropriate.
4) Calibrate and verify the RORB and unsteady hydraulic models to gauged events.
5) Determine the flooding extents for the 5 year, 10 year, 20 year, 50 year and 100 year ARI, and PMP events.
6) Investigate the number of flood affected properties in the 5 year, 10 year, 20 year, 50 year and 100 year ARI, and PMP events and provide flood levels for all the affected properties.
7) Calculate the annual average damages (AAD) expected from the flood events.

Catchment Characteristics

Gardiners Creek (Melbourne Water drain number 4820) is a highly urbanised waterway located in the eastern suburbs of Melbourne. Gardiners Creek outlets to the Yarra River (Melbourne Water drain number 4400) approximately 6 km from the centre of Melbourne. The creek is over 16.5 km long and covers a total catchment area of 111 km^2. Gardiners Creek originates at the Middleborough Road Retarding Basin in the east of the catchment in Box Hill South. Downstream of the basin the remainder of Gardiners Creek from Canterbury Road to Glenferrie Road can be divided into several reaches with the following characteristics:

- Canterbury Road to Burwood Highway – Largely natural channel with some realignment and modification. The adjacent floodplain consists of public open space

- Burwood Highway to Warrigal Road – Concrete lined channel with numerous drop structures. The channel is generally flanked by residential, commercial and industrial development. The floodplain in this reach is limited.

- Warrigal Road to High Street – Largely natural channel with some realignment and modification. The adjacent floodplain predominantly consists of public open space.

- High Street to Toorak Road – Some natural channel with significant realignment and modification due to the construction and widening of the Monash Freeway. A tunnel (culvert) some 400 m in length exists at Burke Road. The adjacent floodplain consists of residential areas and open public space.

- Toorak Road to Glenferrie Road – Concrete lined channel adjacent to the Monash Freeway. The floodplain consists of open public space.

The main zonings within the Gardiners Creek local catchment include residential (64%), public use zone and parks (11 %) and road zone (9%) with the average fraction imperviousness across the catchment being 0.46.

Instantaneous flow gauge 229624 (Gardiners Creek at Gardiners) has recorded flows along Gardiners Creek from January 1978 to present. The data available from this gauge and surrounding rain gauges are a key input to the RORB model calibration for this study.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Overview

This report details the investigations undertaken for the flood mapping of Gardiners Creek. A previous study of Gardiners Creek was carried out by Water Technology in 2004. The objective of this investigation was to update the previous study completed by Water Technology to meet the specifications and objectives outlined in the current Melbourne Water Technical Specifications and Requirements document (*MWC, 2009a*). This study also incorporated the results and models from the various RSS and flood mapping projects which form tributary inlets to Gardiners Creek. A new RORB model was created for the local catchment of Gardiners Creek. The models from existing RSS and flood mapping projects were combined with the new RORB model. The RORB model was calibrated and verified for flows and water levels to the flow gauge '229624 - Gardiners Creek at Gardiners'. The existing hydraulic model was reviewed and updated to ensure it represented current conditions in Gardiners Creek. The new hydraulic model included a detailed 2D hydraulic model around the Burke Road crossing of Gardiners Creek.

1.2 Investigation Objectives

The project scope was prepared in line with the Melbourne Water Technical Specifications document (*MWC, 2009a*) and the Gardiners Creek Flood Mapping project brief (*MWC, 2009b*). The project objectives were as follows:

- Develop a new RORB model for the Gardiners Creek local catchments incorporating available Redevelopment Services Scheme (RSS) catchment and Flood Mapping (FM) RORB models to form a RORB model covering the entire Gardiners Creek catchment.
- Determine the 5 year, 10 year, 20 year, 50 year, 100 year average recurrence interval (ARI) events and Probable Maximum Precipitation (PMP) flows from the Gardiners Creek RORB model for hydrograph inputs to the unsteady state hydraulic model.
- Review the existing hydraulic model (*Water Technology, 2004*) and update the model as appropriate.
- Calibrate the hydraulic model to gauged events in the Gardiners Creek catchment.
- Determine the flooding extents for the 5 year, 10 year, 20 year, 50 year and 100 year ARI, and PMP events.
- Investigate the number of flood affected properties in the 5 year, 10 year, 20 year, 50 year and 100 year ARI and PMP events and provide flood levels for all the affected properties.
- Calculate the annual average damages (AAD) expected from the flood events.

1.3 Overview of Technical Methodology

The flood modelling for the project was carried out in two stages; hydrological modelling and hydraulic modelling. The hydrological modelling, completed in RORB, combined the existing tributary catchment RORB models (created for various FM&M or RSS projects) with a new local model created for this project. Due to the size of the new combined RORB model, a beta version of RORB was used which allows for a greater number of subareas than the standard version. The RORB model was used to generate hydrographs at locations where the tributary catchments or local Gardiners Creek catchments met Gardiners Creek.

The hydraulic modelling then employed the hydrographs from RORB as inflow hydrographs (boundary conditions). A 1D hydraulic model, MIKE11, routed flows along Gardiners Creek. Roughness coefficients and details of structures, etc. were all input directly to the MIKE11 model.

The hydraulic model was run to generate the required flow hydrographs and flood levels outputs for each ARI and duration.

Due to complex hydraulic conditions around the Burke Road tunnel, a 2D TUFLOW model was constructed to model the reach from Great Valley Parade to Toorak Road. This allowed better representation of break-away flows in the model. MIKE11 hydrographs were used as the upstream boundary conditions with the downstream boundary set by the corresponding water level in the MIKE11 model. The results from the TUFLOW model replace the mapping results from the MIKE11 modelling through this reach.

2 CATCHMENT AND DRAINAGE FEATURES

2.1 Catchment and Drainage Description

Gardiners Creek (Melbourne Water drain number 4820) is a highly urbanised waterway located in the eastern suburbs of Melbourne. Gardiners Creek outlets to the Yarra River (Melbourne Water drain number 4400) approximately 6 km from the centre of Melbourne. The creek is over 16.5 km long and covers a total catchment area of 111 km^2. Gardiners Creek originates at the Middleborough Road Retarding Basin in the east of the catchment in Box Hill South. Downstream of the basin the remainder of Gardiners Creek from Canterbury Road to Glenferrie Road can be divided into several reaches with the following characteristics:

- Canterbury Road to Burwood Highway – Largely natural channel with some realignment and modification. The adjacent floodplain consists of public open space
- Burwood Highway to Warrigal Road – Concrete lined channel with numerous drop structures. The channel is generally flanked by residential, commercial and industrial development. The floodplain in this reach is limited.
- Warrigal Road to High Street – Largely natural channel with some realignment and modification. The adjacent floodplain predominantly consists of public open space.
- High Street to Toorak Road – Some natural channel with significant realignment and modification due to the construction and widening of the Monash Freeway. A tunnel (culvert) some 400 m in length exists at Burke Road. The adjacent floodplain consists of residential areas and open public space.
- Toorak Road to Glenferrie Road – Concrete lined channel adjacent to the Monash Freeway. The floodplain consists of open public space.

A site visit of the local catchment was undertaken by the study team, site visit photos are displayed in Appendix C.

There are a number of major tributary catchments. Table 2-1 displays the tributary catchments characteristics and a brief summary of previous relevant investigations. In particular, Table 2-1 notes the availability of a RORB model for the tributary catchments. The source of the available RORB model is noted as a RSS (Redevelopment Services Scheme) or FM (Flood mapping project). Further discussion of the use of the available tributary RORB models is provided in Section 4.2.

Also, there are a number of local sub-catchments draining directly to Gardiners Creek. These local sub-catchments are generally less than 60 ha in area, and therefore the responsibility for drainage lies with the local government authority. For the purposes of this study, these sub-catchments are referred to collectively as the Gardiners Creek local catchment.

Figure 2-1 shows the tributary catchments and the local catchments. Figure 2-2 shows a DEM (Digital Elevation Model) created for the catchment along with some major catchment features. Figure 2-3 shows the locality and many of the features of the local catchment. Figure 2-4 displays the key waterway works undertaken along Gardiners Creek.

Table 2-1 Tributary Catchment Characteristics

Catchment Number	Investigation Name	MW Drains Covered	RSS or FM&M	Source	RORB Available?	Area (ha)	Ave FI	Calibration Technique
4830	Back Creek	Myrtle Rd MD (4835), Faversham Rd MD (4836), "W" Creek (4834), Nichollsdale Rd Drain (4833), Burwood MD (4832), Ashburton MD (4831), Back Creek (4830)	RSS	GHD (2008)	Yes	1871	0.46	Interstation area, reconciled to Rational Method and flows at Toorak Rd
4893	Blackburn MD	Blackburn North MD (4893), South Parade MD (4895), Laburnum St MD (4894), Lake Rd Drain (4891), Forest Hill Drain (4892), Blackburn Sth Drain (4890)	RSS	Water Technology (2008)	Yes	1557.6	0.48	Interstation area, Rational Method
4872	Damper Creek	Damper Creek Drain (4872), Damper Creek East Branch (4873)	RSS	GHD (2007a)	Yes	472	0.42	Rational Method
4871	Winbirra Parade Drain	Winbirra Parade Drain (4871)	RSS	GHD (2007a)	Yes	128	0.44	Rational Method
4842	Darling Road MD	Darling Rd Main Drain (4842)	RSS	GHD (2007b)	Yes	101	0.5	Rational Method
4850	Murrumbeena MD	Carlisle Crescent (4853), Oakleigh MD (4852), Bishop St (4854), Murrumbeena MD(4850)	RSS	SKM (2005)	Yes	1106	0.49	Rational Method
4825	Rix St MD	Rix St MD (4825)	FM&M	WBM (2003)	Yes	99	0.7	Rational Method
4823	Tooroonga Rd MD	Tooroonga Rd MD (4823), Creswisk St MD (4824)	RSS	GHD (2006a)	Yes	392	0.52	Rational Method
4822	Lara St MD	Lara Street MD (4822)	RSS	GHD (2006b)	Yes	69.4	0.5	Rational Method
4841	Hedgely Dene MD	Hedgely Dene MD (4841)	RSS	GHD (2007c)	Yes	172	0.45	Rational Method
4844	East Malvern Drain	East Malvern Drain (4844)	RSS	GHD (2007d)	Yes	97	0.47	Rational Method
4821	Moonga Road Drain	Moonga Road MD (4821)	RSS	GHD (2006c)	Yes	119.8	0.44	Rational Method
4881	Stott St Drain	Stott St Drain (4881)	FM&M	CMPS&F	Yes	90	0.42	Rational Method

				(1998b)				
4885	Box Hill Sth MD	Box Hill Sth MD (4885), Collins St Drain (4886)	FM&M	CMPS&F (1998b)	Yes	304	0.51	Rational Method
4882	Eley Rd West Drain	Eley Rd West Drain (4882)	FM&M	CMPS&F (1998b)	Yes	98	0.52	Rational Method
4883	Fulton Rd Drain	Fulton Rd Drain (4883), Eley Rd East Drain (4884)	FM&M	CMPS&F (1998b)	Yes	516	0.5	Rational Method
4875	McComas Grove Drain	McComas Grove Drain (4875)	FM&M	CMPS&F (1998b)	Yes	140	0.48	Rational Method
4874	Brockhoff's Drain	Brockhoff's Drain (4874)	FM&M	CMPS&F (1998a)	Yes	86	0.5	Rational Method
4861	Oakleigh Nth Drain	Oakleigh Nth Drain (4861)	FM&M	CMPS&F (1998a)	Yes	279	0.52	Rational Method
4863	Macrina St Drain	Macrina St Drain (4863)	FM&M	CMPS&F (1998a)	Yes	162	0.57	Rational Method
4860	Scotchmans Creek	Scotchmans Creek (4860), Mt Waverly Drain (4864), Glen Waverly Drain (4865), Tally Ho Drain (4866), Mt View Drain (4867), Montclair Avenue Drain (4868)	FM&M	WBM (2010)	Yes	2171	0.56	n/a

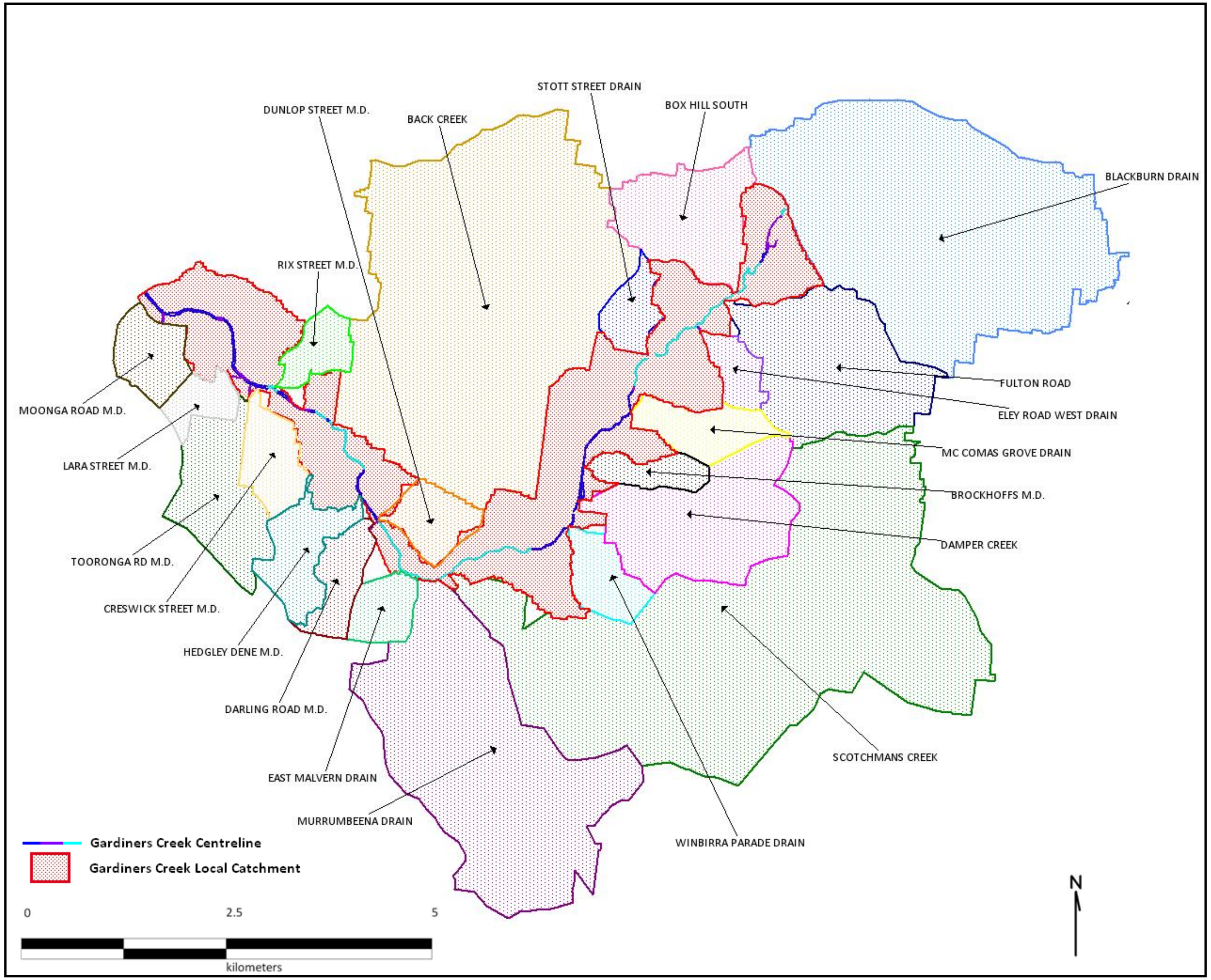

Figure 2-1 Gardiners Creek Local Catchment and Tributary Catchments

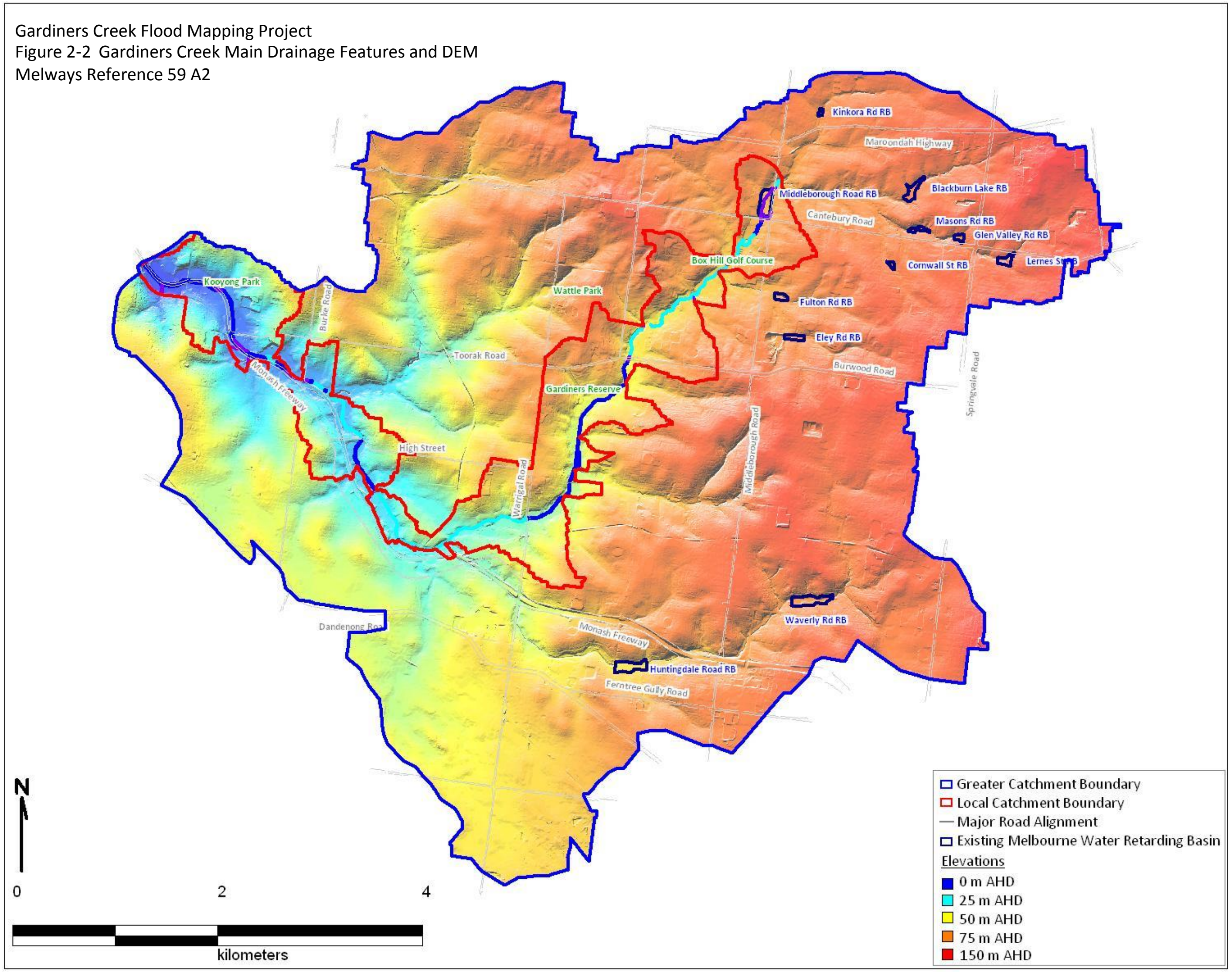

Figure 2-2 Gardiners Creek Main Drainage Features and DEM

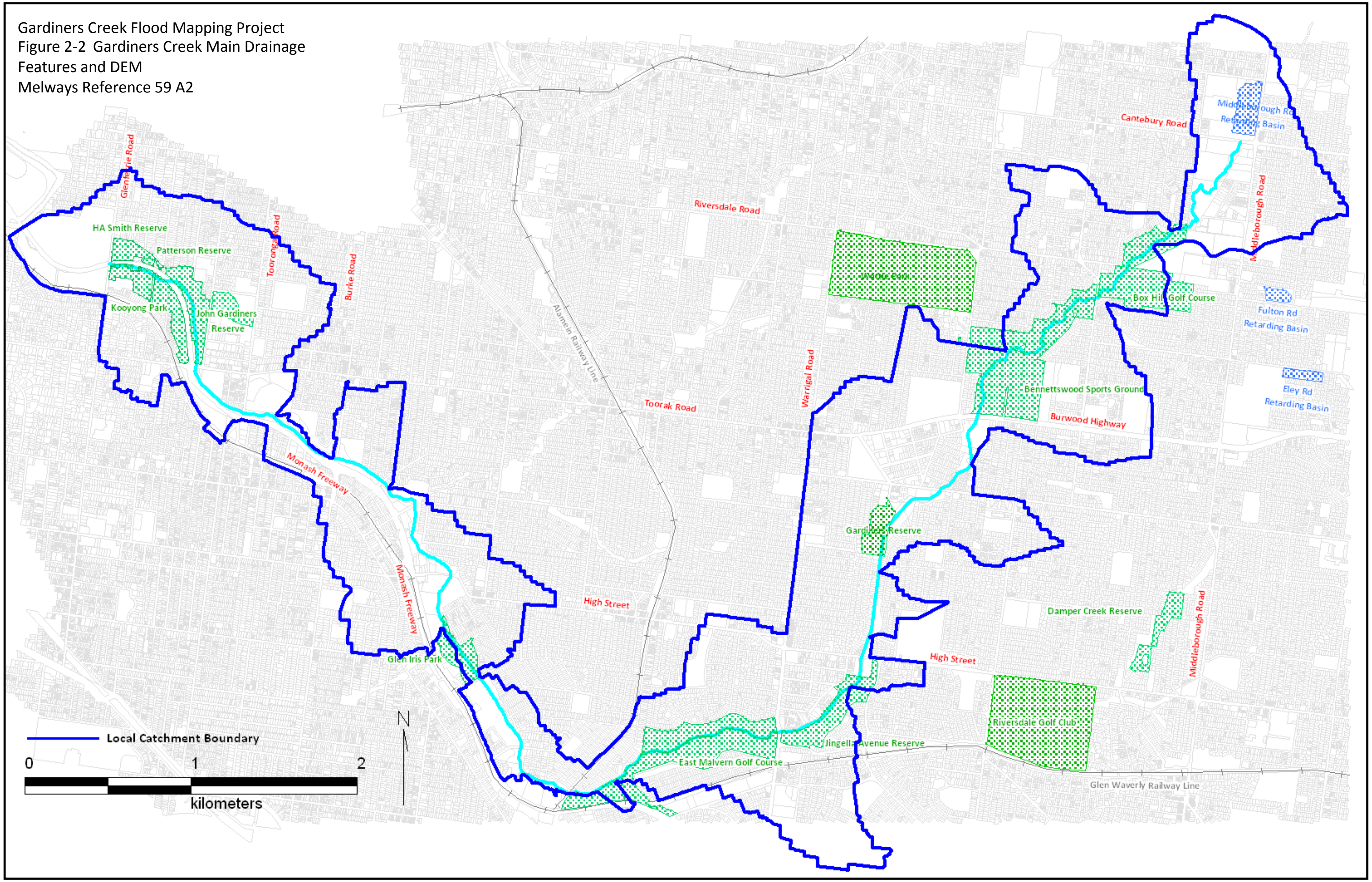

Figure 2-3 Local Catchment Features

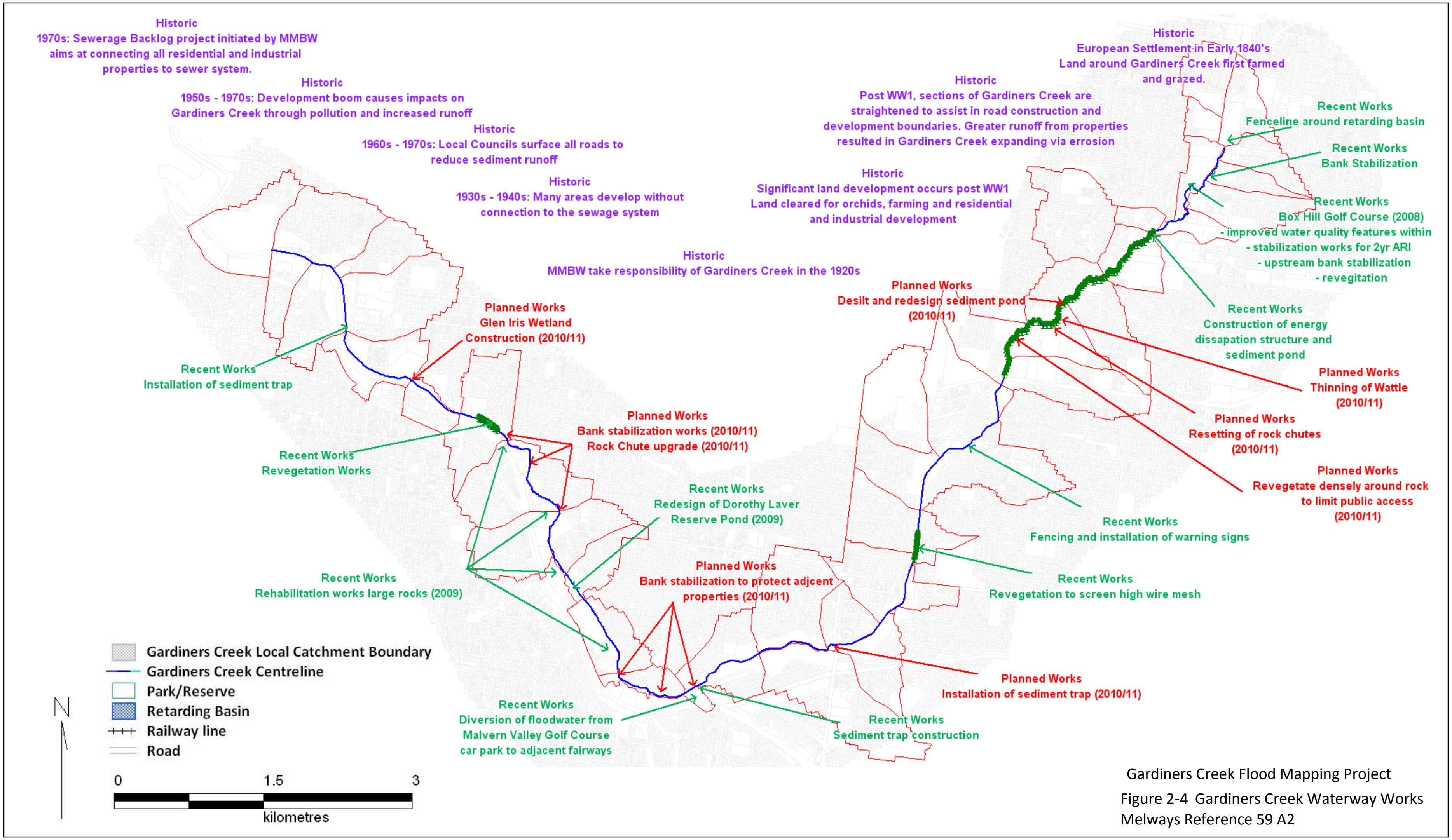

Figure 2-4 Gardiners Creek Waterway Works

2.2 Zonings

The main zonings within the Gardiners Creek local catchment include residential (64%), public use zone and parks (11%) and road zone (9%) with the average fraction imperviousness across the catchment being 0.46.

The main land use within the Gardiners Creek Local Catchment is residential (64%). Residential areas are evenly distributed across the entire catchment. Due to the high value of land throughout the catchment and the limited amount of land available for industrial or commercial areas to expand, it is not expected that the amount of residential land within the catchment will change.

Public use zones and parks cover 11% of the catchment. Majority of these areas are golf courses and parks adjacent to Gardiners Creek. Roads make up 9% of the catchment with many major roads crossing the catchment such as Monash Freeway, Warrigal Road, Toorak Road, Burwood Highway and High Street.

Table 2-2 below and Figure 2-5 summarise the zonings across the local catchment.

Table 2-2 Zoning Summary

Zone Type	Zone Code	Percentage of Total Area
Residential	R1Z, R2Z	64%
Public Use and Parks	PPRZ, PUZ1, PUZ2, PUZ3, PUZ4, PUZ5	11%
Roads	RDZ1, RDZ2	9%
Other	UFZ, SUZ1, SUZ2, MUZ1, CDZ1, B1Z, B2Z, B3Z, B4Z, B5Z, IN1Z, IN3Z	16%

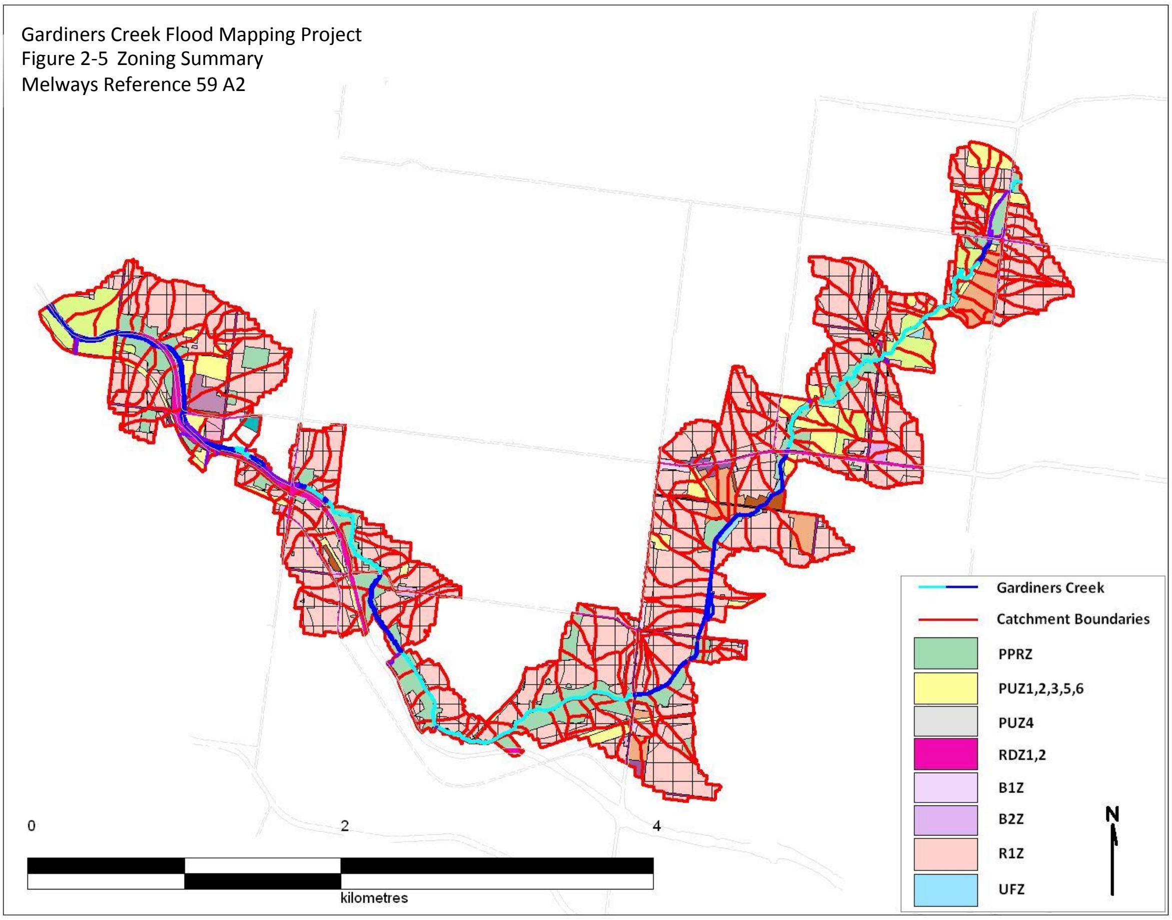

Figure 2-5 Zoning Summary

2.3 Review of Fraction Impervious Data – Local Gardiners Creek Catchment

The Gardiners Creek local catchment RORB model contains 239 sub-catchments. Fraction impervious values were assigned to each sub-catchment via the results from the 'Fraction Impervious Calculator' supplied by Melbourne Water. The values supplied were checked against the supplied aerial photos and were found to be suitable for use with some minor changes. Figure 2-6 below shows the fraction impervious data thematically mapped across each sub-catchment to highlight areas of high and low fraction impervious. The average percentage impervious across the sub-catchments is 46%. Sub-catchments CR, AJ and AK have high percentage impervious values (above 80%) which reflect the high number of industrial buildings in that area. Percentage impervious data within each tributary catchment has been adopted from the previous studies completed for each catchment. Full details of fraction impervious data are shown in Appendix A.

It should be noted that no review of the Fraction Impervious for the available tributary catchments was required by Melbourne Water as part of this study. The fractions impervious for the tributary catchments were adopted as provided by Melbourne Water.

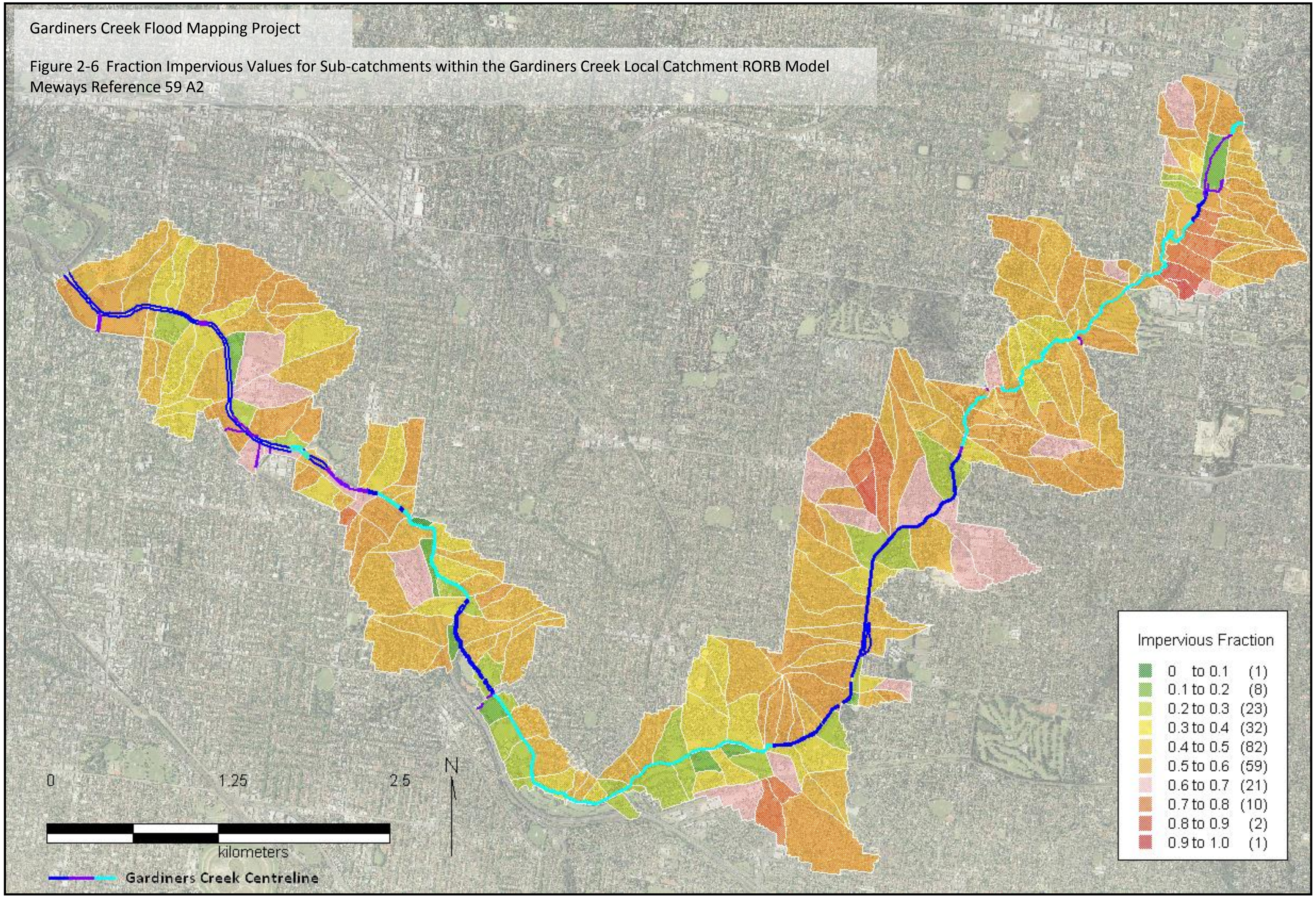

Figure 2-6 Fraction Impervious Values for Sub-catchments within the Gardiners Creek Local Catchment RORB Model

3 DATA COLLATION AND REVIEW

The Gardiners Creek catchment study area was divided into two areas. The local Gardiners Creek catchment focuses on the Gardiners Creek main branch and its immediate local catchments, which does not flow into a Melbourne Water main drain. The tributary catchments incorporate all the remaining areas which comprise of the main tributaries (Melbourne Water main drains) which outlet to Gardiners Creek. Much of the data collation and review was focused on the greater study area.

3.1 Source of Past Investigations

Investigation reports, RORB models and MapInfo data was provided by Melbourne Water from previous RSS and Flood Mapping and Mitigation reports. Table 3-1 below shows past RSS and FM&M investigations completed within the greater catchment boundary along with the Melbourne Water main drains within each investigation.

Table 3-1 Source of Past Investigations

Catchment Number	Investigation Name	MW Drains Covered	RSS or FM&M	Source
4830	Back Creek	Myrtle Rd MD (4835), Faversham Rd MD (4836), "W" Creek (4834), Nichollsdale Rd Drain (4833), Burwood MD (4832), Ashburton MD (4831), Back Creek (4830)	RSS	GHD (2008)
4893	Blackburn MD	Blackburn North MD (4893), South Parade MD (4895), Laburnum St MD (4894), Lake Rd Drain (4891), Forest Hill Drain (4892), Blackburn Sth Drain (4890)	RSS	Water Technology (2008)
4872	Damper Creek	Damper Creek Drain (4872), Damper Creek East Branch (4873)	RSS	GHD (2007a)
4871	Winbirra Parade Drain	Winbirra Parade Drain (4871)	RSS	GHD (2007a)
4842	Darling Road MD	Darling Rd Main Drain (4842)	RSS	GHD (2007b)
4850	Murrumbeena MD	Carlisle Crescent (4853), Oakleigh MD (4852), Bishop St (4854), Murrumbeena MD(4850)	RSS	SKM (2005)
4825	Rix St MD	Rix St MD (4825)	FM&M	WBM (2003)
4823	Tooroonga Rd MD	Tooroonga Rd MD (4823), Creswisk St MD (4824)	RSS	GHD (2006a)
4822	Lara St MD	Lara Street MD (4822)	RSS	GHD (2006b)
4841	Hedgely Dene MD	Hedgely Dene MD (4841)	RSS	GHD (2007c)
4844	East Malvern Drain	East Malvern Drain (4844)	RSS	GHD (2007d)
4821	Moonga Road Drain	Moonga Road MD (4821)	RSS	GHD (2006c)
4881	Stott St Drain	Stott St Drain (4881)	FM&M	CMPS&F (1998b)
4885	Box Hill Sth MD	Box Hill Sth MD (4885), Collins St Drain (4886)	FM&M	CMPS&F (1998b)

4882	Eley Rd West Drain	Eley Rd West Drain (4882)	FM&M	CMPS&F (1998b)
4883	Fulton Rd Drain	Fulton Rd Drain (4883), Eley Rd East Drain (4884)	FM&M	CMPS&F (1998b)
4875	McComas Grove Drain	McComas Grove Drain (4875)	FM&M	CMPS&F (1998b)
4874	Brockhoff's Drain	Brockhoff's Drain (4874)	FM&M	CMPS&F (1998a)
4861	Oakleigh Nth Drain	Oakleigh Nth Drain (4861)	FM&M	CMPS&F (1998a)
4863	Macrina St Drain	Macrina St Drain (4863)	FM&M	CMPS&F (1998a)
4860	Scotchmans Creek	Scotchmans Creek (4860), Mt Waverly Drain (4864), Glen Waverly Drain (4865), Tally Ho Drain (4866), Mt View Drain (4867), Montclair Avenue Drain (4868)	FM&M	WBM, 2010-11

3.2 Key Findings from Past Investigations

The key information from the past investigations within the tributary catchments was the RORB modelling approach, calibration technique and fraction impervious value applied. The flow hydrographs for a range of events from each RORB model was input to the Gardiners Creek RORB model constructed for this study and ultimately the hydraulic model created for this study. Table 3-2 below summarises the key information from the past investigations within the greater catchment area.

Table 3-2 Key Information from Past Investigations for Tributary catchments

Catchment Number	Catchment Name	Area (ha)	Average FI	Calibration Technique	Tc (mins)	Rational Method Q100 (m^3/s)
4830	Back Creek	1871	46%	Interstation area, reconciled to Rational Method and flows at Toorak Rd	n/a	n/a
4893	Blackburn MD	1557.6	48%	Interstation area, Rational Method	72	106
4872	Damper Creek	472	42%	Rational Method	31.75	41.8
4871	Winbirra Parade Drain	128	44%	Rational Method	21.45	17.26
4842	Darling Road MD	101	50%	Rational Method	28.35	13.21
4850	Murrumbeena MD	1106	49%	Rational Method	61	91.9
4825	Rix St MD	99	70%	Rational Method	17	22.5
4823	Tooroonga Rd MD	392	52%	Rational Method	n/a	n/a
4822	Lara St MD	69.4	50%	Rational Method	13.44	13.98

4841	Hedgely Dene MD	172	45%	Rational Method	26.98	21.5
4844	East Malvern Drain	97	47%	Rational Method	24.66	13.26
4821	Moonga Road Drain	119.8	44%	Rational Method	13.59	21.8
4881	Stott St Drain	90	42%	Rational Method	16	14.6
4885	Box Hill Sth MD	304	51%	Rational Method	27	41.5
4882	Eley Rd West Drain	98	52%	Rational Method	17	17.7
4883	Fulton Rd Drain	516	50%	Rational Method	29	66.3
4875	McComas Grove Drain	140	48%	Rational Method	17	23.6
4874	Brockhoff's Drain	86	50%	Rational Method	17	14.9
4861	Oakleigh Nth Drain	279	52%	Rational Method	32	33.9
4863	Macrina St Drain	162	57%	Rational Method	33	20.2
4860	Scotchmans Creek	2171	56%	n/a	n/a	n/a

The tributary catchment RORB model set up (ie routing, fraction impervious data, sub-catchment delineation, etc) was adopted for this study. Each model was run with the kc value listed in Table 3-3 below. Other RORB run parameters such as initial loss were updated to correspond to the requirements in the Melbourne Water Technical Specifications and Requirements (MWC, 2009a).

Table 3-3 Key RORB Input Information

Catchment ID	Investigation Name	Undiverted Kc	Undiverted Dav	Diverted Kc	Diverted Dav
4830	Back Creek	W Creek 4.88	3.57	3.59	4.91
		Burwood 2.48	2.50	2.56	2.54
		Back Ck Upper 0.72	0.59	.59	0.72
		Ashburton 2.89	1.80	1.80	2.89
		Outlet 1.50	1.16	1.16	1.50
4893	Blackburn MD	North 2.50	2.12	2.50	2.12
		Lake Rd Drain 2.20	1.95	2.20	1.95
		Forest Hill 3.85	2.80	3.85	2.80
		South 1.60	1.67	1.60	1.67
		Outlet 1.60	1.35	1.60	1.35
4872	Damper Creek	3.29	2.42	3.29	1.36
4871	Winbirra Parade Drain	4.05	1.19	4.05	3.4
4842	Darling Road MD	2.72	1.06	2.72	1.06
4850	Murrumbeena MD	5.69	4.1	7.04	5
4825	Rix St MD	1.65	1.08	1.19	1.14
4823	Tooroonga Rd MD	3.41	2.08	3.38	2.06
4822	Lara St MD	1.13	0.75	1.24	0.82
4841	Hedgely Dene MD	3.83	1.54	3.81	1.53
4844	East Malvern Drain	2	0.99	2	0.99

4821	Moonga Road Drain	1.28	0.74	1.28	0.74
4881	Stott St Drain	1.85	0.9	1.85	0.9
4885	Box Hill Sth MD	5.6	1.8	5.6	1.8
4882	Eley Rd West Drain	3.18	1	3.18	1
4883	Fulton Rd Drain	3.73	2.4	3.73	2.4
4875	McComas Grove Drain	4.26	1.2	4.26	1.2
4874	Brockhoff's Drain	3.7	1.1	3.7	1.1
4861	Oakleigh Nth Drain	5.4	2	5.4	2
4863	Macrina St Drain	5.29	1.4	5.29	1.4
4860	Scotchmans Creek	10	6.94	n/a	n/a

3.2.1 Past Investigations – Key Assumptions

All past RORB models and investigations within the tributary catchments were assumed to be correct and fit for use. There were some cases however where corrections or assumptions were required to allow the RORB models to run. These are detailed below.

3.2.1.1 Back Creek RORB Model

The Back Creek RORB model was found to have a retarding basin, the Willison Park Defacto Storage, not connected to the outlet of the RORB model. The Back Creek RSS Investigation Report (GHD, 2008) was reviewed to determine the operation of the Willison Park Defacto Storage:

"The main outflow from the storage is via a glory hole, located beneath children's playground equipment, leading to a 2250 mm diameter pipe. Excess flows would spill over the flood wall and across Murdoch Street. A small grated inlet at the south east corner of the tennis courts lead to the 2700 x 3600 mm horseshoe drain to help drain the storage once the flood peak has passed, but provides negligible capacity during a flood." (GHD,2008)

This suggests that there is no reason for the retarding basin to not be connected with the rest of the RORB model. The peak outflow from the retarding basin as listed in the Back Creek RSS Investigation Report (GHD, 2008) is 5.6 m^3/s; it is believed this should be recalled to node 343 titled 'IMMEDIATELY DOWNSTREAM WILLISON PARK DEFACTO' which is connected to the main model.

The correction was made for this study by connecting the outflow from the retarding basin with node 343 via a dummy (code 5) reach. The diversion into the retarding basin in the RORB model ('Diversion to 6250' where $D = 0 + 1(Q - 40.725)^1$) allows all flows greater than 40.725 m^3/s to enter the retarding basin. As the peak 100 year ARI flow upstream of the retarding basin is 46.6 m^3/s only a very small amount of water reaches the retarding basin – A peak 100 year ARI inflow of 5.9 m^3/s with a peak 100 year ARI outflow of 5.6 m^3/s for the same duration storm. This suggests that the retarding basin has very little storage impact in the 100 year event and this was reflected by zero flow increase/decrease when the peak flows were compared before and after the correction. The impacts of the Willison Park Retarding Basin on the model is likely to be more evident when there are greater peak flows upstream of the retarding basin, such as the PMP event. Results used for this study are from the updated model which now includes the Willison Park Retarding Basin. Figure 3-1 below shows the location of the Willison Park Defacto Storage in relation to Gardiners Creek.

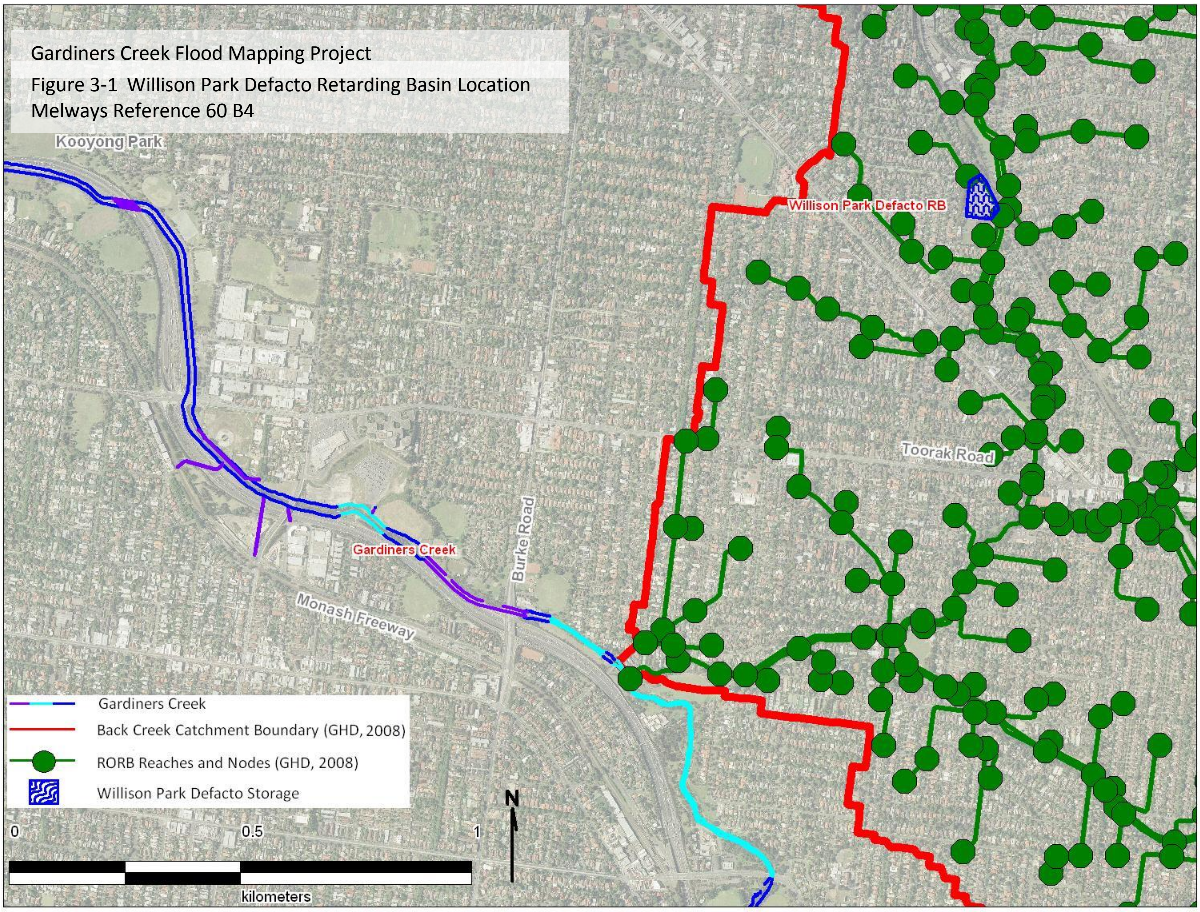

Figure 3-1 **Willison Park Defacto Retarding Basin Location**

3.3 Topographic Data and Survey

3.3.1 Field Survey

At the time of the previous flood mapping study of Gardiners Creek (Water Technology, 2004), Connell Wagner was engaged to undertake field survey of Gardiners Creek extending from Glenferrie Road to Canterbury Road. The field survey consisted of 134 cross sections taken at representative locations along Gardiners Creek and 43 bridge/culvert arrangements as specified by Melbourne Water. Additional field survey was also undertaken by Melbourne Water adjacent to Burke Road.

A review of the existing HECRAS model structures was undertaken for this study to determine if any additional feature survey was required along Gardiners Creek. The HECRAS structures were checked against an aerial image of the site to identify any missing structures. The review revealed that almost all major road crossings, culverts, foot bridges and vehicle bridges have been included in the existing hydraulic model.

There were two structures at the upstream end of Gardiners Creek which were not included in the HECRAS model.

- Monash Freeway crossing (between Glenferrie Rd and Toorak Rd)
- Pitt Street Foot Bridge

The Monash Freeway crossing bridge was incorporated into the new MIKE11 model based on the available survey by Connell Wagner and also through the Monash Alliance HEC-RAS model provided by Melbourne Water which was adapted from the 2004 Water Technology HEC-RAS model.

The Pitt Street bridge was also incorporated into the new MIKE11 model. The Pitt Street foot bridge is very close to the Winton Avenue road crossing. It is thought that the Pitt Street bridge was not included in past modelling due to it's proximity to the Winton Avenue bridge which is lower than the Pitt St bridge and would act as the control. For completeness, the Pitt Street bridge has been included in the modelling based on survey taken by Connell Wagner in 2004.

3.3.2 LiDAR

LiDAR (Light Detection and Ranging) data was provided by Melbourne Water within the catchment boundaries. The available data was used as an input/check of the hydraulic model cross sections and for creating the flood shapes.

4 HYDROLOGIC ANALYSIS

4.1 Overview

RORB (*Laurenson et al 2005*) is a non linear rainfall runoff and streamflow routing model for calculation of flow hydrographs in drainage and stream networks. The model requires catchments to be subdivided into subareas, connected by conceptual flow reaches. Design storm rainfall is input to the centroid of each pre defined subarea. Loss parameters are applied to the model depending on the ARI event being studied and are then deducted by RORB with the excess runoff being routed through the conceptual reach network.

The Gardiners Creek catchment was broken up into two areas, the tributary catchments and the Gardiners Creek local catchment; this is shown below in Figure 4-1.

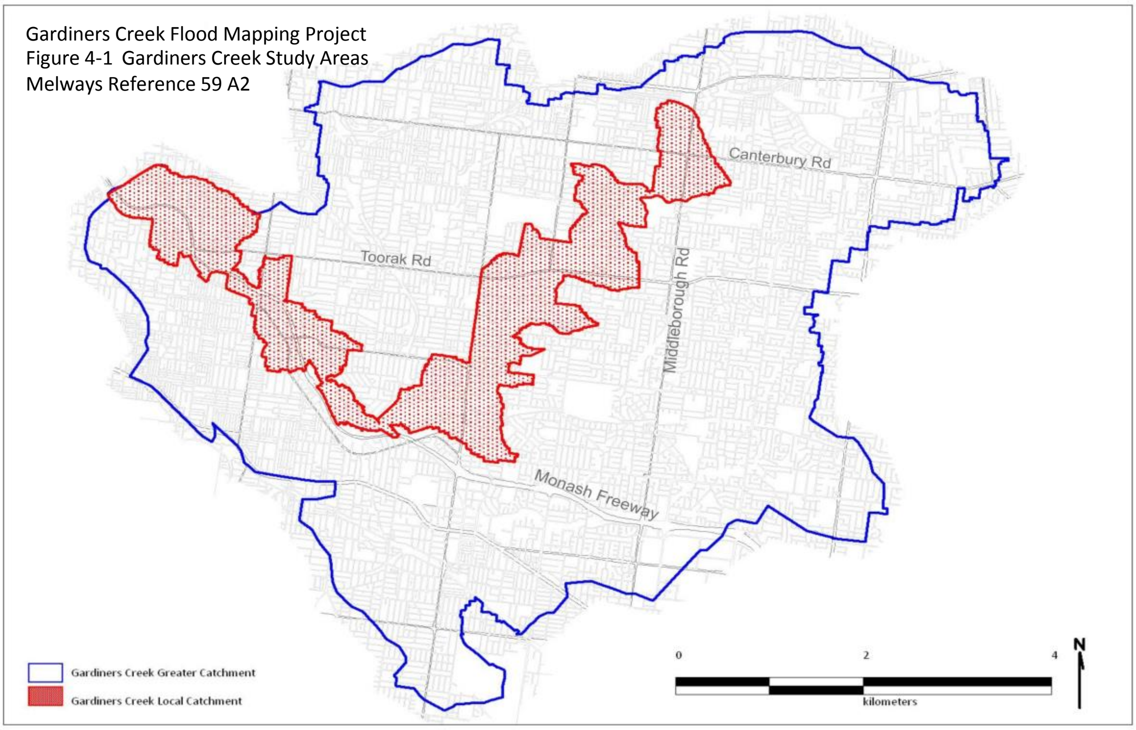

Figure 4-1 Gardiners Creek Study Areas

The RORB model constructed for this study includes new RORB modelling throughout the local catchment area and combines the available RORB models from past RSS and flood mapping projects for the tributary catchments. All models from the greater catchment area have been assumed to be correct and valid for use. The final RORB model provides flow hydrographs for input to the hydraulic model.

4.2 Existing Tributary Catchment RORB Models

RORB models from past RSS and Flood Mapping projects for tributary catchments to Gardiners Creek were adopted. To prepare the existing RORB models to be combined together and combined with the new Gardiners Creek RORB model, some minor changes were made as listed below:

- 'Print' locations were removed leaving calibration point locations remaining;

- Some of the remaining 'Print' locations were renamed to give clearer definition (ie from 'Outlet to Gardiners Ck' to 'Murrumbeena MD Outlet to Gardiners Ck'); and,
- All diversions were renamed from DIV100, DIV200, etc to DIV100xxxx, DIV200xxxx where 'xxxx' represents the catchment number of that RORB model. RORB does not allow multiple diversions to exist with the same name.

It was found that subarea identifiers (ie A,B,C,etc.) did not require amendment as RORBGUI (available in RORBWinv6.0) reads nodes by node numbers, not letters. When a RORB file is exported from RORBGUI, the program reassigns node numbers based on the calculation order for the catchment.

4.3 Local RORB Model Development

4.3.1 Overview

This section details the construction of a Gardiners Creek RORB model. The objective of the RORB model was to assess the flow contribution to Gardiners Creek from the local catchments and combine these with the flows from existing tributary catchment RORB models. The following methodology was applied to build the RORB model.

- Split the Gardiners Creek local catchment into smaller catchments which will form the basis for the RORB models calibrated within the local catchment (total of 45 RORB models created);
- Further divide the catchments to form a minimum of 5 sub-catchments upstream of any inflow location to the hydraulic model;
- Construct undiverted RORB models for 10 of the 45 sub-catchments;
- Reconcile the 10 undiverted RORB models to the Rational Method;
- Derive a k_c vs area relationship for the remaining 35 catchments;
- Check the relationship on a further 4 catchments;
- Create undiverted RORB models for remaining 35 catchments and employ the k_c vs area relationship to evaluate k_c ;
- Combine the 45 new RORB models that cover the local catchment area with the existing tributary RORB models supplied by Melbourne Water into one final RORB model.

Further details of the RORB model construction and inputs are detailed in the following sections.

4.3.2 Local Catchment RORB Model Structure

The local catchment spans an area of approximately 1542 ha. The local catchment was broken up into 45 RORB models. The sub-catchment breakdown within each RORB model is shown in Figure 4-2. Each of the 45 catchments was further delineated into 5 or more sub-areas. The local catchment boundaries were edge matched to the current edge matched boundaries provided by Melbourne Water. Where an edge matched boundary was unavailable, the local catchment boundary was edge matched to properties.

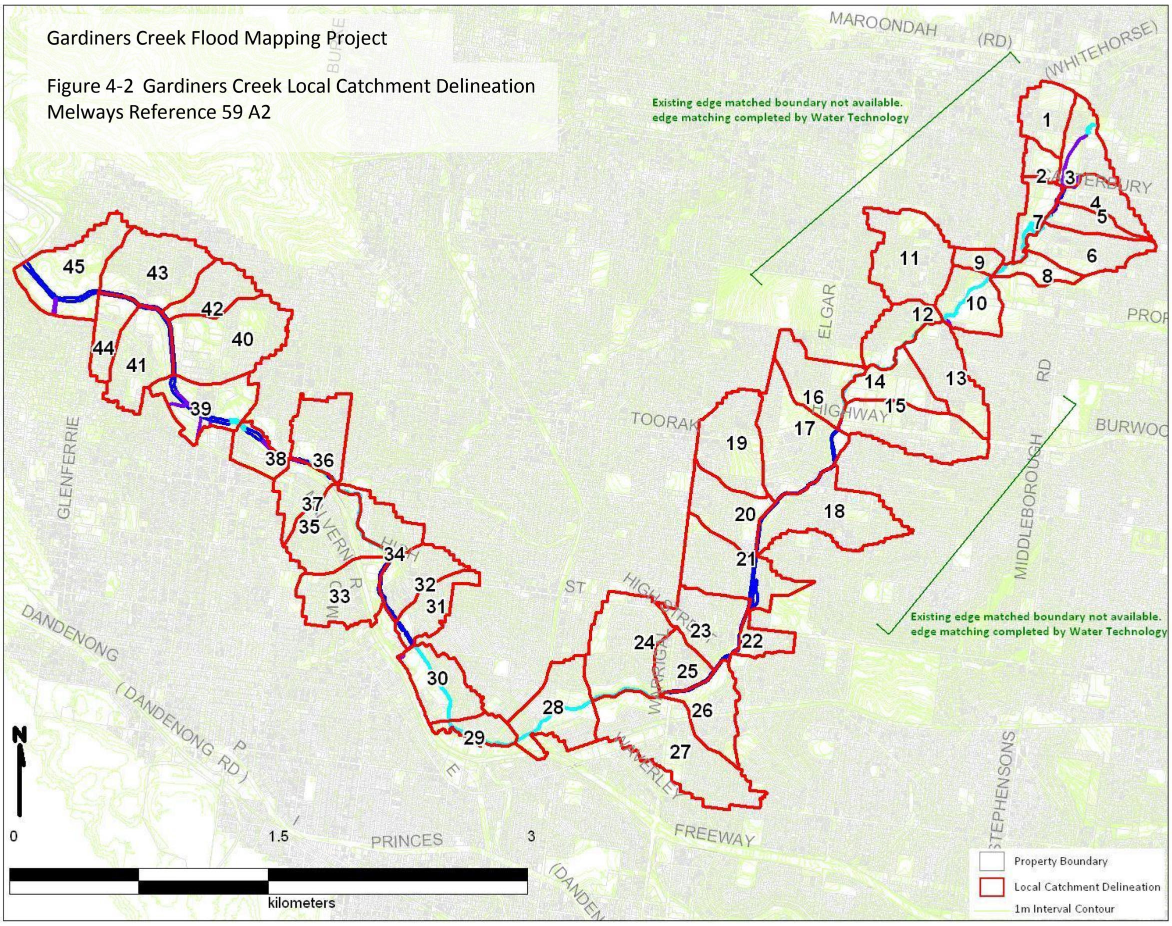

Figure 4-2 Gardiners Creek Local Catchment Delineation

4.3.3 Impervious Fraction

Impervious fractions in the local catchment area were developed from the results provided by Melbourne Water from the 'fraction impervious calculator'. Fraction impervious data for the existing RORB models in the tributary catchments were adopted from previous the studies.

4.4 Local Catchment RORB Model Reconciliation

4.4.1 Overview

The reconciliation process involved selecting a number of sub-catchments, building individual RORB models for each sub-catchment and then reconciling the undiverted RORB models to the Rational Method.

A total of 10 out of the 45 local sub-catchments were selected to give a good representation of the entire local catchment. The 10 sub-catchments were selected for reconciliation based on a sampling method which accounted for slopes, areas and fraction impervious values. The sampling method involved each parameter (area, fraction impervious and slope) being scored from 1 to 45; with 1 representing the highest ranked sub-catchment and 45 the lowest ranked in each category. The scores were summed for each sub-catchment and compared against the spatial distribution to then manually select the sub-catchments with the aim of selecting a good range of high, medium and low scoring catchments with a reasonable spatial distribution. The sub-catchments selected for reconciliation are shown highlighted in green in Table 4-1 below. Figure 4-3 displays the spatial location of the selected sub-catchments.

Table 4-1 Method of Sampling and List of Sub-catchments Selected for Reconciliation

Sub-catchment Number	Area	Area Rank	Fraction Impervious	FI Rank	Slope (%)	Slope Rank	Sum
1	25.37	29	0.52	7	3.7	31	67
2	9.51	43	0.39	18	3.7	30	91
3	26.86	26	0.35	21	3.0	35	82
4	19.58	35	0.49	10	4.2	26	71
5	16.39	38	0.56	4	4.0	27	69
6	33.45	22	0.56	4	3.8	29	55
7	16.63	36	0.46	12	3.1	34	82
8	12.50	41	0.75	1	3.3	33	75
9	8.56	44	0.51	8	8.2	3	55
10	29.43	24	0.54	5	3.9	28	57
11	54.86	8	0.46	12	5.2	13	33
12	25.79	27	0.37	19	10.9	1	47
13	22.57	32	0.42	15	4.7	18	65
14	50.69	11	0.49	10	3.6	32	53
15	51.10	10	0.52	7	4.2	25	42
16	29.31	25	0.46	12	5.4	11	48
17	58.48	6	0.52	7	3.9	28	41
18	57.53	7	0.51	8	5.8	10	25
19	48.21	13	0.57	3	3.9	28	44
20	34.01	21	0.41	16	4.8	17	54
21	49.11	12	0.45	13	6.2	7	32
22	12.19	42	0.41	16	4.3	24	82
23	36.87	18	0.46	12	9.3	2	32
24	59.57	5	0.37	19	4.7	20	44
25	21.42	33	0.45	13	7.3	5	51
26	32.26	23	0.34	22	4.7	19	64
27	79.06	1	0.48	11	3.0	35	47
28	45.83	14	0.34	22	3.0	35	71
29	14.21	39	0.36	20	8.1	4	63
30	34.21	20	0.3	23	5.9	8	51
31	23.48	31	0.39	18	5.3	12	61
32	75.08	2	0.44	14	5.9	9	25
33	34.98	19	0.42	15	4.6	21	55
34	75.08	2	0.37	19	6.2	7	28
35	25.27	30	0.46	12	4.5	22	64
36	41.83	15	0.41	16	4.8	17	48
37	13.51	40	0.53	6	4.9	16	62
38	16.45	37	0.45	13	1.3	36	86
39	37.69	17	0.5	9	5.0	15	41
40	64.89	3	0.49	10	5.2	14	27
41	40.96	16	0.4	17	4.3	23	56
42	25.54	28	0.46	12	5.4	11	51
43	53.23	9	0.41	16	6.3	6	31
44	20.71	34	0.42	15	5.8	10	59
45	60.58	4	0.58	2	5.0	15	21

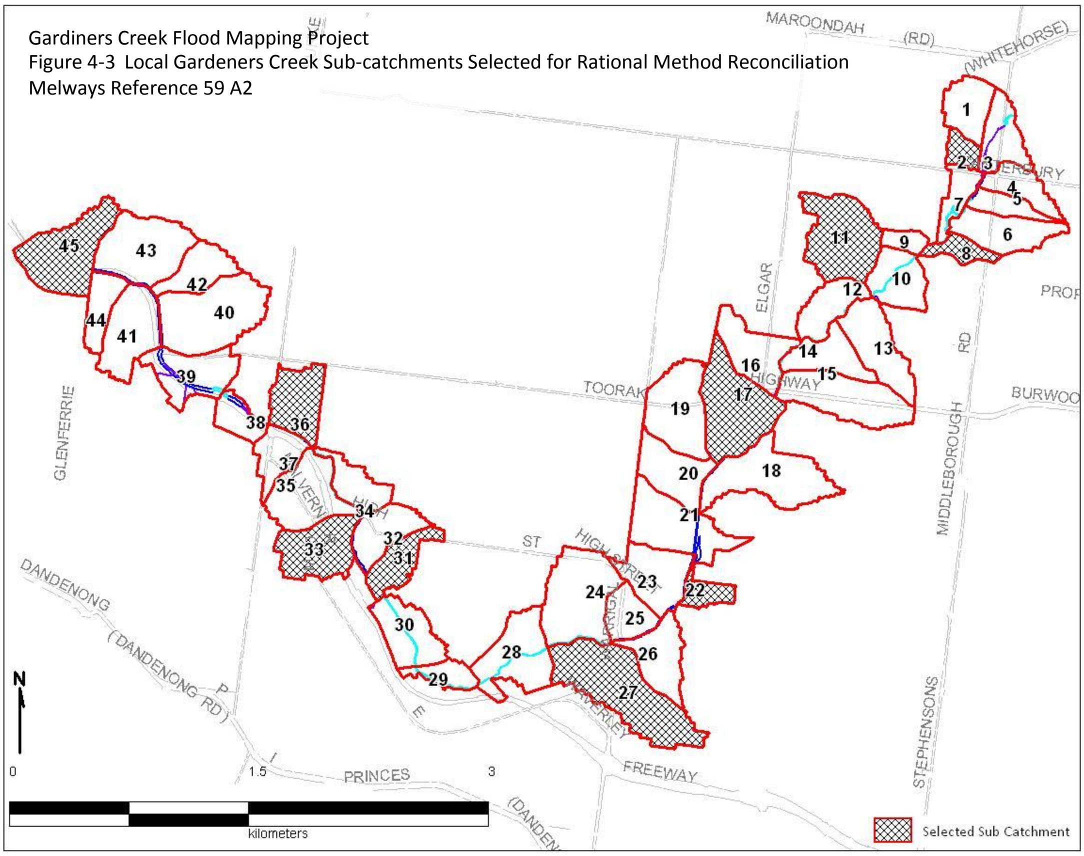

Figure 4-3 Local Gardeners Creek Sub-catchments Selected for Rational Method Reconciliation

4.4.2 Rational Method Calculation

The main purpose of the undiverted RORB model was to select appropriate design parameters by reconciling the RORB peak flows with the peak flow estimates of the 100 year ARI flow from a Rational Method calculation. For this reason the undiverted RORB model was developed to be equivalent to the assumptions made by the Rational Method, i.e. no diversions and no significant storages (e.g. retarding basins).

The Rational Method was applied to the selected sub-catchments to obtain a 100 year ARI peak flow estimate. The objective was to find a relationship between all the selected sub-catchments when reconciled to the Rational Method. The Rational Method calculation was carried out in accordance with the methodology outlined in Book 2 of Australian Rainfall and Runoff (*IEAust, 1997*) and the Melbourne Water Technical Specifications and Requirements (MWC, 2009a). Further details of the Rational Method calculation are provided below.

4.4.2.1 Tc Calculation

The time of concentration was estimated by applying a nominal velocity over the branch with the longest travel time. A velocity of 1.5 m/s was adopted for the catchments which had an average slope of less than 5% whereas catchments with an average slope greater than 5% were assigned a velocity of 2.0 m/s. Average slope was calculated with the aid of MiRORB and is based on the available 1m contour data set [1]. Details of the t_c calculation are shown below in Table 4-2.

Table 4-2 Time of Concentration Results

Sub-catchment Number	Length (m)	Average Slope %	Velocity (m/s)	Reach travel time (min)	Initiation time (min)	Tc (min)
2	524	3.7	1.5	5.8	7.00	12.82
8	934	3.3	1.5	10.4	7.00	17.37
11	1176	5.2	2.0	9.8	7.00	16.80
17	1400	3.9	1.5	15.6	7.00	22.56
22	600	4.3	1.5	6.7	7.00	13.67
27	1800	3.0	1.5	20.0	7.00	27.00
31	997	5.3	2.0	8.3	7.00	15.31
33	1076	4.6	1.5	12.0	7.00	18.96
36	963	4.8	1.5	10.7	7.00	17.70
45	1459	5.0	2.0	12.2	7.00	19.16

4.4.2.2 Intensity Frequency Duration (IFD)

Due to the large size of the local catchment, the design rainfall intensities would be expected to vary throughout the catchment. To calculate rainfall intensities, the local catchment was broken up into three separate areas, as illustrated in Figure 4-4. Design rainfall input parameters were generated for each area using the Bureau of Meteorology's IFD Generator (*BOM, 2009*) and AusIFD. The IFD parameters for the three areas are shown in Table 4-3.

[1] At the time of Tc calculation, LiDAR data did not cover the entire catchment and hence the 1m contours were used. Full LiDAR coverage was provided later in the study. It is not thought that the use of LiDAR in the calculation of the Time of Concentration would add a significant amount of additional accuracy when compared to the 1m contours.

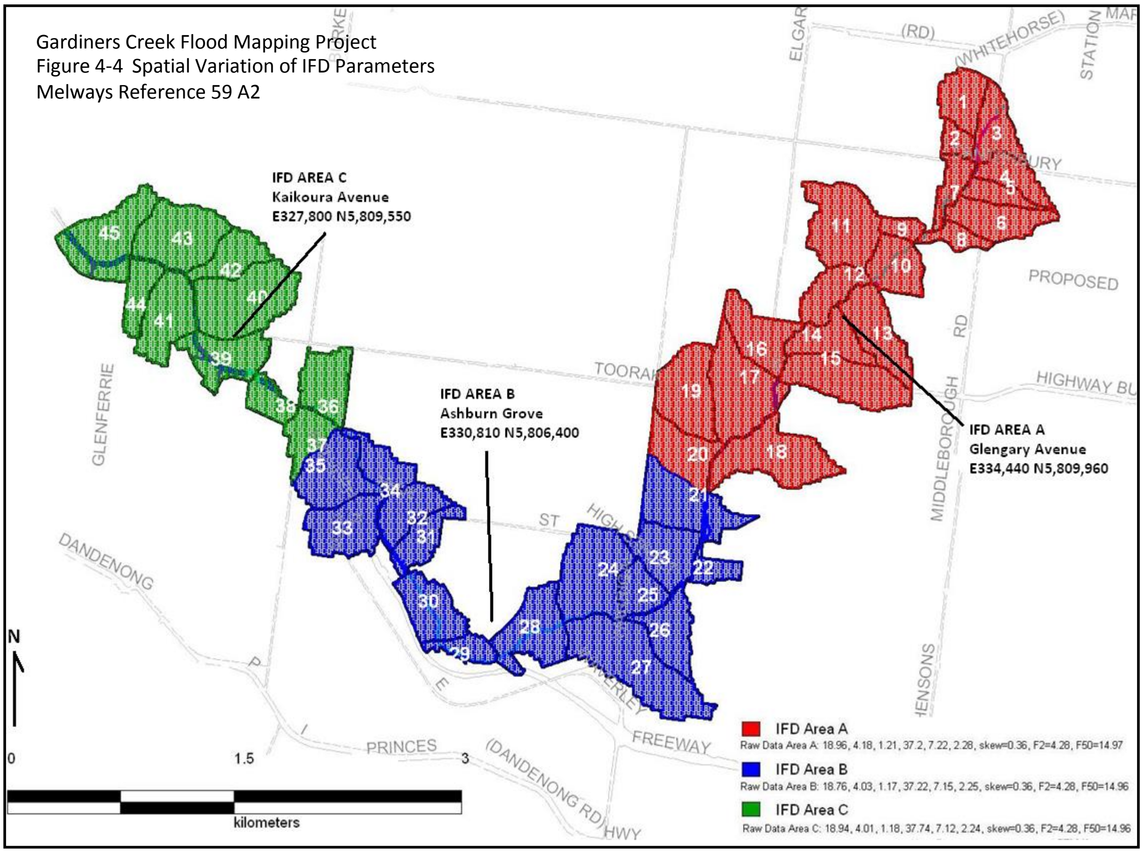

Figure 4-4 Spatial Variation of IFD Parameters

Table 4-3 IFD Parameters for Gardiners Local Catchment

Area	$^{2}I_{1}$	$^{2}I_{12}$	$^{2}I_{72}$	$^{50}I_{1}$	$^{50}I_{12}$	$^{50}I_{72}$	G	F2	F50
A	18.96	4.18	1.21	37.20	7.22	2.28	0.36	4.28	14.97
B	18.76	4.03	1.17	37.22	7.15	2.25	0.36	4.28	14.96
C	18.94	4.01	1.18	37.74	7.12	2.24	0.36	4.28	14.96

4.4.2.3

4.4.2.4 Runoff Coefficient

The runoff coefficient (C_{10}) for each sub-catchment was calculated using the method prescribed in Chapter 14 of Australian Rainfall and Runoff (IEAust, 1987). The results are shown in Table 4-4.

Table 4-4 Runoff Coefficient Calculation

Sub-catchment Number	t_c (mins)	$^{100}I_{tc}$	$^{10}I_{1}$	f	C^{1}_{10}	C_{10}
2	12.8	120.0	27.9	0.39	0.14	0.44
8	17.4	100.0	27.9	0.75	0.14	0.71
11	16.8	103.0	27.9	0.46	0.14	0.49
17	22.6	86.0	27.9	0.52	0.14	0.53
22	13.7	115.0	27.8	0.41	0.14	0.45

27	27.0	76.0	27.8	0.48	0.14	0.50
31	15.3	107.0	27.8	0.39	0.14	0.43
33	19.0	97.0	27.8	0.42	0.14	0.46
36	17.7	101.0	28.2	0.41	0.14	0.45
45	19.2	95.0	28.2	0.58	0.14	0.58

4.4.2.5 Rational Method

A Rational Method analysis was undertaken for the catchment in accordance with the methodology outlined in Book 2 of Australian Rainfall and Runoff (*IEAust, 1997*). The equation is as follows:

$Q_{100} = C.I.A/360$

Where:

- Q_{100} is the flow in m^3/s for the 100 year ARI design event;
- C is the runoff coefficient;
- I is the rainfall intensity specific to the area, corresponding to the t_c (time of concentration of the catchment); and,
- A is the area of the catchment in hectares.

The Rational Method inputs and results for each catchment are presented in Table 4-5.

Table 4-5 Rational Method Calculation

Sub-catchment Number	C	I	A	Q_{100}
2	0.57	120	9.93	1.88
8	0.82	100	12.50	2.86
11	0.61	103	54.86	9.64
17	0.66	86	59.27	9.34
22	0.52	115	12.19	2.03
27	0.58	76	79.06	9.62
31	0.57	107	23.17	3.91
33	0.50	97	40.39	5.48
36	0.60	101	33.08	5.55
45	0.64	95	53.81	9.14

4.4.3 Individual Local Sub-Catchments RORB Model Construction

Individual RORB models were constructed for the ten selected sub-catchments. The undiverted RORB models were constructed using MiRORB in accordance with the Melbourne Water Technical Specifications and Requirements (*MWC, 2009a*). The model reach types were inspected from aerial photography. Natural channel sections and large grassed areas were modelled as 'Type 1 – Natural Reach', while all flows through properties or across roads were modelled as 'Type 2 – Excavated but Unlined Reach' and flows along roads, lined channels or piped sections were modelled as 'Type 3 Lined Channel or Pipe' reaches.

Reaches along Gardiners Creek were modelled as 'Type 5 – Dummy Reach'. A dummy reach in RORB applies no routing to the hydrograph and has the effect of immediately translating the hydrograph to the downstream node. Dummy reaches were used because the purpose of the calibration process was to find a relationship for flows coming from the local catchment into Gardiners Creek, not along Gardiners Creek. Routing along Gardiners Creek will be undertaken using the hydraulic model. Hence, it was important to ensure that flows were not incorrectly routed multiple times over the same flow path.

The RORB models were run using the same spatially varying IFD parameters as applied to the Rational Method. A runoff coefficient of 0.6 and initial loss of 10mm (urban catchment) were used as per the Melbourne Water Technical Specifications and Requirements (*MWC, 2009a*). The other RORB parameters applied were:

- Runoff coefficient model;
- Siriwardena and Weinmann method with Areal Reduction Factor set to 0.0;
- Filtered temporal pattern; and,
- A constant loss factor.

The RORB models were run for the 100 year ARI event for storm durations ranging from 10 minutes to 72 hours. Each RORB model was configured to print hydrographs at the most downstream point of each catchment.

The reconciliation to Rational Method was performed separately for each local catchment RORB model. The k_c value was varied until the peak flow from the RORB model matched the 100 year peak flow of the Rational Method. The reconciled k_c values, corresponding RORB flows and Rational Method flow estimates are shown in Table 4-6.

Table 4-6 100 Year Peak Flows and Kc Values of Selected Sub-catchments

Catchment	Area (ha)	Rational Method Q_{100}	RORB Q_{100}	Peak Duration	k_c
2	9.93	1.88	1.86	15 mins	0.19
8	12.50	2.86	2.87	15 mins	0.42
11	54.86	9.64	9.64	25 mins	0.86
17	59.27	9.34	9.31	25 mins	1.02
22	12.19	2.03	2.05	20 mins	0.30
27	79.06	9.62	9.63	60 mins	0.87
31	23.17	3.91	3.91	20 mins	0.33
33	40.39	5.48	5.51	20 mins	0.70
36	33.08	5.55	5.54	25 mins	0.56
45	53.81	9.14	9.16	20 mins	0.61

4.4.4 Calibration Relationship

RORB can be used to suggest a k_c value based on relationships between k_c and area (i.e. $k_c = \text{constant(a)} * \text{area}^{\text{constant(b)}}$) or a relationship between k_c and d_{av} (i.e. $k_c = \text{constant} * d_{av}$). These suggested relationships are from various studies looking at varied catchment sizes and rainfall patterns.

A k_c vs Area (km^2) graph was plotted to analyse the results in the local catchment. The plot is shown in Figure 4-5. The trend line shows a good relationship between k_c and area. The trend line was used to derive the following relationship between k_c and area.

$Kc = 1.1479 * \text{area}^{0.663}$ ($R^2 = 0.84$): where area is in km^2

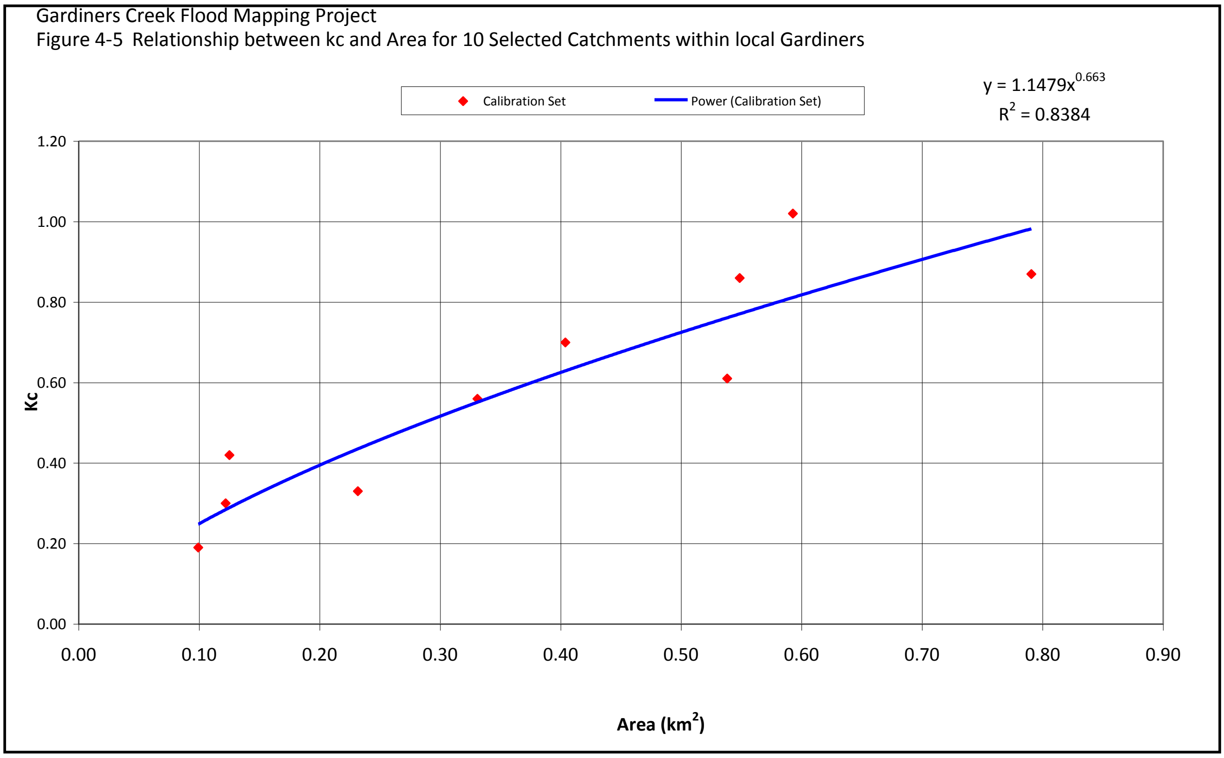

Figure 4-5 Relationship between k_c and Area for 10 Selected Catchments within local Gardiners Creek catchment

To test the applicability of this relationship over the entire local catchment, four new sub-catchments (9, 21, 28 and 42) with varying slope, fraction impervious, spatial location and area were selected. A Rational Method calculation was undertaken for the four sub-catchments, utilising the same parameters from the previous Rational Method calculation.

Undiverted RORB models for sub-catchments 9, 21, 28 and 42 were constructed. The area of each of the four sub-catchments were used to calculate k_c from the k_c : area relationship. The RORB models were run using the k_c values from the relationship as input parameters.

The flows from the Rational Method were compared against the flows from RORB using the kc : area relationship. The results are shown in Table 4-7. Figure 4-6 illustrates the flow comparison between the two model runs. It shows that the RORB flows using the k_c from the relationship are generally very close to the flows calculated in the Rational Method. Catchment 42 and Catchment 28 show a flow increase of 17% and 11% respectively. The remaining catchments all showed a flow reduction below 6%. These results show that the derived relationship is valid for calculating a k_c value for each sub-catchment across the local catchment.

Table 4-7 Comparison of Rational Flow and RORB Peak Flow (Relationship Check)

Catchment	Area (ha)	Rational Q_{100}	RORB Q_{100} (From Rational)	k_c to achieve rational	k_c from relationship	RORB Q_{100} (from Relationship)
9	8.56	2.08	2.09	0.18	0.22	1.96
21	49.11	8.61	8.59	0.67	0.72	8.24
28	45.83	6.00	5.99	0.83	0.68	6.66
42	25.54	5.15	5.15	0.58	0.46	6.03

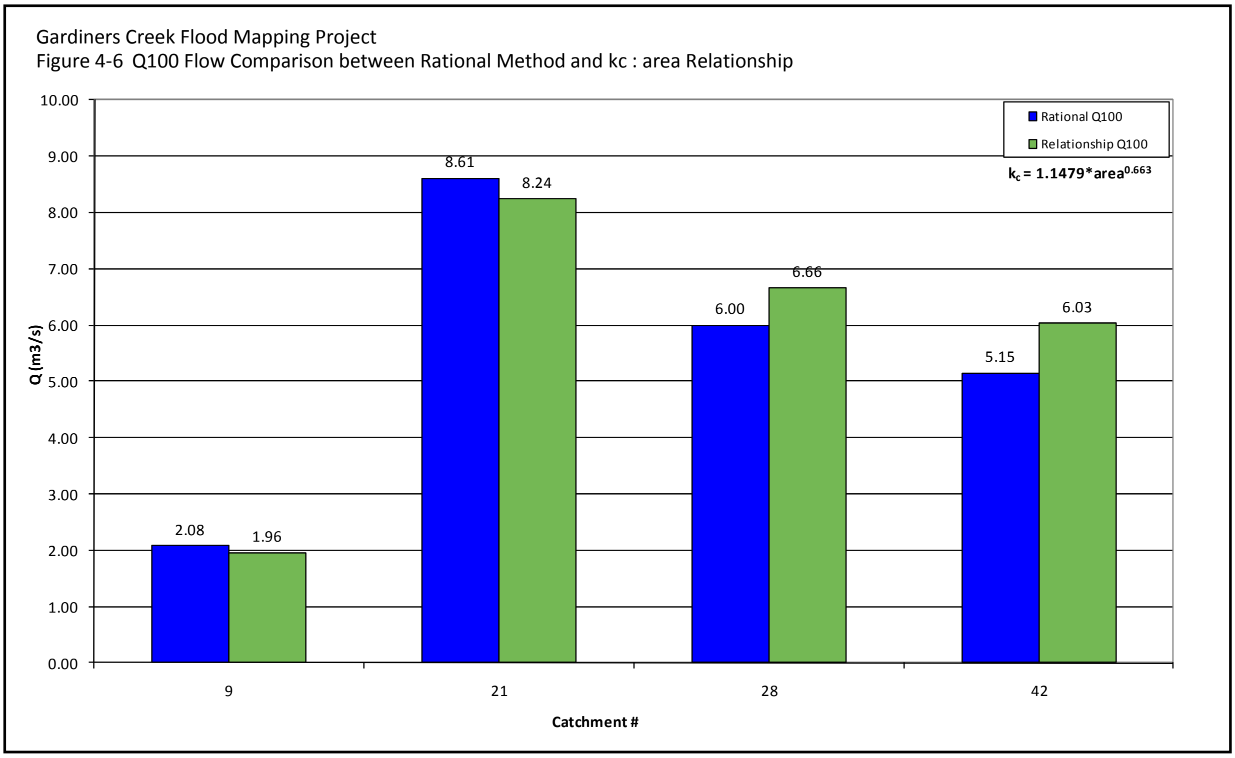

Figure 4-6 Q_{100} Flow Comparison between Rational Method and k_c : area Relationship

The relationship was applied across all 45 catchments within the local catchment to calculate a k_c value. This is shown below in Table 4-8.

Table 4-8 kc Value Derived from kc : Area Relationship across each Catchment

Sub-catchment	Area (km^2)	k_c	Sub-catchment	Area (km^2)	k_c	Sub-catchment	Area (km^2)	k_c
1	0.25	0.46	**16**	0.29	0.51	**31**	0.23	0.43
2	0.10	0.25	**17**	0.58	0.80	**32**	0.75	0.95
3	0.27	0.48	**18**	0.58	0.80	**33**	0.35	0.57
4	0.20	0.39	**19**	0.48	0.71	**34**	0.75	0.95
5	0.16	0.34	**20**	0.34	0.56	**35**	0.25	0.46
6	0.33	0.55	**21**	0.49	0.72	**36**	0.42	0.65
7	0.17	0.35	**22**	0.12	0.28	**37**	0.14	0.31
8	0.13	0.30	**23**	0.37	0.59	**38**	0.16	0.34
9	0.09	0.23	**24**	0.60	0.82	**39**	0.38	0.60
10	0.29	0.51	**25**	0.21	0.41	**40**	0.65	0.86
11	0.55	0.77	**26**	0.32	0.54	**41**	0.41	0.64
12	0.26	0.47	**27**	0.79	0.98	**42**	0.26	0.47
13	0.23	0.43	**28**	0.46	0.69	**43**	0.53	0.75
14	0.51	0.73	**29**	0.14	0.31	**44**	0.21	0.41
15	0.51	0.73	**30**	0.34	0.56	**45**	0.61	0.83

4.4.5 Local Catchment RORB Model Construction

The local catchment RORB model is made up of Gardiners Creek and 45 tributary subcatchments. The local catchment RORB model was constructed using MiRORB, RORB GUI and RORBWIN V6.1

Beta. The Beta version of RORB was used to facilitate the large size of Gardiners Greater Catchment model[2].

The reaches within the tributary subcatchments were set to be consistent with previous studies. Gardiners Creek itself was set to natural, excavated unlined or piped reaches depending on the location and modelled as a branch with 45 junction nodes to allow inflows from the local subcatchments. Dummy reaches were also used to link the subcatchments to the main branch (Gardiners Creek). The utilization of dummy reaches allows print locations to be specified at the downstream end of each subcatchment without counting flows upstream of the creek. This allows print locations to be specified for the hydraulic model. Each subcatchment is divided up into 5 or more subareas. The following reach arrangements were used to represent the two types of subcatchments present in the local model:

- Subcatchments with Gardiners Creek running through (Catchment A). Dummy reaches were used to link the subareas together and outfall at one location along Gardiners Creek. Visually, these dummy reaches are shown parallel to the main branch (Gardiners Creek).A dummy reach is used to connect the farthest downstream subarea to the main branch.
- Subcatchments which outlet into Gardiners Creek at one location (Catchment B). The subareas are linked via reach types 1, 2 or 3 and outfall into Gardiners Creek at the downstream end of the catchment. A dummy reach is used to connect the farthest downstream subarea to the main branch.

4.5 Tributary and local RORB models combination

A single RORB model combining Gardiners Creek Local Catchment and Gardiners Creek Tributary Catchments was constructed to provide inflows into the hydraulic model. The constructed model is a diverted existing RORB model made up of 1,146 subareas (239 subareas in the local catchment and 907 subareas over the 20 tributary catchments).

The combined RORB model was constructed using MiRORB, RORB GUI and RORBWIN V6.15. Figure 4-7 below shows the schematisation of the final RORB model created for Gardiners Creek.

[2] The RORBWIN V6.1 BETA version was later released officially as RORBWIN V6.15 – All models were re-run in v6.15 to ensure consistency.

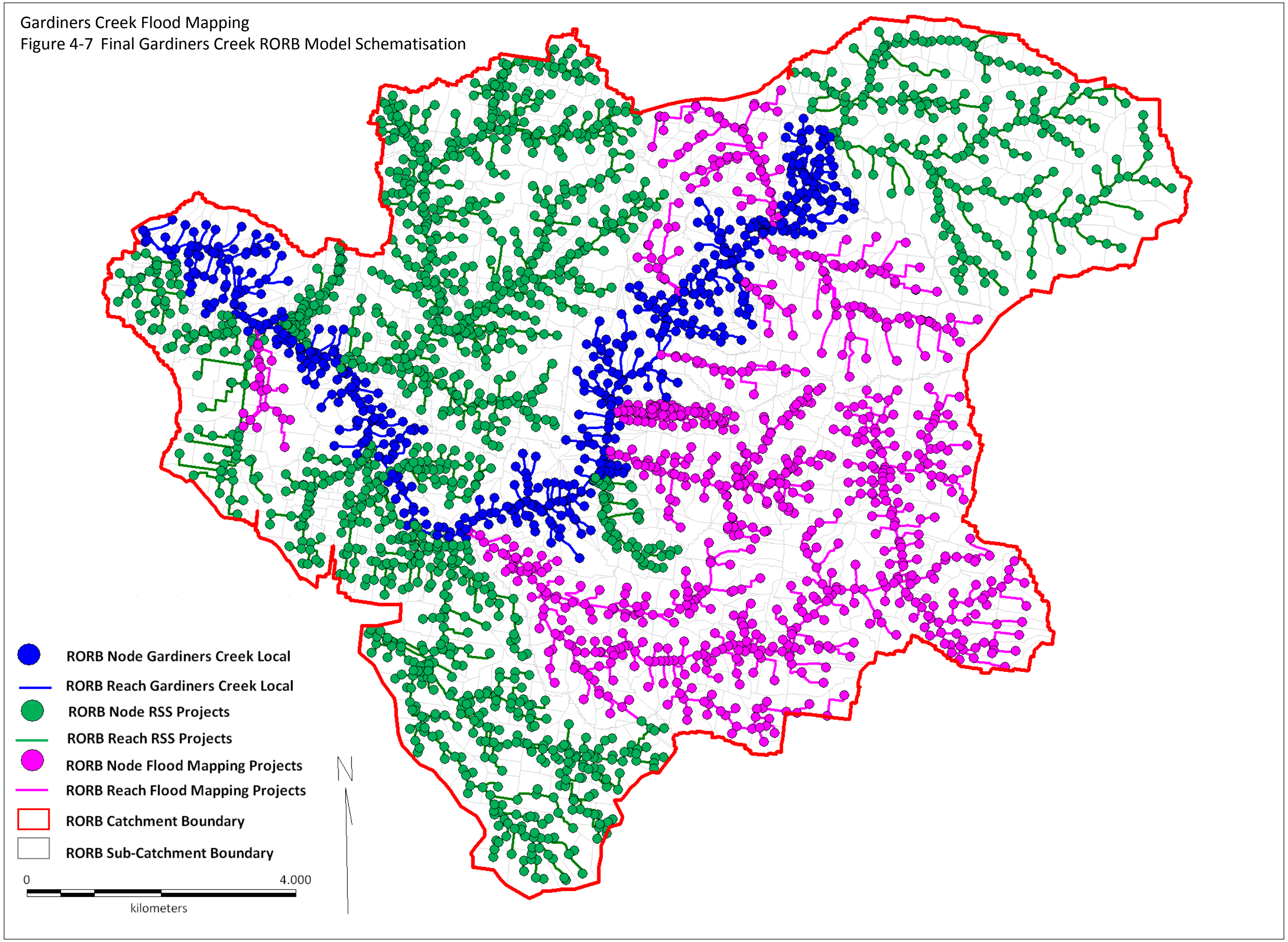

Figure 4-7 Final Gardiners Creek RORB Model Schematisation

4.6 RORB Model Calibration

4.6.1 Overview

The calibration of the RORB model requires the comparison of the modelled flood hydrographs from the RORB model with the observed flood hydrographs at streamflow gauge(s) throughout the catchment. The selection of suitable dates for RORB model calibration relied on the availability of concurrent streamflow and pluviographic rainfall data.

The focus of the RORB model calibration was the determination of a kc value for the Gardiners Creek main channel.

4.6.2 RORB Model calibration event data

The RORB model calibration was carried out for five storm events, four of which were used in the previous study. Table 4-9 details the selected calibration events.

Table 4-9 RORB Model Calibration Events

Event	Event Start & Finish Date	Average Total Catchment Rainfall (mm)	Recorded Peak Flow	Rank of Peak Flow in Record (32 years)
24 December 1978	9 pm 24/12/1978 - 1 pm 25/12/1978	39.8	151.0	6
25 December 1978	5.24 pm 25/12/1978 - 7.24 am 26/12/1978	31.9	189.7	3
17 September 1984	9 am 17/9/1984 - 12 am 19/9/1984	91.3	194.5	1
2 December 2003	3 pm 2/12/2003 - 10 am 3/12/2003	62.8	92.7	13
2 February 2005	4 am 2/2/2005 - 10 am 5/2/2005	142.6	150.8	5

There are eight streamflow gauges located within Gardiners Creek Catchment. Details of the stream flow gauges are shown in Table 4-10. The streamflow data from all eight gauges were assessed to determine its reliability for use in the RORB calibration. Streamflow data at the retarding basins was especially poor due to a lack of any accurate stage discharge rating curves and potential blockage of outlets. The 'Gardiners Creek at Ashwood' was also considered for use but was dismissed as the data for all the events in question was found to be unreliable. 'Gardiners Creek at Gardiners' was found to be the only gauge with a reliable record of streamflow data, suitable for use in the RORB model calibration. 'Gardiners Creek at Gardiners' is located just downstream of the Back Creek confluence, some 20 m upstream of the Great Valley Road bridge.

Table 4-10 Stream Gauge Locations and Period of Record

Gauge No.	Station Name	Period of Record
229625	Gardiners Creek at Ashwood	January 1978 to present
229624	Gardiners Creek at Gardiner	January 1978 to present
229635	Lake Rd Retarding Basin August	1977 to present
229636	Kinkora Rd Retarding Basin	April 1977 to present
229637	Gardiners Creek at Middleborough Rd Retarding Basin	April 1977 to present

229638	Eley Rd Retarding Basin August	1977 to present
229640	Scotchman's Creek at Huntingdale Rd Retarding Basin	April 1977 to present
229639	Waverly Rd Retarding Basin	August 1977 to present

For the 1978, 1984 and 2003 flood events, daily rainfall data was obtained from the ten rainfall stations around Gardiners Creek catchment as per the previous study (Water Technology, 2004). This data however, only extends up to 2003 and does not cover the 2005 event. As such, new rainfall data corresponding to the 2005 flood event was requested from Melbourne Water. Upon review of the Surrey Hills station, it was found that rainfall data was missing through the 2005 rainfall event. This station was consequently removed from the data set. The gauge locations utilised for this study include:

- 37 Evelina Street Box Hill
- Ashwood
- Burnley
- Burwood Presbyterian College
- Caulfield North
- Cornwall Street Retarding Basin
- Eley Road Retarding Basin
- Gardiner
- Gardiners Bowling Club
- Glen Valley Road Retarding Basin
- Huntingdale Retarding Basin
- Kinkora Road Retarding Basin
- Lernes Street Retarding Basin
- Masons Road Retarding Basin
- Micham
- Middleborough Road Retarding Basin
- Mitcham
- Notting Hill
- Surrey Hills[3]

The rainfall depth for each subarea was estimated using storm event rainfall isohyets. The rainfall isohyets were created for all six storm events using the pluviograph and daily rainfall station data. Figure 4-8 below shows the rainfall isohyets across the Gardiners Creek catchment for the 1984 rainfall event. For this event, the highest rainfall totals occurred between the Cornwall Street Retarding Basin and Eley Road Retarding Basin areas in the upper reaches of the Gardiners Creek Catchment.

[3] Surrey Hills removed from data set due to missing rainfall information over the 2005 event

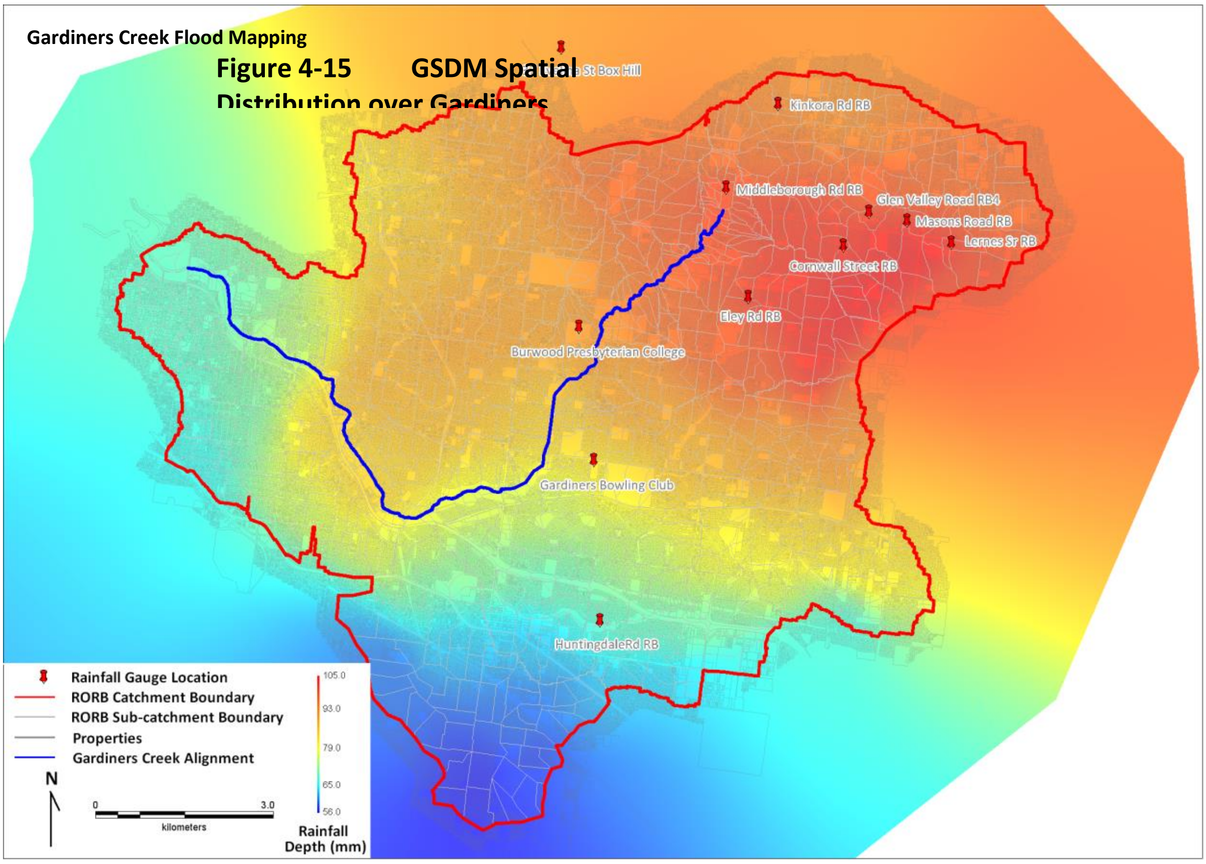

Figure 4-8 Example Rainfall Isohyets across the Gardiners Creek Catchment (1984 event)

4.6.3 RORB Model Parameter Calibration

There are two RORB model parameters requiring calibration (kc and m). The calibration approach followed for this study was as follows:

- Set m= 0.80. This value is an acceptable value for the degree of non-linearity of catchment response (Australian Rainfall and Runoff, 1987).
- For each calibration event, the initial loss (IL) was determined by finding a reasonable match between the observed rising limb of the flood hydrograph. The IL remained constant throughout the 79 interstation areas within the model.
- For each calibration event, the runoff co-efficient (RoC) was determined through matching the modelled and observed runoff volume. The RoC remained constant throughout the 79 interstation areas within the model.
- For each calibration event, the kc values in all tributary and local catchments were adopted from previous studies (tributary catchments) or kc:area relationships (local catchments). The kc value of the Gardiners Creek routing was varied to achieve a reasonable re-production of the peak flow and general hydrograph shape. The kc value along Gardiners Creek represents the routing of flows along Gardiners Creek itself and does not represent any catchment travel time. It was hence expected that the kc value for Gardiners Creek would be quite low.

A summary of calibration results are provided in Table 4-11. The runoff co-efficients shown apply to pervious areas only.

Table 4-11 RORB Model Calibration Parameters

Event	kc	IL	RoC	Peak Flow m^3/s		Volume m^3	
				Observed	Modelled	Observed	Modelled
24 December, 1978	0.30	17	0.10	151	155	1,388,534	1,357,492
25 December, 1978	0.40	15	0.40	190	202	1,965,585	1,977,233
17 September, 1984	0.40	0	0.40	195	197	5,324,670	5,620,249
2 December, 2003	0.60	25	0.05	93	96	3,361,810	3,320,695
2 February, 2005	0.35	45	0.20	150	143	6,151,618	6,688,353

Figure 4-9 to Figure 4-13 displays the modelled and observed flood hydrographs for the calibration events at the Gardiner gauge and cumulative rainfall totals for the event.

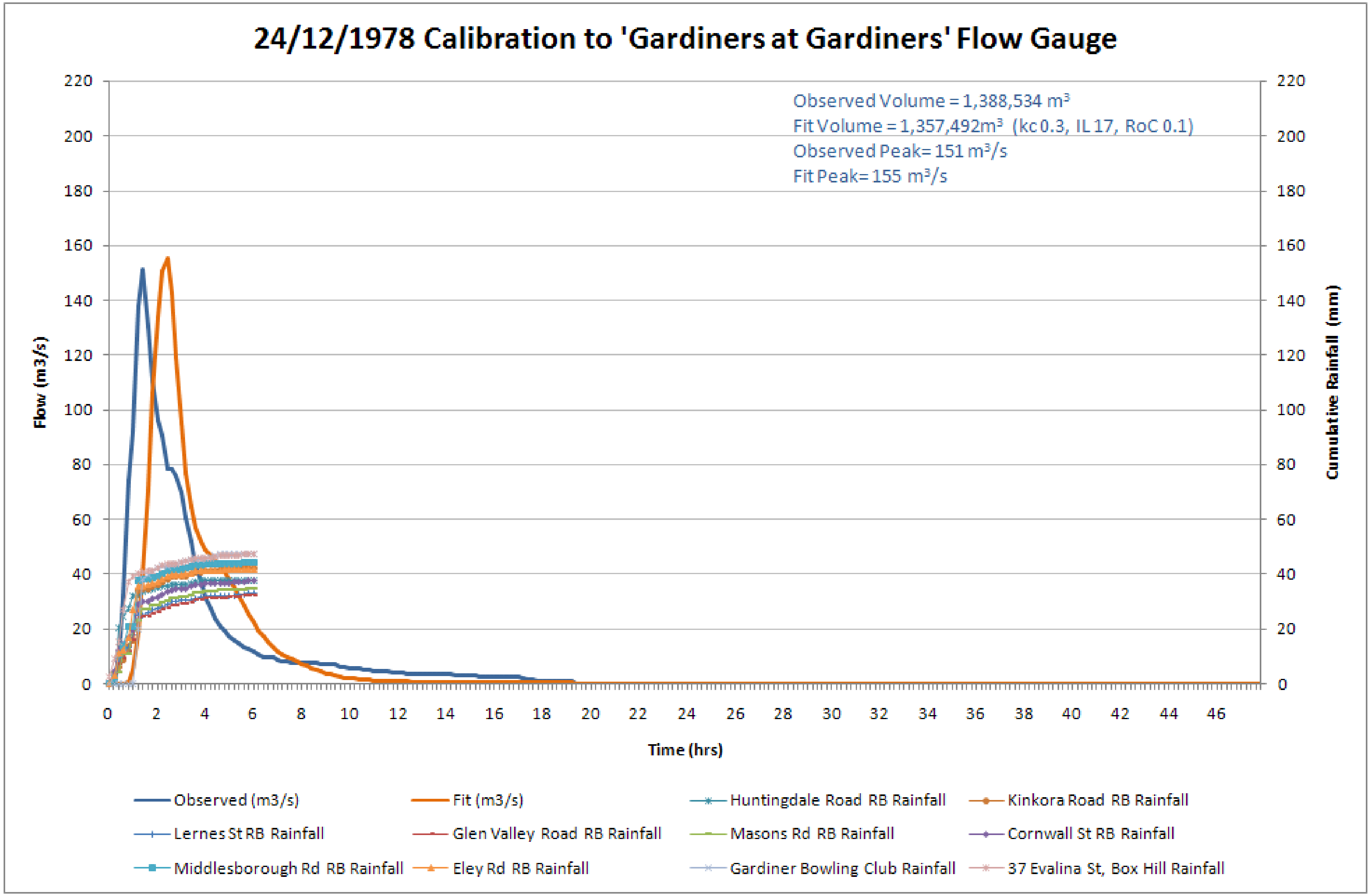

Figure 4-9 RORB Calibration – Gardiners at Gardiners Creek Flow Gauge 24th December 1978

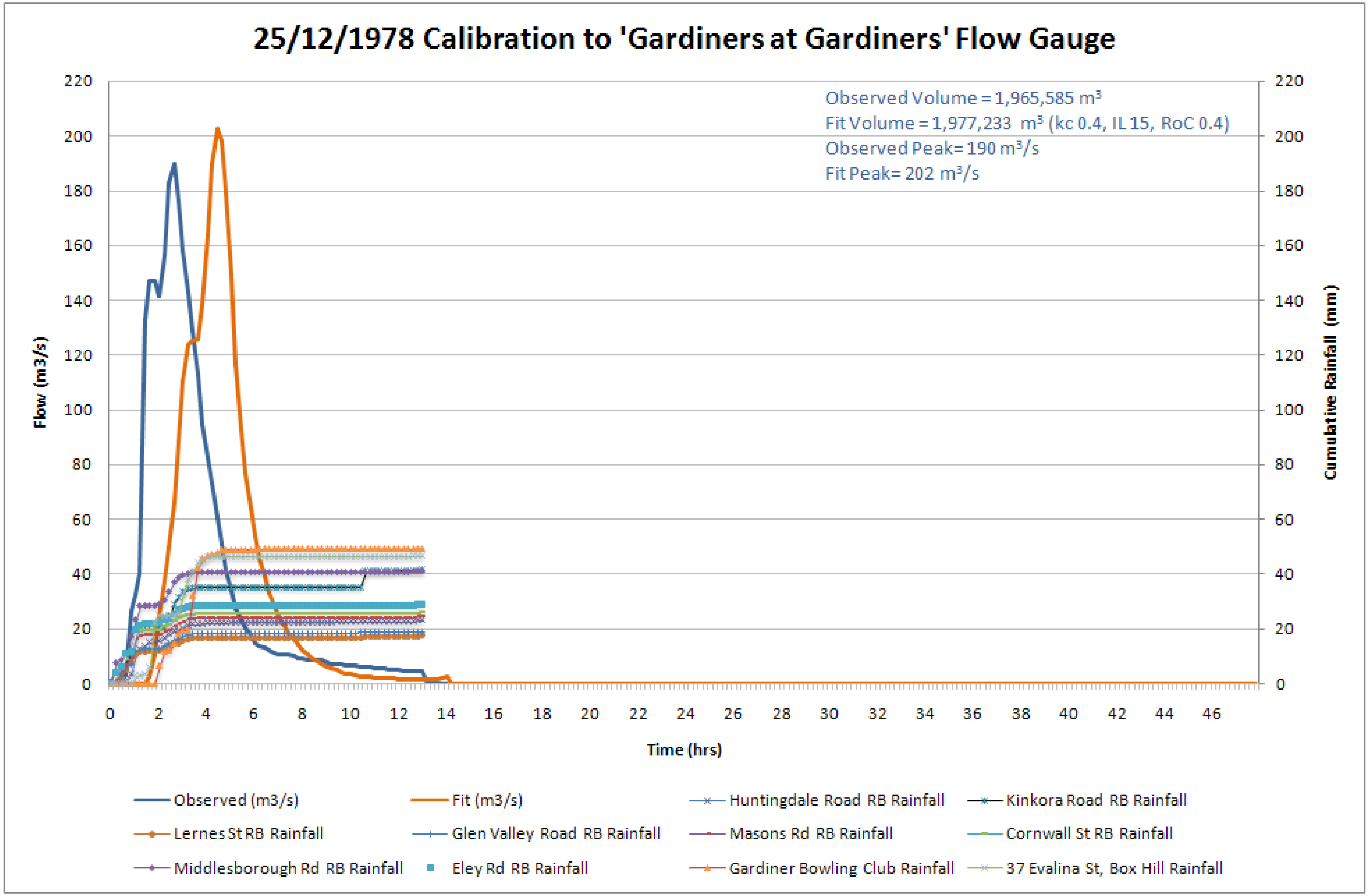

Figure 4-10 **RORB Calibration – Gardiners at Gardiners Creek Flow Gauge 25th December 1978**

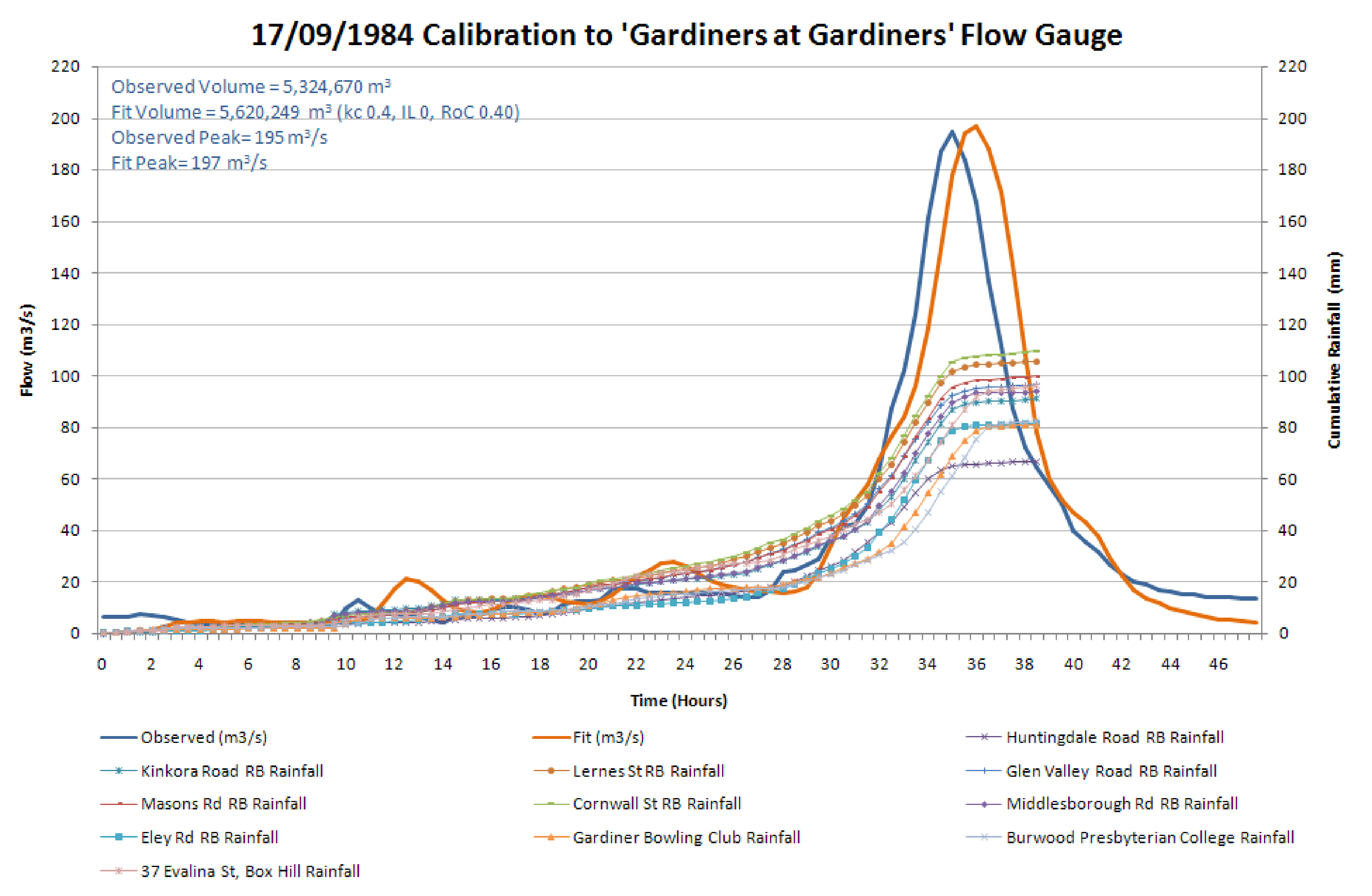

Figure 4-11 RORB Calibration – Gardiners at Gardiners Creek Flow Gauge 17th September 1984

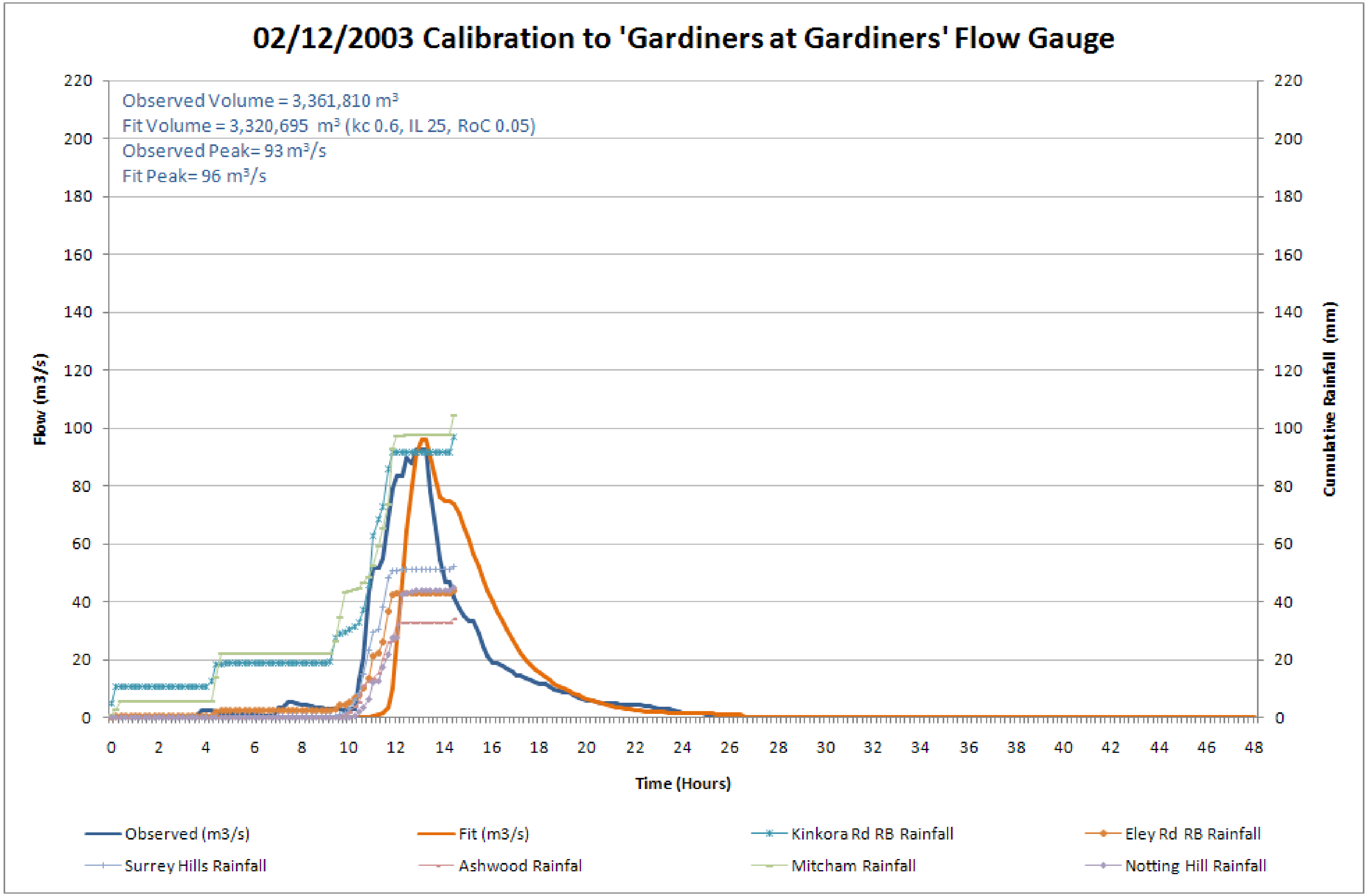

Figure 4-12 RORB Calibration – Gardiners at Gardiners Creek Flow Gauge 2nd December 2003

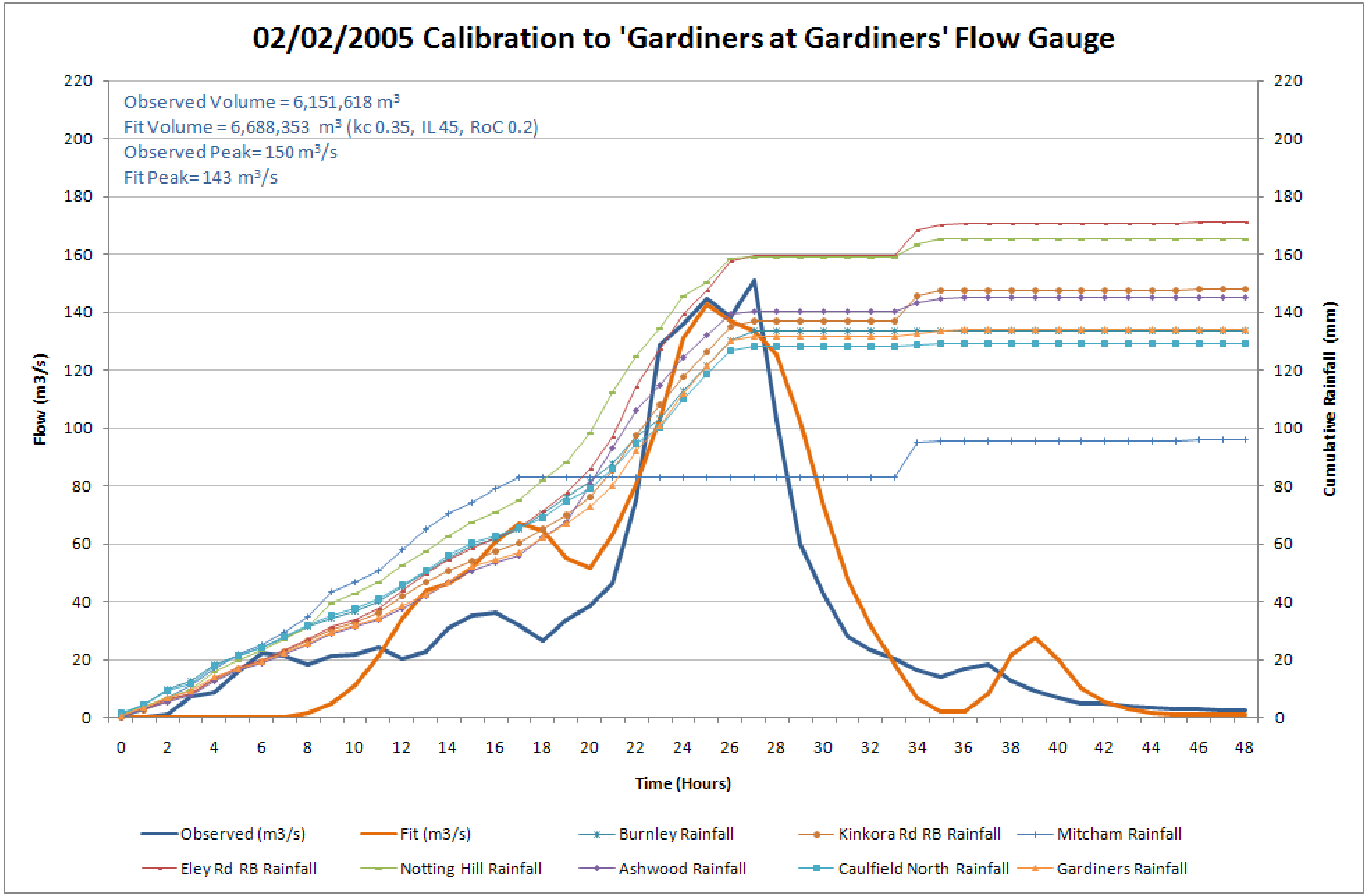

Figure 4-13 RORB Calibration – Gardiners at Gardiners Creek Flow Gauge 2nd February 2005

4.6.4 Discussion

Fits between the observed and modelled hydrographs for all events were considered good. The two 1978 events and the 1984 event showed a lag of approximately 2 hours between the observed and the modelled hydrographs. These time lags may possibly be solved through amending the application of temporal patterns from pluviograph stations to individual RORB sub-areas. As the rising and receding limbs of the hydrographs, the total hydrograph volume and the peaks match well on these events, it is not thought that the timing will influence the hydraulic modelling.

The event of the 25 December 1978 shows a good match in hydrograph shape and volume, with a $12m^3/s$ variation between the peak flows (observed $190m^3/s$, fit $202m^3/s$). Attempts were made to reduce the peak to match the observed hydrograph by increasing the kc value and varying the RoC. Due to the sensitivity of the hydrograph to both parameters, a balance was found between a reasonable kc and RoC, while trying to maintain the shape and volume of the fit hydrograph.

The critical storm events for the Gardiners Creek catchment are considered to be thunderstorms rather than the prolonged rainfall events associated with fronts. By their nature, thunderstorms tend to result in highly varying spatial and temporal patterns across the catchment. The variation of the temporal and spatial rainfall may not be reflected in available pluviographic and daily rainfall data.

Table 4-12 below shows the range of kc values used across the five storm events to achieve a suitable match to the observed hydrographs. A single kc value is required for use in the design flood modelling. A peak flow weighted average of kc values was evaluated at 0.40. A kc value of 0.40 was found to provide a reasonable match between the observed and the modelled hydrographs across all events.

Table 4-12 kc Values from the model calibration

Event	kc
24 December 1978	0.30
25 December 1978	0.40
17 September 1984	0.40
2 December 2003	0.60
2 February 2005	0.35

Initial loss (IL) and RoC values varied across the 5 fit events. The IL and RoC values required to find a suitable fit varied between the models and can be attributed to catchment conditions on the day of the event, the representativeness of the applied fraction impervious values across the catchment to the time of the event and the accuracy of both the flow and rainfall gauges. Table 4-13 shows the adopted IL and RoC coefficients for each event.

Table 4-13 IL and RoC Values from the model calibration

Event	IL	RoC	Observed Peak Flow (m^3/s)
24 December 1978	17	0.10	151
25 December 1978	15	0.40	190
17 September 1984	0	0.40	195
2 December 2003	25	0.05	93
2 February 2005	45	0.20	150

4.7 Design Events Modelling Methodology

The goal of the RORB model design runs is to provide design flow hydrographs for a range of durations, catchment scenarios and events for input to the MIKE 11 hydraulic model. While the focus is on providing robust design flows for input to the MIKE11 hydraulic model, it is also a consideration to maintain consistency between this study's RORB model and the individual previous RORB models.

4.7.1 k_c Values – RORB Routing Parameter

In order to maintain consistency between this study's RORB model and the previous RSS and FM&M RORB models, k_c values were maintained from the previous RSS and FM&M models. k_c values along the Gardiners Creek local models were set to the k_c: area relationship developed for this project as shown in Section 4.4.

The k_c parameter for the routing along Gardiners Creek was set to 0.40. This k_c was selected using a peak flow weighted average (preference given to larger events) of k_c values evaluated in the RORB model calibration (5 events). k_c values in the calibration ranged from 0.30 to 0.60 as shown below in Table 4-14.

Table 4-14 kc Value averaging method for Gardiners Creek model

Event	kc
24 December 1978	0.3
25 December 1978	0.4
17 September 1984	0.4
2 December 2003	0.6
2 February 2005	0.35
Average	**0.4**

4.7.2 Spatial Rainfall Patterns

Examination of the observed historical rainfall events showed considerable spatial variation across the Gardiners Creek catchment.

To maintain consistency between the Gardiners Creek RORB model and the previous RSS and FM&M RORB models, the following approach was used to apply the design rainfall depths:

- IFD parameters for each of the 20 tributary models were adopted from the previous RSS and FM&M studies.
- A rainfall depth for each of the tributary catchments was calculated through 'AUS-IFD' using the 9 IFD parameters from the previous studies.
- Sub-areas within each tributary catchment were assigned the rainfall depth for its corresponding tributary catchment.
- The local Gardiners Catchment was split into 3 IFD areas as per the local model reconciliation (see Section 4.4) with rainfall depths applied to each subarea.
- Individual RORB Storm (.stm) files were created for each rainfall duration and event to apply the rainfall depths appropriately across the catchment.

This method ensured the same rainfall depths are applied to each catchment as their previous RSS and FM&M studies.

4.7.3 Aerial Reduction Factors

Aerial reduction factors applied in previous RSS and FM&M studies were examined. From the 20 RSS and FM&M tributary catchments, 19 used an aerial reduction factor of 1 (catchment area set to 0.00 km^2). The Blackburn catchment used an aerial reduction factor area for a 15.57km^2 catchment. This yielded an aerial reduction factor of 0.89 for the 10 & 100 year 2 hr duration event. As the Blackburn catchment discharges directly into the Middleborough Rd RB, it is considered that the effects of this ARF on the flows along Gardiners Creek would be reduced given the significant storage in the RB.

An aerial reduction factor of 1 (0.00 km^2) was therefore applied across the entire model. This has resulted in small differences in flows downstream of the Middleborough Rd RB when compared to previous RSS modelling.

4.7.4 Temporal Patterns

The standard temporal pattern, 'Zone 1', was used as prescribed by AR&R (IEAust, 1997) for Melbourne.

4.7.5 Design Loss Parameters, IL and RoC

To continue to maintain consistency with previous RSS and FM&M studies, Initial Loss (IL) values were adopted from the previous studies. RoC values were varied in relation to the ARI of each model run as set out in the Melbourne Water Technical Specifications and Requirements (MWC, 2009a).

Design loss parameters, Initial Loss values and Runoff Coefficient values used in this study are shown in Appendix B.

4.8 Design Event RORB Modelling Results

4.8.1 Existing Conditions

Results from the RORB modelling of design events are shown in Appendix B.

A comparison of peak 100 year ARI flows between this study and the previous studies was completed for all of the tributary catchments. The results show that the majority of the peak flows in this study are within 1% of the previous studies. Differences are generally seen where the Aerial Reduction Factor methodology differs from the previous studies (Siriwardena and Weinmann methodology used for this study). The Fulton Road catchment shows a large difference in peak flows. The Fulton Road retarding basin was constructed in 2001 whereas the previous study was completed in 1997. The addition of the new retarding basin has resulted in significantly lower flows at the outlet. Results of the comparison are shown below in Table 4-15.

Table 4-15 Comparisons to Previous Study Peak 100 Year ARI Outlet Flows

Catchment	ARF Method	Q100 previous study (m^3/s)	Q100 this Study (m^3/s)	Difference (m^3/s)	Comments
BLACKBURN MD OUTFALL	S&W	n/a	57.5		Flow taken downstream of RB
BOX HILL SOUTH OUTFALL	AR&R	19.8	19.5	-0.3	AR&R Aerial Reduction Factor method used
FULTON RD OUTFALL	AR&R	28.6	16.7	-11.9	Fulton Road Retarding Basin constructed in 2001, Drainage Survey completed in 1997.
ELEY RD OUTFALL	AR&R	12.0	11.9	-0.1	AR&R Aerial Reduction Factor method used
STOTT ST OUTFALL	AR&R	12.1	12.0	-0.1	AR&R Aerial Reduction Factor method used
McCOMAS ST OUTFALL	AR&R	13.2	11.8	-1.4	AR&R Aerial Reduction Factor method used
BROCKHOFF'S MD OUTFALL	S&W	14.0	14.0	0.0	RORB model diverted for this project
DAMPER CREEK OUTLET	S&W	18.2	18.2	0.0	RORB model diverted for this project
WINBIRRA PDE OUTFALL	S&W	16.5	16.6	0.1	
SCOTCHMANS CREEK OUTFALL	S&W	79.3	79.3	0.0	RORB model diverted for this project
MURRUMBEENA MD OUTFALL	AR&R	39.8	39.1	-0.7	AR&R Aerial Reduction Factor method used
EAST MALVERN OUTFALL	S&W	10.1	10.9	0.7	
DARLING RD OUTFALL	S&W	13.3	13.3	0.0	
DUNLOP ST OUTFALL	S&W	16.6	16.5	-0.1	
HEDGELEY DENE OUTFALL	AR&R	15.2	15.1	-0.1	AR&R Aerial Reduction Factor method used
BACK CREEK OUTFALL	S&W	113.1	111.1	-2.0	Minor corrections made to RORB model for this study
TOORONGA RD OUTFALL	AR&R	47.1	46.8	-0.3	AR&R Aerial Reduction Factor method used
RIX ST OUTFALL	AR&R	13.6	13.6	0.0	AR&R Aerial Reduction Factor method used
LARA ST OUTFALL	AR&R	7.6	7.7	0.1	AR&R Aerial Reduction Factor method used

* Please note: RORB Results shown are upstream of discharge point to Gardiners Creek and are calculated in RORB only and are not hydraulically modelled. Previous study refers to past Flood Mapping or RSS project from various Consultants completed at various dates.

4.8.2 Climate Change Conditions

Climate Change conditions were also examined by increasing the rainfall depth on each RORB subcatchment by 32%. Full results shown in Appendix B.

4.8.3 Initial Loss Modelling Sensitivity

A comparison was completed to examine the difference in flows throughout the model when the initial loss parameter was varied. The RORB model utilised to generate flows for the hydraulic model used varying initial loss values to maintain consistency with previous studies. Where a previous study had not been completed (ie in the Gardiners Creek local catchments) the initial loss was set to 10mm as per Melbourne Water's Technical Specifications and Requirements document (MWC, 2009a). The comparison RORB model set all initial loss values to 10mm. As expected, the results shown in Figure 4-14 below generally show higher flows when the IL was set to 10mm and hence the losses applied to the entire model reduced. The method of varying the IL across the catchment was thought to be the most appropriate methodology to ensure consistency with previous studies.

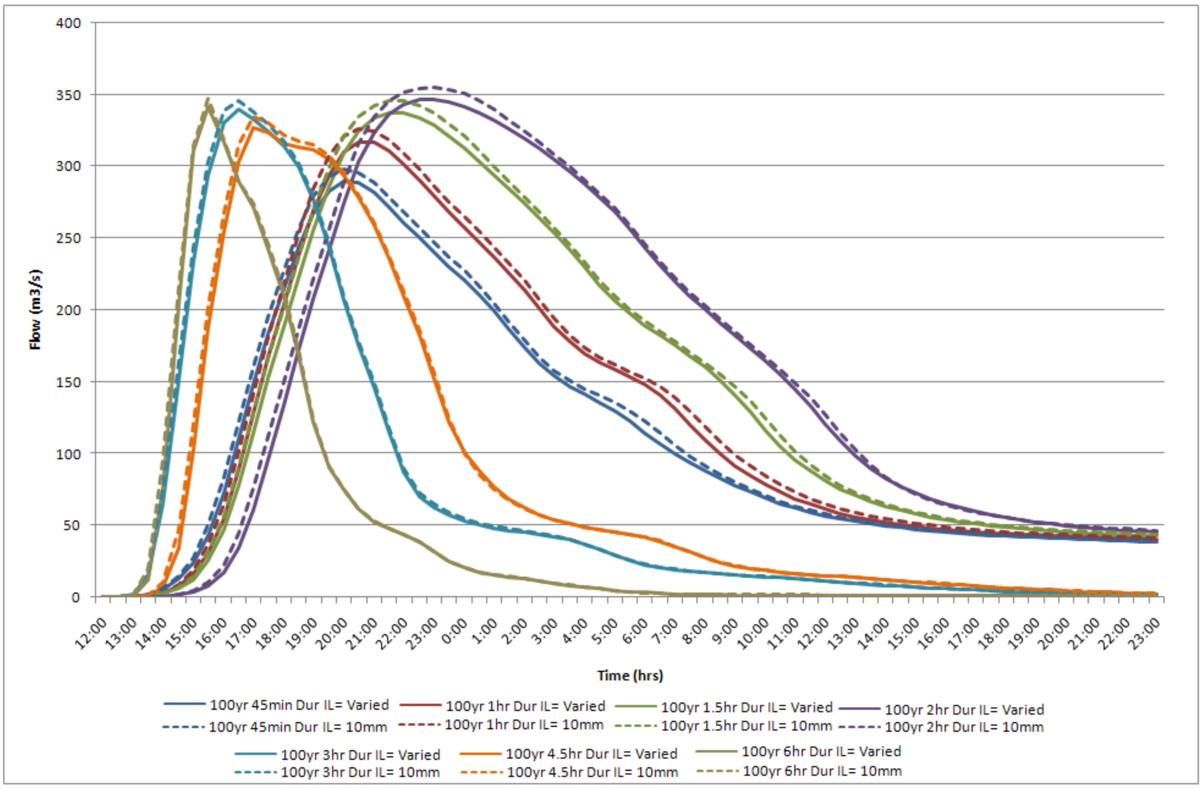

Figure 4-14 Comparison of 100 Year ARI Hydrographs at the 'Gardiners at Gardiners' Flow Gauge – Varied Initial Loss vs. Constant IL = 10mm

4.8.4 PMP Event RORB Modelling Methodology

The probable maximum precipitation (PMP) was estimated using the 'Generalised Short Duration Method' as outlined by the Bureau of Meteorology (2003). The GSDM calculates PMP estimates for durations up to 6 hours for catchments in tropical and subtropical coastal strips. Table 4-16 shows the PMP depths for Gardiners Greek. Details of the calculations are presented in the GSDM calculation sheet in Appendix B

Table 4-16 PMP Depth Estimates

Duration		PMP depth (nearest 10mm)
(mins)	(hr)	
15	0.25	90
30	0.50	130
45	0.75	170
60	1.0	210
90	1.5	230
120	2.0	260
150	2.5	290
180	3.0	300
240	4.0	340
300	5.0	360
360	6.0	390

The default GSDM temporal pattern was applied over the entire catchment.

The PMP spatial distribution was applied to Gardiners Creek Catchment using the spatial distribution diagram displayed in Figure 4-15. All the subareas between successive ellipses were applied a constant rainfall depth as given in Table 4-17.

Gardiners Creek Flood Mapping
Figure 4-15 GSDM Spatial Distribution over Gardiners Creek

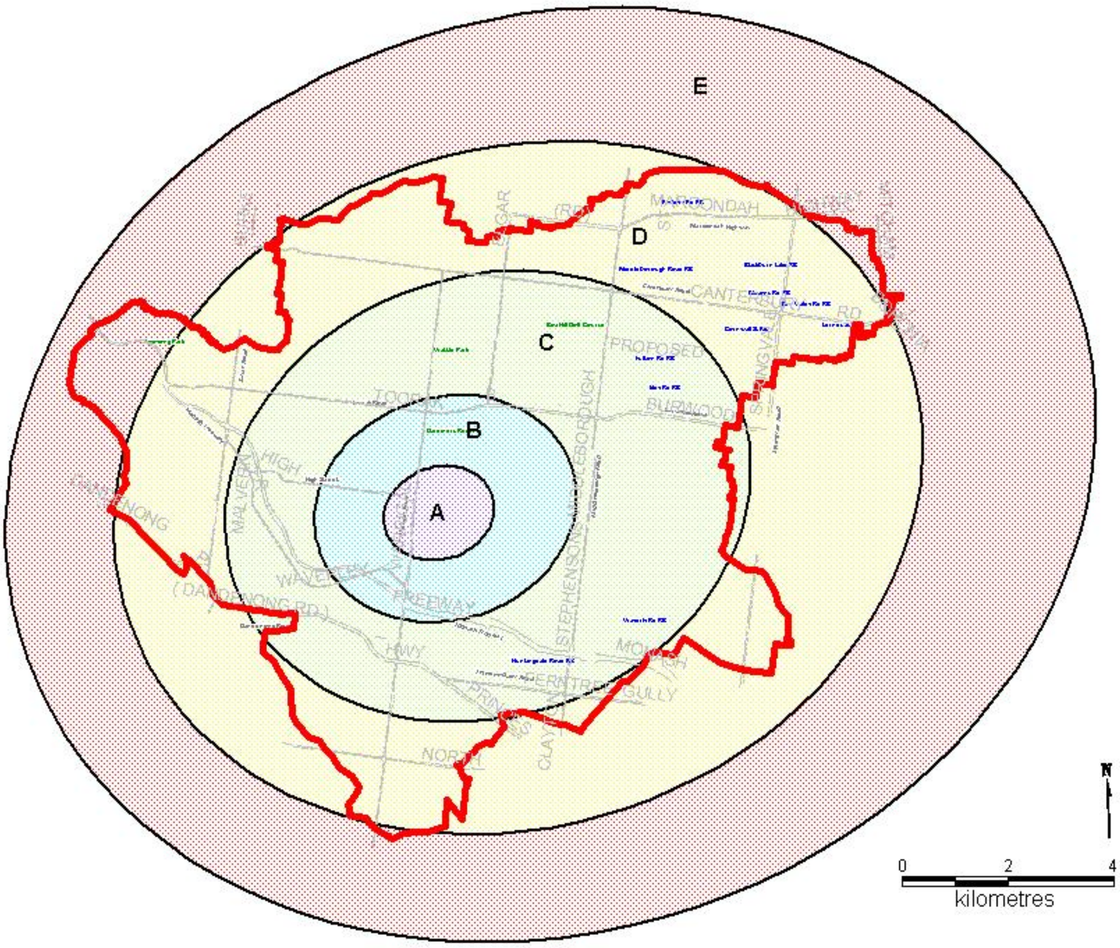

Figure 4-15 GSDM Spatial Distribution over Gardiners Creek

Table 4-17 PMP Rainfall Depths (mm) Between Succesive Ellipses

	Duration										
Ellipse	0.25hr	0.5hr	0.75hr	1hr	1.5hr	2hr	2.5hr	3hr	4hr	5hr	6hr
A	127	184	233	271	309	345	367	387	423	457	483
B	109	161	205	241	276	310	329	345	384	412	438
C	92	135	171	209	238	269	288	304	341	369	391
D	84	123	156	190	216	246	264	284	318	344	366
E	78	114	145	178	202	231	249	269	303	328	349

The RORB model for the PMP design event was run using a runoff coefficient of 0.9 and the same k_c values applied to the other design events. The spillways of nearly all the retarding basins located in the tributary catchments and along Gardiners Creek were enlarged to handle the greater flows associated with the PMP event.

4.8.5 PMP Event Results

Table 4-18 lists the peak flows for the PMP design event at each of the tributary catchment outfalls and at the 'Gardiners at Gardiners' flow gauge. The 30 minute event was found to be typically the critical duration for the PMP design event.

Table 4-18 PMP Design Event Peak Flows

Catchment Outfall	Critical Event (hrs)	Peak Flow (m^3/s)
Blackburn MD	1 hr	683.1
Box Hill South MD	1 hr	155.2
Fulton Rd Drain	1 hr	157.8
Eley Rd Drain	30 min	91.8
Stott St Drain	30 min	109.3
McComas Drain	1 hr	93.2
Brockhoff's MD	30 min	141.5
Damper Creek	1 hr	113.8
Winbirra Pde Drain	30 min	199.3
Scotchmans Creek	2 hr	814.6
Murrumbeena MD	2 hr	347.5
East Malvern MD	30 min	107.2
Darling Road MD	30 min	105.6
Dunlop St MD	30 min	162.8
Hedgeley Dene MD	1 hr	98.7
Back Creek	1 hr	807.1
GARDINERS AT GARDINERS GAUGE	**2 hr**	**3164.9**
Tooronga Rd MD	30 min	295.4
Rix St MD	30 min	108.6
Lara St MD	30 min	88.2
Moonga Rd MD	30 min	150.9
GARDINERS OUTFALL	**2 hr**	**3300.8**

5 HYDRAULIC ANALYSIS

5.1 Hydraulic Analysis Overview

As with the previous flood study (Water Technology 2004), a 1D hydraulic model such as HEC-RAS or MIKE11 was considered appropriate to model flood conditions in a range of events throughout the Gardiners Creek local catchment. At the Burke Rd culvert/tunnel, it was decided to construct a TUFLOW 2D hydraulic model to better assess the complex hydraulic conditions through this section. The Melbourne Water Technical Specifications document (*MWC, 2009a*) prepared for this study requires the hydraulic model to be built to generate flood extents including all breakaway flow paths associated with the events listed below in Table 5-1

Table 5-1 Required Hydraulic Modelling Scenarios

ARI:	PMF	100 yr	50 yr	20 yr	10 yr	5 yr
Base Case	✓	✓	✓	✓	✓	✓
Climate Change		✓		✓		✓

5.2 Previous Model Review and Model Selection

Given the large variance in flows expected in Gardiners Creek from the PMF (Probable Maximum Flood) to the 5 year ARI, it was important to select and build a hydraulic model that could model all events in a stable manner.

The previous flood mapping study completed by Water Technology in 2004 employed a version of HEC-RAS with a 'beta' release of the unsteady flow modelling component. During the 2004 project, model stability problems were experienced, generally in reaches where the flow regime switched between the supercritical (Froude number >1) and subcritical (Froude number <1). At the time of the previous study, the Manning's n values along the Gardiners Creek main branch were increased (as suggested by the HEC-RAS user manual) in an attempt to reduce the instabilities in the model. This had the effect of slowing the flow down in the model (encouraging subcritical flow) and hence may have produced conservative flood levels in these unstable areas.

To provide an alternative approach to the determination of flood levels in the instable areas, the hydraulic analysis was refined for the following 2 reaches using MIKE11:

- Highbury Road to Warrigal Road; and,
- Great Valley Parade to Toorak Road.

These reaches consist of concrete channel with numerous drop structures and bridge crossings. The nature of these reaches leads to portion of supercritical flows which may cause and cause model instabilities.

MIKE11 was used as an alternative modelling package to model these reaches as it is suited to a range of flow conditions ranging from steep river flows to tidally influenced estuaries and contains robust formulations to enable the simulation of flow over a variety of structures such as broad-crested weirs and culverts. This allowed for the reaches to be modelled with a more realistic roughness coefficient. The MIKE11 results were found to be stable in comparison to the HEC-RAS results.

Since 2004, many revisions have been made to the unsteady state modelling component of HEC-RAS. To ascertain whether the later versions of HEC-RAS would lead to greater stability along Gardiners Creek, the HECRAS model created by Water Technology in the 2004 study was run using the latest v4.0 of HEC-RAS.

Lateral inflows (such as Scotchman's Creek) were required to be slightly moved as HEC-RAS no longer allows lateral inflows to be within one cross section of a bridge or culvert. This update to HEC-RAS was one of the measures employed to increase the stability of unsteady state models.

The HECRAS model v4.0 was run for both the 10 and 100 year ARI with the 2 hour storm duration and the 'Errors, Warnings and Notes' generated by HEC-RAS were examined to assess the stability of the model. The notes showed many warnings, including:

- Multiple areas where there was large energy losses around structures.
- Areas where multiple critical depths (where Froude number = 1) were found.
- Bridges and culverts where HEC-RAS could not compute a valid answer within the structure.
- Areas where the weir and energy equations would not converge.

These errors caused mass balance issues within the model and clear stability issues when the flow profiles were examined.

In consultation with Melbourne Water, it was agreed that MIKE11 should be used to provide a stable hydraulic model across the entire Gardiners Creek reach.

5.3 MIKE11 Hydraulic Modelling

5.3.1 MIKE11 Hydraulic Modelling Overview

A new MIKE11 1D hydraulic model was built for this project with reference to the two MIKE11 models and HEC-RAS model built in the previous study (Water Technology, 2004). Various bank stabilisation and stream upgrades have been made since the last study which have been included in the current modelling.

5.3.2 Reference Models

Sections of Gardiners Creek have been modelled in various modelling packages in recent years for various flood mapping, water quality and road upgrade projects. Where available and appropriate, these models have been referenced in the construction of the MIKE11 model for this project as shown in Table 5-2.

As the reference models were created to serve various purposes and hence vary in detail and scale, it is important to note that entire models were not adopted into the new MIKE11 model created for this study. Rather, cross sections and bridge details were adopted where survey data may have been lacking detail.

Table 5-2 Reference Models

Model Type	Sections of Gardiners Creek Covered	Source	Data Utilised/ Referred to
HEC-RAS	Middleborough Rd to Glenferrie Rd	Water Technology, 2004	Some bridges and structures
MIKE 11	Highbury Rd to Warrigal Rd, Great Valley Pde to Toorak Rd	Water Technology, 2004	Burke Rd Tunnel Schematisation
HEC-RAS	Middleborough Rd to Glenferrie Rd (adapted from WT, 2004)	Monash M1 Upgrade, 2010	Monash Fwy Bridge Crossing

HEC-RAS	Station St to Burwood Hwy	Alluvium, 2009	Some surveyed cross-sections were utilised where beneficial
HEC-RAS	Winton Rd to High Street Rd	SKM, 2009	Some surveyed cross-sections were utilised where beneficial
HEC-RAS	Box Hill Golf Course	GHD,2008	Some surveyed cross-sections were utilised where beneficial
HEC-RAS	Upstream of Warrigal Rd	SMEC-Urban, 2009	Some surveyed cross-sections were utilised where beneficial
HEC-RAS	Warrigal Road Footbridge	Maunsell, 2009	Footbridge details

5.3.3 Topography

Cross sections in MIKE11 were developed from detailed cross section survey completed by Connell Wagner in 2004 for the previous flood mapping project. As-constructed plans and available models were used to generate cross section throughout the sections of Gardiners Creek, which have been changed since 2004. Where the flood shape exceeded the cross section, the relevant cross section was expanded with the available LiDAR data.

MIKE11 was used in some areas to generate cross sections between two existing uniform cross sections (i.e. through sections of concrete lined channel). This is done to increase the stability of the model.

In the process of building the MIKE11 model, errors were discovered in the survey (roughly bounded by the Zodiac Street footbridge and Warrigal Road) where the cross sections surveyed show a vertical difference (approximately 2m) to the LiDAR data and the photogrammetry collected for the previous project (WT, 2004). Melbourne Water later supplied an amended version of the surveyed cross sections which corresponded with the LiDAR and photogrammetry well.

Cross sections were found to overlap in some areas throughout the model. This will only impact the results if the area of the cross section that is overlapping is wet. The model was checked for instances of cross over and any problem areas were amended.

5.3.4 Boundary Conditions

Two types of boundary conditions were input to the model:

- Receiving waterway flood level (Yarra River)
- Inflow hydrographs

Table 5-3 below shows the varying tail water conditions and corresponding ARI event at the confluence between the receiving waterway (Yarra River) and Gardiners Creek as provided by Melbourne Water. The tailwater level was applied at the most downstream cross section of the MIKE 11 model.

Table 5-3 Tail Water Boundary Conditions (MWC, 2010)

Gardiners Creek ARI	PMF	100 year	50 year	20 year	10 year	5 year
Corresponding Yarra River ARI	100 year	10 year	10 year	10 year	10 year	5 year
Yarra River Flood Level (m AHD)	7.6	5.1	5.1	5.1	5.1	4.5

66 separate hydrograph inflow boundary conditions were input into the MIKE11 model, 45 from the local catchment and 21 from the tributary catchments. Each inflow hydrograph was sourced from the RORB model constructed for this project. The locations of each inflow are shown below in Figure 5-1.

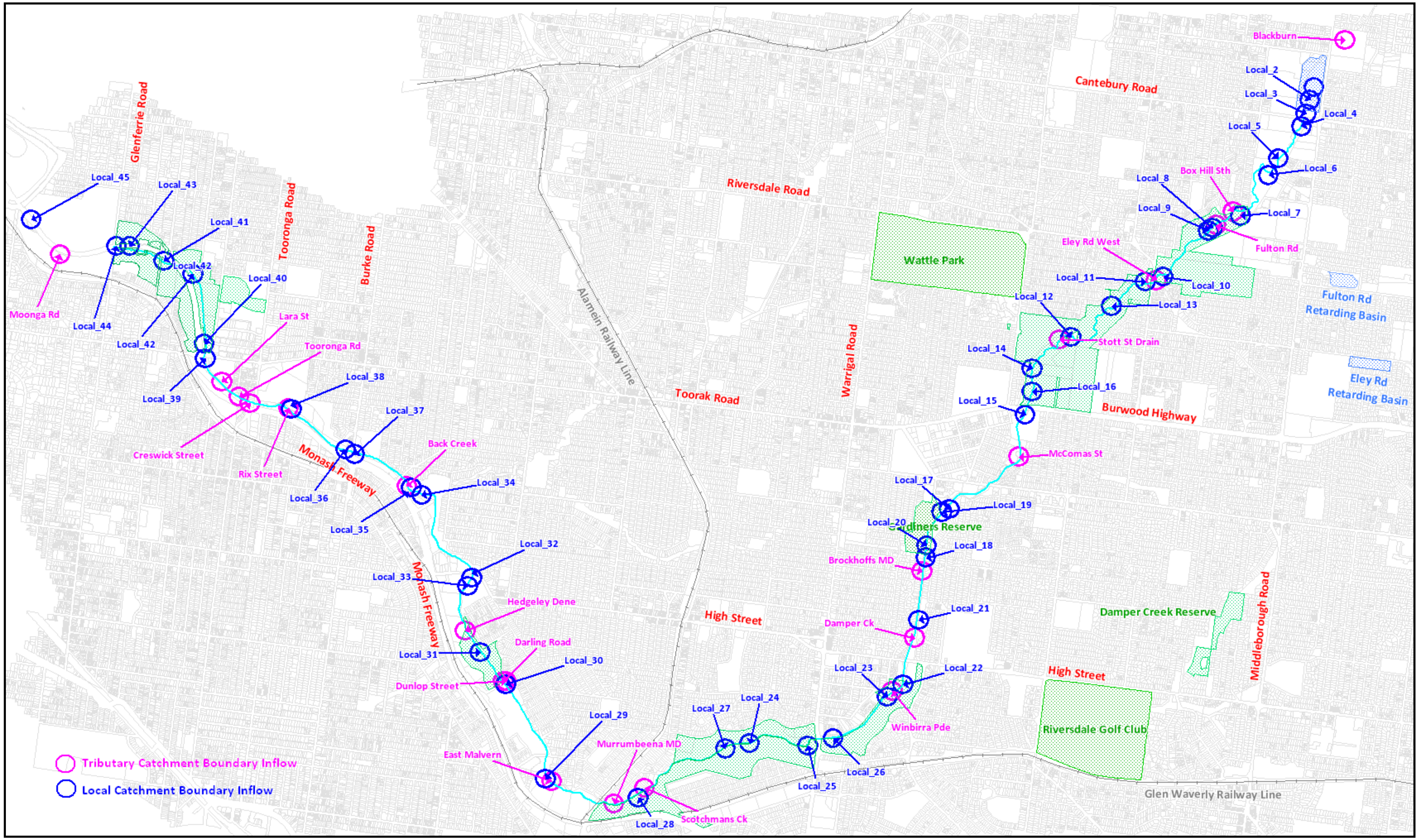

Figure 5-1 MIKE11 Hydrograph Inflow Boundary Locations

5.3.5 Roughness Coefficients

Roughness values were applied throughout the Gardiners Creek MIKE11 model. Manning's n roughness values selected are consistent with aerial photography and observations from site inspections, along with the recommendations listed in the Melbourne Water Land Development Manual (MWC, 2009c). Three roughness values were applied to each cross section, one each for the main channel, the left overbank and right overbank. Conditions throughout the Gardiners Creek main branch and overbanks can be summarised into five separate categories. These categories along with the roughness coefficient values applied are shown below in Table 5-4.

Table 5-4 Typical Channel Types and Associate Roughness Coefficient Applied

Channel Description	Manning's n Value Applied
Main channel - Concrete lined channel	0.020
Main channel - Naturalised channel with small boulders and minor vegetation	0.030
Overbank - Short grassed areas, minimal vegetation	0.035
Overbank - Long grassed areas, medium shrubby vegetation	0.050
Overbank - Dense shrubby vegetation	0.070

5.3.6 Structures

Each structure/ bridge crossing along Gardiners Creek (40 in total) was included in the MIKE11 model. Table 5-5 below details each structure input into the model and its MIKE11 chainage. Each structure was entered in MIKE11 as a culvert section (modelled as the bridge opening) with a weir section directly above the culvert (modelled as the bridge deck and surrounding floodplain). This method (rather than using the bridge function in MIKE11) allows for a separated and more detailed analysis of flows and velocities through the culvert (i.e. underflow of bridge) and weir (i.e. overflow of bridge). Four structures were not modelled with the culvert and weir technique to assist in model stability (as denoted in Table 5-5 below); this is discussed in further detail below.

Table 5-5 Structure ID and Locations

Structure #	Structure ID	Mike 11 Chainage (m)	Structure #	Structure ID	Mike 11 Chainage (m)
1	Box Hill GC Foot Bridge 1	392.96	21	Beechwood Tce Foot Bridge	5,867.00
2	Box Hill GC Foot Bridge 2	420.04	22	High Street Rd Bridge*	6,152.00
3	Box Hill GC Foot Bridge 3	544.99	23	Warrigal Rd Footbridge +	7,096.00
4	Box Hill GC Foot Bridge 4	902.81	24	Warrigal Rd Bridge	7,103.86
5	Box Hill GC Foot Bridge 5	1,101.52	25	Solway Ave Foot Bridge	9,254.36
6	Box Hill GC Foot Bridge 6	1,152.12	26	Glen Rd Foot Bridge	9,463.48
7	Box Hill GC Foot Bridge 7	1,296.22	27	Winton Street Bridge	9,631.40
8	Box Hill GC Foot Bridge 8	1,796.00	28	Pitt Street Foot Bridge	9,735.00
9	Box Hill GC Bridge 1	1,663.52	29	Maxwell St Foot Bridge	10,011.15
10	Box Hill GC Foot Bridge 9	1,820.17	30	Dunlop St Bridge	10,282.33
11	Box Hill GC Foot Bridge 10	1,863.48	31	June Cres Foot Bridge	10,598.88
12	Box Hill GC Foot Bridge 11	1,980.95	32	Estella St Footbridge	10,958.98
13	Station Street Bridge	2,059.42	33	High St Bridge	11,250.61

14	Glengarry Ave Foot Bridge	2,906.07	34	Brixton Rise Foot Bridge	11,590.41
15	Bennettswood Sports Ground Foot Bridge 1	3,329.67	35	Elm Road Foot Bridge	11,954.53
16	Bennettswood Sports Ground Foot Bridge 2	3,594.94	36	Great Valley Rd Bridge	12,321.80
17	Burwood Hwy Bridge	3,762.00	37	Burke Rd Tunnel*	12,688.00
18	Sinnott St Foot Bridge	4,169.61	38	Toorak Rd Bridge	14,160.17
19	Highbury Road Bridge	4,518.00	39	Monash Freeway Crossing*	14,939.90
20	Zodiac St Foot Bridge	5,439.61	40	Glenferrie Road Bridge	15,445.59

* Non standard Mike11 entry + Not physically constructed at the time of modelling

5.3.6.1 High Street Rd Bridge Crossing

The High Street Rd bridge was modelled as a culvert (representing the underside of the bridge) only. The channel geometry both upstream and downstream of the bridge are not favourable to the addition of a weir in this location as the culvert and weir cross sectional area is required to be less than both the upstream and downstream cross sectional areas to form a constriction through the weir and culvert. As flood waters are not expected to exceed the capacity of the culvert, it was decided that it was more appropriate to not enter a weir in this location rather than amending the upstream and downstream cross sections.

5.3.6.2 Warrigal Road Footbridge

A footbridge is proposed immediately upstream of the existing Warrigal Road road bridge. It was requested by Melbourne Water that this be included in the study. Design plans were provided and utilised to construct the bridge in the MIKE11 model. The design also includes a shared path along Gardiners Creek that passes beneath the Warrigal Road road bridge. Detailed plans were not available for this section of the path and hence the hydraulic implications of constructing a path within the hydraulic space beneath the bridge has not been tested in this model.

5.3.6.3 Burke Road Tunnel

As the Burke Road Tunnel is essentially a long culvert; it was modelled as a culvert only. If flow is found to exceed the capacity of the Burke Rd Tunnel, a separate TUFLOW model will be constructed as per the proposed hydraulic approach.

5.3.6.4 Monash Freeway Crossing

The Monash Freeway Crossing was modelled as a culvert (representing the underside of the bridge) only. The channel geometry both upstream and downstream of the bridge are not favourable to the addition of a weir in this location as the culvert and weir cross sectional area is required to be less than both the upstream and downstream cross sectional areas to form a constriction through the weir and culvert. As flood waters are not expected to exceed the capacity of the culvert, it was decided that it was more appropriate to not enter a weir in this location rather than amending the upstream and downstream cross sections.

5.4 Hydraulic Model Validation

Hydrologic calibration presented in Section 4.6 ensured that flow hydrographs entering Gardiners Creek from the local and tributary catchments were routed appropriately through the RORB model to represent conditions at the 'Gardiners at Gardiners' flow gauge. For the hydraulic modelling, hydrographs were entered to MIKE11 with the Gardiners Creek stream routing occurring in the MIKE11 model. To assess the ability of MIKE11 to correctly route the flows along Gardiners Creek, four historical events were run in the MIKE11 model to compare flood levels generated in the model with the flood levels determined from the rating table. The rating table used is shown in Figure 5-2 below and it should be noted that all levels past 0.84m are not considered reliable and gauge zero datum is 8.362 m AHD.

Melbourne Water HYRATAB V146 Output 30/11/20

Site 229624A GARDINERS CREEK AT GREAT VALLEY ROAD, GARDINER

Rating Table 14.01 03/04/2009 to Present Interpolation = Log CTF = 0.0000

Converting 100 Stream Water Level in metres
Into 140 Stream Discharge in Cubic Metres/Second

G.H.	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	0.0	0.00538	0.0144	0.0317	0.0563	0.0867	0.120	0.155	0.193	0.236
0.10	0.281	0.328	0.377	0.429	0.483	0.540	0.603	0.668	0.736	0.806
0.20	0.880	0.964	1.05	1.14	1.24	1.33	1.43	1.54	1.64	1.75
0.30	1.86	1.98	2.10	2.22	2.34	2.47	2.60	2.74	2.89	3.03
0.40	3.18	3.34	3.49	3.65	3.81	3.98	4.15	4.32	4.50	4.68
0.50	4.86	5.03	5.21	5.39	5.57	5.75	5.94	6.13	6.32	6.51
0.60	6.71	6.91	7.08	7.26	7.44	7.63	7.81	8.00	8.18	8.37
0.70	8.56	8.76	8.95	9.14	9.34	9.54	9.74	9.94	10.1	10.3
0.80	10.6	10.8	11.0	11.2	11.4U	11.6U	11.8U	12.0U	12.2U	12.4U
0.90	12.6U	12.8U	13.0U	13.2U	13.5U	13.7U	13.9U	14.1U	14.3U	14.5U
1.00	14.8U	15.0U	15.2U	15.4U	15.7U	15.9U	16.1U	16.3U	16.6U	16.8U
1.10	17.0U	17.3U	17.5U	17.7U	18.0U	18.2U	18.5U	18.8U	19.0U	19.3U
1.20	19.6U	19.9U	20.1U	20.4U	20.7U	20.9U	21.2U	21.5U	21.8U	22.0U
1.30	22.3U	22.6U	22.9U	23.1U	23.4U	23.7U	24.0U	24.2U	24.5U	24.8U
1.40	25.1U	25.4U	25.7U	25.9U	26.2U	26.5U	26.8U	27.1U	27.3U	27.6U
1.50	27.9U	28.2U	28.5U	28.8U	29.1U	29.4U	29.6U	29.9U	30.2U	30.5U
1.60	30.8U	31.1U	31.4U	31.7U	32.0U	32.3U	32.5U	32.8U	33.1U	33.4U
1.70	33.7U	34.0U	34.3U	34.6U	34.9U	35.2U	35.5U	35.8U	36.1U	36.4U
1.80	36.7U	37.0U	37.3U	37.6U	37.9U	38.2U	38.5U	38.8U	39.1U	39.4U
1.90	39.7U	40.0U	40.3U	40.6U	40.9U	41.2U	41.5U	41.8U	42.1U	42.4U
2.00	42.7U	43.0U	43.3U	43.7U	44.0U	44.3U	44.6U	44.9U	45.2U	45.5U
2.10	45.8U	46.1U	46.4U	46.7U	47.1U	47.4U	47.7U	48.0U	48.3U	48.6U
2.20	48.9U	49.2U	49.5U	49.9U	50.2U	50.5U	50.8U	51.1U	51.4U	51.7U
2.30	52.1U	52.4U	52.7U	53.0U	53.3U	53.6U	54.0U	54.3U	54.6U	54.9U
2.40	55.2U	55.6U	55.9U	56.2U	56.5U	56.8U	57.2U	57.5U	57.8U	58.1U
2.50	58.4U	58.8U	59.1U	59.4U	59.7U	60.1U	60.4U	60.7U	61.0U	61.4U
2.60	61.7U	62.0U	62.3U	62.7U	63.0U	63.3U	63.6U	64.0U	64.3U	64.6U
2.70	64.9U	65.3U	65.6U	65.9U	66.2U	66.6U	66.9U	67.2U	67.6U	67.9U
2.80	68.2U	68.6U	68.9U	69.2U	69.5U	69.9U	70.2U	70.5U	70.9U	71.2U
2.90	71.5U	71.9U	72.2U	72.5U	72.9U	73.2U	73.5U	73.9U	74.2U	74.5U
3.00	74.9U	75.2U	75.5U	75.9U	76.5U	77.0U	77.6U	78.2U	78.7U	79.3U
3.10	79.9U	80.5U	81.1U	81.7U	82.3U	82.9U	83.5U	84.1U	84.7U	85.3U
3.20	85.9U	86.5U	87.1U	87.7U	88.3U	88.9U	89.6U	90.2U	90.8U	91.4U
3.30	92.1U	92.7U	93.3U	94.0U	94.6U	95.2U	95.9U	96.5U	97.2U	97.8U
3.40	98.5U	99.2U	99.8U	100U	101U	102U	102U	103U	104U	104U
3.50	105U	106U	107U	107U	108U	109U	109U	110U	111U	111U
3.60	112U	113U	114U	114U	115U	116U	117U	117U	118U	119U
3.70	120U	120U	121U	122U	123U	124U	124U	125U	126U	127U
3.80	128U	128U	129U	130U	131U	132U	133U	133U	134U	135U
3.90	136U	137U	138U	139U	139U	140U	141U	142U	143U	144U
4.00	145U	146U	146U	147U	148U	149U	150U	151U	152U	153U
4.10	154U	154U	155U	156U	157U	158U	159U	160U	161U	162U
4.20	163U	164U	165U	166U	167U	168U	169U	170U	171U	172U
4.30	173U	174U	175U	176U	177U	178U	179U	180U	181U	182U
4.40	183U	184U	186U	187U	188U	189U	190U	191U	192U	193U
4.50	194U	195U	197U	198U	199U	200U	201U	202U	203U	204U
4.60	206U	207U	208U	209U	210U	211U	213U	214U	215U	216U
4.70	217U	218U	220U	221U	222U	223U	224U	226U	227U	228U
4.80	229U	231U	232U	233U	234U	236U	237U	238U	240U	241U
4.90	242U	244U	245U	246U	248U	249U	250U	252U	253U	255U
5.00	256U	257U	259U	260U	261U	263U	264U	266U	267U	269U
5.10	270U	271U	273U	274U	276U	277U	279U	280U	281U	283U
5.20	284U	286U	287U	289U	290U	292U	293U	295U	296U	298U
5.30	299U	301U	302U	304U	306U	307U	309U	310U	312U	313U
5.40	315U	316U	318U	320U	321U	323U	325U	326U	328U	330U
5.50	331U	333U	335U	336U	338U	340U	342U	343U	345U	347U
5.60	348U	350U	352U	354U	355U	357U	359U	361U	363U	364U
5.70	366U	368U	370U	372U	373U	375U	377U	379U	381U	383U
5.80	384U	386U	388U	390U	392U	394U	396U	398U	399U	401U
5.90	403U	405U	407U	409U	411U	413U	415U	417U	419U	421U
6.00	423U	425U	427U							

------------------ Notes -------------------
All rated data has been coded as reliable
except where the following tags are used...
U ...Unreliable data, Rating not verified

Figure 5-2 Rating table – Gardiners Creek gauge 229624a

The results of the validation are shown below in Table 5-6. The results show that the MIKE11 model produces water levels that are close to the water levels determined from the rating table for this gauge. As the results show a good match, further calibration of the modelling process is deemed not appropriate.

Table 5-6 Comparison between gauged water levels and MIKE11 water levels

Historic event date	Flow at gauge (m^3/s)	Gauge height (WSE) from rating table (m AHD)	Flow in MIKE11 (m^3/s)	MIKE11 WSE (m MHD)	WSE difference between gauge and MIKE11 (m)	% Difference between gauged and modelled
24/12/1978	150.98	12.432*	176.894	12.743	-0.311	-2.50%
25/12/1978	189.703	12.822*	168.804	12.748	+0.074	+0.58%
17/09/1984	194.516	12.872*	215.349	12.715	+0.157	+1.22%
02/02/2005	158.151	12.512*	144.195	12.662	-0.150	-1.20%

* note: levels not deemed reliable by Melbourne Water past 9.202m AHD.

5.5 TUFLOW Hydraulic Modelling

5.5.1 TUFLOW Hydraulic Modelling Overview

A TUFLOW model was constructed to model the section of Gardiners Creek between Valley Parade and Toorak Road to more accurately determine the flow characteristics around the Burke Road Tunnel. In previous modelling, overland flow has broken away from Gardiners Creek at the Burke Road tunnel and bypassed the tunnel on the north side. A 1-dimensional hydraulic model is not capable of representing these flow characteristics and hence a 2-dimensional model is employed through this section. As flows remain within the confines of Gardiners Creek throughout the model, the 1-dimensional model is considered to be suitable for use.

The TUFLOW model routes the design flood hydrographs, obtained from the MIKE-11 modelling, along the Melbourne Water infrastructure and any associated overland flow path.

TUFLOW is a widely used hydraulic model that is suitable for the analysis of overland flows in urban areas. TUFLOW has three main inputs:

- Topography and drainage infrastructure data;
- Roughness; and,
- Boundary conditions.

Existing hydraulic models through this section of Gardiners Creek were not considered suitable and hence a new TUFLOW model was constructed for this study to be consistent with the Melbourne Water Technical Specifications and Requirements (*MWC, 2009a*).

The TUFLOW model was used to route flows along the path of Gardiners Creek and through the Burke Road tunnel. Flow was routed along one-dimensional (1D) elements as open channel and pipes. Where the capacity of the 1D elements was exceeded, the excess flows are routed overland in a two dimensional (2D) domain. The TUFLOW model outputs flood depths and velocities.

5.5.2 TUFLOW Model Construction and Parameters

The TUFLOW model was constructed in MapInfo V10.0 and SMS. This section details key elements and parameters of the TUFLOW model.

Model Version

- The single precision version of the latest TUFLOW release was used for all simulations (TUFLOW Version: 2009-07-DB-iSP).

2D Grid Size and Topography

- A single 2D domain was used with a grid size of 2.5m. The 2d_zpt file was populated with elevations from LiDAR data provided by Melbourne Water and site survey available from Stocklands for the Tooronga Village development (2010).

1d Network

- All pipes, culverts, and other structures were modelled in 1D using the MapInfo Tables and plans/survey provided by Melbourne Water.
- For the 1D open channels, surveyed cross sections were used from the available survey completed by Connell Wagner for the previous study (Water Technology, 2004).

Roughness

- For the 2D domain, 2d_mat files were produced for each land use zoning, with further refinement through the use of aerial photographs, building footprints and site inspection observations. The Manning's values are specified in the .tmf TUFLOW model file.
- Manning's values were only applied to sections of the model with wet cells.
- Proposed Manning's 'n' roughness coefficients are listed in Table 5-7 below and are consistent with the Manning's 'n' roughness coefficients used in the MIKE 11 modelling.

Table 5-7 Manning's n Roughness Coefficients

Land Use	Manning's n Roughness Coefficient
Open Space	0.050
Residential Properties	0.200
Channel	0.040

Boundary Conditions

- Upstream inflow boundary
  - As the upstream section of the model is on Gardiners Creek, the upstream section of the model was a 1D open channel.
  - A 1d_bc QT boundary was placed on the upstream end of the open channel with hydrographs from the MIKE11 model.
- Outlet boundary
  - Gardiners Creek was modelled in 2D with a 2d_bc HT boundary at the downstream end.
  - The water level used in the HT boundary was sourced from the MIKE11 model.

Levee Walls and Monash Freeway Sound Walls

- Levee wall heights immediately upstream of the tunnel were adopted from site survey and entered as a z-line. The levee wall is shown in Figure 5-3.

Figure 5-3 Levee wall upstream of the Burke Road tunnel

- Sound walls along the Monash Freeway are well above expected flood levels. Sound walls were entered as a z-line with an elevation of 25m AHD to ensure it is above the flood height and no overtopping occurs. The sound walls are shown below in Figure 5-4.

Figure 5-4 Sound walls on top of the south side of the bank

- A levee exists along the north side of Gardiners Creek between Toorak Road and Tooronga Road consisting of earthen embankment and reinforced brick wall. The levee was entered as a z-line with an elevation of 25m AHD to ensure it is above the flood height and no overtopping occurs. The levee wall is shown in Figure 5-5.

Figure 5-5 Levee wall along the northern side of Gardiners Creek upstream of Toorak Road

Tooronga Road Bridge

The Tooronga Road bridge spans Gardiners Creek well above the floodplain and does not impact the hydraulic space in a flood event. For these reasons, the bridge has not been included in the model. The bridge is shown below in Figure 5-6.

Figure 5-6 Tooronga Road overpass

5.5.3 Hydraulic model application

The TUFLOW model was run for a suite of storm durations for each of the required durations in the Existing Conditions and Climate Change Conditions scenarios (refer to Table 5-1 for details of scenarios).

Tailwater levels were extracted from the corresponding event in the MIKE11 model and were applied to the TUFLOW model.

5.5.4 TUFLOW model checks

As outlined in the Melbourne Water Technical Specifications (MWC, 2009a) *Section 3.4.9*, the following checks were undertaken on TUFLOW model parameters and outputs:

- 2D grid size: The 2D grid size is 2.5m, within the range of 2-3m for urban catchments
- 2D timestep: The 2D timestep is 0.75 seconds, between ½ and ¼ of the grid size
- 1D timestep: The 1D timestep is 0.5 seconds. The time step could not be between 1/10 and 1/5 of the 2D time step without going below Melbourne Water's recommended minimum of 0.5 seconds.
- Model mass errors: The Mass Errors for all models were no greater than 1%, and generally less than 0.1%.
- Errors and warning messages: None
- Pipe flow: All pipes flow full in all models, as was expected
- Channel junction continuity: Water can flow freely between the Burke Road tunnel and the upstream and downstream channels.
- 2D Model extent: The flood extents are within the model extent.

Based on the above checks, we consider the TUFLOW model to meet the requirements as outlined in the Melbourne Water Technical Specifications (MWC, 2009a). Figure 5-7 below shows the schematisation of the TUFLOW model.

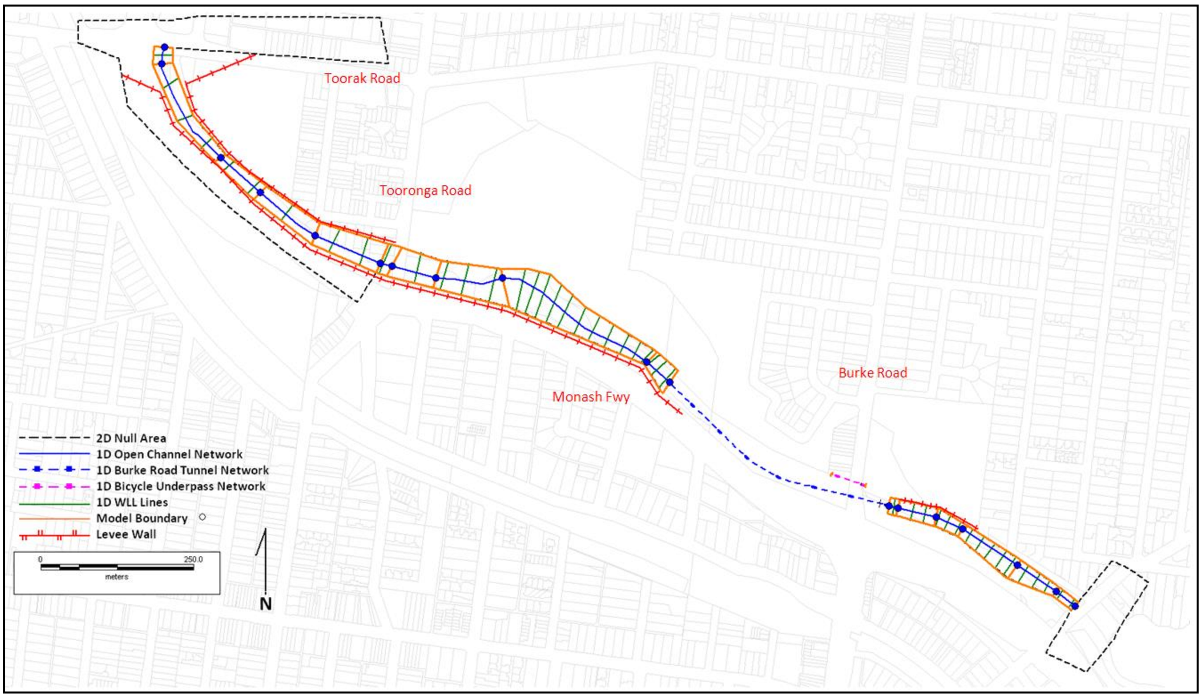

Figure 5-7 TUFLOW Model Schematisation

5.5.5 TUFLOW model outputs

TUFLOW provided times- series of depths (m), water surface elevations (m AHD) and flow velocities (m/s) at cross sections location within the 1D elements, and at the grid points within the 2D domain.

6 FLOOD MAPPING

Following the construction of the detailed 1D Mike 11 and 1D/2D TUFLOW models, results were provided to Melbourne Water for the full range of ARI results.

Early February 2011 saw an intense rainfall event over the Gardiners Creek catchment with flows at the 'Gardiners at Gardiners' flow gauge peaking at 339 m^3/s, the largest recorded flow at the gauge and the TUFLOW modelling was calibrated to pegged levels in the area.

It is understood by Water Technology that Melbourne Water was largely happy with the results of the study. As of March 2014, Melbourne Water requested the report to be marked final and the completed flood models be sent to Melbourne Water. This marked the completion of flood modelling by Water Technology and it is understood that Melbourne Water will continue to work on developing an overlay that is acceptable to Melbourne Water.

Given the above, this report has be titled "Flood Mapping of Gardiners Creek – Part 1" with future parts to be completed by Melbourne Water.

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APPENDIX A FRACTION IMPERVIOUS DATA

Table 7-1 Fraction Impervious Data throughout Gardiners Creek

Sub Area	Area (ha)	Impervious Fraction	Sub Area	Area (ha)	Impervious Fraction	Sub Area	Area (ha)	Impervious Fraction
A	0.05	0.56	CC	0.06	0.40	FJ	0.19	0.41
B	0.04	0.60	CD	0.05	0.48	FK	0.03	0.60
C	0.08	0.60	CE	0.16	0.60	FL	0.10	0.44
D	0.05	0.57	CF	0.11	0.72	FM	0.03	0.10
E	0.03	0.48	CG	0.14	0.30	FN	0.06	0.33
F	0.02	0.62	CH	0.14	0.61	FO	0.04	0.49
G	0.03	0.46	CI	0.23	0.68	FP	0.10	0.46
H	0.02	0.43	CJ	0.09	0.63	FQ	0.04	0.51
I	0.02	0.30	CK	0.14	0.48	FR	0.09	0.49
J	0.02	0.39	CL	0.08	0.29	FS	0.02	0.22
K	0.07	0.50	CM	0.04	0.36	FT	0.04	0.40
L	0.04	0.49	CN	0.16	0.52	FU	0.06	0.38
M	0.09	0.15	CO	0.10	0.60	FV	0.07	0.44
N	0.03	0.50	CP	0.05	0.75	FW	0.05	0.36
O	0.04	0.49	CQ	0.05	0.53	FX	0.01	0.09
P	0.05	0.53	CR	0.04	0.80	FY	0.03	0.27
Q	0.05	0.52	CS	0.07	0.61	FZ	0.18	0.46
R	0.07	0.56	CT	0.06	0.56	GA	0.12	0.68
S	0.02	0.55	CU	0.07	0.46	GB	0.04	0.17
T	0.03	0.52	CV	0.10	0.50	GC	0.07	0.43
U	0.01	0.52	CW	0.05	0.37	GD	0.03	0.48
V	0.06	0.48	CX	0.08	0.26	GE	0.09	0.54
W	0.03	0.51	CY	0.19	0.48	GF	0.02	0.47
X	0.03	0.73	CZ	0.11	0.45	GG	0.11	0.38
Y	0.11	0.50	DA	0.06	0.43	GH	0.09	0.48
Z	0.04	0.48	DB	0.06	0.44	GI	0.07	0.50
AA	0.05	0.49	DC	0.07	0.42	GJ	0.03	0.59
AB	0.07	0.75	DD	0.03	0.63	GK	0.08	0.55
AC	0.06	0.72	DE	0.02	0.52	GL	0.02	0.70
AD	0.04	0.29	DF	0.02	0.39	GM	0.02	0.66
AE	0.05	0.42	DG	0.02	0.43	GN	0.02	0.50
AF	0.04	0.50	DH	0.01	0.10	GO	0.02	0.64
AG	0.02	0.48	DI	0.02	0.27	GP	0.05	0.37
AH	0.02	0.44	DL	0.08	0.52	GQ	0.03	0.51
AI	0.02	0.67	DM	0.12	0.52	GR	0.01	0.47
AJ	0.04	0.81	DQ	0.11	0.38	GS	0.04	0.42
AK	0.02	0.90	DR	0.15	0.35	GT	0.06	0.51
AL	0.02	0.72	DS	0.04	0.57	GU	0.04	0.26
AM	0.02	0.50	DT	0.05	0.55	GV	0.02	0.61
AN	0.02	0.53	DU	0.05	0.56	GW	0.04	0.64
AO	0.03	0.64	DV	0.03	0.52	GX	0.07	0.58
AP	0.02	0.54	DW	0.04	0.47	GY	0.11	0.60
AQ	0.01	0.58	DX	0.05	0.46	GZ	0.04	0.22
AR	0.01	0.47	DY	0.07	0.45	HB	0.17	0.43
AS	0.07	0.50	DZ	0.06	0.26	HC	0.14	0.66
AT	0.10	0.49	EA	0.10	0.35	HD	0.05	0.17
AU	0.04	0.49	EB	0.04	0.32	HE	0.12	0.69

AV	0.08	0.51	EC	0.33	0.54	HF	0.05	0.38
AW	0.02	0.48	ED	0.03	0.72	HG	0.05	0.38
AX	0.11	0.51	EE	0.08	0.77	HH	0.11	0.49
AY	0.11	0.48	EF	0.05	0.62	HI	0.08	0.37
AZ	0.13	0.49	EG	0.10	0.60	HJ	0.12	0.39
BA	0.10	0.51	EH	0.06	0.23	HN	0.02	0.56
BB	0.11	0.50	EI	0.02	0.10	HO	0.08	0.43
BC	0.06	0.40	EJ	0.05	0.39	HP	0.06	0.32
BD	0.06	0.36	EK	0.04	0.37	HT	0.05	0.40
BE	0.04	0.37	EL	0.04	0.12	HU	0.04	0.44
BF	0.05	0.41	EM	0.04	0.24	HV	0.05	0.47
BG	0.04	0.62	EN	0.09	0.29	HW	0.03	0.50
BH	0.08	0.41	EO	0.11	0.28	HX	0.07	0.28
BI	0.08	0.48	EP	0.11	0.41	HY	0.02	0.46
BJ	0.05	0.52	EQ	0.05	0.45	IC	0.07	0.53
BK	0.10	0.42	ER	0.04	0.30	ID	0.08	0.53
BL	0.09	0.46	ES	0.03	0.30	IE	0.08	0.55
BM	0.07	0.59	ET	0.03	0.37	IF	0.02	0.75
BN	0.06	0.37	EU	0.02	0.42	IA	0.18	0.49
BO	0.07	0.52	EV	0.02	0.42	IB	0.12	0.48
BP	0.04	0.45	EW	0.06	0.36	HQ	0.07	0.35
BQ	0.05	0.53	EX	0.02	0.21	HR	0.15	0.41
BR	0.12	0.60	EY	0.09	0.41	HS	0.20	0.50
BS	0.07	0.69	EZ	0.06	0.27	HK	0.05	0.51
BT	0.10	0.53	FA	0.06	0.20	HL	0.07	0.53
BU	0.11	0.53	FB	0.07	0.48	HM	0.04	0.49
BV	0.07	0.52	FC	0.04	0.15	HA	0.17	0.36
BW	0.05	0.38	FD	0.02	0.27	DN	0.07	0.38
BX	0.06	0.53	FE	0.02	0.50	DO	0.17	0.49
BY	0.05	0.49	FF	0.03	0.47	DP	0.09	0.32
BZ	0.06	0.49	FG	0.09	0.48	DK	0.08	0.45
CA	0.06	0.48	FH	0.03	0.49	DJ	0.09	0.57
CB	0.06	0.55	FI	0.06	0.25			

APPENDIX B HYDROLOGICAL MODEL DETAILS

Table 7-2 IFD Table for Gardiners Greater Catchment

Duration		1yr ARI	2yr ARI	5yr ARI	10yr ARI	20yr ARI	50yr ARI	100yr ARI
(min)	(hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)
5	0.083	47.4	63	86	102	123	154	179
5.5	0.092	45.8	61	83	98	119	148	172
6	0.100	44.3	59	80	95	115	143	166
6.5	0.108	43	57	78	92	111	138	160
7	0.117	41.8	55	76	89	107	134	155
7.5	0.125	40.6	54	73	87	104	130	151
8	0.133	39.6	53	71	84	101	126	146
8.5	0.142	38.6	51	70	82	99	122	142
9	0.150	37.7	50	68	80	96	119	138
9.5	0.158	36.9	48.9	66	78	94	116	135
10	0.167	36.1	47.8	65	76	91	113	132
11	0.183	34.6	45.8	62	73	87	108	126
12	0.200	33.3	44	59	70	84	104	120
13	0.217	32.1	42.4	57	67	81	100	115
14	0.233	31	41	55	65	78	96	111
15	0.250	30	39.6	53	63	75	92	107
16	0.267	29.1	38.4	52	60	72	89	103
17	0.283	28.2	37.3	50	59	70	86	100
18	0.300	27.4	36.2	48.6	57	68	84	97
19	0.317	26.7	35.3	47.2	55	66	81	94
20	0.333	26	34.3	46	54	64	79	91
21	0.350	25.4	33.5	44.8	52	62	77	89
22	0.367	24.8	32.7	43.7	51	61	75	86
23	0.383	24.2	31.9	42.6	49.8	59	73	84
24	0.400	23.7	31.2	41.6	48.6	58	71	82
25	0.417	23.2	30.5	40.7	47.5	57	69	80
26	0.433	22.7	29.9	39.8	46.4	55	68	78
27	0.450	22.3	29.3	39	45.4	54	66	76
28	0.467	21.8	28.7	38.2	44.5	53	65	75
29	0.483	21.4	28.2	37.4	43.6	52	64	73
30	0.500	21	27.7	36.7	42.8	51	62	72
32	0.533	20.3	26.7	35.4	41.2	48.9	60	69
34	0.567	19.6	25.8	34.2	39.7	47.2	58	66
36	0.600	19	25	33	38.4	45.6	56	64
38	0.633	18.5	24.2	32	37.2	44.1	54	62
40	0.667	17.9	23.5	31	36	42.7	52	60
45	0.750	16.8	22	28.9	33.5	39.7	48.4	56
50	0.833	15.8	20.7	27.1	31.4	37.2	45.3	52
55	0.917	14.9	19.5	25.6	29.6	35	42.6	48.8
60	1.000	14.2	18.5	24.3	28	33.1	40.2	46

75	1.250	12.4	16.2	21.1	24.4	28.7	34.8	39.8
90	1.500	11.2	14.5	18.9	21.7	25.5	30.9	35.2
105	1.750	10.2	13.2	17.1	19.7	23.1	27.9	31.8
120	2.000	9.38	12.2	15.7	18	21.2	25.5	29
135	2.250	8.73	11.3	14.6	16.7	19.6	23.6	26.8
150	2.500	8.19	10.6	13.7	15.6	18.3	22	25
165	2.750	7.73	10	12.8	14.7	17.1	20.6	23.4
180	3.000	7.33	9.5	12.2	13.9	16.2	19.4	22
195	3.250	6.98	9.04	11.5	13.2	15.4	18.4	20.9
210	3.500	6.67	8.63	11	12.5	14.6	17.5	19.8
225	3.750	6.39	8.27	10.5	12	14	16.7	18.9
240	4.000	6.15	7.95	10.1	11.5	13.4	16	18.1
270	4.500	5.72	7.39	9.37	10.6	12.4	14.8	16.7
300	5.000	5.36	6.92	8.76	9.93	11.5	13.8	15.5
360	6.000	4.8	6.18	7.79	8.81	10.2	12.2	13.7
420	7.000	4.37	5.62	7.06	7.97	9.23	11	12.4
480	8.000	4.02	5.17	6.49	7.31	8.45	10	11.3
540	9.000	3.75	4.81	6.02	6.77	7.82	9.27	10.4
600	10.000	3.51	4.51	5.63	6.32	7.3	8.63	9.7
660	11.000	3.32	4.25	5.29	5.95	6.85	8.1	9.09
720	12.000	3.14	4.03	5.01	5.62	6.47	7.64	8.57
840	14.000	2.84	3.65	4.55	5.11	5.89	6.97	7.82
960	16.000	2.61	3.35	4.18	4.7	5.43	6.43	7.23
1080	18.000	2.41	3.1	3.88	4.37	5.05	5.99	6.74
1200	20.000	2.25	2.89	3.63	4.09	4.74	5.62	6.33
1320	22.000	2.11	2.72	3.42	3.86	4.47	5.31	5.98
1440	24.000	1.99	2.57	3.23	3.65	4.23	5.03	5.67
1800	30.000	1.72	2.21	2.8	3.17	3.68	4.38	4.95
2160	36.000	1.51	1.95	2.48	2.81	3.27	3.9	4.41
2520	42.000	1.36	1.75	2.23	2.54	2.95	3.53	4
2880	48.000	1.23	1.59	2.03	2.31	2.7	3.23	3.66
3240	54.000	1.13	1.46	1.87	2.13	2.49	2.99	3.39
3600	60.000	1.04	1.35	1.73	1.98	2.31	2.77	3.15
3960	66.000	0.97	1.26	1.61	1.84	2.16	2.59	2.95
4320	72.000	0.9	1.17	1.51	1.73	2.02	2.43	2.77

Table 7-3 Adopted RORB Parameters at RORB Interstation Locations

Interstation Area #	Interstation Area Name	Catchment #	Kc	m	IL	RoC PMP	RoC 100 yr ARI	RoC 50 yr ARI	RoC 20 yr ARI	RoC 10 yr ARI	RoC 5 yr ARI
1	IA - Blackburn Nth	4893	2.50	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
2	IA - Lake Rd MD	4893	2.20	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
3	IA - Forest Hill MD	4893	3.85	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
4	IA - Blackburn Sth	4893	1.60	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
5	BLACKBURN OUTFALL	4893	1.60	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
6	LC1	4820	0.46	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
7	LC2	4820	0.25	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
8	LC4	4820	0.39	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
9	LC3	4820	0.48	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
10	LC5	4820	0.34	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
11	LC6	4820	0.55	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
12	LC7	4820	0.35	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
13	BOX HILL OUTFALL	4885(4886)	5.60	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
14	LC8	4820	0.30	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
15	LC9	4820	0.23	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
16	FULTON OUTFALL	4883(4884)	3.73	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
17	LC10	4820	0.51	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
18	ELEY RD OUTFALL	4882	3.18	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
19	LC11	4820	0.77	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
20	LC13	4820	0.43	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
21	LC12	4820	0.47	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
22	STOTT ST OUTFALL	4881	1.85	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
23	LC14	4820	0.73	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
24	LC16	4820	0.51	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
25	LC15	4820	0.73	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
26	McCOMAS OUTFALL	4875	4.26	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
27	LC17	4820	0.80	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
28	LC19	4820	0.71	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
29	LC20	4820	0.56	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
30	LC18	4820	0.80	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25

31	IA - Top of Brockhoffs MD	4874	1.00	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
32	BROCKHOFFS OUTFALL	4874	0.70	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
33	LC21	4820	0.72	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
34	IA - U/S MW Pipe DamperCk - Rear 17 Bengal Crescent	4872(4873)	0.33	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
35	IA - U/S Confluence DamperCk	4872(4873)	0.40	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
36	IA - U/S MW Pipe DamperCk East - Downstream Stephensons	4872(4873)	0.88	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
37	IA - U/S Confluence DamperCk East	4872(4873)	0.66	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
38	DAMPER OUTFALL	4872(4873)	4.10	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
39	LC22	4820	0.28	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
40	LC23	4820	0.59	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
41	WINBIRRA OUTFALL	4871	4.05	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
42	LC26	4820	0.54	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
43	LC25	4820	0.41	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
44	LC24	4820	0.82	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
45	LC27	4820	0.98	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
46	LC28	4820	0.69	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
47	SCOTCHMANS CK OUTFALL	4860	9.97	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
48	LC29	4820	0.31	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
49	MURRUMBEENA OUTFALL	4850(4853,4852,4854)	7.04	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
50	MALVERN OUTFALL	4844	2.00	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
51	LC30	4820	0.56	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
52	DARLING OUTFALL	4842	2.72	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
53	DUNLOP OUTFALL	4843	1.93	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
54	LC31	4820	0.43	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25

55	HEDGLEY OUTFALL	4841	3.81	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
56	LC33	4820	0.57	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
57	LC32	4820	0.95	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
58	LC34	4820	0.95	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
59	LC35	4820	0.46	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
60	IA - End of 4834	4830	4.91	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
61	IA - End of 4832	4830	2.54	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
62	IA - Back CK Upstream Ashburton MD	4830	0.72	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
63	IA - End of 4831	4830	2.89	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
64	BACK CREEK OUTFALL	4830	1.50	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
65	LC37	4820	0.31	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
66	LC36	4820	0.65	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
67	LC38	4820	0.34	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
68	TOORONGA OUTFALL	4823(4824)	3.38	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
69	RIX ST OUTFALL	4825	1.74	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
70	LC39	4820	0.60	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
71	LARA ST OUTFALL	4822	1.24	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
72	LC40	4820	0.86	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
73	LC42	4820	0.47	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
74	LC41	4820	0.64	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
75	LC43	4820	0.75	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
76	LC44	4820	0.41	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
77	MOONGA OUTFALL	4821	1.28	0.8	15	0.9	0.6	0.55	0.45	0.35	0.25
78	LC45	4820	0.83	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25
79	Catchment Outlet	4820	0.40	0.8	10	0.9	0.6	0.55	0.45	0.35	0.25

Table 7-4 Existing Conditions Peak Flows and Corresponding Critical Durations at Key Locations for all ARI's

	5 Year ARI		10 Year ARI		20 Year ARI		50 Year ARI		100 Year ARI	
Location	**Peak Q (m^3/s)**	**Critical Duration**	**Peak Q (m^3/s)**	**Critical Duration**	**Peak Q (m^3/s)**	**Critical Duration**	**Peak Q (m^3/s)**	**Critical Duration**	**Peak Q (m^3/s)**	**Critical Duration**
BLACKBURN MD OUTFALL	21.85	9hr	26.49	9hr	34.38	4.5hr	46.72	2hr	57.49	1hr
LocalCatch3	0.73	2hr	1.00	2hr	1.38	2hr	1.88	2hr	2.31	2hr
LocalCatch4	2.50	2hr	3.13	2hr	4.10	45min	5.25	45min	6.26	45min
LocalCatch1	2.15	2hr	2.67	2hr	3.40	2hr	4.38	45min	5.30	45min
LocalCatch2	1.96	2hr	2.50	2hr	3.24	2hr	4.29	1hr	5.20	1hr
LocalCatch5	1.37	2hr	1.69	2hr	2.14	2hr	2.65	2hr	3.12	45min
LocalCatch6	3.03	2hr	3.75	2hr	4.76	2hr	5.91	2hr	6.94	2hr
LocalCatch7	0.90	2hr	1.20	2hr	1.61	2hr	2.11	2hr	2.54	2hr
BOX HILL SOUTH OUTFALL	11.55	2hr	13.90	2hr	16.40	2hr	18.31	2hr	19.48	2hr
LocalCatch8	1.44	2hr	1.71	2hr	2.10	2hr	2.52	2hr	2.91	2hr
LocalCatch9	0.67	2hr	0.84	1hr	1.08	1hr	1.37	1hr	1.62	1hr
FULTON RD OUTFALL	11.44	4.5hr	13.65	2hr	15.19	6hr	15.98	3hr	16.71	1.5hr
LocalCatch10	1.59	2hr	2.07	2hr	2.73	2hr	3.52	2hr	4.21	2hr
ELEY RD OUTFALL	5.33	2hr	6.30	2hr	7.75	2hr	9.82	1hr	11.88	1hr
LocalCatch11	3.96	2hr	4.97	2hr	6.46	45min	8.44	1hr	10.09	1hr
LocalCatch13	2.72	2hr	3.57	2hr	4.72	2hr	6.04	2hr	7.17	2hr
LocalCatch12	1.57	2hr	2.08	2hr	2.80	2hr	3.66	2hr	4.39	2hr
STOTT ST OUTFALL	4.52	2hr	5.57	1.5hr	7.19	2hr	9.78	2hr	12.02	2hr
LocalCatch14	1.76	2hr	2.29	2hr	3.02	2hr	3.90	2hr	4.66	2hr
LocalCatch16	1.93	2hr	2.58	2hr	3.51	2hr	4.64	2hr	5.57	2hr
LocalCatch15	3.25	2hr	4.16	2hr	5.41	2hr	6.89	2hr	8.17	1hr
McCOMAS ST OUTFALL	4.98	2hr	5.97	2hr	7.47	2hr	9.73	2hr	11.84	2hr
LocalCatch17	3.80	2hr	4.88	2hr	6.39	2hr	8.20	2hr	9.77	2hr

LocalCatch19	3.88	2hr	4.76	2hr	5.97	2hr	7.75	1hr	9.27	45min
LocalCatch20	1.41	2hr	1.92	2hr	2.61	2hr	3.53	2hr	4.36	1hr
LocalCatch18	3.62	2hr	4.57	2hr	6.03	2hr	7.85	1hr	9.50	1hr
BROCKHOFF'S MD OUTFALL	5.36	2hr	6.80	2hr	8.96	2hr	11.84	1hr	13.96	1hr
LocalCatch21	2.80	2hr	3.75	2hr	5.04	2hr	6.61	2hr	8.00	2hr
DAMPER CREEK OUTLET	12.01	2hr	13.03	4.5hr	14.24	2hr	16.23	2hr	18.20	2hr
LocalCatch22	0.60	2hr	0.81	2hr	1.10	2hr	1.46	1hr	1.78	1hr
LocalCatch23	2.53	2hr	3.28	2hr	4.29	2hr	5.48	2hr	6.56	2hr
WINBIRRA PDE OUTFALL	5.81	2hr	7.22	2hr	9.55	2hr	13.47	2hr	16.55	2hr
LocalCatch26	1.34	2hr	1.85	2hr	2.57	2hr	3.45	2hr	4.23	2hr
LocalCatch25	1.62	2hr	2.07	2hr	2.68	2hr	3.39	2hr	4.03	2hr
LocalCatch24	2.29	2hr	3.26	2hr	4.60	2hr	6.29	2hr	7.75	2hr
LocalCatch27	3.32	2hr	4.44	2hr	5.93	2hr	8.00	1hr	9.93	1hr
LocalCatch28	1.93	2hr	2.77	2hr	3.95	2hr	5.43	2hr	6.71	2hr
SCOTCHMANS CREEK OUTFALL	34.12	9hr	39.84	9hr	46.43	9hr	65.52	4.5hr	79.29	4.5hr
LocalCatch29	0.90	2hr	1.22	2hr	1.64	2hr	2.15	2hr	2.60	2hr
MURRUMBEENA MD OUTFALL	22.11	4.5hr	27.80	4.5hr	31.36	2hr	35.61	3hr	39.05	4.5hr
EAST MALVERN OUTFALL	4.08	2hr	5.13	2hr	6.88	2hr	8.46	1hr	10.86	1hr
LocalCatch30	1.48	2hr	2.08	2hr	2.91	2hr	3.95	2hr	4.87	2hr
DARLING RD OUTFALL	3.88	2hr	5.48	2hr	7.78	2hr	10.53	2hr	13.27	2hr
DUNLOP ST OUTFALL	4.58	2hr	7.09	2hr	10.07	2hr	13.50	2hr	16.50	2hr
LocalCatch31	1.30	2hr	1.75	2hr	2.34	2hr	3.04	2hr	3.76	1hr
HEDGELEY DENE OUTFALL	5.99	2hr	7.88	2hr	9.36	2hr	12.18	2hr	15.09	2hr
LocalCatch33	2.01	2hr	2.78	2hr	3.81	2hr	5.04	2hr	6.09	2hr
LocalCatch32	1.10	2hr	1.52	2hr	2.10	2hr	2.85	2hr	3.50	2hr
LocalCatch34	0.86	2hr	1.19	2hr	1.65	2hr	2.28	1.5hr	2.83	2hr
LocalCatch35	2.64	2hr	3.42	2hr	4.56	2hr	6.11	1hr	7.48	1hr
BACK CREEK OUTFALL	46.94	2hr	57.03	2hr	71.06	2hr	95.58	2hr	111.08	2hr

LocalCatch37	2.03	2hr	2.53	2hr	3.23	2hr	4.05	45min	4.82	45min
LocalCatch36	1.67	2hr	2.25	2hr	3.08	2hr	4.08	2hr	4.96	2hr
LocalCatch38	1.12	2hr	1.46	2hr	1.93	2hr	2.47	1.5hr	2.99	1.5hr
TOORONGA RD OUTFALL	18.79	2hr	23.13	2hr	29.70	2hr	39.12	2hr	46.79	2hr
RIX ST OUTFALL	4.57	2hr	5.88	2hr	7.83	2hr	10.87	2hr	13.61	2hr
LocalCatch39	2.88	2hr	3.64	2hr	4.70	2hr	5.95	2hr	7.09	2hr
LARA ST OUTFALL	4.14	2hr	4.77	2hr	5.73	2hr	6.78	1hr	7.70	1hr
LocalCatch40	3.39	2hr	4.47	2hr	6.01	2hr	8.08	1hr	9.98	1hr
LocalCatch42	1.91	2hr	2.44	2hr	3.17	1hr	4.08	1hr	4.88	45min
LocalCatch41	0.98	2hr	1.37	2hr	1.96	2hr	2.75	2hr	3.42	1hr
LocalCatch43	2.96	2hr	4.02	2hr	5.49	2hr	7.26	2hr	8.80	2hr
LocalCatch44	0.99	2hr	1.37	2hr	1.88	2hr	2.51	2hr	3.04	2hr
OUTLET OF MODEL	**177.14**	**9hr**	**214.48**	**9hr**	**261.78**	**9hr**	**318.80**	**3hr**	**372.29**	**2hr**

Table 7-5 RORB Peak Flows – 5 Year Average Recurrence Interval, Existing Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	16.4029	17.4985	18.0685	18.5794	19.1907	20.2483	20.0505	21.8464	19.9147	**21.8464**	**9hr**
LocalCatch3	0.5552	0.6558	0.7034	0.7328	0.497	0.5764	0.4515	0.4419	0.4002	**0.7328**	**2hr**
LocalCatch4	2.2113	2.2415	2.1551	2.5022	1.407	1.3392	0.9897	0.8316	0.8516	**2.5022**	**2hr**
LocalCatch1	1.9711	2.0465	2.0031	2.1466	1.2473	1.2604	0.8892	0.7937	0.7791	**2.1466**	**2hr**
LocalCatch2	1.6486	1.7751	1.8314	1.9637	1.4093	1.404	1.1697	1.0581	0.866	**1.9637**	**2hr**
LocalCatch5	1.183	1.1794	1.3581	1.3726	0.8157	0.7074	0.5586	0.4618	0.4839	**1.3726**	**2hr**
LocalCatch6	2.5587	2.6255	2.561	3.0328	1.7536	1.6897	1.207	1.0541	1.0691	**3.0328**	**2hr**
LocalCatch7	0.655	0.792	0.8086	0.9008	0.5114	0.6016	0.4282	0.4186	0.3997	**0.9008**	**2hr**
BOX HILL SOUTH OUTFALL	10.6357	11.0835	10.9967	11.5527	10.2511	11.1834	9.8959	9.0155	7.3635	**11.5527**	**2hr**
LocalCatch8	1.3075	1.1481	1.3473	1.4367	0.8705	0.6955	0.5339	0.4475	0.477	**1.4367**	**2hr**
LocalCatch9	0.6409	0.6578	0.6528	0.6654	0.3964	0.4221	0.2894	0.2688	0.2555	**0.6654**	**2hr**

FULTON GR OUTFALL	10.0466	10.5423	10.438	10.7772	10.2041	11.4374	10.7778	10.3145	8.8716	**11.4374**	**4.5hr**
LocalCatch10	1.1552	1.3901	1.4119	1.5938	0.9121	1.0772	0.7919	0.7779	0.7341	**1.5938**	**2hr**
ELEY RD OUTFALL	4.7451	4.9975	5.1523	5.3257	4.2992	4.7257	3.3283	3.0152	2.73	**5.3257**	**2hr**
LocalCatch11	3.3834	3.6408	3.7797	3.9619	2.423	2.5065	1.7071	1.5968	1.4826	**3.9619**	**2hr**
LocalCatch13	2.022	2.4185	2.4585	2.7203	1.4663	1.6728	1.2112	1.0612	1.044	**2.7203**	**2hr**
LocalCatch12	1.1465	1.389	1.42	1.5651	0.8773	1.0186	0.7172	0.6662	0.6459	**1.5651**	**2hr**
STOTT ST OUTFALL	3.3272	3.8885	4.319	4.5204	3.0486	3.5862	2.5582	2.4119	2.2788	**4.5204**	**2hr**
LocalCatch14	1.2949	1.4574	1.5236	1.7555	0.9788	1.154	0.8306	0.7846	0.7587	**1.7555**	**2hr**
LocalCatch16	1.5851	1.6906	1.8581	1.9287	1.3358	1.4855	1.0839	1.0249	0.9285	**1.9287**	**2hr**
LocalCatch15	2.7401	2.9832	2.9518	3.2531	2.3031	2.277	1.7245	1.5942	1.372	**3.2531**	**2hr**
McCOMAS ST OUTFALL	4.6436	4.7488	4.7183	4.9779	4.3991	4.9469	4.5269	4.1924	3.5535	**4.9779**	**2hr**
LocalCatch17	3.1261	3.5169	3.6286	3.7951	2.4547	2.6345	1.8945	1.7965	1.6606	**3.7951**	**2hr**
LocalCatch19	3.2881	3.5125	3.5365	3.8798	2.427	2.3846	1.6928	1.5548	1.4083	**3.8798**	**2hr**
LocalCatch20	1.1958	1.2725	1.2828	1.4081	1.0068	1.1236	0.988	0.8811	0.72	**1.4081**	**2hr**
LocalCatch18	2.9967	3.3203	3.5089	3.6193	2.5082	2.5817	1.8726	1.7708	1.6012	**3.6193**	**2hr**
BROCKHOFF'S MD OUTFALL	4.5249	5.0455	5.0163	5.3579	3.779	3.8358	2.7623	2.5902	2.2847	**5.3579**	**2hr**
LocalCatch21	2.09	2.5192	2.5914	2.8016	1.6841	1.9244	1.3564	1.2968	1.2222	**2.8016**	**2hr**
DAMPER CREEK OUTLET	9.8848	11.1898	11.5994	12.0138	11.2915	11.8518	11.5106	10.6332	9.8477	**12.0138**	**2hr**
LocalCatch22	0.5236	0.5616	0.5683	0.6016	0.4406	0.4602	0.3616	0.3273	0.2758	**0.6016**	**2hr**
LocalCatch23	2.0395	2.3458	2.38	2.5251	1.4871	1.6425	1.15	1.0632	1.0093	**2.5251**	**2hr**
WINBIRRA PDE OUTFALL	4.6239	5.1266	5.4094	5.8074	4.3045	4.8007	4.1139	3.6981	2.9599	**5.8074**	**2hr**
LocalCatch26	0.9266	1.1674	1.1854	1.3375	0.7954	0.9269	0.7281	0.7048	0.6556	**1.3375**	**2hr**
LocalCatch25	1.2502	1.456	1.4279	1.6241	0.9044	0.9703	0.6999	0.6233	0.6125	**1.6241**	**2hr**
LocalCatch24	1.9708	2.1239	2.1337	2.2943	1.7376	1.9623	1.6236	1.4724	1.255	**2.2943**	**2hr**
LocalCatch27	3.0598	3.2068	3.1758	3.3217	2.7226	2.8182	2.4454	2.1861	1.7838	**3.3217**	**2hr**
LocalCatch28	1.4472	1.727	1.8714	1.9273	1.3032	1.4982	1.0993	1.0332	0.9542	**1.9273**	**2hr**
SCOTCHMANS CREEK OUTFALL	22.4362	23.3041	23.2804	24.5771	25.9142	27.016	28.2849	34.1176	31.0004	**34.1176**	**9hr**
LocalCatch29	0.6336	0.7893	0.779	0.8984	0.4557	0.5271	0.3833	0.3356	0.3363	**0.8984**	**2hr**

MURRUMBEENA MD OUTFALL	19.787	21.0637	21.3136	21.8885	21.135	22.1055	22.0059	21.7351	20.5244	**22.1055**	**4.5hr**
EAST MALVERN OUTFALL	3.3339	3.6495	3.6888	4.0769	2.9936	3.2961	2.9597	2.666	2.1708	**4.0769**	**2hr**
LocalCatch30	1.0812	1.3262	1.3945	1.4822	0.93	1.0732	0.7793	0.7519	0.7024	**1.4822**	**2hr**
DARLING RD OUTFALL	3.3121	3.5569	3.6804	3.8762	3.1472	3.5288	3.051	2.7748	2.2203	**3.8762**	**2hr**
DUNLOP ST OUTFALL	3.9229	4.1449	4.3265	4.5811	3.3338	3.9104	3.4248	3.046	2.5213	**4.5811**	**2hr**
LocalCatch31	1.0318	1.1703	1.1575	1.3011	0.8767	0.9087	0.6669	0.6067	0.5306	**1.3011**	**2hr**
HEDGELEY DENE OUTFALL	5.2281	5.6569	5.6939	5.9917	4.9941	5.82	4.7173	4.3814	3.7197	**5.9917**	**2hr**
LocalCatch33	1.5947	1.797	1.8149	2.0112	1.3963	1.5017	1.1366	1.0305	0.8913	**2.0112**	**2hr**
LocalCatch32	0.9645	1.0239	1.0075	1.1022	0.8544	0.9708	0.8268	0.7529	0.6418	**1.1022**	**2hr**
LocalCatch34	0.6892	0.7509	0.8234	0.8613	0.6213	0.7149	0.5702	0.5336	0.4738	**0.8613**	**2hr**
LocalCatch35	2.1741	2.3673	2.515	2.6373	1.7405	1.8406	1.3115	1.2247	1.1202	**2.6373**	**2hr**
BACK CREEK OUTFALL	40.4247	44.3102	45.467	46.9433	44.6911	46.035	46.5681	44.1128	38.4084	**46.9433**	**2hr**
LocalCatch37	1.8394	1.7515	1.8057	2.0348	1.1717	1.0573	0.7918	0.6528	0.6825	**2.0348**	**2hr**
LocalCatch36	1.333	1.5243	1.629	1.6663	1.1403	1.2652	0.9358	0.8792	0.7995	**1.6663**	**2hr**
LocalCatch38	0.8531	0.9229	1.0543	1.115	0.6332	0.6592	0.4934	0.4253	0.4365	**1.115**	**2hr**
TOORONGA RD OUTFALL	15.2402	16.8003	17.5074	18.7919	13.7681	15.7748	12.6032	11.4304	9.7917	**18.7919**	**2hr**
RIX ST OUTFALL	3.4929	4.0463	4.3015	4.5695	3.0283	3.4486	2.8053	2.4749	2.0941	**4.5695**	**2hr**
LocalCatch39	2.4507	2.4405	2.5848	2.8781	1.6403	1.6056	1.1789	1.0375	1.0563	**2.8781**	**2hr**
LARA ST OUTFALL	3.3132	3.8838	3.9936	4.1396	2.8725	3.1518	2.1902	2.0021	1.8379	**4.1396**	**2hr**
LocalCatch40	2.8623	3.1184	3.1921	3.3943	2.4226	2.4788	2.0554	1.8471	1.516	**3.3943**	**2hr**
LocalCatch42	1.703	1.8509	1.8157	1.9082	1.0817	1.149	0.814	0.719	0.6914	**1.9082**	**2hr**
LocalCatch41	0.922	0.9631	0.9368	0.9798	0.8541	0.9526	0.8705	0.7807	0.6535	**0.9798**	**2hr**
LocalCatch43	2.2809	2.718	2.8467	2.9598	1.856	2.0702	1.4418	1.3685	1.2797	**2.9598**	**2hr**
LocalCatch44	0.7931	0.8855	0.8992	0.9891	0.6991	0.7484	0.5782	0.5217	0.4478	**0.9891**	**2hr**
OUTLET OF MODEL	93.8899	108.902	128.184	139.446	146.31	145.9	157.984	177.143	151.976	**177.143**	**9hr**

Table 7-6 RORB Peak Flows – 10 Year Average Recurrence Interval, Existing Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	23.1294	24.3685	24.5848	25.7052	24.8276	26.03	24.985	26.4873	23.9645	**26.4873**	**9hr**
LocalCatch3	0.7852	0.9161	0.9683	0.9981	0.6647	0.7634	0.5906	0.5705	0.5137	**0.9981**	**2hr**
LocalCatch4	3.06	2.7985	2.7208	3.13	1.8333	1.6568	1.1988	1.0126	1.0334	**3.13**	**2hr**
LocalCatch1	2.4533	2.567	2.5053	2.6699	1.6206	1.5363	1.0691	0.9546	0.9371	**2.6699**	**2hr**
LocalCatch2	2.1576	2.3428	2.4071	2.495	1.8308	1.7498	1.4233	1.2917	1.0565	**2.495**	**2hr**
LocalCatch5	1.5669	1.5258	1.6764	1.6932	1.0312	0.8603	0.6695	0.5559	0.5787	**1.6932**	**2hr**
LocalCatch6	3.3275	3.304	3.2396	3.7455	2.2282	2.0422	1.4494	1.2666	1.2781	**3.7455**	**2hr**
LocalCatch7	0.904	1.0745	1.0791	1.1951	0.6612	0.7722	0.5428	0.5259	0.5009	**1.1951**	**2hr**
BOX HILL SOUTH OUTFALL	13.441	13.7357	13.5988	13.898	12.5993	13.4113	12.1928	10.9217	8.83	**13.898**	**2hr**
LocalCatch8	1.5638	1.403	1.6377	1.7135	1.0368	0.8196	0.6278	0.5238	0.5547	**1.7135**	**2hr**
LocalCatch9	0.8301	0.8396	0.823	0.8315	0.4989	0.5146	0.3495	0.3243	0.3083	**0.8396**	**1hr**
FULTON GR OUTFALL	12.7929	13.1233	13.0893	13.6462	12.4666	13.6389	12.9445	12.2289	10.3798	**13.6462**	**2hr**
LocalCatch10	1.6359	1.8428	1.8422	2.0666	1.1893	1.3588	0.9863	0.9586	0.9024	**2.0666**	**2hr**
ELEY RD OUTFALL	5.5678	6.0254	6.0198	6.2958	5.3354	5.3043	3.9812	3.6384	3.2964	**6.2958**	**2hr**
LocalCatch11	4.7342	4.8523	4.8722	4.9743	3.0018	3.092	2.0964	1.9602	1.8193	**4.9743**	**2hr**
LocalCatch13	2.7686	3.2459	3.2008	3.5725	1.9607	2.0965	1.5078	1.316	1.2947	**3.5725**	**2hr**
LocalCatch12	1.5811	1.8834	1.8873	2.0812	1.1412	1.2967	0.9249	0.8349	0.8083	**2.0812**	**2hr**
STOTT ST OUTFALL	4.5676	5.3695	5.567	5.5449	3.9084	4.4554	3.1903	2.9933	2.814	**5.567**	**1.5hr**
LocalCatch14	1.8357	1.9513	2.041	2.2861	1.3094	1.4491	1.0408	0.9644	0.9311	**2.2861**	**2hr**
LocalCatch16	2.0943	2.3296	2.503	2.5847	1.7066	1.8643	1.3299	1.2592	1.1416	**2.5847**	**2hr**
LocalCatch15	3.622	3.9011	3.8177	4.1574	2.9044	2.8013	2.0854	1.9336	1.6653	**4.1574**	**2hr**
McCOMAS ST OUTFALL	5.5014	5.6448	5.7437	5.9673	5.3653	5.9255	5.4515	5.0707	4.3415	**5.9673**	**2hr**
LocalCatch17	4.102	4.6158	4.682	4.8795	3.0316	3.2578	2.2941	2.1806	2.0163	**4.8795**	**2hr**
LocalCatch19	4.3954	4.4832	4.4654	4.7577	2.9644	2.8738	2.025	1.865	1.6865	**4.7577**	**2hr**
LocalCatch20	1.6439	1.781	1.7959	1.9168	1.3896	1.4771	1.2389	1.11	0.9063	**1.9168**	**2hr**

LocalCatch18	3.9377	4.4241	4.5603	4.5727	3.1088	3.1797	2.2645	2.1471	1.9441	**4.5727**	**2hr**
BROCKHOFF'S MD OUTFALL	5.8969	6.4102	6.3256	6.8012	4.583	4.5586	3.3527	3.138	2.7739	**6.8012**	**2hr**
LocalCatch21	2.8976	3.4132	3.4485	3.7539	2.1447	2.4389	1.7186	1.6212	1.5277	**3.7539**	**2hr**
DAMPER CREEK OUTLET	12.3476	12.5918	12.7778	12.9037	12.857	13.0264	12.9693	12.7875	12.1178	**13.0264**	**4.5hr**
LocalCatch22	0.7041	0.764	0.7625	0.8101	0.5855	0.5847	0.4498	0.4107	0.3479	**0.8101**	**2hr**
LocalCatch23	2.7654	3.0951	3.0763	3.2811	1.8408	2.0279	1.4176	1.3055	1.2391	**3.2811**	**2hr**
WINBIRRA PDE OUTFALL	6.4425	6.8791	6.9596	7.2245	5.4872	5.9257	5.1967	4.5946	3.6815	**7.2245**	**2hr**
LocalCatch26	1.3244	1.6381	1.6368	1.8537	1.0511	1.228	0.9357	0.9093	0.8462	**1.8537**	**2hr**
LocalCatch25	1.7547	1.8811	1.8192	2.0726	1.1945	1.1953	0.8566	0.7615	0.7482	**2.0726**	**2hr**
LocalCatch24	2.7852	2.9504	2.9903	3.2562	2.3815	2.5792	2.0699	1.8806	1.6034	**3.2562**	**2hr**
LocalCatch27	4.0694	4.3123	4.1814	4.4359	3.4765	3.4996	3.0446	2.7209	2.1759	**4.4359**	**2hr**
LocalCatch28	2.1	2.5372	2.6688	2.7687	1.7565	1.9869	1.426	1.3443	1.2423	**2.7687**	**2hr**
SCOTCHMANS CREEK OUTFALL	28.9312	30.0103	29.842	31.553	30.2629	30.9958	33.6735	39.8377	34.9779	**39.8377**	**9hr**
LocalCatch29	0.8963	1.0785	1.0468	1.2153	0.6333	0.6799	0.5083	0.4297	0.431	**1.2153**	**2hr**
MURRUMBEENA MD OUTFALL	26.1655	26.6083	26.6334	27.3202	26.0714	27.8001	26.4306	26.2138	23.9831	**27.8001**	**4.5hr**
EAST MALVERN OUTFALL	4.5069	4.8478	4.8655	5.1334	3.8305	4.345	3.7827	3.3427	2.7274	**5.1334**	**2hr**
LocalCatch30	1.5794	1.8912	1.9465	2.0798	1.2408	1.4216	1.0185	0.9792	0.9134	**2.0798**	**2hr**
DARLING RD OUTFALL	4.523	5.0016	5.0494	5.4787	4.0777	4.4488	3.8834	3.4595	2.7614	**5.4787**	**2hr**
DUNLOP ST OUTFALL	5.6074	6.171	6.294	7.093	4.7582	5.5849	4.3261	3.8305	3.1785	**7.093**	**2hr**
LocalCatch31	1.4432	1.5891	1.609	1.7502	1.1487	1.1513	0.8321	0.7643	0.6714	**1.7502**	**2hr**
HEDGELEY DENE OUTFALL	7.2506	7.6204	7.5958	7.884	6.8607	7.523	6.271	5.5905	4.6355	**7.884**	**2hr**
LocalCatch33	2.2487	2.5185	2.5368	2.782	1.873	1.9335	1.4323	1.3086	1.1359	**2.782**	**2hr**
LocalCatch32	1.3351	1.396	1.405	1.5213	1.1442	1.2574	1.0374	0.9442	0.8033	**1.5213**	**2hr**
LocalCatch34	0.9595	1.0719	1.1637	1.1938	0.8384	0.9412	0.7334	0.6841	0.6073	**1.1938**	**2hr**
LocalCatch35	2.9065	3.2373	3.3392	3.4225	2.2054	2.2993	1.6213	1.5149	1.3904	**3.4225**	**2hr**
BACK CREEK OUTFALL	50.3753	54.0271	55.7662	57.0326	54.7447	54.5288	55.0026	51.9884	46.28	**57.0326**	**2hr**
LocalCatch37	2.4448	2.2154	2.2981	2.5347	1.4996	1.3033	0.9583	0.794	0.8273	**2.5347**	**2hr**
LocalCatch36	1.8146	2.1157	2.1995	2.2514	1.4671	1.6166	1.1703	1.0981	0.9984	**2.2514**	**2hr**

LocalCatch38	1.1903	1.2433	1.4136	1.4595	0.8434	0.8337	0.6251	0.5293	0.5423	**1.4595**	**2hr**
TOORONGA RD OUTFALL	19.9319	21.81	22.0623	23.1265	18.0995	19.281	15.3796	14.0864	12.0764	**23.1265**	**2hr**
RIX ST OUTFALL	4.7462	5.4035	5.5818	5.8772	4.1189	4.4395	3.5133	3.1042	2.6378	**5.8772**	**2hr**
LocalCatch39	3.2304	3.163	3.3565	3.6387	2.1291	2.007	1.4579	1.2779	1.2955	**3.6387**	**2hr**
LARA ST OUTFALL	4.1031	4.4957	4.6024	4.7659	3.659	3.8318	2.6577	2.4725	2.2711	**4.7659**	**2hr**
LocalCatch40	3.8811	4.1879	4.326	4.4685	3.2015	3.1782	2.5637	2.2922	1.8774	**4.4685**	**2hr**
LocalCatch42	2.31	2.4266	2.3264	2.4362	1.3578	1.431	1.0019	0.8879	0.8543	**2.4362**	**2hr**
LocalCatch41	1.289	1.3428	1.3077	1.3701	1.1362	1.2492	1.1272	0.9995	0.8193	**1.3701**	**2hr**
LocalCatch43	3.2336	3.765	3.8444	4.018	2.3769	2.6553	1.8343	1.7238	1.6134	**4.018**	**2hr**
LocalCatch44	1.1123	1.2499	1.251	1.365	0.9349	0.9715	0.7271	0.6612	0.5692	**1.365**	**2hr**
OUTLET OF MODEL	128.098	146.466	170.069	184.501	192.167	190.017	200.041	214.475	184.72	**214.475**	**9hr**

Table 7-7 RORB Peak Flows – 20 Year Average Recurrence Interval, Existing Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	31.365	33.0304	32.8512	34.3226	32.4848	34.3764	33.2743	32.612	29.0696	34.3764	4.5hr
LocalCatch3	1.1208	1.2931	1.3439	1.3835	0.8975	1.0172	0.7842	0.7441	0.6691	1.3835	2hr
LocalCatch4	4.1031	3.5408	3.4734	4.0189	2.4181	2.0803	1.4816	1.2547	1.2822	4.1031	45min
LocalCatch1	3.3262	3.2522	3.1759	3.4026	2.1325	1.9046	1.3129	1.1743	1.1549	3.4026	2hr
LocalCatch2	2.9717	3.1861	3.1769	3.2397	2.4044	2.2084	1.7714	1.6073	1.319	3.2397	2hr
LocalCatch5	2.0776	1.9927	2.0925	2.1424	1.3254	1.0648	0.822	0.6842	0.7089	2.1424	2hr
LocalCatch6	4.3983	4.206	4.1353	4.7565	2.8823	2.5091	1.7833	1.5519	1.5656	4.7565	2hr
LocalCatch7	1.3301	1.4623	1.4448	1.6089	0.9241	1.0009	0.706	0.6705	0.6392	1.6089	2hr
BOX HILL SOUTH OUTFALL	15.4563	15.7667	15.9139	16.3974	14.8662	15.1054	14.7572	13.4136	10.7821	16.3974	2hr
LocalCatch8	1.9122	1.7483	2.0243	2.0975	1.2638	0.981	0.7581	0.6284	0.6622	2.0975	2hr
LocalCatch9	1.0718	1.0808	1.0496	1.0678	0.667	0.6389	0.4316	0.3992	0.3809	1.0808	1hr
FULTON GR OUTFALL	14.5795	14.4845	14.3291	14.4086	14.6331	14.7662	15.1851	14.4345	12.2275	15.1851	6hr
LocalCatch10	2.301	2.4678	2.4251	2.7263	1.6189	1.737	1.2548	1.2037	1.1334	2.7263	2hr
ELEY RD OUTFALL	7.0898	7.5162	7.2901	7.7481	6.251	6.0766	4.8437	4.4825	4.0684	7.7481	2hr
LocalCatch11	6.458	6.4548	6.331	6.3706	3.7535	3.8718	2.621	2.4452	2.2808	6.458	45min
LocalCatch13	3.9574	4.3666	4.1739	4.7203	2.7053	2.6593	1.9045	1.6583	1.6374	4.7203	2hr
LocalCatch12	2.2835	2.5623	2.5159	2.8027	1.5955	1.6659	1.1827	1.0614	1.0299	2.8027	2hr
STOTT ST OUTFALL	6.0721	6.7595	6.9049	7.1861	5.185	5.5771	4.0044	3.7608	3.5455	7.1861	2hr
LocalCatch14	2.5229	2.6349	2.7508	3.0247	1.7733	1.8399	1.3168	1.2072	1.1669	3.0247	2hr
LocalCatch16	2.8679	3.2404	3.3741	3.5072	2.2041	2.3628	1.6711	1.5761	1.4336	3.5072	2hr
LocalCatch15	4.7881	5.1259	5.0763	5.4084	3.7057	3.4899	2.5849	2.3911	2.0691	5.4084	2hr
McCOMAS ST OUTFALL	6.6927	7.2452	7.305	7.4715	6.4928	6.8903	6.4397	5.9377	5.1804	7.4715	2hr
LocalCatch17	5.455	6.1184	6.0992	6.3921	3.8904	4.0866	2.8471	2.6988	2.5049	6.3921	2hr
LocalCatch19	5.9206	5.9317	5.673	5.9676	3.6694	3.5214	2.4875	2.2806	2.0704	5.9676	2hr
LocalCatch20	2.3239	2.4604	2.5169	2.6086	1.9236	1.9393	1.5811	1.4193	1.1621	2.6086	2hr
LocalCatch18	5.3495	5.9237	5.9628	6.0252	3.9027	3.9816	2.8076	2.6546	2.415	6.0252	2hr

BROCKHOFF'S MD OUTFALL	7.9323	8.7073	8.3661	8.9624	5.9009	5.6389	4.1209	3.8811	3.4417	8.9624	2hr
LocalCatch21	4.0716	4.6663	4.6308	5.0421	2.893	3.16	2.2056	2.0586	1.9459	5.0421	2hr
DAMPER CREEK OUTLET	12.9622	13.4085	13.9255	14.2402	14.1873	14.2001	14.0442	13.3622	12.9652	14.2402	2hr
LocalCatch22	0.9931	1.0676	1.0229	1.1025	0.7857	0.7563	0.5691	0.5225	0.4466	1.1025	2hr
LocalCatch23	3.7238	4.1258	4.0223	4.2944	2.5342	2.5695	1.782	1.6318	1.5547	4.2944	2hr
WINBIRRA PDE OUTFALL	8.2629	8.8607	9.2085	9.5481	6.9975	7.589	6.5916	5.7886	4.6599	9.5481	2hr
LocalCatch26	2.0147	2.2903	2.2646	2.5679	1.4161	1.6601	1.2297	1.1853	1.1069	2.5679	2hr
LocalCatch25	2.416	2.4641	2.3627	2.6796	1.6108	1.5117	1.0708	0.9479	0.9341	2.6796	2hr
LocalCatch24	3.911	4.2506	4.2905	4.5984	3.295	3.4421	2.6725	2.4308	2.0799	4.5984	2hr
LocalCatch27	5.6094	5.871	5.7353	5.9331	4.4871	4.4409	3.8587	3.4487	2.7272	5.9331	2hr
LocalCatch28	3.1305	3.6802	3.7691	3.9484	2.3806	2.6662	1.8685	1.7623	1.6348	3.9484	2hr
SCOTCHMANS CREEK OUTFALL	38.1662	39.9145	39.2708	41.3448	36.4054	43.2451	43.9063	46.426	41.6444	46.426	9hr
LocalCatch29	1.396	1.4737	1.4449	1.6437	0.91	0.8941	0.6615	0.5561	0.5599	1.6437	2hr
MURRUMBEENA MD OUTFALL	30.5817	31.328	31.1519	31.3602	30.0904	29.9994	29.8645	29.2411	27.967	31.3602	2hr
EAST MALVERN OUTFALL	6.2057	6.6261	6.5975	6.882	5.0821	5.3255	4.794	4.2605	3.4896	6.882	2hr
LocalCatch30	2.2937	2.6952	2.7179	2.9114	1.6725	1.9098	1.3471	1.2852	1.2011	2.9114	2hr
DARLING RD OUTFALL	6.4473	7.0907	7.3628	7.777	5.3288	5.83	5.079	4.3663	3.5061	7.777	2hr
DUNLOP ST OUTFALL	7.7996	8.8762	9.4782	10.073	7.0892	7.6469	5.6744	4.9285	4.0638	10.073	2hr
LocalCatch31	1.9869	2.1592	2.227	2.3394	1.518	1.486	1.0561	0.9766	0.8648	2.3394	2hr
HEDGELEY DENE OUTFALL	8.8536	9.1303	9.2203	9.3636	8.6167	8.8507	8.1054	7.1559	5.8694	9.3636	2hr
LocalCatch33	3.2022	3.5123	3.5982	3.8121	2.5239	2.5246	1.8317	1.6814	1.4701	3.8121	2hr
LocalCatch32	1.8542	1.939	1.9943	2.104	1.5585	1.6611	1.3247	1.203	1.0257	2.104	2hr
LocalCatch34	1.3659	1.5568	1.6477	1.6541	1.1434	1.2608	0.9582	0.8875	0.7897	1.6541	2hr
LocalCatch35	4.0298	4.4771	4.4594	4.5558	2.8393	2.9418	2.0459	1.9063	1.7608	4.5558	2hr
BACK CREEK OUTFALL	60.7749	66.2474	68.995	71.0611	65.1031	65.0055	65.5167	62.2033	54.83	71.0611	2hr
LocalCatch37	3.1931	2.8333	2.9514	3.2274	1.9619	1.6225	1.1868	0.9878	1.0241	3.2274	2hr
LocalCatch36	2.5575	2.9302	2.9743	3.0752	1.9176	2.0758	1.4939	1.3953	1.2689	3.0752	2hr
LocalCatch38	1.6681	1.6724	1.8987	1.9269	1.1472	1.0595	0.795	0.6703	0.686	1.9269	2hr

TOORONGA RD OUTFALL	25.7317	27.8537	29.0286	29.697	21.9361	22.5843	18.4491	17.1284	14.9831	29.697	2hr
RIX ST OUTFALL	6.7305	7.3941	7.335	7.8276	5.5961	5.6264	4.518	3.9303	3.3348	7.8276	2hr
LocalCatch39	4.3238	4.1167	4.3807	4.7011	2.8293	2.534	1.8453	1.6031	1.6204	4.7011	2hr
LARA ST OUTFALL	5.3215	5.5845	5.5029	5.7267	4.4141	4.5015	3.333	3.1107	2.863	5.7267	2hr
LocalCatch40	5.3321	5.8308	5.8548	6.0051	4.3105	4.0843	3.2309	2.895	2.3738	6.0051	2hr
LocalCatch42	3.0335	3.1718	3.0037	3.1669	1.8774	1.8002	1.2563	1.1151	1.0757	3.1718	1hr
LocalCatch41	1.8293	1.8971	1.8586	1.9616	1.5306	1.6325	1.4719	1.2998	1.0468	1.9616	2hr
LocalCatch43	4.5402	5.1833	5.1849	5.4914	3.0861	3.4161	2.3749	2.2046	2.066	5.4914	2hr
LocalCatch44	1.5793	1.739	1.7687	1.8803	1.2616	1.2598	0.9297	0.8509	0.7346	1.8803	2hr
OUTLET OF MODEL	175.325	197.65	223.852	239.012	249.406	246.473	252.543	261.784	226.19	261.784	9hr

Table 7-8 RORB Peak Flows – 50 Year Average Recurrence Interval, Existing Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	43.666	46.4769	45.2771	46.7247	40.5902	45.1847	40.501	40.7478	36.7921	**46.7247**	**2hr**
LocalCatch3	1.5686	1.8132	1.8348	1.8808	1.1782	1.2916	1.0015	0.9268	0.8327	**1.8808**	**2hr**
LocalCatch4	5.2525	4.5259	4.3715	5.0298	3.0927	2.5038	1.7584	1.499	1.5194	**5.2525**	**45min**
LocalCatch1	4.3765	4.0746	3.9746	4.2456	2.7421	2.2771	1.5515	1.3888	1.3621	**4.3765**	**45min**
LocalCatch2	3.9963	4.2899	4.1393	4.2346	3.0628	2.666	2.128	1.9138	1.5869	**4.2899**	**1hr**
LocalCatch5	2.629	2.5677	2.5622	2.6519	1.6471	1.2679	0.9705	0.804	0.8301	**2.6519**	**2hr**
LocalCatch6	5.6015	5.3005	5.1935	5.9111	3.5714	2.9576	2.115	1.8355	1.8341	**5.9111**	**2hr**
LocalCatch7	1.8384	1.9696	1.9027	2.1106	1.2478	1.2395	0.8738	0.8198	0.7789	**2.1106**	**2hr**
BOX HILL SOUTH OUTFALL	17.7867	18.0647	18.2075	18.3147	17.0438	17.1388	16.6013	15.2331	12.6476	**18.3147**	**2hr**
LocalCatch8	2.3343	2.1686	2.4597	2.5213	1.4917	1.1327	0.881	0.722	0.7556	**2.5213**	**2hr**
LocalCatch9	1.3477	1.3718	1.3224	1.342	0.8712	0.7618	0.5133	0.4728	0.4506	**1.3718**	**1hr**
FULTON GR OUTFALL	15.2124	15.2632	15.5419	15.6589	15.9791	15.8088	15.7253	15.1751	13.8227	**15.9791**	**3hr**
LocalCatch10	3.0699	3.2899	3.17	3.5232	2.1401	2.128	1.55	1.4542	1.3662	**3.5232**	**2hr**
ELEY RD OUTFALL	9.3026	9.8205	9.2692	9.7453	7.4945	6.9022	5.8465	5.1755	4.7267	**9.8205**	**1hr**
LocalCatch11	8.3696	8.4412	8.0779	7.9967	4.9338	4.6277	3.1822	2.9293	2.7356	**8.4412**	**1hr**
LocalCatch13	5.4172	5.7866	5.4301	6.0351	3.6089	3.2257	2.3053	2.0083	1.9746	**6.0351**	**2hr**
LocalCatch12	3.2023	3.4402	3.2927	3.6573	2.1538	2.0424	1.4495	1.2931	1.2495	**3.6573**	**2hr**
STOTT ST OUTFALL	8.5884	9.5131	9.3045	9.7779	6.513	6.5943	4.9838	4.5516	4.2101	**9.7779**	**2hr**
LocalCatch14	3.3219	3.5444	3.6361	3.9004	2.3303	2.2387	1.6041	1.4513	1.3976	**3.9004**	**2hr**
LocalCatch16	3.8902	4.4872	4.4672	4.6367	2.7726	2.8604	2.0343	1.8909	1.7218	**4.6367**	**2hr**
LocalCatch15	6.2702	6.7201	6.636	6.8885	4.5957	4.1676	3.1001	2.8338	2.4694	**6.8885**	**2hr**
McCOMAS ST OUTFALL	8.5707	9.4266	9.4156	9.7298	8.1649	7.6791	7.4267	6.8227	5.796	**9.7298**	**2hr**
LocalCatch17	7.1603	8.0529	7.8427	8.2037	5.0959	4.917	3.4455	3.2085	2.9808	**8.2037**	**2hr**
LocalCatch19	7.719	7.7535	7.0915	7.3794	4.4221	4.1491	2.9704	2.6788	2.4394	**7.7535**	**1hr**
LocalCatch20	3.2158	3.4777	3.4425	3.5321	2.5623	2.4127	1.9388	1.7297	1.4325	**3.5321**	**2hr**

LocalCatch18	7.116	7.854	7.6742	7.7664	4.796	4.781	3.3865	3.1506	2.8723	**7.854**	**1hr**
BROCKHOFF'S MD OUTFALL	10.891	11.8376	11.1506	11.6563	7.6254	6.8354	5.0585	4.5446	4.0815	**11.8376**	**1hr**
LocalCatch21	5.6572	6.3102	6.1053	6.6066	3.936	3.875	2.7099	2.5085	2.3673	**6.6066**	**2hr**
DAMPER CREEK OUTLET	14.5891	15.2398	15.9133	16.2297	15.9623	15.7775	15.785	14.8941	13.8103	**16.2297**	**2hr**
LocalCatch22	1.377	1.4627	1.4033	1.4541	1.0172	0.9239	0.6941	0.6357	0.5486	**1.4627**	**1hr**
LocalCatch23	4.9049	5.4305	5.1672	5.4819	3.3801	3.0904	2.147	1.9622	1.8648	**5.4819**	**2hr**
WINBIRRA PDE OUTFALL	11.8087	12.9885	12.4626	13.4739	8.987	9.1268	7.5917	6.8751	5.6463	**13.4739**	**2hr**
LocalCatch26	3.0294	3.1556	3.0691	3.4486	1.9854	2.1163	1.5692	1.4812	1.383	**3.4486**	**2hr**
LocalCatch25	3.1938	3.1981	3.0597	3.385	2.1055	1.8153	1.2827	1.1373	1.1138	**3.385**	**2hr**
LocalCatch24	5.5474	6.0701	6.0558	6.2873	4.3794	4.3141	3.3066	2.9976	2.5804	**6.2873**	**2hr**
LocalCatch27	7.7217	8.0035	7.8073	7.8129	5.7444	5.5726	4.676	4.175	3.335	**8.0035**	**1hr**
LocalCatch28	4.5294	5.2215	5.172	5.4258	3.1046	3.3603	2.3632	2.2043	2.0443	**5.4258**	**2hr**
SCOTCHMANS CREEK OUTFALL	51.7384	54.3923	52.7781	55.392	62.945	65.5164	61.6405	58.2672	53.7868	**65.5164**	**4.5hr**
LocalCatch29	2.0033	1.975	1.9348	2.1486	1.2471	1.111	0.8167	0.69	0.6896	**2.1486**	**2hr**
MURRUMBEENA MD OUTFALL	33.3718	34.0406	33.9292	35.0211	35.6114	35.523	35.3914	32.6112	30.8667	**35.6114**	**3hr**
EAST MALVERN OUTFALL	8.1839	8.4563	8.3316	8.4222	6.4279	6.5129	5.747	5.012	4.2915	**8.4563**	**1hr**
LocalCatch30	3.2473	3.7739	3.7003	3.9529	2.2645	2.4126	1.7156	1.611	1.5023	**3.9529**	**2hr**
DARLING RD OUTFALL	9.1763	10.2013	10.4562	10.5332	7.6916	7.5764	6.3129	5.3963	4.2639	**10.5332**	**2hr**
DUNLOP ST OUTFALL	11.0918	12.5074	13.228	13.5037	9.2277	9.1264	6.6972	6.0767	5.0978	**13.5037**	**2hr**
LocalCatch31	2.8269	3.0275	2.9915	3.0393	1.9286	1.8084	1.2987	1.1936	1.0617	**3.0393**	**2hr**
HEDGELEY DENE OUTFALL	10.8148	11.9645	11.7248	12.1753	9.8505	9.998	9.6133	8.3782	7.1924	**12.1753**	**2hr**
LocalCatch33	4.433	4.8275	4.9262	5.0367	3.2648	3.1025	2.2561	2.0651	1.8164	**5.0367**	**2hr**
LocalCatch32	2.5819	2.749	2.7752	2.8545	2.0535	2.07	1.6256	1.4676	1.257	**2.8545**	**2hr**
LocalCatch34	1.9392	2.2265	2.2766	2.2759	1.5046	1.5888	1.2018	1.1007	0.9817	**2.2766**	**1.5hr**
LocalCatch35	5.5267	6.1142	5.8261	5.9681	3.632	3.565	2.4965	2.3034	2.1336	**6.1142**	**1hr**
BACK CREEK OUTFALL	84.2171	91.0779	92.7527	95.5781	82.9505	80.5682	78.084	71.5807	63.1252	**95.5781**	**2hr**
LocalCatch37	4.054	3.6438	3.7106	4.0161	2.4853	1.9536	1.4054	1.1765	1.2124	**4.054**	**45min**
LocalCatch36	3.5284	4.0301	3.946	4.0793	2.4346	2.5644	1.8384	1.6968	1.5469	**4.0793**	**2hr**

LocalCatch38	2.2219	2.2642	2.4739	2.4705	1.5058	1.2968	0.9663	0.816	0.8289	**2.4739**	**1.5hr**
TOORONGA RD OUTFALL	34.5973	38.0846	37.1538	39.1228	27.493	26.8908	21.753	19.6096	17.7716	**39.1228**	**2hr**
RIX ST OUTFALL	9.5875	10.5568	10.1005	10.8716	7.2547	6.687	5.5745	4.7876	4.0382	**10.8716**	**2hr**
LocalCatch39	5.647	5.3231	5.5992	5.9489	3.6464	3.0759	2.2261	1.9339	1.9403	**5.9489**	**2hr**
LARA ST OUTFALL	6.6387	6.7829	6.5848	6.7343	5.3763	5.2489	4.0768	3.7223	3.4507	**6.7829**	**1hr**
LocalCatch40	7.4233	8.0814	7.7637	8.0362	5.6	5.0302	3.9034	3.4873	2.8915	**8.0814**	**1hr**
LocalCatch42	3.9096	4.0827	3.8092	4.0314	2.5098	2.1806	1.5052	1.3446	1.2963	**4.0827**	**1hr**
LocalCatch41	2.6302	2.7169	2.6458	2.7498	2.0708	2.096	1.8336	1.6098	1.3111	**2.7498**	**2hr**
LocalCatch43	6.2104	7.0556	6.8457	7.2573	4.2417	4.2251	2.9262	2.6965	2.5278	**7.2573**	**2hr**
LocalCatch44	2.1928	2.405	2.4263	2.506	1.6377	1.5625	1.1461	1.0432	0.9076	**2.506**	**2hr**
OUTLET OF MODEL	242.781	268.799	299.653	315.57	318.8	311.214	312.908	314.895	269.155	**318.8**	**3hr**

Table 7-9 RORB Peak Flows – 100 Year Average Recurrence Interval, Existing Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	53.9853	57.4912	55.8211	57.4259	49.7611	52.7209	46.7295	46.1279	42.0156	**57.4912**	**1hr**
LocalCatch3	1.9533	2.2605	2.261	2.3062	1.4268	1.5513	1.1878	1.0907	0.9831	**2.3062**	**2hr**
LocalCatch4	6.2611	5.3577	5.1591	5.9262	3.71	2.9183	2.0246	1.7283	1.7603	**6.2611**	**45min**
LocalCatch1	5.3047	4.8166	4.6872	5.0008	3.2934	2.6553	1.7822	1.5951	1.5731	**5.3047**	**45min**
LocalCatch2	4.8459	5.1995	4.9533	5.0834	3.6565	3.1292	2.4641	2.2115	1.8437	**5.1995**	**1hr**
LocalCatch5	3.1171	3.0489	2.9984	3.0965	1.9526	1.4735	1.1151	0.9248	0.9566	**3.1171**	**45min**
LocalCatch6	6.6905	6.2586	6.138	6.9363	4.2355	3.4272	2.4378	2.1067	2.1138	**6.9363**	**2hr**
LocalCatch7	2.2808	2.4017	2.2959	2.5401	1.5414	1.4684	1.0254	0.9562	0.9121	**2.5401**	**2hr**
BOX HILL SOUTH OUTFALL	18.958	19.3562	19.4708	19.4835	18.2943	18.3206	17.3696	16.6636	14.1305	**19.4835**	**2hr**
LocalCatch8	2.7364	2.552	2.876	2.9149	1.7193	1.2981	1.0071	0.8219	0.8609	**2.9149**	**2hr**
LocalCatch9	1.6155	1.6233	1.5655	1.5845	1.0515	0.8899	0.5941	0.5439	0.5209	**1.6233**	**1hr**
FULTON GR OUTFALL	15.6605	16.056	16.7103	16.5834	16.2162	15.981	15.5786	15.4457	14.9255	**16.7103**	**1.5hr**
LocalCatch10	3.7578	3.9885	3.8453	4.2131	2.6152	2.5092	1.812	1.6868	1.5906	**4.2131**	**2hr**
ELEY RD OUTFALL	11.371	11.8752	11.211	11.5853	8.5397	7.7449	6.6489	5.8517	5.1104	**11.8752**	**1hr**
LocalCatch11	9.9669	10.0883	9.6075	9.4531	6.0808	5.4188	3.7029	3.3867	3.1819	**10.0883**	**1hr**
LocalCatch13	6.7042	6.982	6.5614	7.1719	4.4238	3.78	2.6732	2.3307	2.303	**7.1719**	**2hr**
LocalCatch12	3.9794	4.184	3.9552	4.3895	2.6581	2.4061	1.69	1.5054	1.4617	**4.3895**	**2hr**
STOTT ST OUTFALL	10.8915	11.9304	11.4218	12.0235	7.819	7.8366	5.8752	5.2939	4.8567	**12.0235**	**2hr**
LocalCatch14	4.04	4.3036	4.4105	4.6559	2.8398	2.618	1.8657	1.6805	1.6244	**4.6559**	**2hr**
LocalCatch16	4.6954	5.5421	5.3916	5.5748	3.3596	3.3459	2.3617	2.1892	2.0038	**5.5748**	**2hr**
LocalCatch15	7.7099	8.1699	7.9618	8.1559	5.3884	4.8731	3.5826	3.2641	2.8582	**8.1699**	**1hr**
McCOMAS ST OUTFALL	10.7022	11.6933	11.6106	11.8398	9.7998	9.032	8.025	7.4841	6.4178	**11.8398**	**2hr**
LocalCatch17	8.7761	9.7065	9.3483	9.769	6.1836	5.7513	3.9899	3.6993	3.4541	**9.769**	**2hr**
LocalCatch19	9.2718	9.2053	8.3329	8.6416	5.3606	4.8295	3.4192	3.0717	2.8128	**9.2718**	**45min**
LocalCatch20	3.9327	4.3589	4.2075	4.324	3.1239	2.8559	2.2613	2.0194	1.6816	**4.3589**	**1hr**

LocalCatch18	8.5995	9.4985	9.1524	9.2552	5.8361	5.5841	3.9202	3.6294	3.3283	**9.4985**	**1hr**
BROCKHOFF'S MD OUTFALL	13.4072	13.9641	13.4607	13.7846	9.1372	7.9825	5.8831	5.2813	4.6874	**13.9641**	**1hr**
LocalCatch21	7.0063	7.6934	7.3756	7.9981	4.8551	4.5956	3.1869	2.9338	2.779	**7.9981**	**2hr**
DAMPER CREEK OUTLET	16.0746	17.0205	17.7548	18.2028	17.3865	17.2428	17.1515	16.0663	14.7867	**18.2028**	**2hr**
LocalCatch22	1.677	1.7779	1.7216	1.7598	1.2133	1.093	0.8141	0.7436	0.6455	**1.7779**	**1hr**
LocalCatch23	6.0107	6.5128	6.1608	6.558	4.1241	3.6352	2.5018	2.2797	2.1764	**6.558**	**2hr**
WINBIRRA PDE OUTFALL	15.0815	16.1384	15.9044	16.55	10.7263	10.8009	8.6516	7.5786	6.5654	**16.55**	**2hr**
LocalCatch26	3.7926	3.882	3.791	4.2302	2.4866	2.5613	1.8767	1.751	1.6399	**4.2302**	**2hr**
LocalCatch25	3.8642	3.8138	3.6657	4.0342	2.5433	2.1323	1.4922	1.3194	1.2972	**4.0342**	**2hr**
LocalCatch24	6.8739	7.5446	7.5732	7.746	5.3078	5.1642	3.8996	3.5295	3.0512	**7.746**	**2hr**
LocalCatch27	9.3218	9.9316	9.5026	9.5947	7.0497	6.6309	5.4656	4.8857	3.9096	**9.9316**	**1hr**
LocalCatch28	5.6309	6.5087	6.3649	6.7059	3.8752	4.0338	2.8118	2.6076	2.4288	**6.7059**	**2hr**
SCOTCHMANS CREEK OUTFALL	63.2642	65.2225	63.7504	71.7923	77.7434	79.2916	78.8196	74.5514	66.6827	**79.2916**	**4.5hr**
LocalCatch29	2.4809	2.3919	2.3567	2.5979	1.5424	1.3253	0.9607	0.8124	0.815	**2.5979**	**2hr**
MURRUMBEENA MD OUTFALL	35.5142	36.2512	36.8659	38.1717	39.0062	39.0525	38.4777	36.2918	33.2102	**39.0525**	**4.5hr**
EAST MALVERN OUTFALL	9.8405	10.8624	9.8023	10.7141	7.8747	7.7617	6.7552	5.7814	4.908	**10.8624**	**1hr**
LocalCatch30	4.0839	4.6803	4.5406	4.8668	2.8531	2.9028	2.0476	1.9072	1.7845	**4.8668**	**2hr**
DARLING RD OUTFALL	11.6847	12.9714	13.0147	13.271	9.5521	9.0098	7.2956	6.3837	5.0871	**13.271**	**2hr**
DUNLOP ST OUTFALL	14.1364	15.6484	16.3645	16.4978	10.8594	10.6026	7.6937	7.026	6.1104	**16.4978**	**2hr**
LocalCatch31	3.5196	3.7582	3.6394	3.6483	2.2818	2.1374	1.5285	1.3981	1.2511	**3.7582**	**1hr**
HEDGELEY DENE OUTFALL	14.188	15.0429	14.8054	15.0931	11.7143	11.4607	10.7344	9.4357	8.368	**15.0931**	**2hr**
LocalCatch33	5.5335	6.0711	6.0493	6.0897	3.8934	3.681	2.6576	2.425	2.145	**6.0897**	**2hr**
LocalCatch32	3.14	3.4113	3.4542	3.5044	2.4815	2.4726	1.9083	1.7201	1.4781	**3.5044**	**2hr**
LocalCatch34	2.4221	2.7937	2.8187	2.8276	1.8138	1.9097	1.4252	1.2976	1.1618	**2.8276**	**2hr**
LocalCatch35	6.7634	7.4834	6.9953	7.1939	4.4506	4.2029	2.926	2.6849	2.499	**7.4834**	**1hr**
BACK CREEK OUTFALL	100.7	108.444	109.997	111.079	96.5197	93.08	91.1936	83.3007	70.2958	**111.079**	**2hr**
LocalCatch37	4.8248	4.3594	4.3963	4.7418	2.9625	2.2802	1.6301	1.3649	1.4062	**4.8248**	**45min**
LocalCatch36	4.3455	4.9541	4.7976	4.9551	3.0114	3.0456	2.1619	1.9883	1.8144	**4.9551**	**2hr**

LocalCatch38	2.7152	2.7794	2.9917	2.9592	1.8349	1.5293	1.1322	0.9549	0.9694	**2.9917**	**1.5hr**
TOORONGA RD OUTFALL	42.3416	45.6271	43.4448	46.7876	32.7235	31.1464	25.0557	22.2469	19.9693	**46.7876**	**2hr**
RIX ST OUTFALL	12.2596	13.1861	12.7936	13.6146	8.6312	7.782	6.4969	5.599	4.7005	**13.6146**	**2hr**
LocalCatch39	6.8146	6.4168	6.7004	7.0858	4.3998	3.6139	2.6009	2.2546	2.2608	**7.0858**	**2hr**
LARA ST OUTFALL	7.5149	7.7025	7.4247	7.5688	6.0608	5.7724	4.7455	4.2686	3.9012	**7.7025**	**1hr**
LocalCatch40	9.1894	9.9789	9.396	9.779	6.7399	5.9535	4.5564	4.0767	3.3858	**9.9789**	**1hr**
LocalCatch42	4.8825	4.8453	4.539	4.8132	3.0795	2.5834	1.7482	1.5672	1.5146	**4.8825**	**45min**
LocalCatch41	3.2721	3.4207	3.3482	3.42	2.5829	2.5538	2.1693	1.9061	1.5507	**3.4207**	**1hr**
LocalCatch43	7.7227	8.6432	8.2965	8.796	5.2928	5.0109	3.444	3.1661	2.9724	**8.796**	**2hr**
LocalCatch44	2.7402	2.9864	2.9961	3.0362	1.9661	1.8548	1.3495	1.2274	1.0703	**3.0362**	**2hr**
OUTLET OF MODEL	293.434	322.76	358.085	372.294	370.983	364.33	365.228	365.118	306.25	**372.294**	**2hr**

Table 7-10 Climate Change Conditions Peak Flows and Corresponding Critical Durations at Key Locations for all ARI's

	5 YEAR ARI		10 YEAR ARI		20 YEAR ARI		50 YEAR ARI		100 YEAR ARI		
Location	Peak Q (m^3/s)	Critical Duration	Peak Q (m^3/s)	Critical Duration	Peak Q (m^3/s)	Critical Duration	Peak Q (m^3/s)	Critical Duration	Peak Q (m^3/s)	*Peak Q (m^3/s) (Existing Conditions)**	Critical Duration
BLACKBURN MD OUTFALL	29.18	4.5hr	37.63	4.5hr	49.73	4.5hr	66.42	2hr	79.49	*57.49*	1hr
LocalCatch3	1.07	2hr	1.43	2hr	1.96	2hr	2.63	2hr	3.21	*2.31*	2hr
LocalCatch4	3.35	2hr	4.29	45min	5.6	45min	7.06	45min	8.37	*6.26*	45min
LocalCatch1	2.88	2hr	3.58	2hr	4.74	2hr	6.11	45min	7.33	*5.30*	45min
LocalCatch2	2.7	2hr	3.43	2hr	4.52	2hr	5.89	1hr	7.08	*5.20*	1hr
LocalCatch5	1.83	2hr	2.26	2hr	2.84	2hr	3.53	2hr	4.18	*3.12*	45min
LocalCatch6	4.08	2hr	5.05	2hr	6.38	2hr	7.89	2hr	9.25	*6.94*	2hr
LocalCatch7	1.26	2hr	1.66	2hr	2.21	2hr	2.87	2hr	3.44	*2.54*	2hr
BOX HILL SOUTH OUTFALL	14.85	2hr	16.95	2hr	18.87	2hr	21.22	2hr	25.8	*19.48*	2hr
LocalCatch8	1.91	2hr	2.27	2hr	2.78	2hr	3.34	2hr	3.86	*2.91*	2hr
LocalCatch9	0.9	2hr	1.13	1hr	1.44	1hr	1.89	1hr	2.3	*1.62*	1hr
FULTON GR OUTFALL	14.27	4.5hr	15.46	12hr	16.19	6hr	17.66	3hr	21.08	*16.71*	1.5hr
LocalCatch10	2.22	2hr	2.85	2hr	3.73	2hr	4.79	2hr	5.72	*4.21*	2hr
ELEY RD OUTFALL	6.71	2hr	8.16	2hr	10.37	2hr	13.64	1hr	16.56	*11.88*	1hr
LocalCatch11	5.26	2hr	6.69	45min	8.75	45min	11.22	1hr	13.35	*10.09*	1hr
LocalCatch13	3.77	2hr	4.85	2hr	6.33	2hr	8.05	2hr	9.57	*7.17*	2hr
LocalCatch12	2.2	2hr	2.87	2hr	3.82	2hr	4.94	2hr	5.91	*4.39*	2hr
STOTT ST OUTFALL	5.82	2hr	7.71	2hr	10.44	2hr	13.97	2hr	17.06	*12.02*	2hr
LocalCatch14	2.45	2hr	3.15	2hr	4.12	2hr	5.28	2hr	6.28	*4.66*	2hr
LocalCatch16	2.81	2hr	3.69	2hr	4.9	2hr	6.34	2hr	7.66	*5.57*	2hr
LocalCatch15	4.52	2hr	5.7	2hr	7.34	2hr	9.31	2hr	11.25	*8.17*	1hr
McCOMAS ST OUTFALL	6.44	2hr	7.82	2hr	10.18	2hr	13.85	2hr	17	*11.84*	2hr

LocalCatch17	5.28	2hr	6.72	2hr	8.74	2hr	11.14	2hr	13.22	*9.77*	2hr
LocalCatch19	5.14	2hr	6.34	45min	8.31	2hr	10.63	1hr	12.6	*9.27*	45min
LocalCatch20	2.03	2hr	2.69	2hr	3.67	2hr	4.94	2hr	6.07	*4.36*	1hr
LocalCatch18	4.95	2hr	6.33	2hr	8.25	2hr	10.75	1hr	12.91	*9.50*	1hr
BROCKHOFF'S MD OUTFALL	7.3	2hr	9.48	2hr	12.5	2hr	15.63	1hr	19.21	*13.96*	1hr
LocalCatch21	3.96	2hr	5.21	2hr	6.93	2hr	8.98	2hr	10.83	*8.00*	2hr
DAMPER CREEK OUTLET	13.22	2hr	14.47	2hr	16.39	2hr	19.91	2hr	22.99	*18.2*	2hr
LocalCatch22	0.86	2hr	1.14	2hr	1.52	2hr	1.99	1hr	2.44	*1.78*	1hr
LocalCatch23	3.5	2hr	4.48	2hr	5.81	2hr	7.38	2hr	8.81	*6.56*	2hr
WINBIRRA PDE OUTFALL	7.66	2hr	10.26	2hr	14.29	2hr	18.78	2hr	23.64	*16.55*	2hr
LocalCatch26	1.88	2hr	2.58	2hr	3.53	2hr	4.72	2hr	5.77	*4.23*	2hr
LocalCatch25	2.21	2hr	2.8	2hr	3.6	2hr	4.54	2hr	5.4	*4.03*	2hr
LocalCatch24	3.44	2hr	4.73	2hr	6.5	2hr	8.71	2hr	10.63	*7.75*	2hr
LocalCatch27	4.82	2hr	6.26	2hr	8.27	2hr	11.39	1hr	13.91	*9.93*	1hr
LocalCatch28	2.85	2hr	3.99	2hr	5.55	2hr	7.49	2hr	9.18	*6.71*	2hr
SCOTCHMANS CREEK OUTFALL	42.57	9hr	51.32	4.5hr	71.11	9hr	95.88	4.5hr	124.17	*79.29*	4.5hr
LocalCatch29	1.24	2hr	1.65	2hr	2.21	2hr	2.88	2hr	3.47	*2.60*	2hr
MURRUMBEENA MD OUTFALL	28.49	4.5hr	31.82	2hr	36.21	2hr	41.34	3hr	50.38	*39.05*	4.5hr
EAST MALVERN OUTFALL	5.5	2hr	7.17	2hr	8.7	2hr	14.04	1hr	17.66	*10.86*	1hr
LocalCatch30	2.14	2hr	2.95	2hr	4.06	2hr	5.44	2hr	6.66	*4.87*	2hr
DARLING RD OUTFALL	6	2hr	8.2	2hr	11.25	2hr	15.38	2hr	18.91	*13.27*	2hr
DUNLOP ST OUTFALL	7.7	2hr	10.44	2hr	14.12	2hr	18.67	2hr	23.11	*16.50*	2hr
LocalCatch31	1.82	2hr	2.39	2hr	3.15	2hr	4.22	2hr	5.14	*3.76*	1hr
HEDGELEY DENE OUTFALL	8.2	2hr	9.6	2hr	12.59	2hr	17.47	2hr	21.96	*15.09*	2hr
LocalCatch33	2.9	2hr	3.88	2hr	5.2	2hr	6.89	2hr	8.48	*6.09*	2hr
LocalCatch32	1.64	2hr	2.21	2hr	2.99	2hr	3.98	2hr	4.86	*3.50*	2hr
LocalCatch34	1.25	2hr	1.7	2hr	2.36	2hr	3.19	1.5hr	3.93	*2.83*	2hr

LocalCatch35	3.62	2hr	4.75	2hr	6.32	2hr	8.43	1hr	10.14	*7.48*	1hr
BACK CREEK OUTFALL	60.34	2hr	75.05	2hr	98.15	2hr	127.14	2hr	150.73	*111.08*	2hr
LocalCatch37	2.71	2hr	3.37	2hr	4.32	2hr	5.43	45min	6.44	*4.82*	45min
LocalCatch36	2.4	2hr	3.18	2hr	4.27	2hr	5.6	2hr	6.8	*4.96*	2hr
LocalCatch38	1.54	2hr	1.98	2hr	2.59	2hr	3.35	1.5hr	4.02	*2.99*	1.5hr
TOORONGA RD OUTFALL	24.75	2hr	30.88	2hr	41.57	2hr	52.09	2hr	61.11	*46.79*	2hr
RIX ST OUTFALL	6.29	2hr	8.19	2hr	11.53	2hr	15.4	2hr	18.91	*13.61*	2hr
LocalCatch39	3.87	2hr	4.89	2hr	6.32	2hr	7.98	2hr	9.48	*7.09*	2hr
LARA ST OUTFALL	5.01	2hr	5.88	2hr	6.95	2hr	8.33	1hr	9.34	*7.70*	1hr
LocalCatch40	4.76	2hr	6.31	2hr	8.49	2hr	11.3	1hr	13.72	*9.98*	1hr
LocalCatch42	2.55	2hr	3.26	2hr	4.25	1hr	5.64	1hr	6.92	*4.88*	45min
LocalCatch41	1.47	2hr	2.04	2hr	2.85	2hr	3.91	2hr	4.86	*3.42*	1hr
LocalCatch43	4.22	2hr	5.61	2hr	7.55	2hr	9.86	2hr	11.9	*8.80*	2hr
LocalCatch44	1.43	2hr	1.92	2hr	2.59	2hr	3.39	2hr	4.18	*3.04*	2hr
OUTLET OF MODEL	**228.78**	**9hr**	**274.4**	**9hr**	**336.63**	**9hr**	**422.15**	**3hr**	**504.27**	***372.29***	**2hr**

Peak 100 year ARI flow in Existing Conditions Scenario shown for comparison purposes

Table 7-11 RORB Peak Flows – 5 Year Average Recurrence Interval, Climate Change Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	25.2421	26.4018	27.251	28.2791	26.8218	29.176	29.109	28.6384	25.9229	**29.176**	**4.5hr**
LocalCatch3	0.8439	0.9694	1.0111	1.0652	0.6959	0.7958	0.6109	0.5871	0.5345	**1.0652**	**2hr**
LocalCatch4	3.319	2.8997	2.8648	3.3486	2.0394	1.787	1.2701	1.0948	1.127	**3.3486**	**2hr**
LocalCatch1	2.7105	2.7089	2.6625	2.8821	1.8293	1.6651	1.1462	1.0433	1.034	**2.8821**	**2hr**
LocalCatch2	2.3829	2.5535	2.589	2.7016	2.0288	1.8864	1.5291	1.4049	1.1588	**2.7016**	**2hr**
LocalCatch5	1.7229	1.6646	1.7753	1.8303	1.1493	0.9324	0.7238	0.6112	0.6389	**1.8303**	**2hr**
LocalCatch6	3.6783	3.5188	3.4883	4.0847	2.5098	2.2095	1.5745	1.3886	1.415	**4.0847**	**2hr**
LocalCatch7	1.0072	1.1191	1.1171	1.2617	0.7342	0.8113	0.5724	0.554	0.5321	**1.2617**	**2hr**
BOX HILL SOUTH OUTFALL	14.1402	14.3408	14.2938	14.8529	13.5321	14.0731	13.2357	11.8539	9.6778	**14.8529**	**2hr**
LocalCatch8	1.7091	1.5516	1.8042	1.9075	1.1647	0.9101	0.7073	0.5925	0.6311	**1.9075**	**2hr**
LocalCatch9	0.8922	0.8925	0.8728	0.8989	0.568	0.5556	0.375	0.3536	0.3395	**0.8989**	**2hr**
FULTON GR OUTFALL	13.6367	14.1038	14.016	14.2573	13.3108	14.2707	13.9749	13.0901	11.1463	**14.2707**	**4.5hr**
LocalCatch10	1.8106	1.9591	1.9464	2.2178	1.3316	1.4605	1.064	1.0319	0.9789	**2.2178**	**2hr**
ELEY RD OUTFALL	6.0167	6.3867	6.2792	6.707	5.6309	5.4977	4.225	3.9659	3.6312	**6.707**	**2hr**
LocalCatch11	5.141	5.133	5.091	5.257	3.1659	3.2654	2.2206	2.1024	1.971	**5.257**	**2hr**
LocalCatch13	3.0195	3.4004	3.3033	3.7699	2.1804	2.2001	1.5716	1.3968	1.3865	**3.7699**	**2hr**
LocalCatch12	1.7117	1.9585	1.9472	2.1959	1.2665	1.354	0.9593	0.8788	0.858	**2.1959**	**2hr**
STOTT ST OUTFALL	5.0632	5.5849	5.7599	5.8205	4.2107	4.7743	3.3325	3.1806	3.0291	**5.8205**	**2hr**
LocalCatch14	1.9897	2.0771	2.1757	2.4523	1.4563	1.5523	1.1103	1.0393	1.0097	**2.4523**	**2hr**
LocalCatch16	2.264	2.5242	2.6729	2.8102	1.8336	1.9853	1.4188	1.3519	1.2356	**2.8102**	**2hr**
LocalCatch15	3.929	4.1964	4.1242	4.5175	3.1754	3.0084	2.2526	2.1065	1.8294	**4.5175**	**2hr**
McCOMAS ST OUTFALL	5.6917	6.0192	6.2129	6.4387	5.8939	6.2651	5.7766	5.3955	4.6935	**6.4387**	**2hr**
LocalCatch17	4.4606	4.9607	5.0067	5.2806	3.2697	3.5249	2.4833	2.3727	2.2098	**5.2806**	**2hr**
LocalCatch19	4.9087	4.9313	4.7929	5.1422	3.2247	3.1107	2.2136	2.0528	1.8761	**5.1422**	**2hr**
LocalCatch20	1.7553	1.8735	1.8919	2.033	1.5081	1.5524	1.2936	1.1735	0.9635	**2.033**	**2hr**

LocalCatch18	4.3323	4.7746	4.8816	4.9533	3.3669	3.4355	2.4533	2.339	2.1319	**4.9533**	**2hr**
BROCKHOFF'S MD OUTFALL	6.3505	6.9173	6.8379	7.2997	5.0586	4.8618	3.6169	3.4125	3.0401	**7.2997**	**2hr**
LocalCatch21	3.0973	3.5887	3.5975	3.956	2.2812	2.5782	1.7972	1.7132	1.6254	**3.956**	**2hr**
DAMPER CREEK OUTLET	12.4419	12.6802	12.9497	13.13	13.0049	13.2222	13.086	12.8823	12.6397	**13.2222**	**4.5hr**
LocalCatch22	0.7525	0.8148	0.8011	0.8583	0.6295	0.6113	0.4673	0.4334	0.3681	**0.8583**	**2hr**
LocalCatch23	2.9786	3.2933	3.2429	3.4966	2.0731	2.167	1.5009	1.4018	1.3406	**3.4966**	**2hr**
WINBIRRA PDE OUTFALL	6.8247	7.1694	7.2427	7.6574	5.7185	6.4672	5.5437	4.8915	3.9545	**7.6574**	**2hr**
LocalCatch26	1.3893	1.6515	1.6501	1.8809	1.0737	1.276	0.9639	0.9378	0.8754	**1.8809**	**2hr**
LocalCatch25	1.9296	1.9966	1.9224	2.2109	1.3365	1.2876	0.9109	0.8216	0.8131	**2.2109**	**2hr**
LocalCatch24	2.9174	3.1088	3.1189	3.4391	2.5347	2.6939	2.1299	1.9557	1.6767	**3.4391**	**2hr**
LocalCatch27	4.4357	4.6858	4.5231	4.8186	3.7605	3.7525	3.2452	2.9314	2.349	**4.8186**	**2hr**
LocalCatch28	2.2059	2.5985	2.6948	2.8482	1.7852	2.0194	1.436	1.3663	1.2704	**2.8482**	**2hr**
SCOTCHMANS CREEK OUTFALL	31.6614	32.8734	32.5684	34.8673	32.1945	34.3646	36.5523	42.572	38.122	**42.572**	**9hr**
LocalCatch29	0.9969	1.0909	1.0635	1.238	0.6877	0.6986	0.5149	0.442	0.4462	**1.238**	**2hr**
MURRUMBEENA MD OUTFALL	27.0854	27.8437	27.4509	28.4939	27.0512	28.0242	27.077	26.743	25.0357	**28.4939**	**2hr**
EAST MALVERN OUTFALL	4.8286	5.2078	5.2089	5.5012	4.2851	4.5709	4.0208	3.5418	2.9043	**5.5012**	**2hr**
LocalCatch30	1.6584	1.9448	1.9771	2.1448	1.2632	1.4537	1.0319	0.9949	0.9354	**2.1448**	**2hr**
DARLING RD OUTFALL	4.9416	5.4231	5.5688	6	4.3182	4.6408	4.1843	3.6936	2.9682	**6**	**2hr**
DUNLOP ST OUTFALL	5.9841	6.6916	6.999	7.696	5.3289	6.004	4.5337	4.0367	3.371	**7.696**	**2hr**
LocalCatch31	1.5237	1.652	1.6726	1.8188	1.2083	1.1896	0.8577	0.8002	0.707	**1.8188**	**2hr**
HEDGELEY DENE OUTFALL	7.5446	7.9603	7.8274	8.1993	7.3307	7.7922	6.7322	5.9006	4.8991	**8.1993**	**2hr**
LocalCatch33	2.3836	2.6238	2.6469	2.9011	1.971	1.9928	1.4682	1.3603	1.1886	**2.9011**	**2hr**
LocalCatch32	1.4287	1.489	1.5106	1.6371	1.243	1.3496	1.0932	1.0031	0.8591	**1.6371**	**2hr**
LocalCatch34	1.0042	1.1302	1.2081	1.2453	0.8789	0.9819	0.7571	0.7087	0.6332	**1.2453**	**2hr**
LocalCatch35	3.1577	3.4945	3.5233	3.6217	2.3458	2.4367	1.7112	1.6111	1.4905	**3.6217**	**2hr**
BACK CREEK OUTFALL	53.1849	57.2029	58.9602	60.3362	57.8288	57.7607	58.4323	54.9204	49.2503	**60.3362**	**2hr**
LocalCatch37	2.6188	2.3271	2.4361	2.7067	1.6684	1.4043	1.0236	0.8626	0.9042	**2.7067**	**2hr**
LocalCatch36	1.9568	2.2397	2.3065	2.4041	1.5597	1.7025	1.2362	1.164	1.0654	**2.4041**	**2hr**

LocalCatch38	1.2913	1.3025	1.4886	1.539	0.9277	0.875	0.6549	0.5609	0.579	**1.539**	**2hr**
TOORONGA RD OUTFALL	21.0937	23.0397	23.321	24.7524	19.2919	20.1167	16.116	15.0196	13.0121	**24.7524**	**2hr**
RIX ST OUTFALL	5.2687	5.7352	5.8211	6.2853	4.5378	4.6321	3.6778	3.2582	2.7935	**6.2853**	**2hr**
LocalCatch39	3.4834	3.3197	3.5512	3.8706	2.3668	2.1471	1.5615	1.3711	1.4013	**3.8706**	**2hr**
LARA ST OUTFALL	4.3871	4.7958	4.8251	5.0149	3.8337	3.9538	2.7849	2.6418	2.4418	**5.0149**	**2hr**
LocalCatch40	4.1569	4.5155	4.6035	4.7614	3.5241	3.3826	2.6947	2.4436	2.0217	**4.7614**	**2hr**
LocalCatch42	2.433	2.5182	2.4091	2.5523	1.5242	1.5076	1.0473	0.9467	0.9184	**2.5523**	**2hr**
LocalCatch41	1.3651	1.4205	1.3889	1.4747	1.2104	1.3119	1.1796	1.0504	0.863	**1.4747**	**2hr**
LocalCatch43	3.4304	3.9021	3.963	4.2193	2.4765	2.7558	1.9059	1.8069	1.702	**4.2193**	**2hr**
LocalCatch44	1.1775	1.2967	1.3042	1.4283	0.9898	1	0.7481	0.69	0.5973	**1.4283**	**2hr**
OUTLET OF MODEL	140.36	160.483	185.406	201.463	208.652	208.283	216.684	228.78	199.064	**228.78**	**9hr**

Table 7-12 RORB Peak Flows – 10 Year Average Recurrence Interval, Climate Change Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	33.3199	35.2082	35.0422	36.9451	34.2587	37.6291	35.3189	34.1497	32.408	**37.6291**	**4.5hr**
LocalCatch3	1.1614	1.3332	1.3776	1.4321	0.9222	1.0466	0.7972	0.7577	0.686	**1.4321**	**2hr**
LocalCatch4	4.289	3.6369	3.6107	4.1972	2.6102	2.2104	1.542	1.3317	1.3685	**4.289**	**45min**
LocalCatch1	3.563	3.3777	3.3299	3.5845	2.3303	2.0396	1.3822	1.2574	1.2442	**3.5845**	**2hr**
LocalCatch2	3.1558	3.3689	3.345	3.4303	2.5865	2.3413	1.8645	1.7134	1.4129	**3.4303**	**2hr**
LocalCatch5	2.1876	2.1149	2.1922	2.256	1.4337	1.1366	0.8713	0.7361	0.7651	**2.256**	**2hr**
LocalCatch6	4.6832	4.3993	4.3788	5.0501	3.1285	2.6768	1.9007	1.6672	1.693	**5.0501**	**2hr**
LocalCatch7	1.3957	1.4958	1.4766	1.6555	0.9917	1.0391	0.7251	0.696	0.6667	**1.6555**	**2hr**
BOX HILL SOUTH OUTFALL	15.7427	16.3601	16.6038	16.9494	15.3024	16.0138	15.4949	14.0859	11.534	**16.9494**	**2hr**
LocalCatch8	2.0536	1.8927	2.1965	2.2725	1.3872	1.0708	0.8316	0.6939	0.7339	**2.2725**	**2hr**
LocalCatch9	1.1167	1.1265	1.0996	1.1245	0.7327	0.6813	0.453	0.4267	0.4096	**1.1265**	**1hr**
FULTON GR OUTFALL	14.7553	14.6766	14.564	14.9135	15.4321	15.2661	15.4582	14.7503	12.9304	**15.4582**	**12hr**
LocalCatch10	2.4185	2.5692	2.5221	2.8482	1.7539	1.8374	1.3224	1.2719	1.2029	**2.8482**	**2hr**
ELEY RD OUTFALL	7.5233	7.8621	7.6402	8.1603	6.5871	6.2897	5.21	4.7926	4.3861	**8.1603**	**2hr**
LocalCatch11	6.687	6.6792	6.5312	6.5914	3.9971	4.0447	2.7345	2.5773	2.4183	**6.687**	**45min**
LocalCatch13	4.1607	4.4835	4.2628	4.8458	2.9094	2.7627	1.9545	1.733	1.7194	**4.8458**	**2hr**
LocalCatch12	2.4262	2.6159	2.5644	2.8732	1.7114	1.7215	1.2078	1.1011	1.0736	**2.8732**	**2hr**
STOTT ST OUTFALL	6.5287	7.1653	7.2199	7.713	5.47	5.7423	4.1879	3.9254	3.7329	**7.713**	**2hr**
LocalCatch14	2.6244	2.7443	2.8783	3.1485	1.9124	1.9407	1.3756	1.2771	1.238	**3.1485**	**2hr**
LocalCatch16	2.9944	3.413	3.5271	3.6879	2.3183	2.481	1.7476	1.6625	1.5188	**3.6879**	**2hr**
LocalCatch15	5.0403	5.3866	5.3609	5.7046	3.9538	3.6993	2.7339	2.5535	2.2195	**5.7046**	**2hr**
McCOMAS ST OUTFALL	7.1377	7.5033	7.5711	7.8216	6.8981	7.1421	6.7707	6.1984	5.3947	**7.8216**	**2hr**
LocalCatch17	5.7581	6.4273	6.4107	6.7216	4.2499	4.3524	3.0243	2.879	2.6823	**6.7216**	**2hr**
LocalCatch19	6.3394	6.3342	5.9827	6.3036	3.9012	3.7702	2.6601	2.4567	2.2448	**6.3394**	**45min**
LocalCatch20	2.3945	2.529	2.5942	2.688	2.0289	2.0068	1.6232	1.4767	1.213	**2.688**	**2hr**

LocalCatch18	5.6774	6.2271	6.2572	6.3342	4.1394	4.2356	2.9816	2.8347	2.5873	**6.3342**	**2hr**
BROCKHOFF'S MD OUTFALL	8.5075	9.2436	8.7731	9.4798	6.4047	5.9225	4.3891	4.1103	3.691	**9.4798**	**2hr**
LocalCatch21	4.2864	4.7896	4.7392	5.2113	3.085	3.2596	2.2658	2.1418	2.0314	**5.2113**	**2hr**
DAMPER CREEK OUTLET	13.0947	13.5723	14.1409	14.4739	14.458	14.4326	14.3889	13.6746	13.0785	**14.4739**	**2hr**
LocalCatch22	1.0341	1.0992	1.054	1.1405	0.8183	0.7733	0.584	0.5428	0.4639	**1.1405**	**2hr**
LocalCatch23	3.8817	4.2797	4.1576	4.4812	2.7314	2.6785	1.8514	1.7205	1.6461	**4.4812**	**2hr**
WINBIRRA PDE OUTFALL	8.6919	9.3427	9.5919	10.2559	7.39	7.798	6.837	6.0443	4.909	**10.2559**	**2hr**
LocalCatch26	2.1294	2.2779	2.2577	2.5752	1.4729	1.6863	1.2566	1.2089	1.1298	**2.5752**	**2hr**
LocalCatch25	2.5515	2.557	2.4623	2.803	1.7312	1.5858	1.1169	1.0038	0.993	**2.803**	**2hr**
LocalCatch24	3.9992	4.3489	4.3929	4.7305	3.3979	3.5045	2.7127	2.4955	2.1409	**4.7305**	**2hr**
LocalCatch27	5.9215	6.1694	6.0379	6.2618	4.7062	4.6892	4.0221	3.6444	2.8894	**6.2618**	**2hr**
LocalCatch28	3.19	3.6842	3.7489	3.9871	2.3758	2.6632	1.8728	1.7769	1.6532	**3.9871**	**2hr**
SCOTCHMANS CREEK OUTFALL	40.6749	42.6188	41.9878	44.303	43.9578	51.3159	49.3142	48.9855	46.0156	**51.3159**	**4.5hr**
LocalCatch29	1.4704	1.468	1.4451	1.6512	0.9492	0.9023	0.6614	0.566	0.5717	**1.6512**	**2hr**
MURRUMBEENA MD OUTFALL	31.245	31.7323	31.4994	31.8232	30.71	30.9435	30.6457	29.8158	28.4704	**31.8232**	**2hr**
EAST MALVERN OUTFALL	6.51	6.907	6.8706	7.1674	5.3534	5.4715	4.8785	4.4246	3.6471	**7.1674**	**2hr**
LocalCatch30	2.336	2.7085	2.7145	2.9488	1.6817	1.9151	1.3531	1.2953	1.2159	**2.9488**	**2hr**
DARLING RD OUTFALL	6.8143	7.4853	7.8013	8.1973	5.8727	6.2013	5.3052	4.5863	3.6825	**8.1973**	**2hr**
DUNLOP ST OUTFALL	8.1331	9.2462	9.9291	10.4419	7.5563	7.7852	5.7041	5.1378	4.2314	**10.4419**	**2hr**
LocalCatch31	2.069	2.2024	2.264	2.3909	1.556	1.5063	1.0803	1.0082	0.8948	**2.3909**	**2hr**
HEDGELEY DENE OUTFALL	9.0208	9.3557	9.3424	9.5954	8.7934	8.9402	8.3253	7.3693	6.0966	**9.5954**	**2hr**
LocalCatch33	3.2813	3.5659	3.6551	3.8835	2.5822	2.5519	1.8593	1.7269	1.5135	**3.8835**	**2hr**
LocalCatch32	1.9272	2.0204	2.0807	2.2062	1.6355	1.7279	1.3698	1.257	1.0751	**2.2062**	**2hr**
LocalCatch34	1.3985	1.5925	1.6734	1.6973	1.1676	1.283	0.9741	0.9083	0.8108	**1.6973**	**2hr**
LocalCatch35	4.2622	4.6711	4.5948	4.7532	2.9378	3.0457	2.1241	1.9953	1.8498	**4.7532**	**2hr**
BACK CREEK OUTFALL	63.5116	69.5911	72.4981	75.0457	67.9425	69.5817	67.4757	64.5107	56.9072	**75.0457**	**2hr**
LocalCatch37	3.3426	2.9675	3.0811	3.3733	2.1059	1.7304	1.2435	1.0506	1.0953	**3.3733**	**2hr**
LocalCatch36	2.6747	3.0452	3.0696	3.1843	1.986	2.1682	1.5481	1.4532	1.3298	**3.1843**	**2hr**

LocalCatch38	1.7329	1.7357	1.9611	1.9797	1.2162	1.1032	0.8185	0.6986	0.7195	**1.9797**	**2hr**
TOORONGA RD OUTFALL	27.1071	29.4252	30.331	30.8774	23.0451	23.4958	18.9891	17.8137	15.7653	**30.8774**	**2hr**
RIX ST OUTFALL	7.0692	7.7163	7.611	8.1894	5.9358	5.7395	4.6377	4.0719	3.4626	**8.1894**	**2hr**
LocalCatch39	4.5449	4.265	4.5696	4.888	3.0306	2.6754	1.9267	1.687	1.718	**4.888**	**2hr**
LARA ST OUTFALL	5.5273	5.7374	5.6449	5.8811	4.6379	4.6512	3.482	3.2619	3.0135	**5.8811**	**2hr**
LocalCatch40	5.6481	6.1363	6.0883	6.3109	4.5665	4.2965	3.3367	3.0307	2.5063	**6.3109**	**2hr**
LocalCatch42	3.1175	3.2546	3.0811	3.2603	2.0179	1.884	1.2906	1.1673	1.1341	**3.2603**	**2hr**
LocalCatch41	1.895	1.9687	1.9268	2.0407	1.5873	1.697	1.5099	1.3429	1.0879	**2.0407**	**2hr**
LocalCatch43	4.6778	5.3026	5.2814	5.6137	3.2823	3.5292	2.4184	2.2752	2.145	**5.6137**	**2hr**
LocalCatch44	1.6206	1.7769	1.8098	1.9177	1.2984	1.2912	0.9469	0.8744	0.7589	**1.9177**	**2hr**
OUTLET OF MODEL	185.652	208.839	236.446	252.164	263.084	262.539	267.197	274.401	237.293	**274.401**	**9hr**

Table 7-13 RORB Peak Flows – 20 Year Average Recurrence Interval, Climate Change Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	45.2236	47.8717	47.8079	49.7295	44.902	49.5602	43.5352	44.3237	39.4991	49.7295	2hr
LocalCatch3	1.6237	1.8521	1.8904	1.962	1.2351	1.3882	1.0527	0.9881	0.8932	1.962	2hr
LocalCatch4	5.6004	4.7178	4.6053	5.367	3.3839	2.7637	1.919	1.6511	1.7	5.6004	45min
LocalCatch1	4.7391	4.2772	4.2243	4.5637	3.0196	2.5418	1.7078	1.5446	1.5332	4.7391	45min
LocalCatch2	4.2239	4.4689	4.3545	4.515	3.3354	2.9537	2.3259	2.1303	1.763	4.515	2hr
LocalCatch5	2.8184	2.7188	2.7441	2.8395	1.82	1.4084	1.0739	0.9055	0.9384	2.8395	2hr
LocalCatch6	6.0723	5.5681	5.562	6.3847	3.9567	3.2957	2.3491	2.0438	2.0756	6.3847	2hr
LocalCatch7	1.9501	2.0136	1.9638	2.2064	1.354	1.3437	0.9344	0.8872	0.8503	2.2064	2hr
BOX HILL SOUTH OUTFALL	17.8677	18.2726	18.6244	18.8685	17.6944	17.926	17.0611	16.5337	13.9384	18.8685	2hr
LocalCatch8	2.592	2.3569	2.7174	2.7811	1.6852	1.2906	1.0053	0.8325	0.876	2.7811	2hr
LocalCatch9	1.4246	1.4381	1.4042	1.4384	0.9605	0.85	0.5624	0.5253	0.5059	1.4384	2hr
FULTON GR OUTFALL	15.2796	15.4721	16.1903	16.0143	16.1361	15.9828	15.6842	15.5347	14.5705	16.1903	1.5hr
LocalCatch10	3.28	3.4083	3.3401	3.731	2.3424	2.3412	1.679	1.5963	1.5102	3.731	2hr
ELEY RD OUTFALL	9.8024	10.1919	9.7847	10.3661	8.0412	7.4469	6.3262	5.7133	5.0326	10.3661	2hr
LocalCatch11	8.7506	8.7444	8.4535	8.4175	5.4072	5.0844	3.449	3.2164	3.0315	8.7506	45min
LocalCatch13	5.7649	5.9403	5.6531	6.3294	3.9228	3.5069	2.4732	2.1844	2.1734	6.3294	2hr
LocalCatch12	3.3944	3.5139	3.3915	3.819	2.3351	2.209	1.5463	1.3995	1.3669	3.819	2hr
STOTT ST OUTFALL	9.1025	9.8714	9.7208	10.4374	7.081	7.2641	5.3836	5.0014	4.6392	10.4374	2hr
LocalCatch14	3.5252	3.6612	3.8349	4.1193	2.5467	2.4511	1.7398	1.5975	1.5501	4.1193	2hr
LocalCatch16	3.9989	4.6609	4.674	4.8969	2.9809	3.13	2.199	2.0806	1.9069	4.8969	2hr
LocalCatch15	6.7197	7.0073	7.0102	7.343	4.9807	4.6262	3.3985	3.1559	2.7564	7.343	2hr
McCOMAS ST OUTFALL	8.8602	9.7069	9.7513	10.1825	8.7571	8.3631	7.7214	7.3409	6.229	10.1825	2hr
LocalCatch17	7.675	8.4145	8.2817	8.7359	5.6042	5.4571	3.7678	3.5626	3.3313	8.7359	2hr
LocalCatch19	8.311	8.1914	7.5462	7.9329	4.9207	4.6567	3.2759	3.0026	2.7535	8.311	45min
LocalCatch20	3.2636	3.5415	3.5403	3.6693	2.7412	2.6049	2.0728	1.8857	1.5553	3.6693	2hr
LocalCatch18	7.5401	8.2053	8.0958	8.2515	5.2751	5.3032	3.7128	3.5033	3.213	8.2515	2hr

BROCKHOFF'S MD OUTFALL	11.4684	12.2954	11.8238	12.495	8.3465	7.6067	5.4791	5.0795	4.5155	12.495	2hr
LocalCatch21	5.9811	6.4662	6.3089	6.9258	4.2487	4.2141	2.9064	2.7177	2.5868	6.9258	2hr
DAMPER CREEK OUTLET	14.6193	15.3054	16.0018	16.3911	16.1106	16.2869	16.2363	15.4243	14.2703	16.3911	2hr
LocalCatch22	1.4142	1.4871	1.4465	1.5183	1.0788	0.9987	0.744	0.6901	0.5949	1.5183	2hr
LocalCatch23	5.2161	5.6268	5.3978	5.8144	3.6785	3.4014	2.3295	2.1498	2.0649	5.8144	2hr
WINBIRRA PDE OUTFALL	12.4714	13.3638	13.2076	14.2924	9.5302	9.8888	7.9062	7.3028	6.1887	14.2924	2hr
LocalCatch26	3.134	3.1568	3.1114	3.5324	2.1044	2.2682	1.6599	1.5753	1.4767	3.5324	2hr
LocalCatch25	3.4088	3.321	3.2187	3.6048	2.2932	2.0042	1.3989	1.2493	1.2391	3.6048	2hr
LocalCatch24	5.6367	6.1026	6.2178	6.5001	4.6068	4.6358	3.504	3.2223	2.7762	6.5001	2hr
LocalCatch27	7.9236	8.2522	8.1186	8.2697	6.2395	6.1132	5.0759	4.6067	3.6559	8.2697	2hr
LocalCatch28	4.574	5.2264	5.2158	5.5496	3.247	3.5605	2.4695	2.3289	2.1757	5.5496	2hr
SCOTCHMANS CREEK OUTFALL	53.8038	56.4292	55.7347	59.3433	67.4213	71.1081	69.2228	66.0999	60.3847	71.1081	4.5hr
LocalCatch29	2.0779	1.9838	1.9701	2.2122	1.3257	1.1872	0.8582	0.7326	0.7416	2.2122	2hr
MURRUMBEENA MD OUTFALL	33.612	34.2618	34.1296	35.3622	36.0108	36.2111	35.812	33.8311	31.3878	36.2111	4.5hr
EAST MALVERN OUTFALL	8.2809	8.5333	8.4896	8.7034	7.0121	7.1703	6.1471	5.3805	4.5857	8.7034	2hr
LocalCatch30	3.3657	3.7928	3.7447	4.0633	2.4139	2.5638	1.7924	1.6996	1.5986	4.0633	2hr
DARLING RD OUTFALL	9.4545	10.5676	10.9286	11.2478	8.4356	8.2446	6.7378	5.9646	4.6887	11.2478	2hr
DUNLOP ST OUTFALL	11.3409	12.7901	13.7421	14.1206	9.6934	9.7484	7.0756	6.556	5.5746	14.1206	2hr
LocalCatch31	2.9495	3.0889	3.0711	3.1536	2.0263	1.9478	1.3859	1.2872	1.149	3.1536	2hr
HEDGELEY DENE OUTFALL	11.0626	12.1227	11.8696	12.5948	10.1983	10.5578	10.0122	8.8607	7.7772	12.5948	2hr
LocalCatch33	4.5632	4.9125	5.0443	5.2034	3.4204	3.3287	2.3939	2.2189	1.9577	5.2034	2hr
LocalCatch32	2.6161	2.7997	2.8923	2.9922	2.1899	2.2606	1.748	1.6001	1.3713	2.9922	2hr
LocalCatch34	1.9909	2.2593	2.3293	2.3592	1.5706	1.7067	1.271	1.1776	1.0538	2.3592	2hr
LocalCatch35	5.8018	6.3215	6.0523	6.2802	3.943	3.8951	2.6903	2.512	2.3417	6.3215	1hr
BACK CREEK OUTFALL	85.8864	92.6473	95.4022	98.1477	87.5623	86.8158	83.0129	77.0856	66.9867	98.1477	2hr
LocalCatch37	4.3193	3.8272	3.9378	4.2921	2.7166	2.1461	1.5461	1.3062	1.3554	4.3193	45min
LocalCatch36	3.6606	4.1419	4.1006	4.2745	2.6198	2.7787	1.9753	1.8458	1.6896	4.2745	2hr
LocalCatch38	2.3381	2.3474	2.5944	2.5859	1.6285	1.3996	1.0414	0.885	0.9096	2.5944	1.5hr

TOORONGA RD OUTFALL	36.2784	39.2938	38.2058	41.566	29.5128	29.0784	23.3285	21.0274	19.1021	41.566	2hr
RIX ST OUTFALL	9.9466	10.7939	10.4014	11.5253	7.6889	7.1026	5.9159	5.1659	4.3358	11.5253	2hr
LocalCatch39	6.0147	5.5482	5.9209	6.315	3.9754	3.3565	2.4275	2.1163	2.1483	6.315	2hr
LARA ST OUTFALL	6.7582	6.8734	6.7069	6.948	5.6172	5.4958	4.3787	4.0074	3.7414	6.948	2hr
LocalCatch40	7.7665	8.3384	8.0673	8.4853	6.0248	5.4729	4.2119	3.8266	3.1703	8.4853	2hr
LocalCatch42	4.1785	4.2095	3.9763	4.2526	2.7227	2.3834	1.6251	1.4668	1.4277	4.2526	2hr
LocalCatch41	2.6485	2.7322	2.7373	2.8518	2.2164	2.2653	1.9574	1.7429	1.4078	2.8518	2hr
LocalCatch43	6.4601	7.1919	7.0548	7.546	4.5693	4.5371	3.1166	2.9091	2.7462	7.546	2hr
LocalCatch44	2.252	2.4214	2.4977	2.5876	1.7226	1.6684	1.2183	1.1243	0.9786	2.5876	2hr
OUTLET OF MODEL	248.203	274.696	307.499	322.792	328.283	331.118	333.386	336.63	286.019	336.63	9hr

Table 7-14 RORB Peak Flows – 50 Year Average Recurrence Interval, Climate Change Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	62.3158	65.8538	64.5296	66.4156	56.8777	58.9323	55.6079	54.2263	49.6197	66.4156	2hr
LocalCatch3	2.2411	2.5569	2.5548	2.6338	1.6382	1.7554	1.3378	1.2301	1.1107	**2.6338**	**2hr**
LocalCatch4	7.0611	5.9271	5.7616	6.6987	4.2814	3.3036	2.2846	1.9743	2.0142	**7.0611**	**45min**
LocalCatch1	6.1142	5.3914	5.277	5.6829	3.7975	3.0309	2.0198	1.828	1.8075	**6.1142**	**45min**
LocalCatch2	5.5549	5.889	5.6086	5.8281	4.1801	3.5696	2.7997	2.5345	2.1187	**5.889**	**1hr**
LocalCatch5	3.5267	3.4064	3.3875	3.4974	2.2476	1.6735	1.2685	1.064	1.0986	**3.5267**	**45min**
LocalCatch6	7.64	7.0347	6.9705	7.8922	4.8814	3.9037	2.7853	2.4178	2.4312	**7.8922**	**2hr**
LocalCatch7	2.6183	2.6869	2.5719	2.8716	1.7963	1.6583	1.1629	1.0847	1.0357	**2.8716**	**2hr**
BOX HILL SOUTH OUTFALL	19.6054	20.0493	20.7058	21.2171	19.6234	19.1933	18.2976	17.4968	15.6728	**21.2171**	**2hr**
LocalCatch8	3.1622	2.9056	3.2955	3.3404	1.9717	1.5056	1.1702	0.9574	0.9996	**3.3404**	**2hr**
LocalCatch9	1.8914	1.8146	1.7665	1.803	1.2191	1.0173	0.6797	0.6227	0.5984	**1.8914**	**45min**
FULTON GR OUTFALL	16.2723	16.909	17.6475	17.6572	16.4376	16.1311	15.442	15.4905	15.4067	**17.6572**	**2hr**
LocalCatch10	4.3193	4.4867	4.3624	4.7949	3.0525	2.8546	2.0707	1.9278	1.819	**4.7949**	**2hr**
ELEY RD OUTFALL	13.045	13.6367	12.9423	13.384	9.6269	8.9651	7.5844	6.702	5.5909	**13.6367**	**1hr**
LocalCatch11	11.174	11.222	10.7668	10.7058	7.1484	6.1833	4.2167	3.8553	3.635	**11.222**	**1hr**
LocalCatch13	7.718	7.7628	7.3715	8.0549	5.1416	4.2628	2.9942	2.6463	2.6187	**8.0549**	**2hr**
LocalCatch12	4.5737	4.6718	4.4323	4.9431	3.0806	2.7068	1.8959	1.7051	1.6579	**4.9431**	**2hr**
STOTT ST OUTFALL	12.6751	13.7218	13.0043	13.9746	9.0237	8.8769	6.7561	5.9374	5.3621	**13.9746**	**2hr**
LocalCatch14	4.611	4.8403	5.0003	5.2811	3.304	2.9549	2.1161	1.9185	1.8549	**5.2811**	**2hr**
LocalCatch16	5.4064	6.2901	6.079	6.344	3.9521	3.7896	2.6786	2.4961	2.2889	**6.344**	**2hr**
LocalCatch15	8.9718	9.3057	9.0355	9.279	6.0817	5.5661	4.0878	3.7382	3.2827	**9.3057**	**1hr**
McCOMAS ST OUTFALL	12.5557	13.7051	13.4842	13.8488	11.4219	10.4141	9.2072	8.2425	7.2123	**13.8488**	**2hr**
LocalCatch17	10.1699	10.968	10.5724	11.1353	7.1728	6.5576	4.5577	4.2368	3.9626	**11.1353**	**2hr**
LocalCatch19	10.6301	10.3327	9.3897	9.8102	6.2809	5.5543	3.9079	3.5286	3.2423	**10.6301**	**45min**
LocalCatch20	4.5329	4.9388	4.7402	4.9309	3.582	3.2134	2.5475	2.296	1.9146	**4.9388**	**1hr**

LocalCatch18	9.8678	10.7462	10.3489	10.5489	6.8179	6.3644	4.4878	4.1575	3.8187	**10.7462**	**1hr**
BROCKHOFF'S MD OUTFALL	14.9309	15.6272	15.2375	15.6109	10.4944	9.0649	6.7731	6.0507	5.2773	**15.6272**	**1hr**
LocalCatch21	8.1028	8.6334	8.256	8.9842	5.6701	5.1553	3.5666	3.3129	3.1449	**8.9842**	**2hr**
DAMPER CREEK OUTLET	17.3896	18.4965	19.3882	19.9085	19.0306	18.5129	18.3247	17.1225	15.8497	**19.9085**	**2hr**
LocalCatch22	1.9091	1.9934	1.9401	1.9779	1.3693	1.2231	0.912	0.839	0.7302	**1.9934**	**1hr**
LocalCatch23	7.0111	7.299	6.8958	7.3765	4.8206	4.0984	2.8063	2.5854	2.4758	**7.3765**	**2hr**
WINBIRRA PDE OUTFALL	17.4284	18.5216	18.5	18.7792	12.5727	12.3324	9.8902	8.4465	7.2106	**18.7792**	**2hr**
LocalCatch26	4.2921	4.321	4.2339	4.7157	2.8857	2.8772	2.1095	1.968	1.8433	**4.7157**	**2hr**
LocalCatch25	4.443	4.2715	4.1264	4.5379	2.9551	2.4034	1.6771	1.4991	1.4774	**4.5379**	**2hr**
LocalCatch24	7.8713	8.5102	8.5885	8.7146	6.0303	5.7722	4.3449	3.9702	3.4401	**8.7146**	**2hr**
LocalCatch27	10.7727	11.3918	10.7779	10.965	8.2499	7.5031	6.15	5.5695	4.463	**11.3918**	**1hr**
LocalCatch28	6.3814	7.2836	7.0766	7.4873	4.5393	4.4768	3.1251	2.9121	2.7183	**7.4873**	**2hr**
SCOTCHMANS CREEK OUTFALL	71.9643	74.4563	76.0607	85.6815	94.0555	94.6698	95.8818	89.2753	77.2699	**95.8818**	**12hr**
LocalCatch29	2.8122	2.6403	2.6163	2.8759	1.7799	1.4752	1.0594	0.9095	0.9142	**2.8759**	**2hr**
MURRUMBEENA MD OUTFALL	36.8452	37.8187	38.9105	40.0579	40.964	41.3391	41.1555	38.9713	36.6091	**41.3391**	**12hr**
EAST MALVERN OUTFALL	12.35	14.0361	12.6296	13.7933	8.8011	8.4252	7.511	6.6173	5.422	**14.0361**	**1hr**
LocalCatch30	4.7317	5.2334	5.0525	5.4391	3.3356	3.2315	2.2795	2.1302	1.998	**5.4391**	**2hr**
DARLING RD OUTFALL	13.4537	14.9552	14.8653	15.3755	11.0669	10.0677	8.137	7.2412	5.8436	**15.3755**	**2hr**
DUNLOP ST OUTFALL	16.3568	18.01	18.6732	18.6292	12.106	11.6466	8.5371	7.8713	6.9959	**18.6732**	**1.5hr**
LocalCatch31	4.0432	4.2187	4.0576	4.0564	2.5518	2.3953	1.7099	1.5723	1.4119	**4.2187**	**1hr**
HEDGELEY DENE OUTFALL	16.4245	17.4686	16.949	17.3213	13.7803	13.0484	11.6897	10.342	9.1112	**17.4686**	**1hr**
LocalCatch33	6.4159	6.8899	6.7817	6.7778	4.3651	4.0989	2.9639	2.7237	2.4168	**6.8899**	**1hr**
LocalCatch32	3.5846	3.8812	3.9496	3.9809	2.8476	2.7879	2.1428	1.9496	1.6785	**3.9809**	**2hr**
LocalCatch34	2.7881	3.1697	3.1761	3.1945	2.0481	2.1399	1.5922	1.4587	1.3085	**3.1945**	**2hr**
LocalCatch35	7.7941	8.4272	7.8271	8.0839	5.1941	4.7286	3.2913	3.0366	2.8347	**8.4272**	**1hr**
BACK CREEK OUTFALL	114.004	123.696	123.338	127.136	110.066	106.159	100.46	91.8576	79.346	**127.136**	**2hr**
LocalCatch37	5.434	4.8795	4.9265	5.3388	3.3858	2.5718	1.8399	1.551	1.6048	**5.434**	**45min**
LocalCatch36	4.9516	5.5784	5.3846	5.5999	3.5216	3.4262	2.4314	2.2438	2.0582	**5.5999**	**2hr**

LocalCatch38	3.0808	3.1401	3.3526	3.3186	2.106	1.7129	1.2686	1.0769	1.0975	**3.3526**	**1.5hr**
TOORONGA RD OUTFALL	47.3923	50.8191	49.3314	52.091	37.0193	34.3626	28.1614	24.9757	21.855	**52.091**	**2hr**
RIX ST OUTFALL	13.8108	14.8583	14.7474	15.4004	9.9435	8.7007	7.1927	6.3232	5.2896	**15.4004**	**2hr**
LocalCatch39	7.6952	7.2145	7.5233	7.9825	5.0243	4.0754	2.9299	2.5531	2.5721	**7.9825**	**2hr**
LARA ST OUTFALL	8.169	8.332	8.0926	8.1572	6.6075	6.3343	5.2743	4.8328	4.2937	**8.332**	**1hr**
LocalCatch40	10.5296	11.297	10.5442	11.088	7.6654	6.7063	5.1075	4.6083	3.8553	**11.297**	**1hr**
LocalCatch42	5.6386	5.3584	5.0678	5.4017	3.5717	2.9243	1.9499	1.7694	1.7209	**5.6386**	**45min**
LocalCatch41	3.7296	3.8993	3.836	3.9107	2.9925	2.9069	2.4309	2.1537	1.7594	**3.9107**	**2hr**
LocalCatch43	8.8957	9.6515	9.2353	9.8631	6.1545	5.6099	3.8376	3.558	3.358	**9.8631**	**2hr**
LocalCatch44	3.1507	3.3765	3.3627	3.3949	2.2052	2.0729	1.5057	1.3771	1.2081	**3.3949**	**2hr**
OUTLET OF MODEL	331.83	366.515	405.327	422.145	420.045	408.943	415.45	414.164	345.015	**422.145**	**2hr**

Table 7-15 RORB Peak Flows – 100 Year Average Recurrence Interval, Climate Change Conditions

OUTFALL	45min	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	PEAK Q	PEAK DUR
BLACKBURN MD OUTFALL	75.6762	79.488	77.9466	79.264	66.1921	69.3816	62.9457	67.8499	57.2983	79.488	1hr
LocalCatch3	2.7622	3.1612	3.127	3.2093	2.0321	2.1023	1.5842	1.4474	1.3116	**3.2093**	**2hr**
LocalCatch4	8.3709	6.9812	6.7744	7.8975	5.045	3.8407	2.6376	2.2768	2.333	**8.3709**	**45min**
LocalCatch1	7.3272	6.3705	6.2171	6.6904	4.4351	3.5257	2.337	2.1	2.0873	**7.3272**	**45min**
LocalCatch2	6.6564	7.0805	6.6746	6.9553	4.9003	4.1881	3.2498	2.927	2.4583	**7.0805**	**1hr**
LocalCatch5	4.1781	4.0101	3.9973	4.0948	2.6498	1.9394	1.46	1.2239	1.266	**4.1781**	**45min**
LocalCatch6	9.0852	8.3199	8.2562	9.252	5.7656	4.5245	3.2104	2.7734	2.8012	**9.252**	**2hr**
LocalCatch7	3.2088	3.2583	3.1085	3.4441	2.1936	1.9592	1.3649	1.2649	1.2125	**3.4441**	**2hr**
BOX HILL SOUTH OUTFALL	21.8875	24.9868	25.7971	25.7306	22.3794	21.0163	19.1249	18.5433	16.8323	**25.7971**	**1.5hr**
LocalCatch8	3.7001	3.4058	3.8532	3.8588	2.2754	1.7349	1.3389	1.0903	1.139	**3.8588**	**2hr**
LocalCatch9	2.3036	2.146	2.0913	2.1288	1.4415	1.1875	0.7847	0.7159	0.6917	**2.3036**	**45min**
FULTON GR OUTFALL	18.1509	19.5667	21.0829	20.967	17.64	16.6036	15.6851	15.4982	15.6151	**21.0829**	**1.5hr**
LocalCatch10	5.2453	5.4069	5.2512	5.7172	3.6951	3.3561	2.4182	2.2359	2.1174	**5.7172**	**2hr**
ELEY RD OUTFALL	15.7907	16.5575	15.8089	15.9953	11.1961	10.6406	8.7074	7.7195	6.1702	**16.5575**	**1hr**
LocalCatch11	13.1919	13.352	12.8095	12.7224	8.6903	7.2672	4.907	4.462	4.2273	**13.352**	**1hr**
LocalCatch13	9.4426	9.2638	8.8085	9.5688	6.2269	5.0082	3.4778	3.0709	3.0538	**9.5688**	**2hr**
LocalCatch12	5.6135	5.6411	5.3592	5.9106	3.746	3.1869	2.2162	1.985	1.9392	**5.9106**	**2hr**
STOTT ST OUTFALL	15.6702	16.8525	16.0893	17.0647	10.7895	10.5246	7.9087	6.9681	6.0268	**17.0647**	**2hr**
LocalCatch14	5.5794	5.8282	6.0169	6.2829	3.9794	3.4536	2.4575	2.2205	2.1551	**6.2829**	**2hr**
LocalCatch16	6.6218	7.6596	7.2593	7.5696	4.8093	4.4341	3.1124	2.8884	2.6632	**7.6596**	**1hr**
LocalCatch15	10.913	11.2481	10.7837	10.9558	7.0604	6.5091	4.7356	4.3048	3.8061	**11.2481**	**1hr**
McCOMAS ST OUTFALL	15.6817	17.0011	16.6331	16.9573	13.6917	12.4552	10.6161	9.5428	8.3535	**17.0011**	**1hr**
LocalCatch17	12.3801	13.1618	12.5613	13.2222	8.5614	7.6614	5.2749	4.883	4.5909	**13.2222**	**2hr**
LocalCatch19	12.6007	12.1772	11.0442	11.4652	7.4701	6.4807	4.5002	4.0446	3.7381	**12.6007**	**45min**
LocalCatch20	5.5907	6.0727	5.7298	5.9744	4.3087	3.8014	2.9734	2.6792	2.2467	**6.0727**	**1hr**

LocalCatch18	11.8305	12.9108	12.3005	12.5343	8.2073	7.4308	5.1996	4.7883	4.4243	**12.9108**	**1hr**
BROCKHOFF'S MD OUTFALL	18.6589	19.2075	18.0904	18.5743	12.3444	10.5319	7.8853	7.0781	6.0633	**19.2075**	**1hr**
LocalCatch21	9.9223	10.439	9.92	10.8342	6.9132	6.1001	4.1949	3.8738	3.6932	**10.8342**	**2hr**
DAMPER CREEK OUTLET	20.094	21.5412	22.4864	22.9907	21.8254	20.7153	20.1205	18.8225	17.1436	**22.9907**	**2hr**
LocalCatch22	2.2929	2.4354	2.3526	2.3832	1.6154	1.4533	1.0735	0.9817	0.8598	**2.4354**	**1hr**
LocalCatch23	8.5516	8.7137	8.2034	8.8113	5.7842	4.827	3.2715	3.0036	2.8892	**8.8113**	**2hr**
WINBIRRA PDE OUTFALL	21.7727	23.6394	22.4889	23.3691	14.8213	14.4048	11.7188	10.1378	8.5146	**23.6394**	**1hr**
LocalCatch26	5.2685	5.2938	5.2071	5.7669	3.5663	3.4643	2.5157	2.3265	2.1851	**5.7669**	**2hr**
LocalCatch25	5.3328	5.0813	4.9273	5.4002	3.4999	2.8178	1.954	1.7391	1.7204	**5.4002**	**2hr**
LocalCatch24	9.6203	10.4534	10.5986	10.6283	7.2423	6.8869	5.128	4.672	4.0665	**10.6283**	**2hr**
LocalCatch27	13.1773	13.912	13.1157	13.2787	9.9774	8.888	7.1931	6.5102	5.2318	**13.912**	**1hr**
LocalCatch28	7.9532	8.9887	8.6527	9.1798	5.6623	5.3657	3.7182	3.444	3.2282	**9.1798**	**2hr**
SCOTCHMANS CREEK OUTFALL	83.9927	85.9106	99.6984	115.276	124.166	118.655	113.345	107.228	90.2617	**124.166**	**3hr**
LocalCatch29	3.4277	3.1837	3.1726	3.4708	2.175	1.756	1.2493	1.0706	1.0803	**3.4708**	**2hr**
MURRUMBEENA MD OUTFALL	39.373	40.241	42.3488	47.5782	50.0984	50.3799	48.7807	43.9265	40.7605	**50.3799**	**12hr**
EAST MALVERN OUTFALL	17.0067	17.487	17.657	17.3876	11.6523	9.6389	8.5501	7.7063	6.2391	**17.657**	**1.5hr**
LocalCatch30	5.9013	6.4316	6.1682	6.6555	4.1399	3.882	2.7186	2.5214	2.3728	**6.6555**	**2hr**
DARLING RD OUTFALL	16.8246	18.4674	18.1852	18.9117	13.3	11.9507	9.3925	8.4191	6.997	**18.9117**	**2hr**
DUNLOP ST OUTFALL	20.5202	22.4294	23.1137	22.4773	14.2028	13.9452	9.8714	9.1094	8.1629	**23.1137**	**1.5hr**
LocalCatch31	4.9375	5.137	4.8959	4.8596	3.0313	2.8517	2.0151	1.8414	1.6638	**5.137**	**1hr**
HEDGELEY DENE OUTFALL	20.9414	21.956	21.1714	21.5695	16.7997	16.0296	13.7604	11.7449	10.3487	**21.956**	**1hr**
LocalCatch33	7.9301	8.4764	8.2427	8.1645	5.1606	4.8859	3.4982	3.1973	2.8538	**8.4764**	**1hr**
LocalCatch32	4.3745	4.7578	4.8571	4.8416	3.4149	3.3132	2.5171	2.2836	1.9726	**4.8571**	**1.5hr**
LocalCatch34	3.4408	3.9247	3.8989	3.9297	2.4551	2.5628	1.8872	1.72	1.5482	**3.9297**	**2hr**
LocalCatch35	9.4066	10.141	9.3407	9.7099	6.2984	5.5875	3.8577	3.5383	3.3196	**10.141**	**1hr**
BACK CREEK OUTFALL	138.861	149.602	149.153	150.726	132.978	126.921	116.312	105.459	90.7164	**150.726**	**2hr**
LocalCatch37	6.4369	5.8028	5.8465	6.3021	3.9848	2.9994	2.1415	1.7995	1.8612	**6.4369**	**45min**
LocalCatch36	6.0427	6.7981	6.5067	6.7628	4.3265	4.0566	2.8589	2.6287	2.4136	**6.7981**	**1hr**

LocalCatch38	3.7425	3.8272	4.0181	3.9663	2.5428	2.017	1.4885	1.2598	1.2836	**4.0181**	**1.5hr**
TOORONGA RD OUTFALL	55.7646	60.0308	59.0601	61.1139	43.1555	40.0186	32.3175	28.8587	24.6782	**61.1139**	**2hr**
RIX ST OUTFALL	17.7982	18.9114	18.211	18.4307	12.1195	10.6604	8.4048	7.3106	6.2118	**18.9114**	**1hr**
LocalCatch39	9.2049	8.6717	8.9976	9.4849	5.9615	4.7891	3.4359	2.9762	2.9968	**9.4849**	**2hr**
LARA ST OUTFALL	9.1745	9.335	9.0993	9.0867	7.3393	7.2295	6.046	5.4454	4.9076	**9.335**	**1hr**
LocalCatch40	12.8256	13.7185	12.7466	13.3517	9.1509	7.9126	5.9736	5.3835	4.5136	**13.7185**	**1hr**
LocalCatch42	6.9211	6.3718	6.0483	6.4435	4.3079	3.4507	2.2735	2.0642	2.0103	**6.9211**	**45min**
LocalCatch41	4.5853	4.8609	4.7883	4.8002	3.6892	3.5037	2.8737	2.5442	2.0797	**4.8609**	**1hr**
LocalCatch43	11.0616	11.7247	11.132	11.9005	7.5726	6.651	4.5184	4.1769	3.9477	**11.9005**	**2hr**
LocalCatch44	3.9233	4.1817	4.105	4.0911	2.6277	2.4641	1.7748	1.6196	1.4247	**4.1817**	**1hr**
OUTLET OF MODEL	402.991	443.619	489.64	504.273	494.175	477.467	482.406	484.393	399.722	**504.273**	**2hr**

Table 7-16 GSDM Calculation Sheet – PMP Event

LOCATION INFORMATION

Catchment GARDINERS CK Area 113 km²

State VICTORIA Duration Limit 6 hrs

Latitude ....°..........' S Longitude..........°..........' E

Portion of Area Considered:

Smooth , **S** = 1 (0.0 - 1.0) Rough , **R** = 0 (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation ....m NOT ABOVE 1500 m

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

EAF = 1.00 (0.85 - 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF = 0.55 (0.40 - 1.00)

PMP VALUES (mm)

Duration (hours)	Initial Depth - Smooth (D_S)	Initial Depth - Rough (D_R)	PMP Estimate = ($D_S \times S + D_R \times R$) $\times$ MAF $\times$ EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	165	–	90.75	90
0.50	245	–	134.75	130
0.75	310	–	170.50	170
1.0	375	–	206.25	210
1.5	425	–	233.75	230
2.0	480	–	264.00	260
2.5	520	–	286.00	290
3.0	550	–	302.50	300
4.0	615	–	338.25	340
5.0	660	–	363.00	360
6.0	705	–	387.75	390

Prepared by AARON VENDARGON Date 3 / 3 / 10

Checked by LUKE CUNNINGHAM Date 3 / 3 / 10