Fern Bay Seaside Village

Annexures S to X

Volume 4

Fern Bay Seaside Village

Environmental Assessment

for Aspen Group Pty Ltd

February 2009

0063154

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Fern Bay Seaside Village

Environmental Assessment

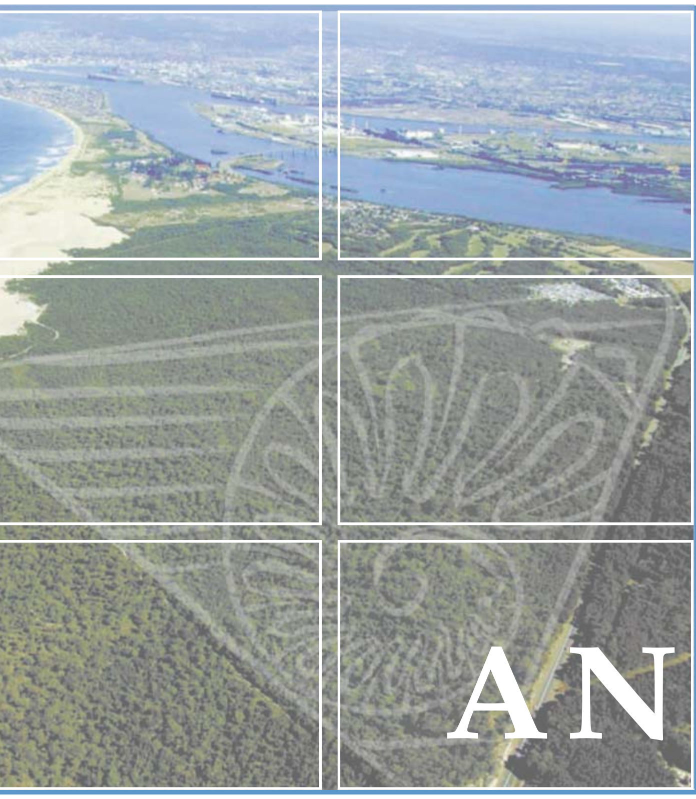
for
Aspen Group Pty Ltd

February 2009

Project No. 0063154

Project Manager:	*Amanda Antcliff*
Signed:	
Date:	*February 2009*
Partner:	*Paul Douglass*
Date:	*February 2009*

Environmental Resources Management Australia Pty Ltd Quality System



Volume 4

ANNEXURES

ANNEX S

Water Cycle Management Report

TRUNK DRAINAGE CONCEPTUAL PLAN & WATER SENSITIVE URBAN DESIGN PRINCIPALS REPORT

for

ASPEN GROUP

FERN BAY SEADSIDE VILLAGE

Report Prepared on 10th April 2008 by

DMS Survey Pty Ltd

- Design
- Management
- Surveying

Contents

Diagrams

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Trunk Drainage Conceptual Plan & Water Sensitive Urban Design Principals

(1) Introduction

DMS Survey Pty Ltd has been associated with Fern Bay Seaside Village, a new residential community since 1991. The Village was first proposed by the original proponents in 1990, Planning, Rezoning and Design work was conducted over a ten (10) year period. The site was acquired by the Winten Property Group in 2000 and in 2004 a major roundabout on Nelson Bay Road (Main Road 108), a lead in road and approximately 100 allotments were constructed and released as Stage 1 of the development.

Another 50 allotments were designed, constructed and released to the property market in early 2007 as Stage 2.

Aspen Group acquired the development in 2007 and have commenced the planning and approved stages for the remainder of the project. The remainder of the project will eventually create approximately 700 allotments and several integrated housing areas, the final lot yield from the site may be as high as 950 allotments. *(See Diagram 1A: Allotment Layout)*

As part of the planning of the estate, Conceptual Trunk Drainage has been produced from the Project Plan. Road hierarchies, major drainage structures, services delivery and active and passive recreational open space has been considered in the layout of the town plan.

Urban Water Cycle Solutions was engaged by Aspen Group to produce an Urban Water Cycle Management Strategy based on the subject town plan, this strategy was completed in May 2007. The Urban Water Cycle Management Strategy comprehensively encompasses all aspects of Water Sensitive Urban Design and supplies indicative catchment, and detention requirements. This strategy presents a conceptual framework for trunk drainage and water treatment outcomes.

DMS Survey Pty Ltd has now completed additional grading and levelling detail of the Town Plan, examining the town plan through detailed rational method modelling for water flows and storage requirements, tested water quality outcomes of the water treatment train utilizing the Model for Urban Stormwater Improvement Conceptualization (MUSIC) software and reviewed the practical implementation of Water Sensitive Urban Design philosophies. These sheets indicating this detail are annexed to this commentary. Through Stages 1 and 2 of the development Water Sensitive Urban Design procedures were successfully implemented on the site and have proved desired outcomes.

(2) Trunk Drainage Conceptual Plan

Fern Bay Seaside Village occupies a site of some 200 hectares and is comprised of undulating remnant sand hills, low lying areas and scattered remnant forest. The predominant soil type is a fine grained sandy soil, some organic topsoil and swamp deposit materials and some areas of peat. The predominant sandy soils are therefore highly suitable for the implementation of WSUD Strategies over the site.

The Urban Water Cycle Management Strategy 2007 produced by Urban Water Cycle Solutions has been extensively consulted throughout the production of the Trunk Drainage Conceptual Plan and the detail contained in that plan is based on the Management Strategy. *(See Diagram 1B: Trunk Drainage Conceptual Plan)*

Three areas are proposed to create the remainder of the Village, Area 1 some 60 allotments in the south west, Area 2 some 60 allotments and integrated housing sites in the north west and Area 3 the remainder of the site containing in excess of 600 allotments and integrated housing sites in the eastern part of the estate.

Area 1 has flows predominantly from east to west, levels ranging from 4.7 m AHD to 2.5 m AHD and drainage terminating in a detention basin, Detention Basin 1. The detention basin will be sited in both position and level to provide further stormwater treatment and contain 1 to 100 peak discharge within the detention basin and within the subject site. No impact upon adjoining areas is expected.

Area 2 has flows predominantly from east to west, levels ranging from 7.1m AHD to 2.5 m AHD and drainage terminating in a detention basin, Detention Basin 2 This area is constrained by existing Stages 1 and 2 and the cultural Heritage Reserve. Flows from the basin in the 1 to 100 storm event and peak discharge will be wholly contained within the detention basin and wholly contained within the subject site. No impact upon adjoining areas is expected.

Area 3, the remainder of the estate, which includes the approved but not yet constructed Stage 3, can be divided by a watershed running north-south and east-west roughly segregating the area into four catchments. The apex of the watershed has levels peaking at approximately 6.3 m AHD and grading to 2.5 m AHD at each proposed detention basin. Stormwater will flow from the watershed, be treated using WSUD principles and conveyed to each detention basin. At each detention basin the 1:100 storm event peak flows will be wholly contained within the detention basin and wholly contained within the subject site. No impact upon adjoining areas is expected.

For each of the urban areas and individual catchments, water will be treated, conveyed and stored wholly within the subject site and treated accordingly to Water Sensitive Urban Design principles. Due to the sizing of the detention basins and the full containment of the 1:100 year rainfall event no impact upon adjoining areas is expected.

(3) Detailed Examination of Stormwater Flows

The subject development consists of three separate and distinct areas. Area 1 and 2 are separate and homogenous catchments and Area 3, (the larger development area) consists of four areas roughly divided by a north-south and east-west watershed. Each of these areas have been modelled in detail utilizing Drains Software by Watercom Pty Ltd. This software through the rational method of stormwater modelling was used to simulate the operation of urban stormwater drainage systems. The model uses time-area calculations and Horton Infiltration procedures to calculate flow hydrographs from sub-catchments. In this particular case calculations were performed at step intervals using some 20 storms ranging from 5 minutes to 72 hours. The catchments produce peak flows, nodally connected by overland flow paths (drainage swales) and eventually terminate in a detention basin as required by this site. The software therefore models peak flows and total detention requirements, less infiltration under hydraulically saturated conditions, over the major maximum flow storm event. *(See Appendix 1: indicating the Rational Method Modelling)*

This data was then used to size the required detention basins in accordance with the Project Plan. Once watersheds, catchments and detention basin positions are determined, individual areas can be modelled using MUSIC software to examine the effectiveness of the Water Sensitive Urban Design Treatment Train.

Area 1

Catchment 1 situated in the south west of the site consists of 2.16 ha, has peak flows of 1.498 m^3/s and requires a 2500 m^3 detention basin, Detention Basin (1).

Area 2

Catchment 2 situated in the north west of the site consists of 4.25 ha, has peak flows of 2.970 m^3/s and requires a 6,600 m^3 detention basin, Detention Basin (2).

Area 3

Area 3 forms the remainder of the subject site and consists of four distinct catchments divided by a north-south, east-west watershed

- **Catchment 3** situated in the south-west of Area 3 of the site consists of 14.71 ha, has peak flows of 5.370 m^3/s and requires a 12,300 m^3 detention basin, Detention Basin (3).
- **Catchment 4** situated in the north-west of Area 3 of the site consists of 13.57 ha, has peak flows of 4.990 m^3/s and requires a 10,000 m^3 detention basin, Detention Basin (4).
- **Catchment 5** situated in the north-east of Area 3 of the site consists of 9.20 ha, has peak flows of 4.139 m^3/s and requires a 7,800 m^3 detention basin, Basin (5).
- **Catchment 6** situated in the south-east of Area 3 of the site consists of 7.89 ha, has peak flows of 3.950 m^3/s and requires a 6200 m^3 detention basin, Basin (6).

The resultant Detention Basin requirements are indicated in Table (1), below.

Area	Catchment	Catchment Size Ha	Peak Flow m^3	Basin m^3
1	1	2.16	1.498	2,500
2	2	4.25	2.970	6,600
3	3	14.71	5.370	12,300
3	4	13.57	4.990	10,000
3	5	9.20	4.139	7,800
3	6	7.89	3.950	6,900

(4) Urban Water Cycle Solutions Water Cycle Management Strategy

Urban Water Cycle Solutions was commissioned by Aspen Group to develop an Urban Water Cycle Management Strategy, for the proposed urban village at Fern Bay. The Strategy comprehensively incorporates Water Sensitive Urban Design features and philosophy and produces a strategy for the implementation of these philosophies. The report contains a conceptual framework of modelling, data and stormwater management protocols, information from previous studies and "proposes an urban water cycle management that is consistent with the natural water cycle process currently operating at the site".

The report is a comprehensive document and will not be further commented upon in detail in this supplement. Reference should be made to the report and the zero impact upon existing aquifers and ground water levels.

(5) Water Sensitive Urban Design – a Treatment Philosophy in Brief

Water Sensitive Urban Design essentially involves the onsite treatment of rainwater and therefore urban runoff by utilizing a treatment train process. The process purifies the runoff through treatment well upstream in the catchment, conveys the runoff to mass storage devices and then slow infiltration into the aquifer.

Rainwater naturally contains Total Nitrogen, Total Phosphors and Total Suspended Solids. These contaminants by using WSUD devices can be greatly reduced. An analysis using the MUSIC program can indicate target percentage reductions of these quantities. Reductions may typically range in Total Nitrogen of 15%, Total Phosphorus 65% and total suspended solids of 90%. Additional removal of debris and rubbish using gross pollutant traps and planted conveyance swales will remove sand and suspended silt and contaminants such oils and paints etc.

The Treatment train begins with Rain Water falling on Road and hardstand surfaces and flowing to a bioretention swale. Rainwater falling onto roof and driveway areas are captured initially in rainwater tanks and overflows are conveyed to interallotment drainage pipes which terminate into a surcharge pit. Upwelling from these pits delivers water to the top of the bioretention trench. At that stage the planted swale above the bioretention trench captures sand and gravel sediments and debris and rubbish collects at the downstream surface inlet pit. As water traverses the bioretention trench it filters through a sandy treatment medium and into a socked agricultural pipe for conveyance to the larger reinforced concrete drainage pipe system. The sandy treatment medium has designed particle sizes to filter contaminants and trap these contaminants. The treated water then is conveyed to the detention basin in a conventional piped system.

The treatment train is designed for first flush 1 to 3 month flows to be treated by the bioretention swales, the pipe system designed to carry the 1 to 5 year rainfall flows and the swales designed to carry the 1 to 100 year rainfall event.

Detention and treatment basins at the termination of the catchment utilizing similar principles further treat the larger flows. Once treated the water flows to natural low lying areas around the site for storage and eventual infiltration into the aquifer. Using these techniques the total addition of water to the aquifer is not increased in any respect, flows are totally contained within the site and water that flows to the aquifer has been treated within the parameters of WSUD philosophies.

(6) WSUD Outcomes as Modelled Using the MUSIC Software

Using MUSIC software (model for urban stormwater improvement conceptualizations) the project plan was now conceptually evaluated to ensure an appropriate stormwater management system.

By simulating the performance of stormwater quality improvement measures, MUSIC can determine if proposed systems can meet specified water quality objectives. MUSIC is designed to simulate stormwater systems in urban catchment and to operate at a range of temporal and spatial scales suitable for catchment areas up to 100km². Modelling time steps can range from 6 minutes to 24 hours to match the range of spatial scale.

Pollutant loads contain gross pollutants, Total Suspended Solids TSS, Total Phosphorus TS & Total Nitrogen TN. As a result of the implementation of an effective treatment train of utilizing WSUD principals removal rates of TSP, TP and TN could be expected to be as high as 90%, 65% and 15% respectively. Outcomes higher than these target ranges can decrease the effect on groundwater and groundwater contamination.

Throughout the modelling of both the rational method and the MUSIC water quality conceptualization saturated hydraulic conductivities of no more than 200mm/hour to less than 50mm/hour have been used. This range of hydraulic condition is therefore consistent with current Australian standards, Horton infiltration equations and consistent best practice.

(6A) Individual Catchment Outcomes Utilising MUSIC Software

Individual nodal inputs have been modelled for each catchment and overall reductions of Total Suspended Solids TSS, Total Phosphorus TS & Total Nitrogen TN have been obtained and the results are indicated in the following table, Table (2). As can be seen from Table (2) individual WSUD treatment train elements have been added to the model and resultant outcomes of percentage reductions have been achieved. Appendix 2 contains the detailed data inputted into MUSIC and results from the MUSIC modelling. Graphs indicate the effectiveness of the treatment train in removing target pollutants.

Catchment	**WSUD Device**	**Reductions %**			
		TSS	**TP**	**TP**	**Cross Pollutants**
1	Bioretention Swale 1A	80.7	65.1	38.3	100
1	Detention Area 1	90.9	76.0	57.0	100
1	Wetland Area 1	97.2	87.2	65.6	100
2	Bioretention Swale 2A	80.0	62.6	38.0	100
2	Detention Area 2	90.7	76.1	59.5	100
2	Wetland Area 2	91.9	78.1	60.1	100
3	Bioretention Swale 3A	88.3	71.7	43.7	100
3	Bioretention Swale 3B	80.0	62.5	38.0	100
3	Bioretention Swale 3C	78.6	64.5	38.4	100
3	Basin 3	90.6	74.6	54.4	100
3	Wetlands 3	91.4	76.0	54.8	100
4	Swale 4A	77.3	54.9	30.0	100
4	Bioretention Swale 4A	79.9	62.9	37.6	100
4	Swale 4B	80.6	57.5	32.4	100
4	Bioretention Swale	79.8	62.1	37.3	100

	4B				
4	Detention Area 4	92.8	78.3	60.4	100
4	Wetland Area 4	93.4	79.4	60.6	100
5	Bioretention Swale 5A	76.7	61.9	39.9	100
5	Detention Basin 5	88.9	73.2	52.9	100
5	Wetland Area 5	90.1	75.0	53.5	100
6	Bioretention Swale 6A	78.1	60.2	36.8	100
6	Detention Basin 6	90.5	74.6	53.8	100
6	Wetland Area 6	91.6	76.5	54.4	100

(7) Some Examples of WSUD Devices

Attached to this commentary are some examples of WSUD Devices utilized in providing a treatment train for urban catchments. These have been organized into initial devices for connecting into individual allotments, through to detention basins at the end of the treatment train.

The Bioretention Trench House drains detail and house drainage pit detail, indicates how water is supplied to the individual drainage pit from each allotment, filtered for rubbish and debris and then treated by flowing out of the agricultural pipe to the sandy filter. The water then flows to surrounding soils as it passes along the trench to the next node.

The James Hardie slotted frc sump pit indicates the detail for a pit that upwells water into the bioretention trench.

The bioretention swale and trench indicates the sandy layer and agricultural pipe for conveyance and infiltration.

The bioretention surface inlet pit indicates typical detail of how water enters the bioretention treatment and conveyance systems.

The bioretention infiltration trench indicates storage and infiltration devices located at terminal points of some treatment reaches.

The infiltration basin indicates a typical arrangement of the conveyance swales, bioretention trenches, pipes and detention/infiltration basins.

Other drawings indicate piped and structural detail of other devices.

(8) Conclusion

Utilizing Water Sensitive Urban Design through a treatment train philosophy has the capacity to treat and purify rainwater and urban residential contaminants to very high standards suitable for further input into the aquifer.

The implementation of this philosophy by constructing WSUD devices throughout the site will achieve target reductions in these contaminants and will be wholly contained within the subject site. The net effect to groundwater quantity and groundwater quality will not in any way be modified or be detrimental through the construction of Fern Bay Seaside Village.

<u>FAGAN MATHER DUGGAN PTY LTD</u>

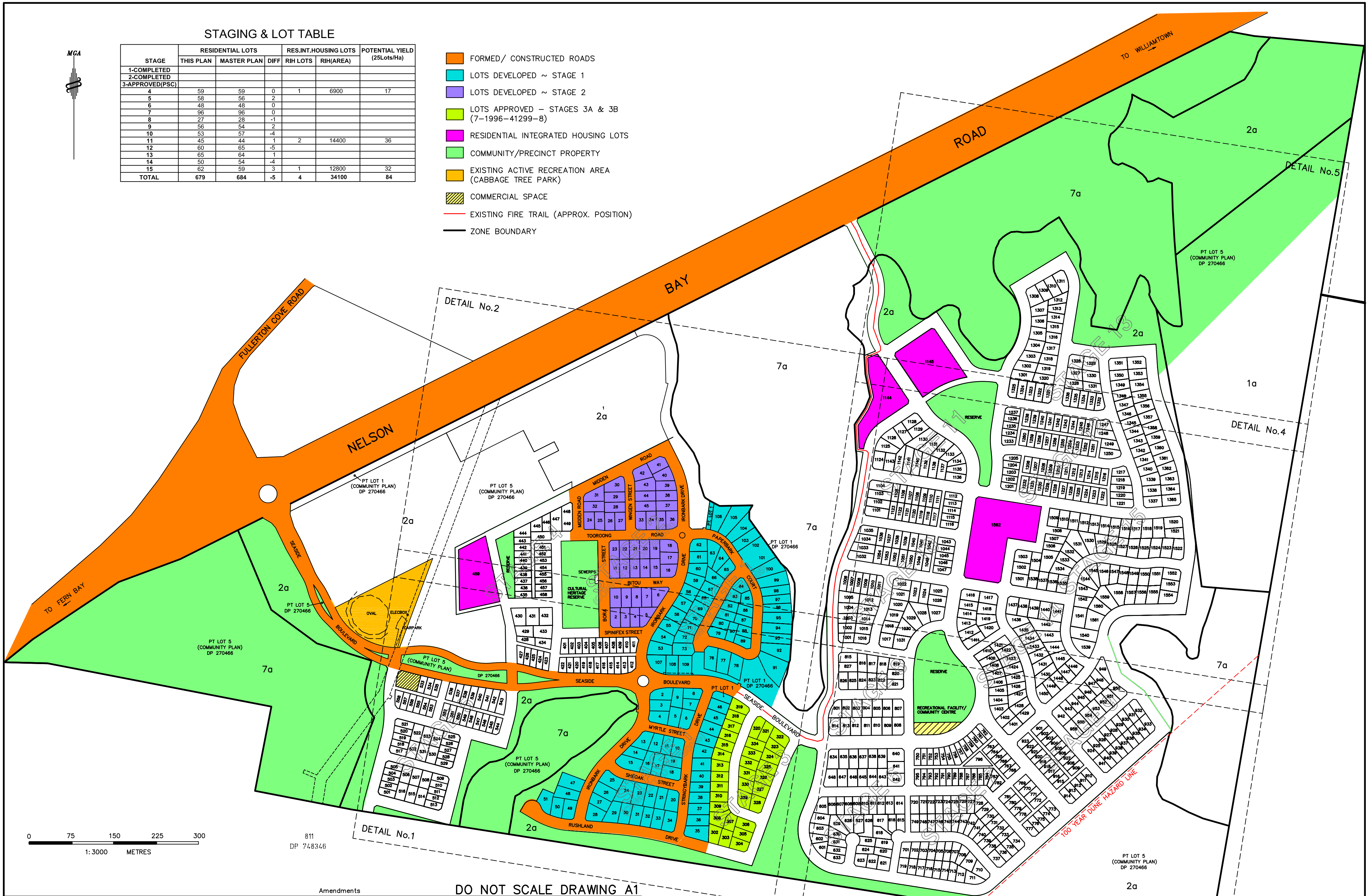
PG MATHER
WSUD Consultant

DIAGRAM 1A

Allotment Layout

STAGING & LOT TABLE

STAGE	RESIDENTIAL LOTS			RES.INT.HOUSING LOTS		POTENTIAL YIELD (25Lots/Ha)
	THIS PLAN	MASTER PLAN	DIFF	RIH LOTS	RIH(AREA)	
1-COMPLETED						
2-COMPLETED						
3-APPROVED(PSC)						
4	59	59	0	1	6900	17
5	58	56	2			
6	48	48	0			
7	96	96	0			
8	27	28	-1			
9	56	54	2			
10	53	57	-4			
11	45	44	1	2	14400	36
12	60	65	-5			
13	65	64	1			
14	50	54	-4			
15	62	59	3	1	12800	32
TOTAL	**679**	**684**	**-5**	**4**	**34100**	**84**



DO NOT SCALE DRAWING A1

Amendments

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Consultants in Surveying, Planning & Engineering
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Phone (02) 49190166 Fax (02) 49190294
A.C.N. 003 887 563 A.B.N. 38 003 887 563

Client	ASPEN GROUP LIMITED
Job	FERN BAY SEASIDE VILLAGE NELSON BAY ROAD FERN BAY
This Drawing	PROJECT PLAN – SITE & STAGING
THIS DRAWING FORMS PART OF A REPORT DATED	N/A

2006172–1–18–SB1.DWG	
Date Of Survey N/A	
Surveyed	Date 10/02/09
Design –	Scale 1:3000
Drawn KL	Datum
Checked AED	Source SSM RL
Surveyors Ref. 2006172	Sheet No. 1 Of 18 Sheets

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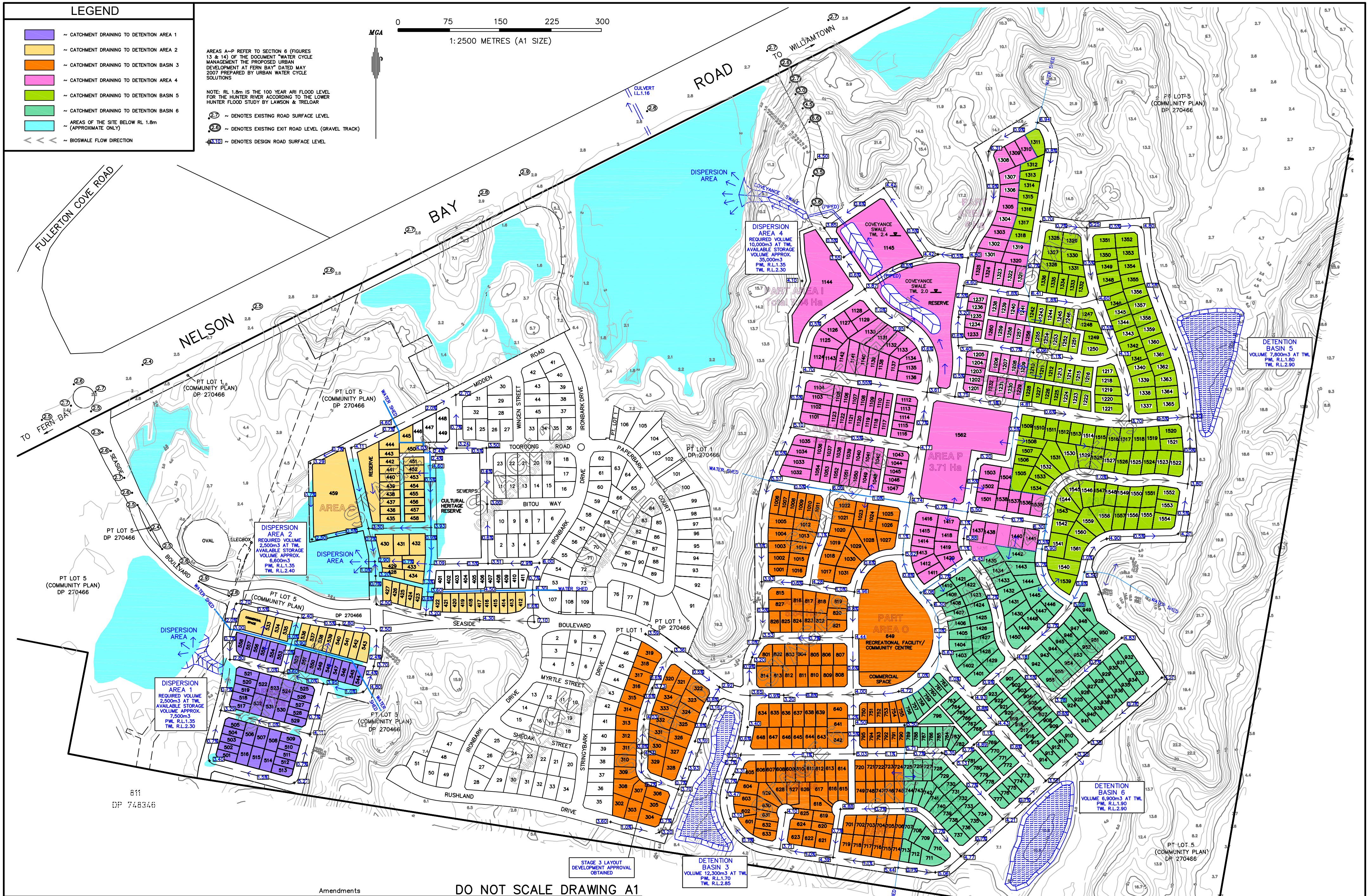
DIAGRAM 1B

Trunk Drainage Conceptual Plan



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Amendments	
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This Drawing	TRUNK DRAINAGE CONCEPTUAL PLAN
THIS DRAWING FORMS PART OF A REPORT DATED	N/A

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Surveyed	Date 10/02/09
Design PM	Scale 1:2500
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Checked PM	Source SSM RL
Surveyors Ref.	Sheet No. 10
2006172	Of 18 Sheets

DIAGRAM 2

Rational Method Modelling

DIAGRAM 2

DMS survey

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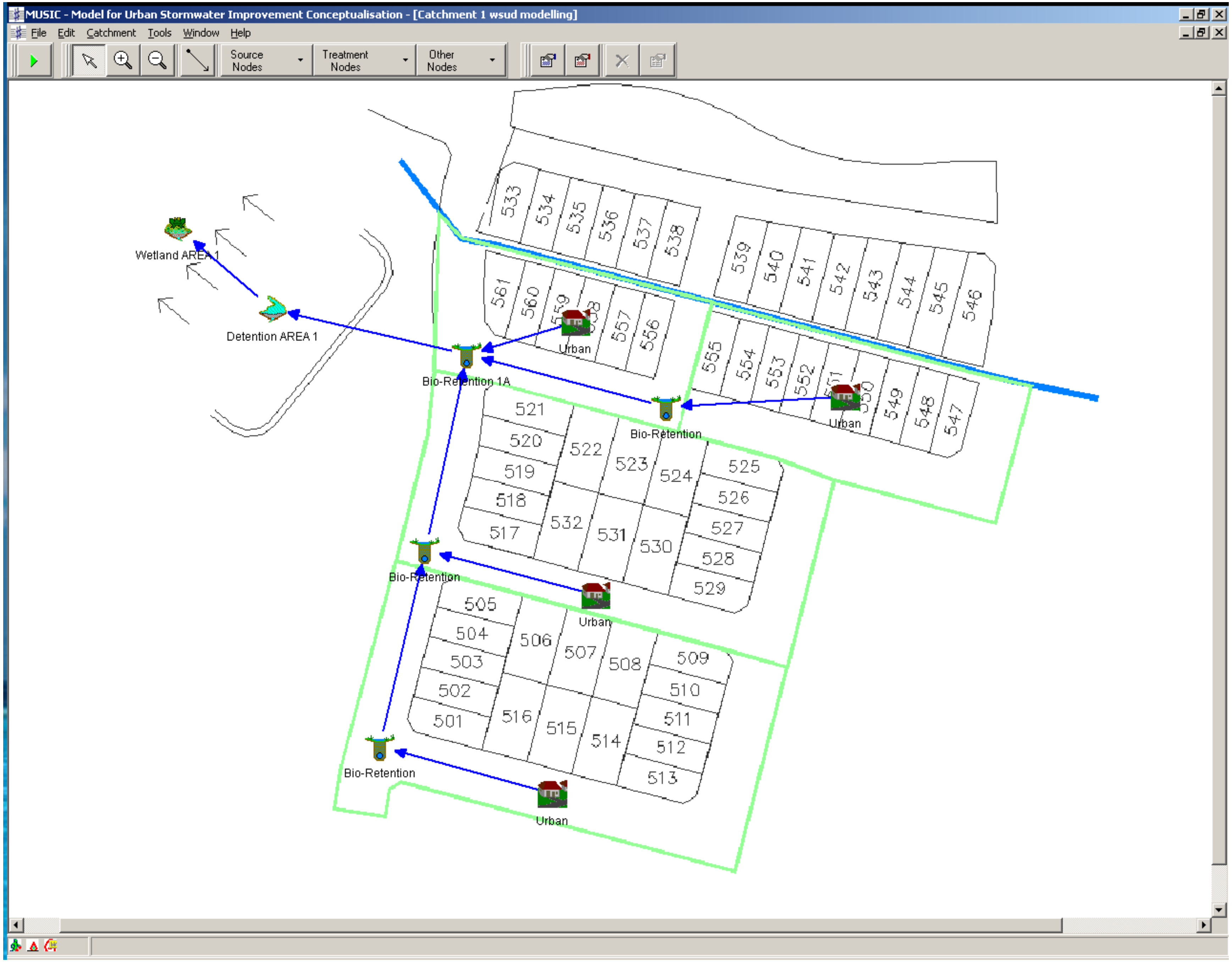
RATIONAL METHOD MODELLING

DIAGRAM 3

MUSIC Modelling
Catchment 1

DIAGRAM 3



MUSIC MODELLING – CATCHMENT 1

DIAGRAM 4

MUSIC Modelling
Catchment 2

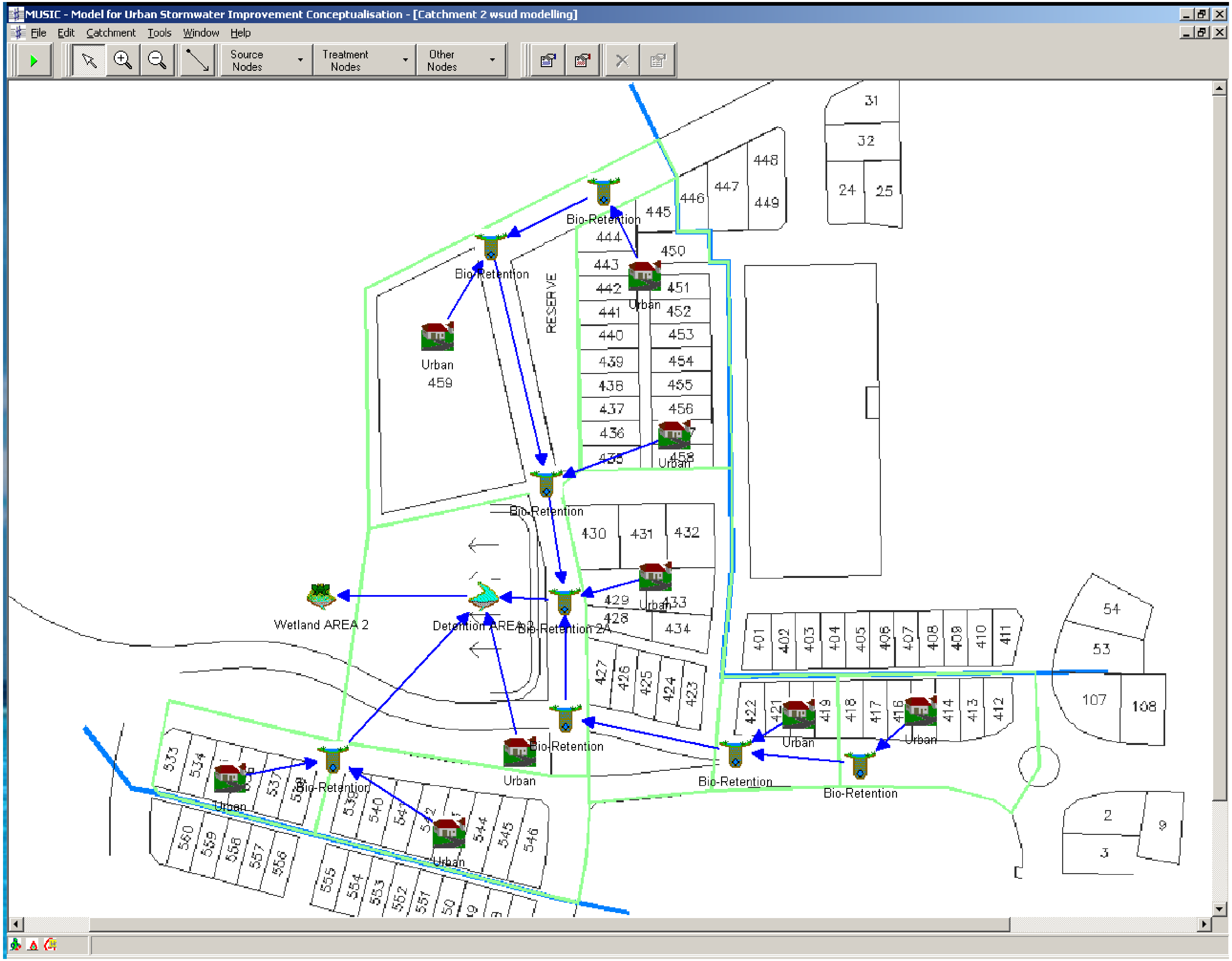
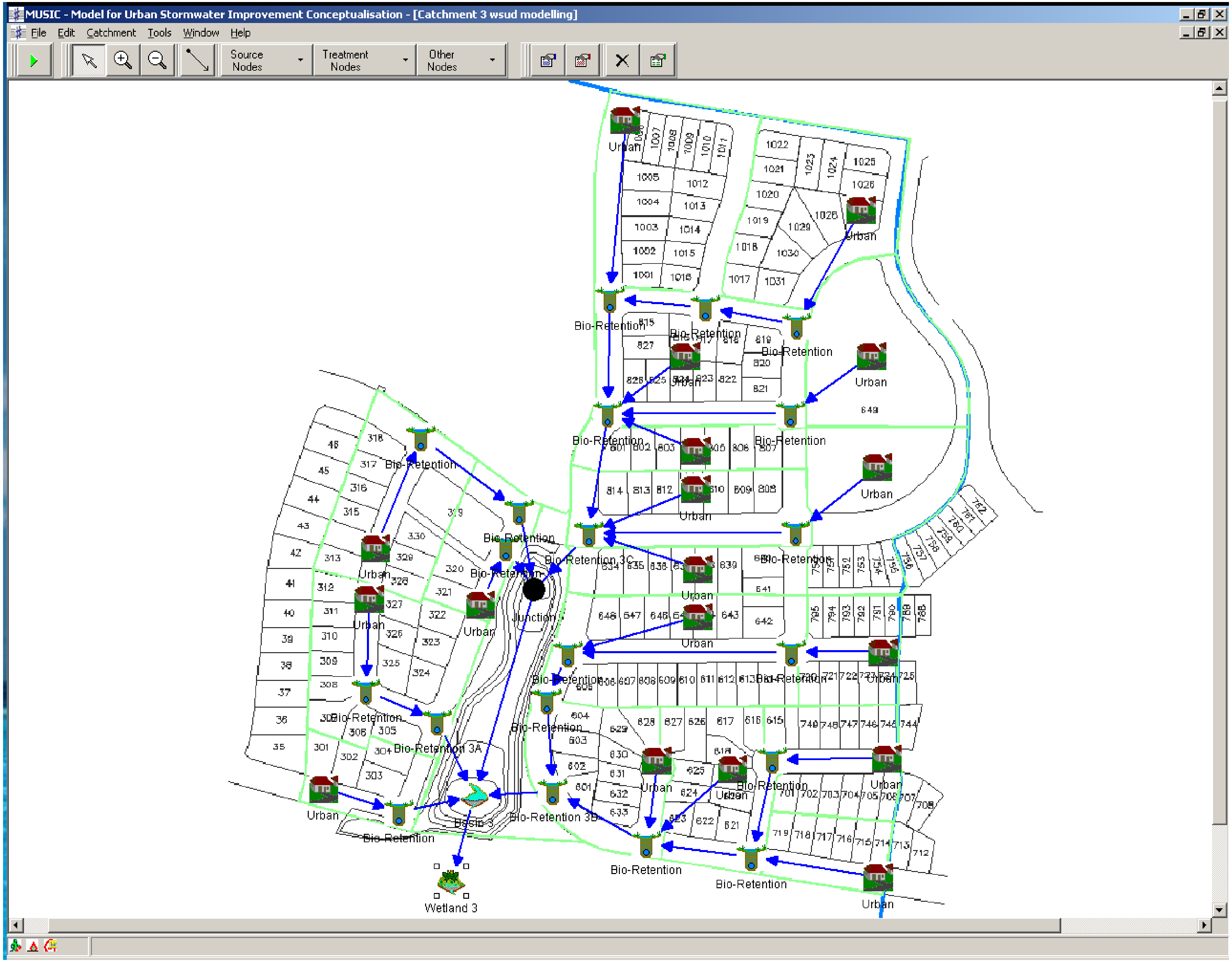

MUSIC - Model for Urban Stormwater Improvement Conceptualisation - [Catchment 2 wsud modelling]
File Edit Catchment Tools Window Help
Source Nodes
Treatment Nodes
Other Nodes
Bio-Retention
Urban
459
RESERVE
Wetland AREA 2
Detention AREA 2
Bio-Retention 2A

DIAGRAM 5

MUSIC Modelling
Catchment 3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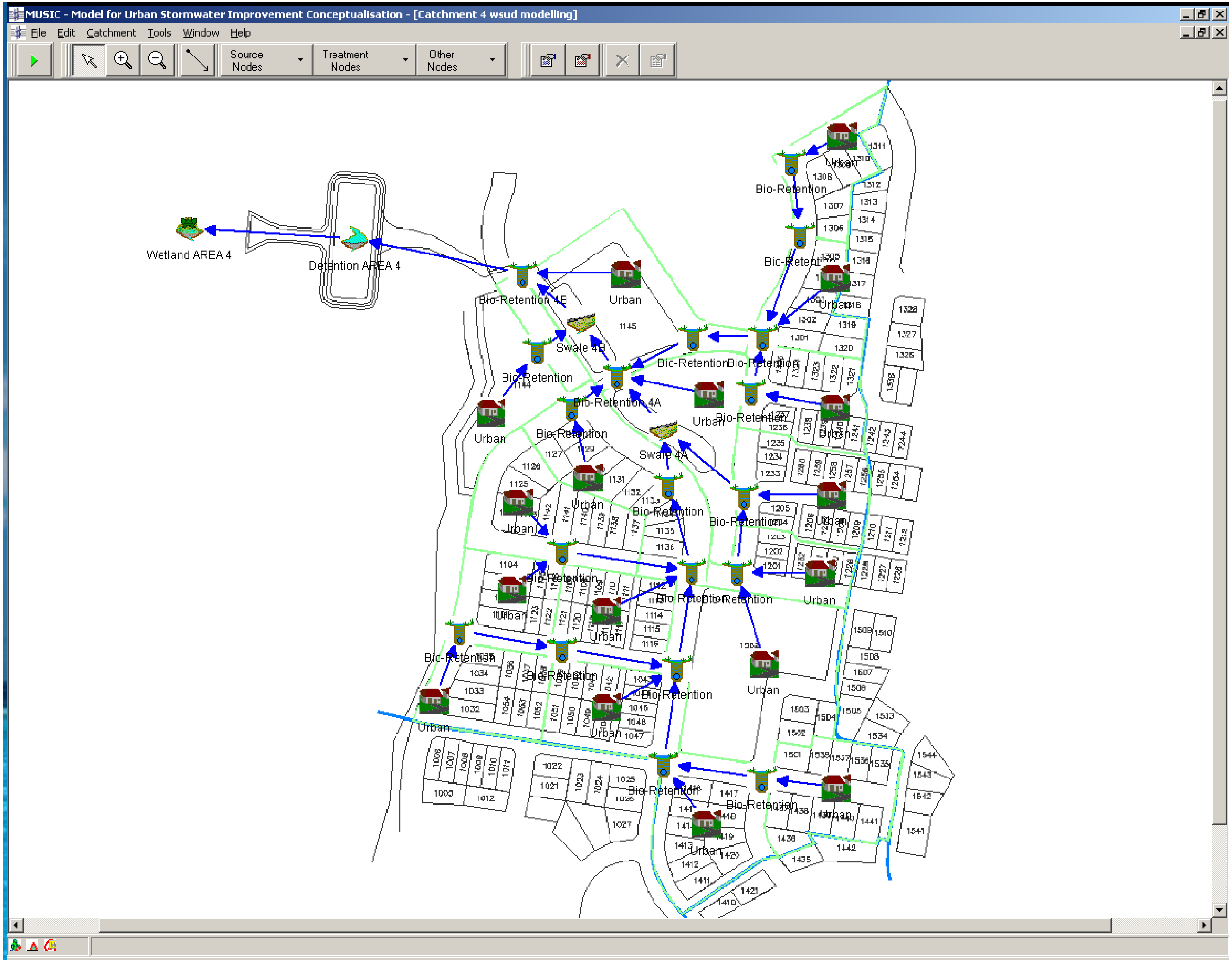
Treatment Nodes
Other Nodes
Urban
Bio-Retention
Bio-Retention 3A
Bio-Retention 3B
Bio-Retention 3C
Junction
Basin 3
Wetland 3

DIAGRAM 6

MUSIC Modelling
Catchment 4

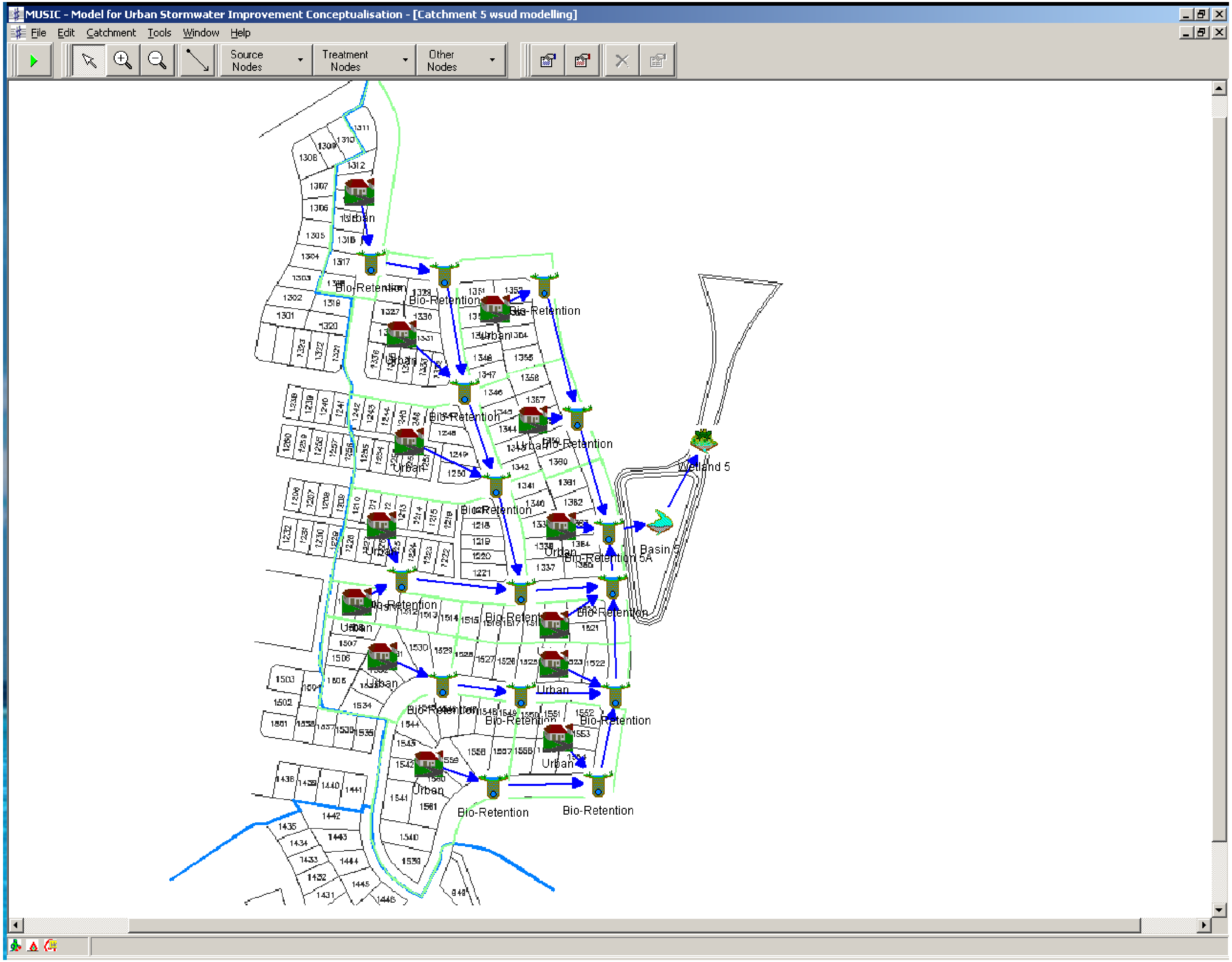
DIAGRAM 6



MUSIC MODELLING – CATCHMENT 4

DIAGRAM 7

MUSIC Modelling
Catchment 5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Other Nodes
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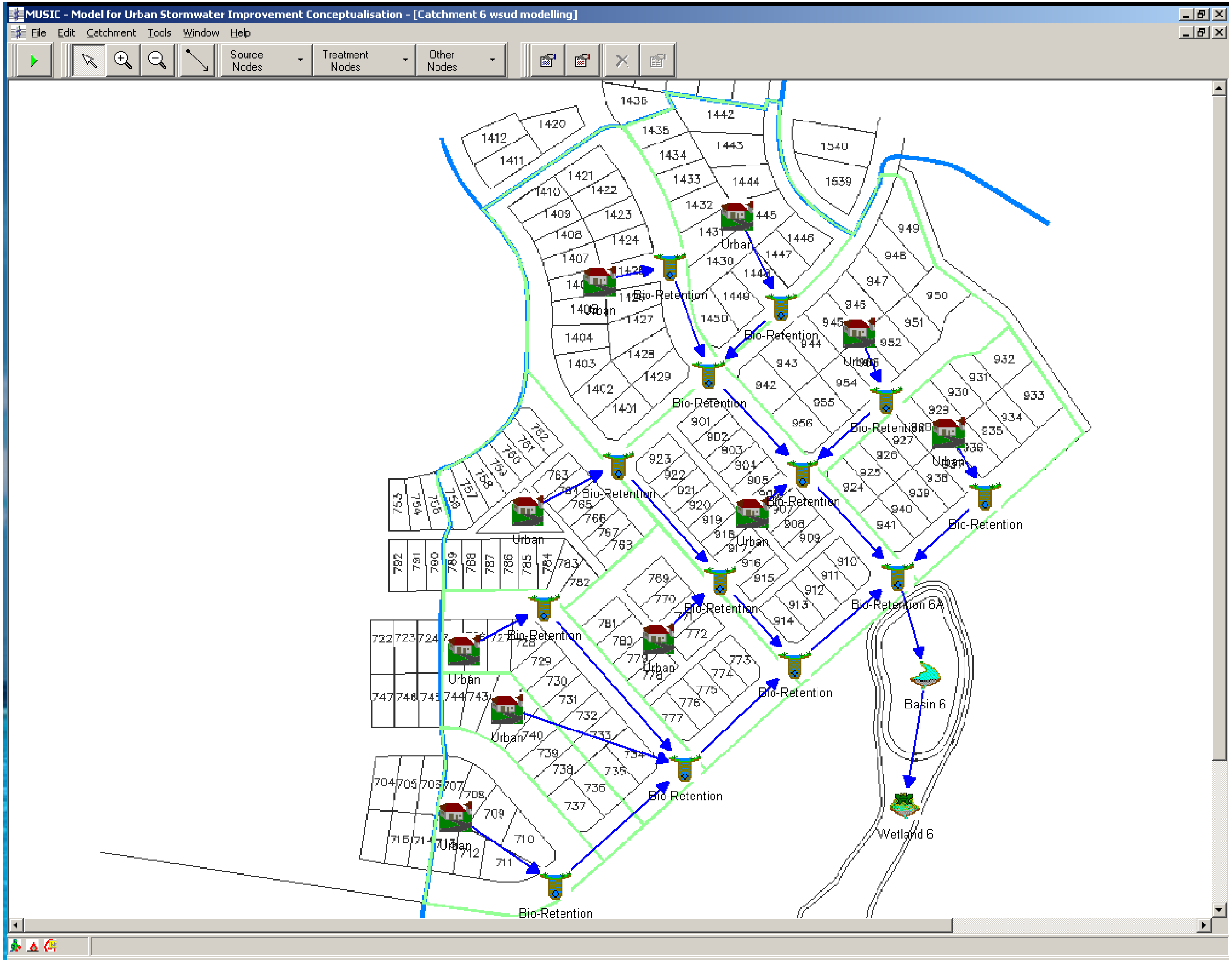
Urban
Wetland 5
Basin 5
Bio-Retention 5A

DIAGRAM 8

MUSIC Modelling
Catchment 6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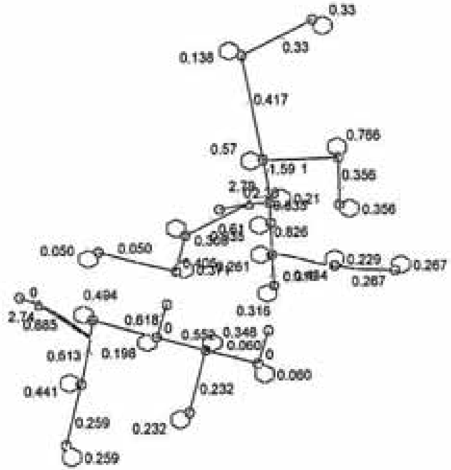
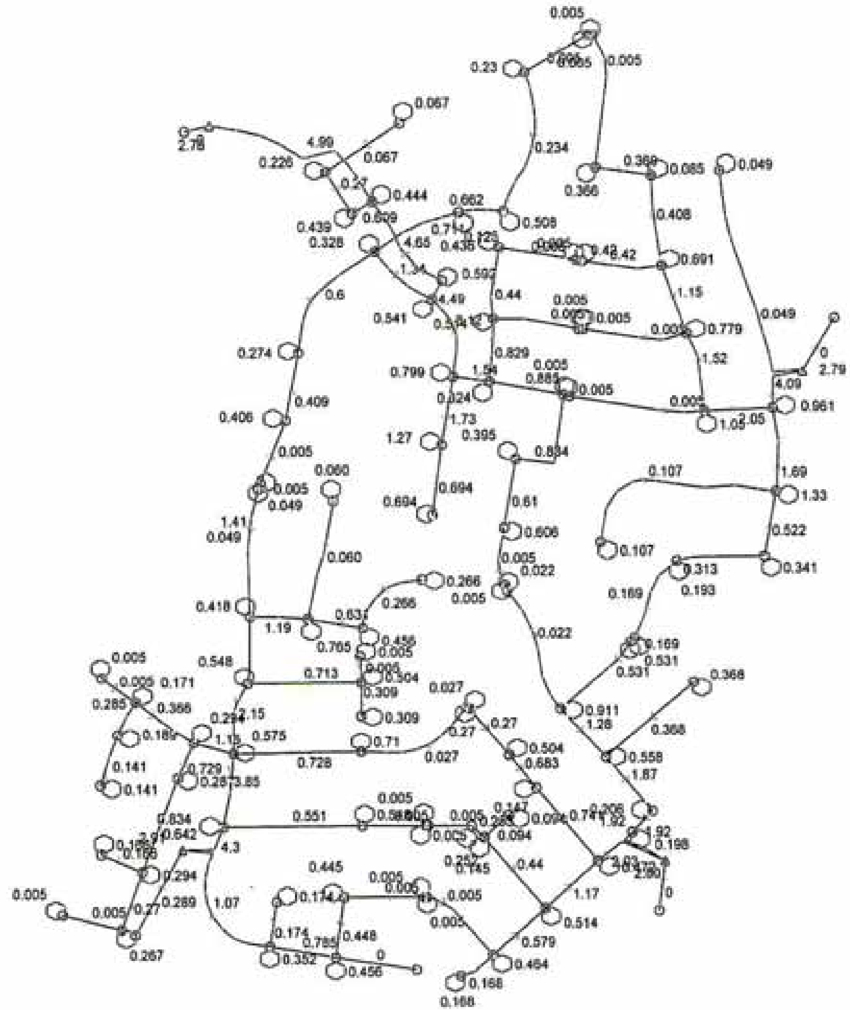
File Edit Catchment Tools Window Help
Source Nodes
Treatment Nodes
Other Nodes
Bio-Retention
Bio-Retention 6A
Urban
Basin 6
Wetland 6

APPENDIX 1

RATIONAL METHOD:

Data Input, Output & Results





Aspen Fern B

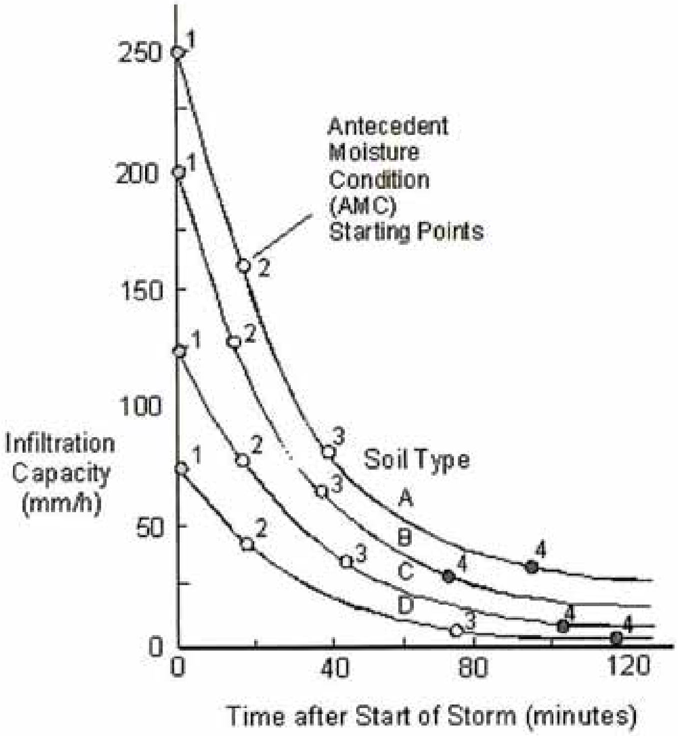
20061

Soil type

Soil types used in ILSAX and *DRAINS* follow the U.S. Soil Conservation Service system adopted in the ILLUDAS model from which ILSAX was developed. There are four soil types involving different infiltration characteristics:

- Type 1 (or A) low runoff potential, high infiltration rates (sand and gravels),
- Type 2 (or B) moderate infiltration rates and moderately well-drained,
- Type 3 (or C) slow infiltration rates (may have layers that impede downward movement of water),
- Type 4 (or D) soils with high runoff potential, very slow infiltration rates (consisting of clays with a permanent high water table and a high swelling potential).

Users can specify a number between 1 and 4. *DRAINS* will interpolate between the standard infiltration factors applying to values of 1, 2, 3 or 4. The infiltration curves for these standard soil types are illustrated below.

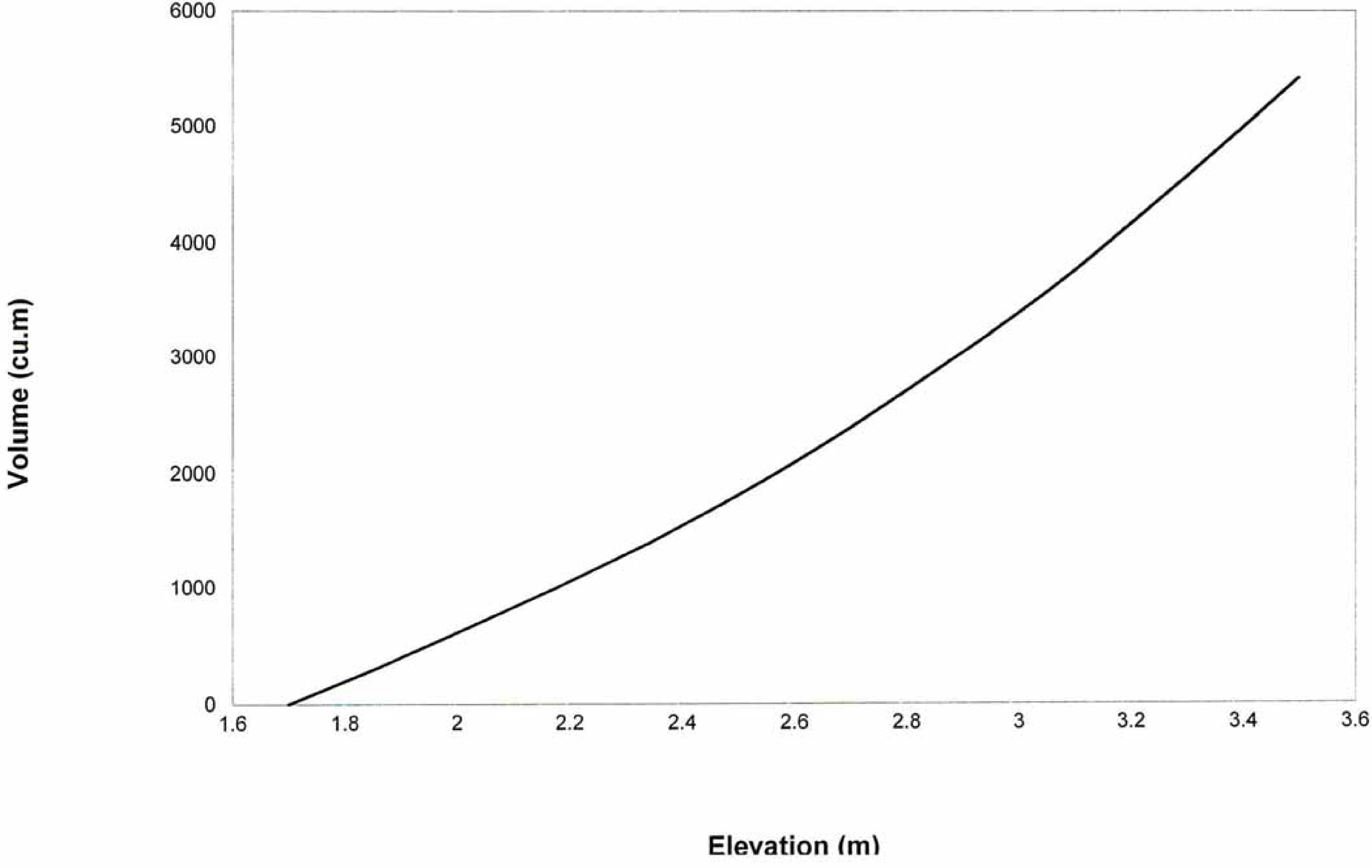


If you require soil characteristics that are not covered by the standard types, you can specify your own parameters. To do this, you must click the **You specify** box in the ILSAX hydrological model property sheet called from the hydrological model menu. Additional entry spaces will appear for seven parameters describing the new soil type.

The numbered dots on the infiltration curve refer to antecedent moisture conditions that indicate the catchment wetness prior to a storm.

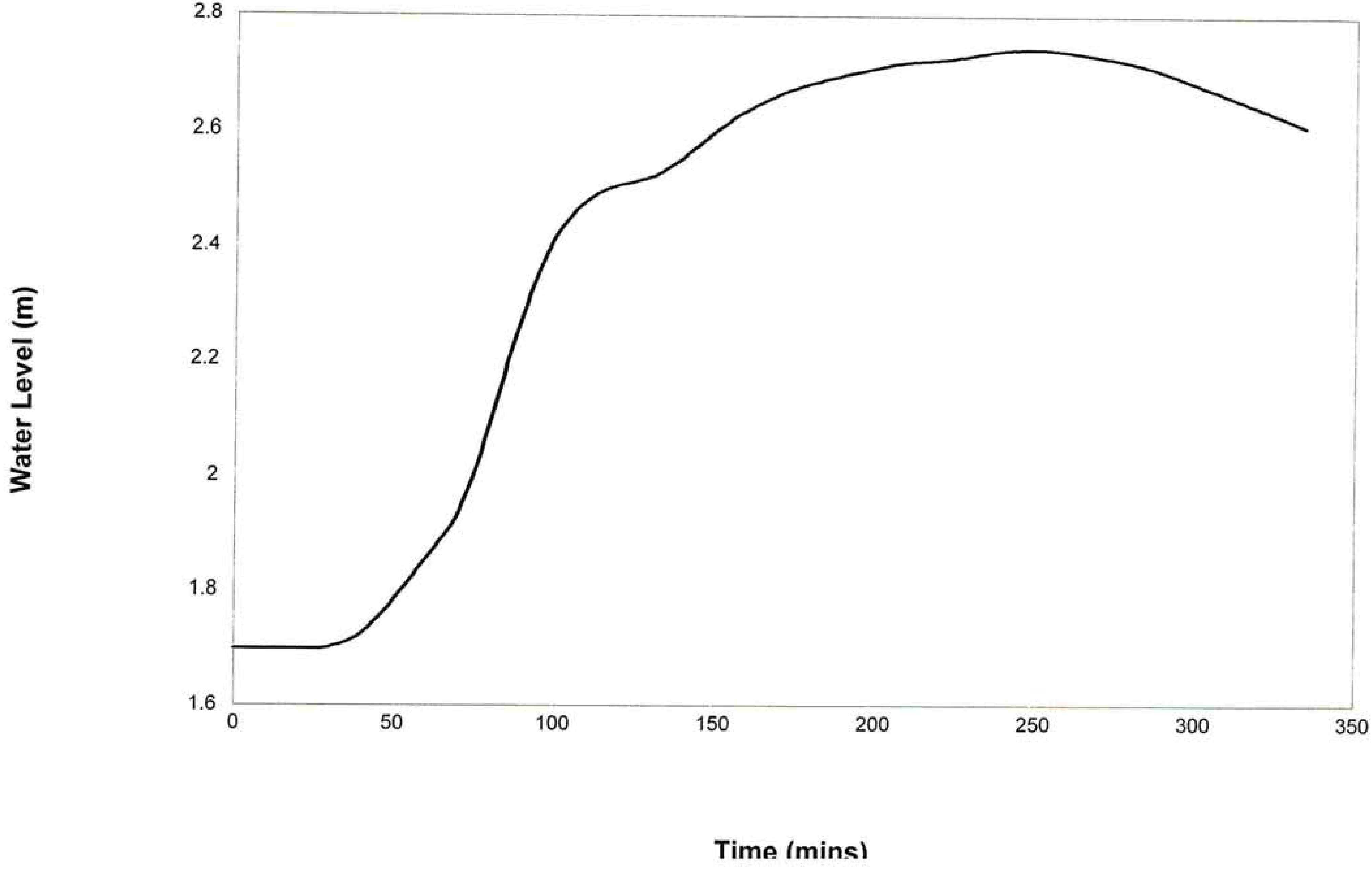
The effects of varying soil types can be determined by sensitivity analysis, using techniques similar to those for examining AMCs and sub-catchment surface roughnesses.

Basin 1

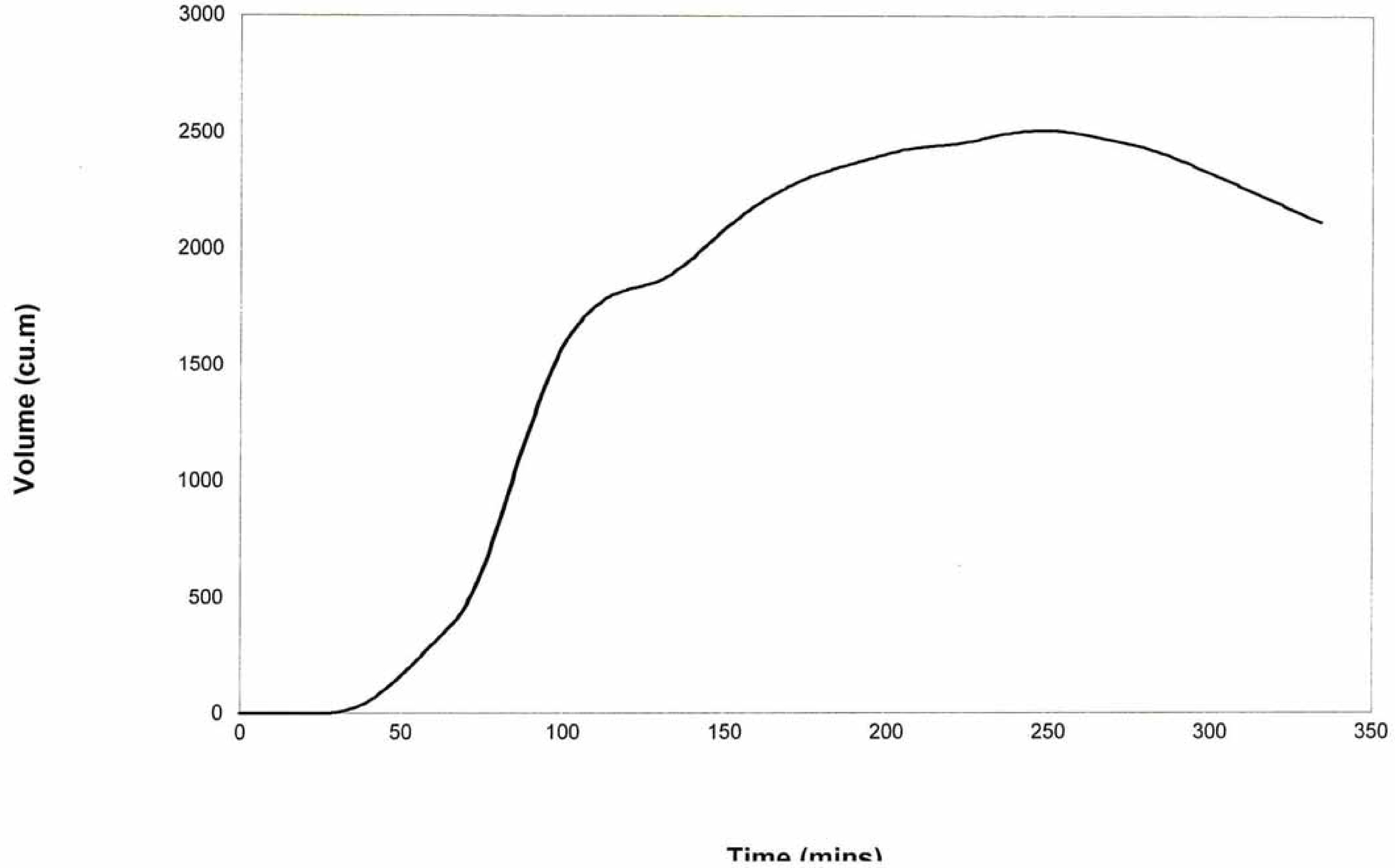


6000
5000
4000
3000
2000
1000
0
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
Volume (cu.m)
Elevation (m)

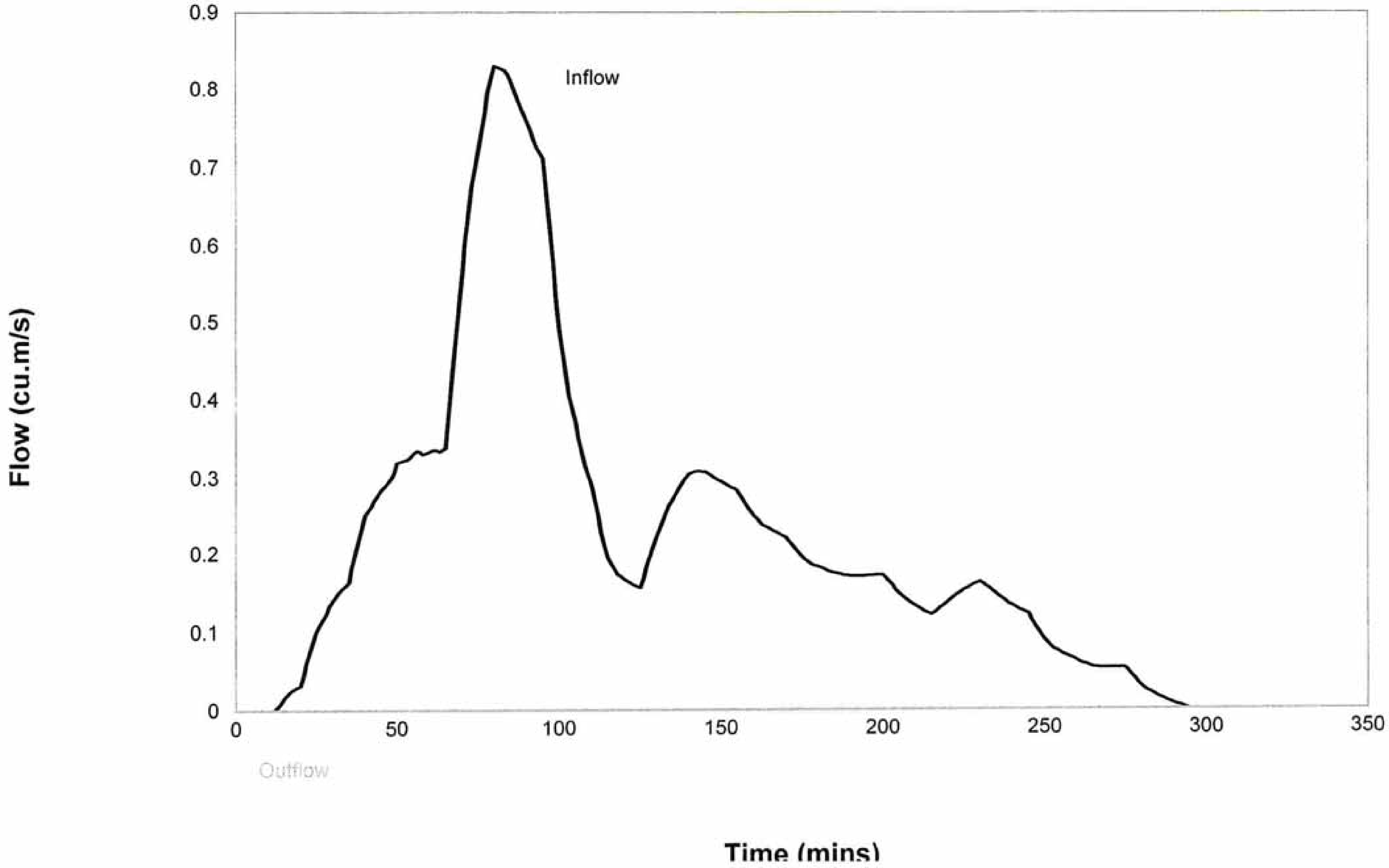
Basin 1 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



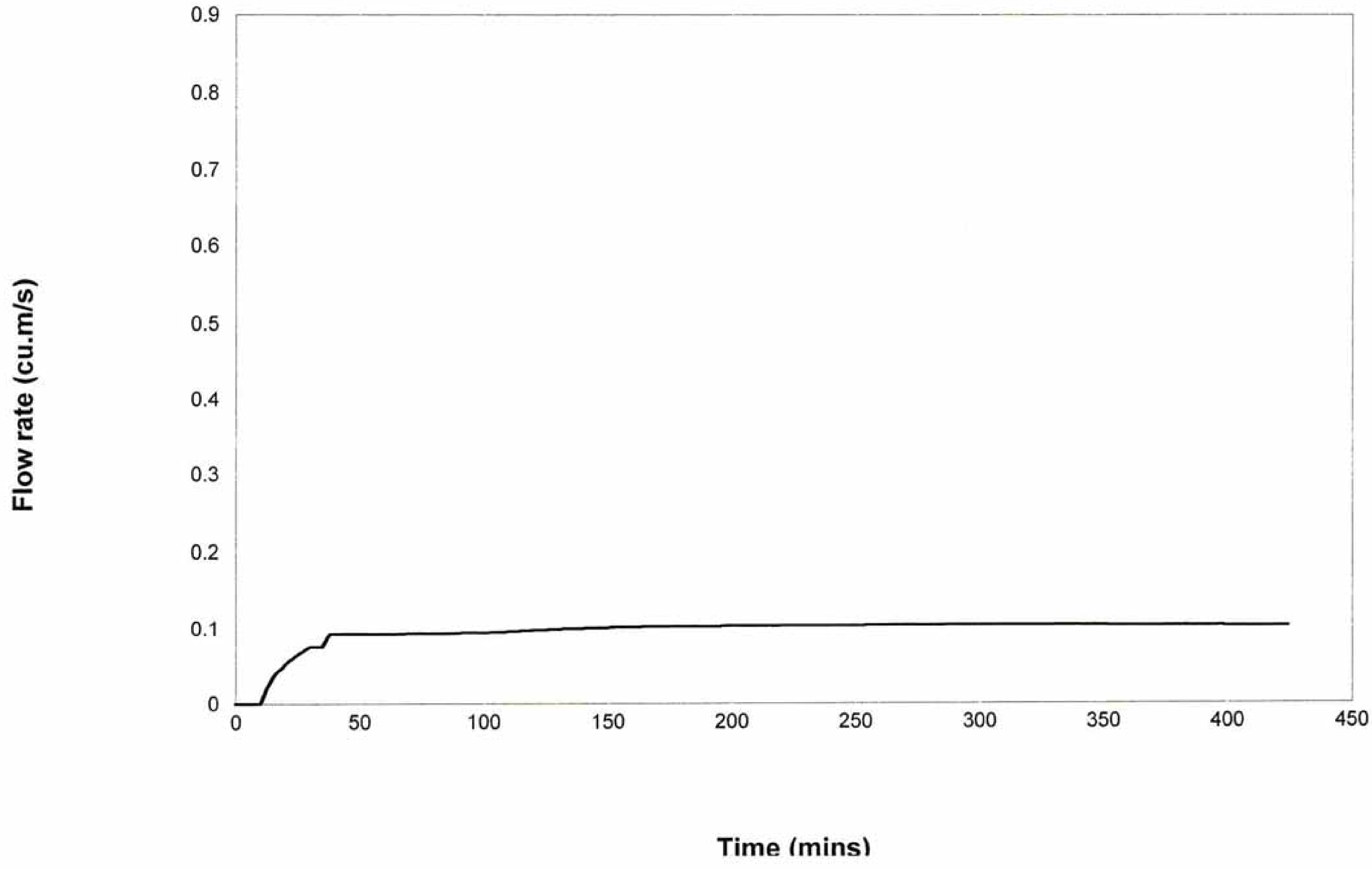
Basin 1 Storage Volume - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



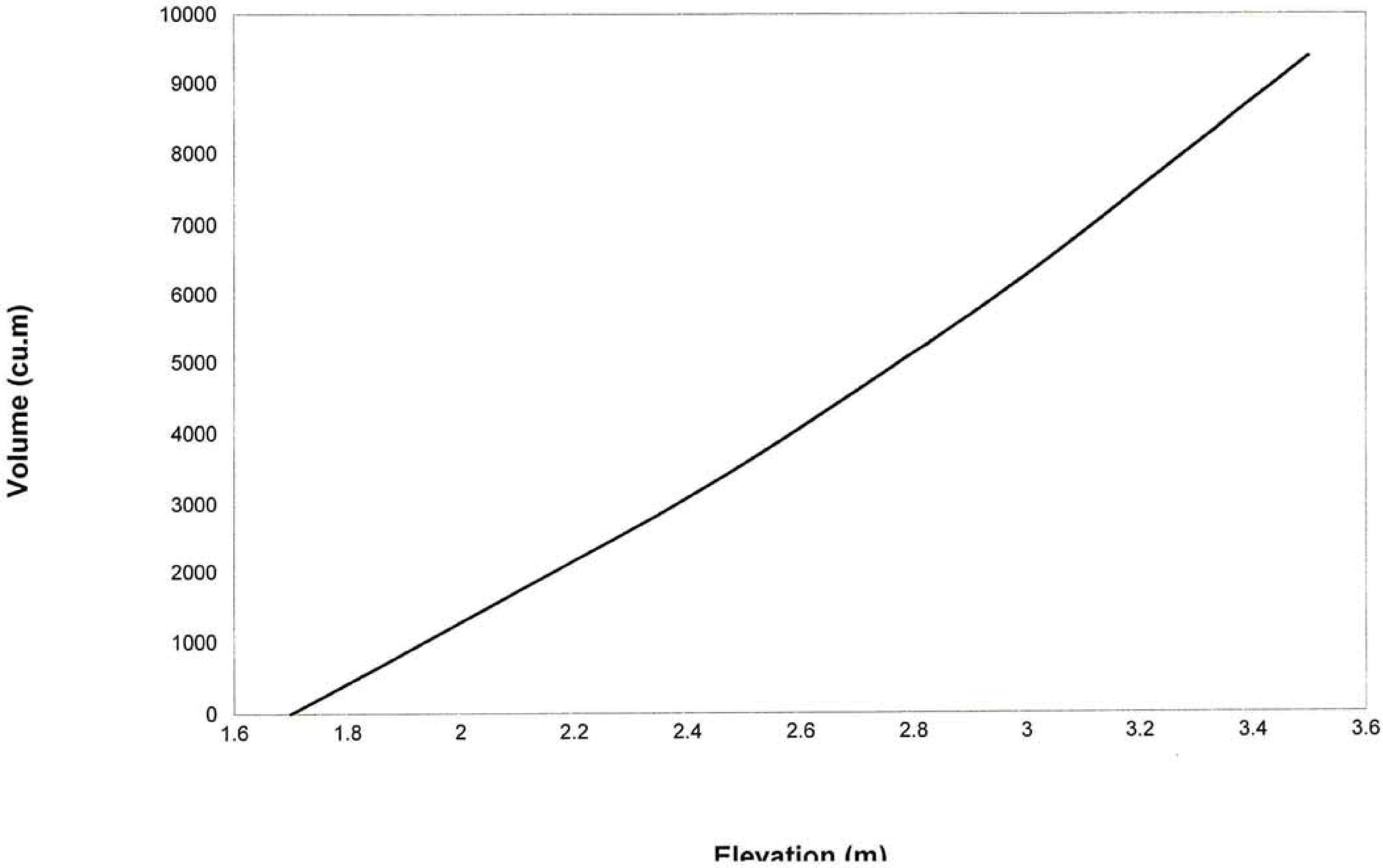
sin 1 Inflow/Outflow Hydrographs - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Z



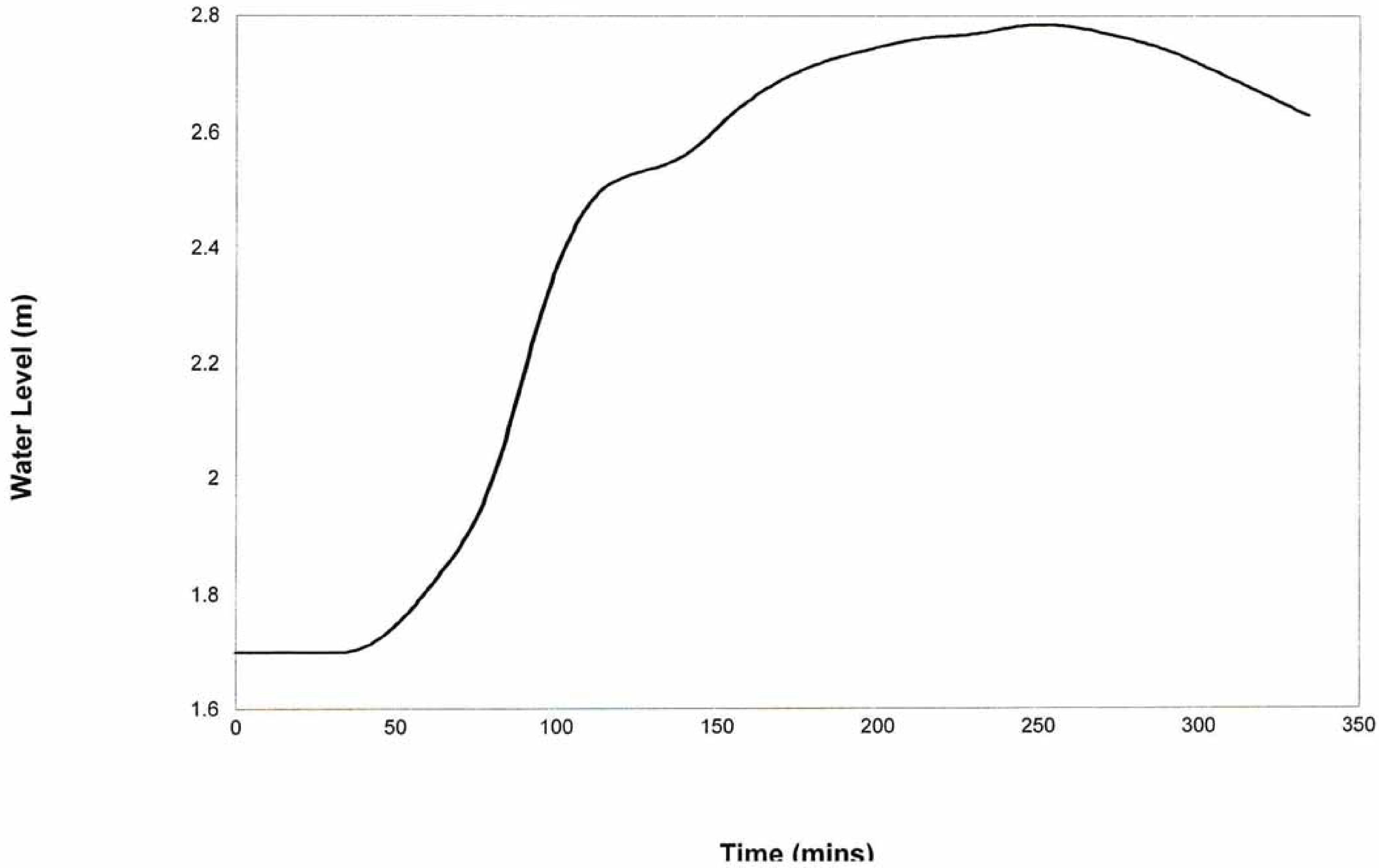
3asin 1 Infiltration Hydrograph - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Zon



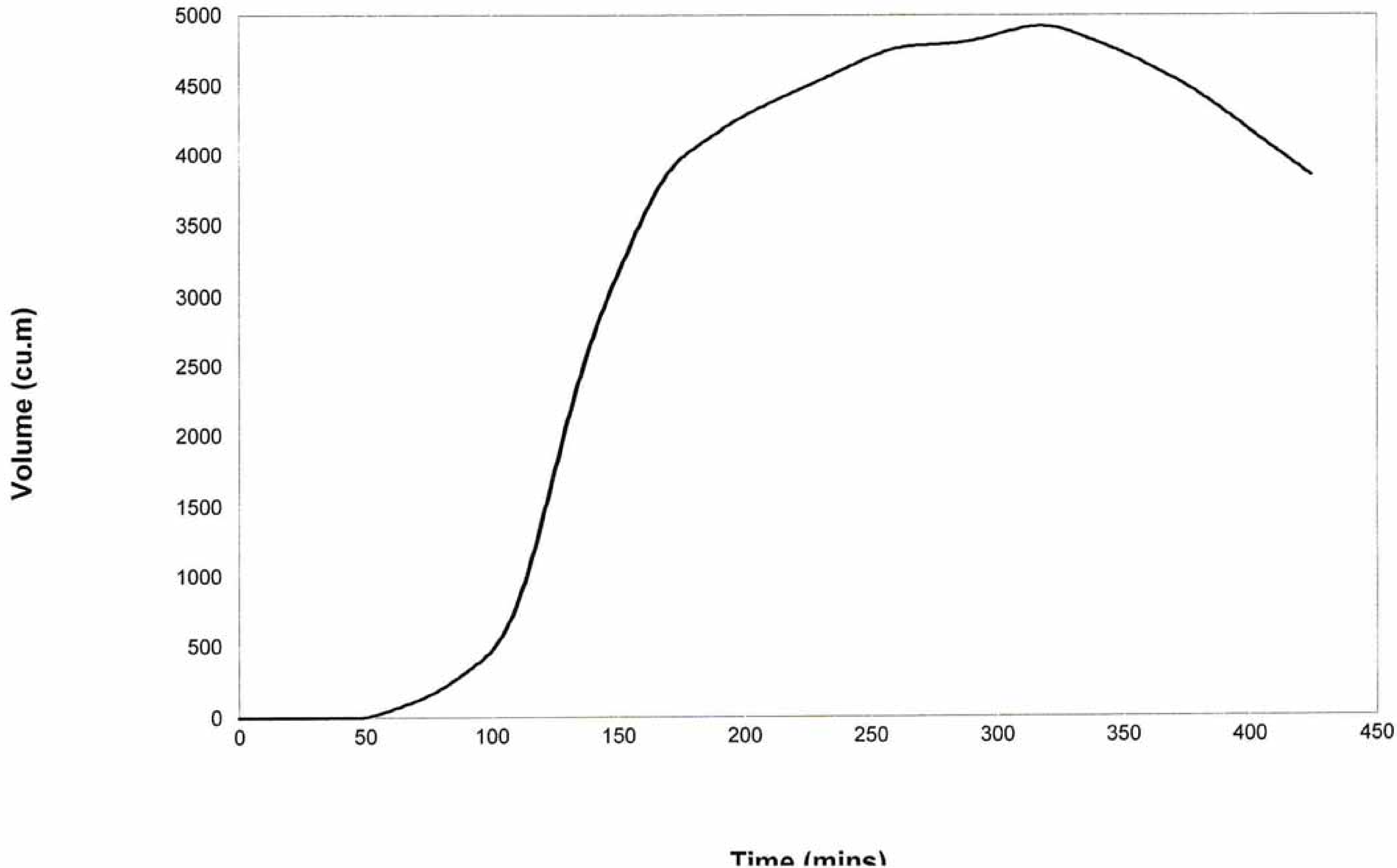
Basin 2


Volume (cu.m)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
Elevation (m)

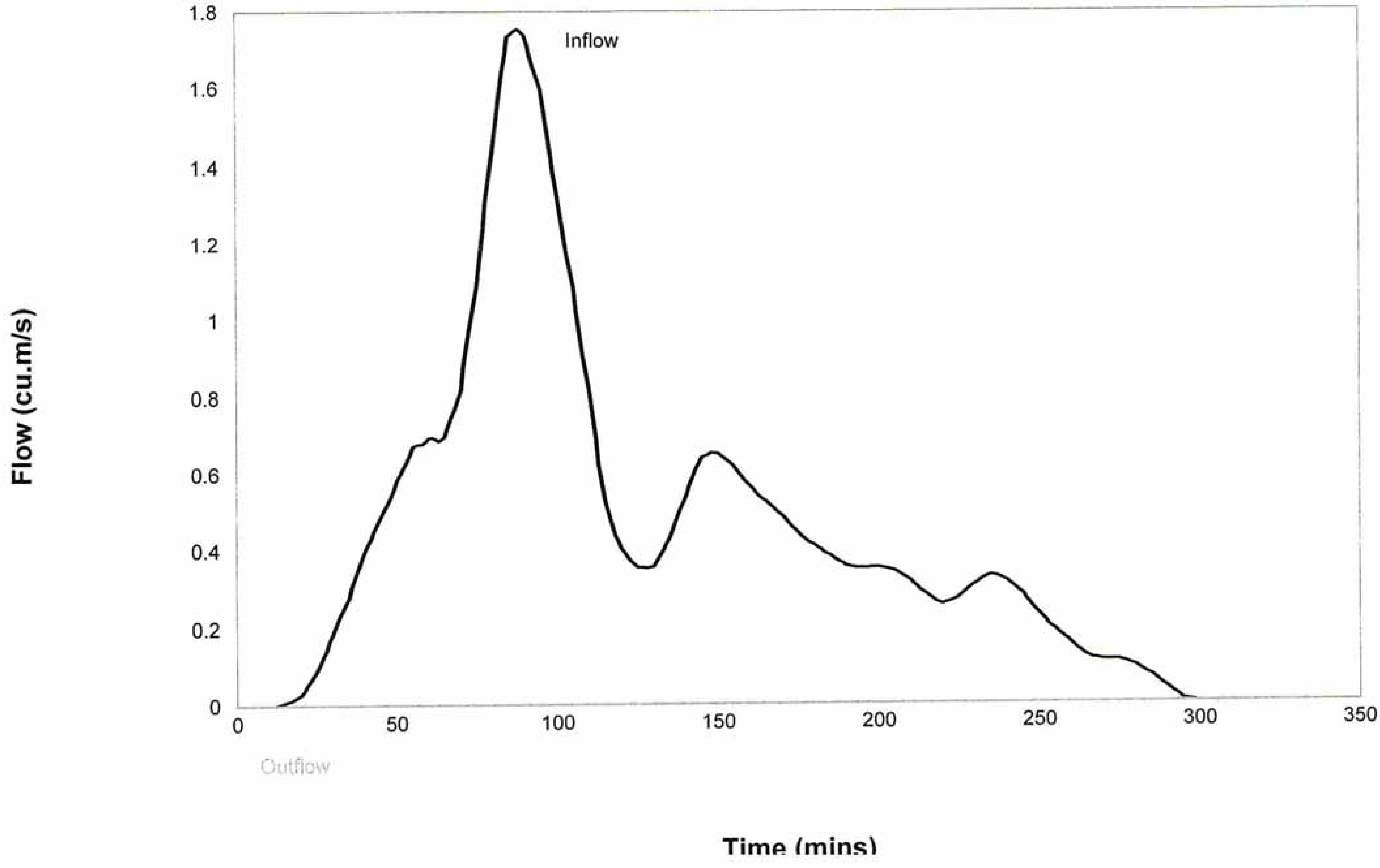
Basin 2 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



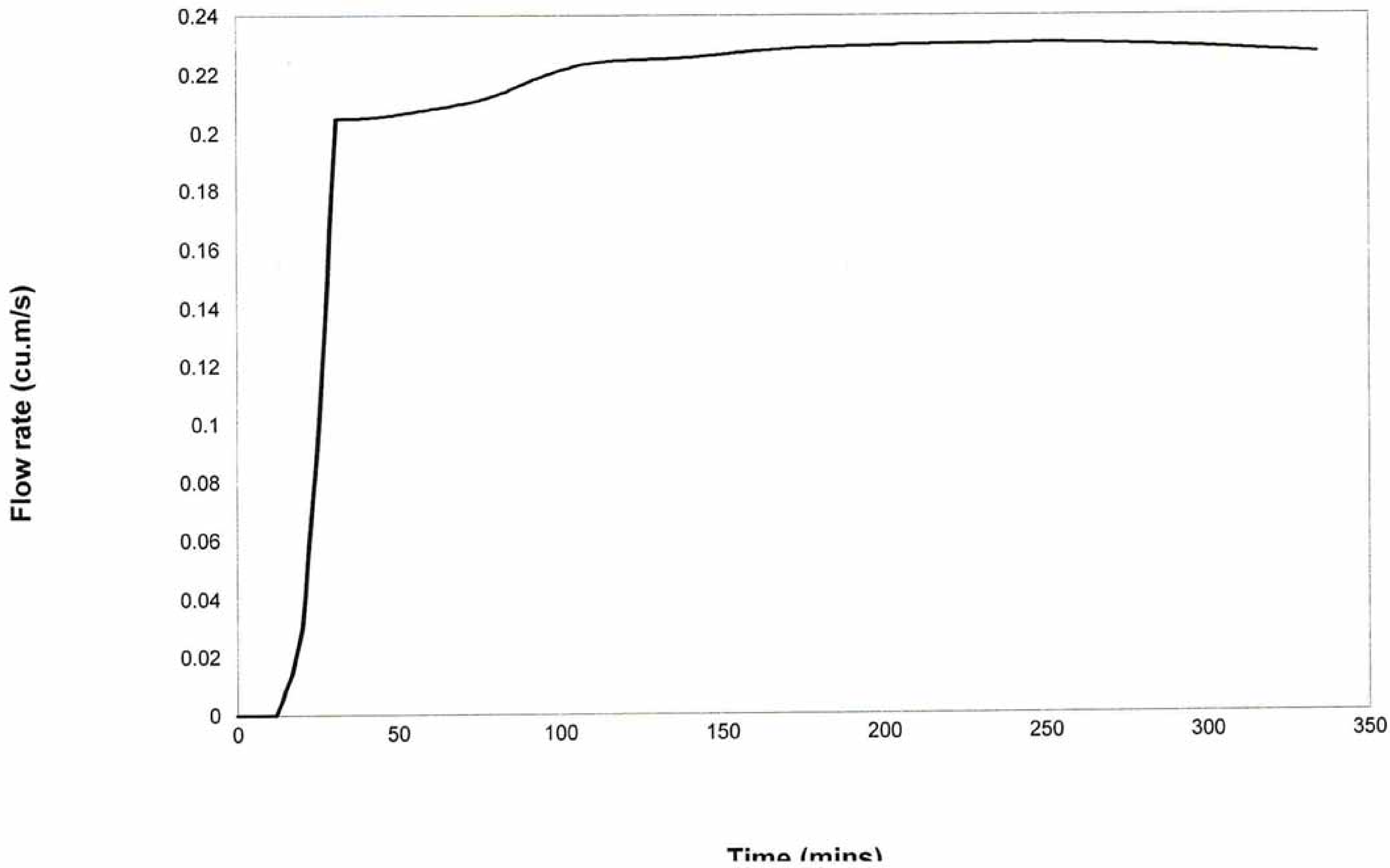
Basin 2 Storage Volume - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Zone 1



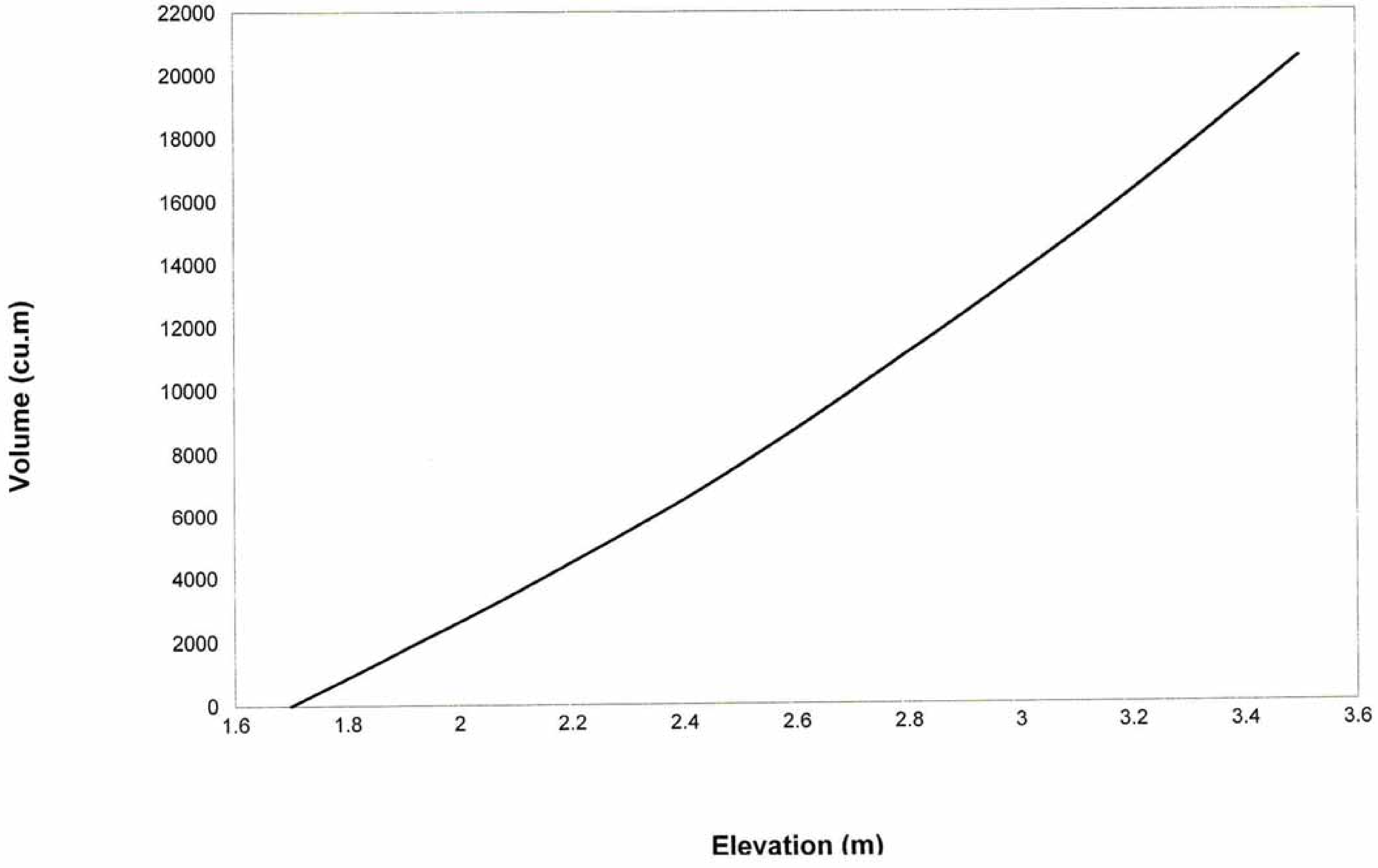
sin 2 Inflow/Outflow Hydrographs - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Z



Basin 2 Infiltration Hydrograph - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone

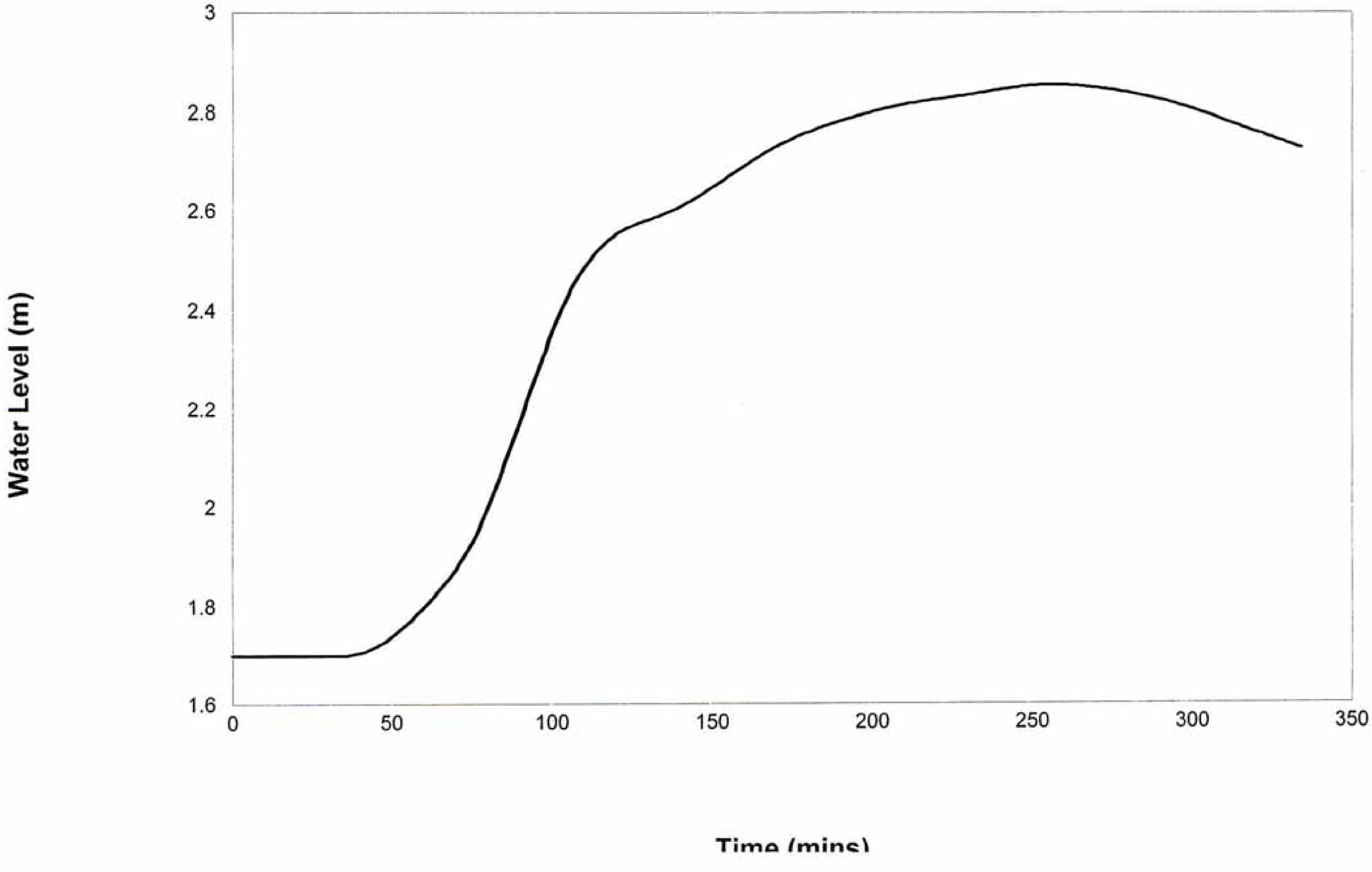


Basin 3

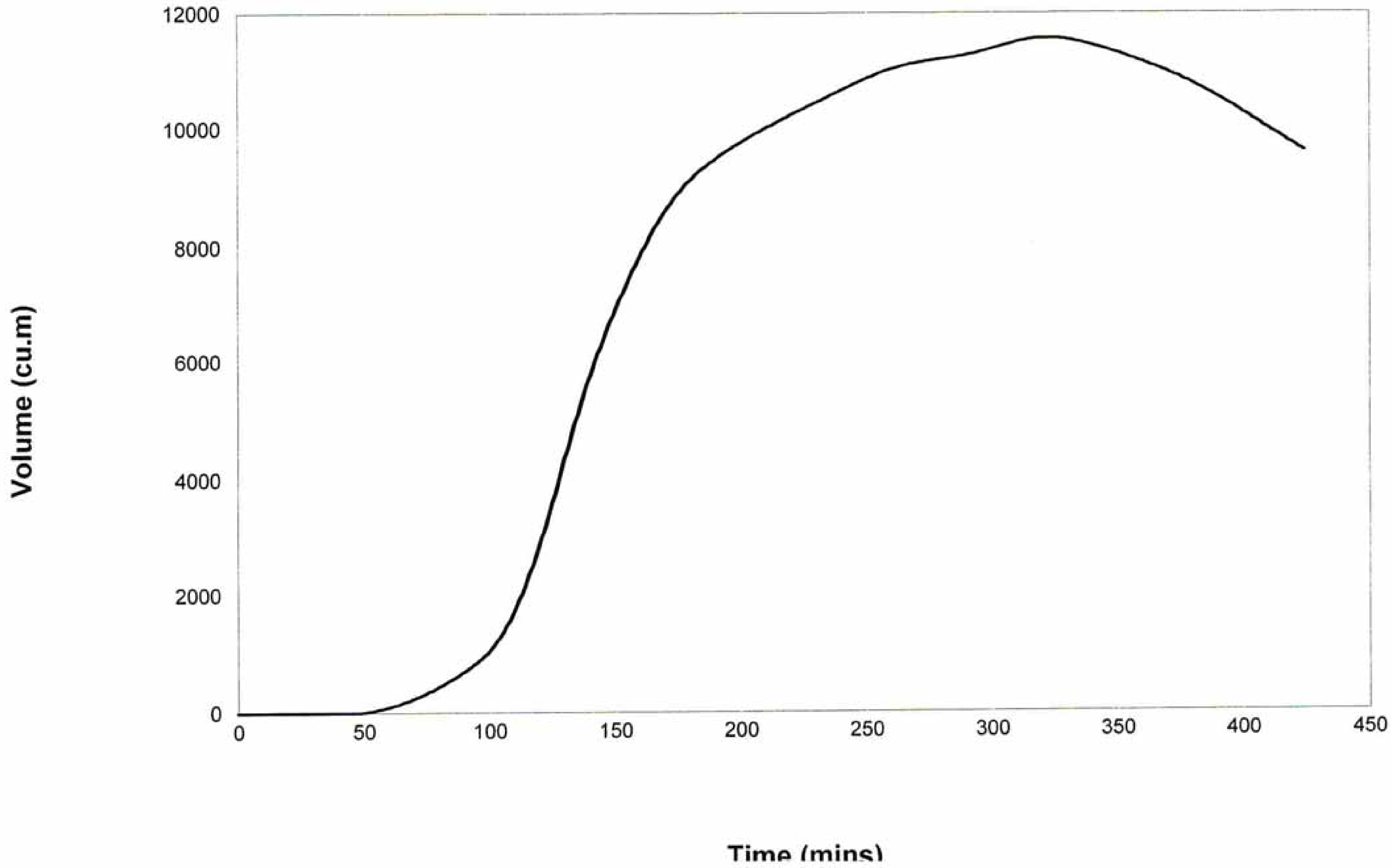


22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Volume (cu.m)
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
Elevation (m)

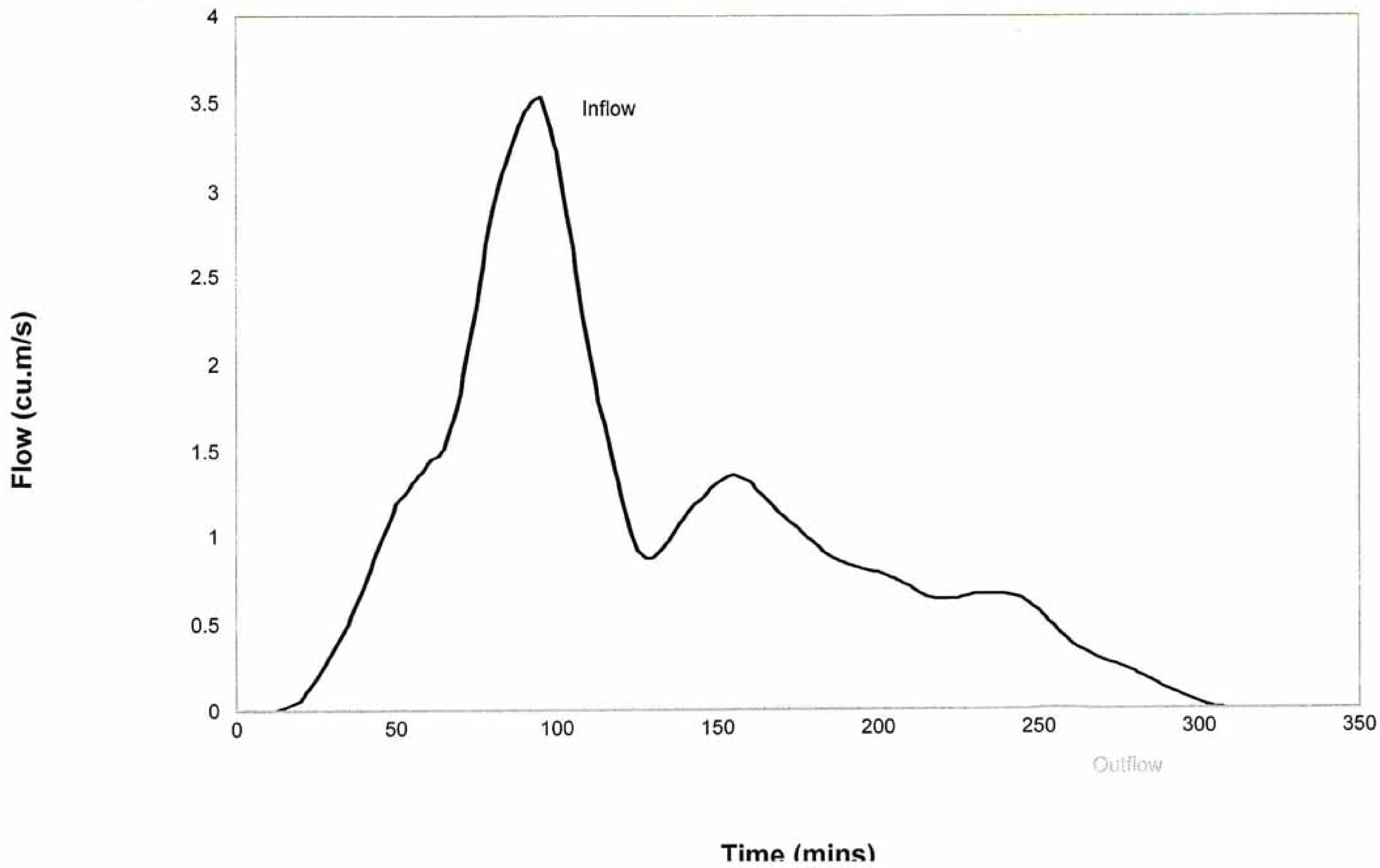
Basin 3 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



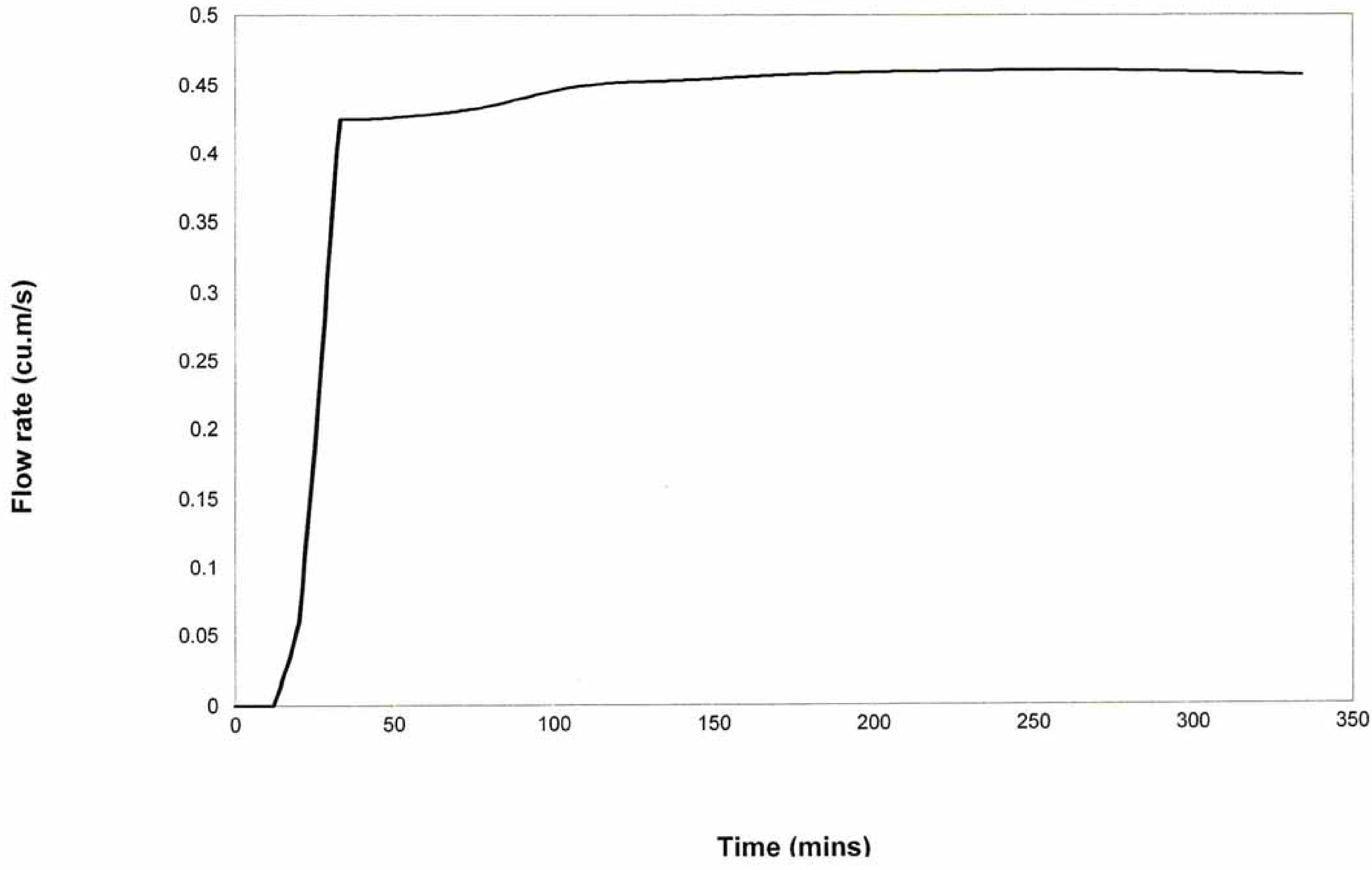
Basin 3 Storage Volume - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Zone 1

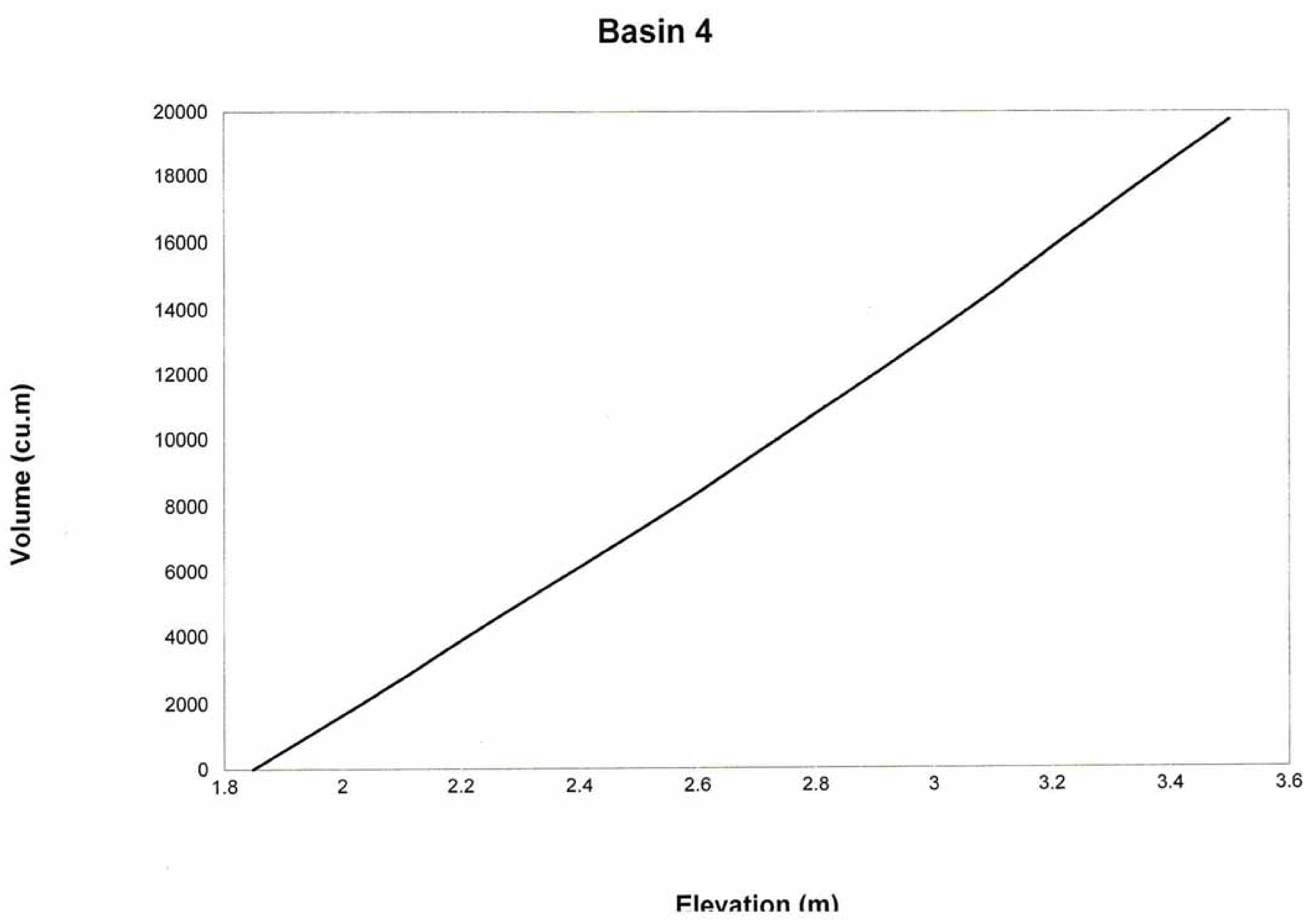


sin 3 Inflow/Outflow Hydrographs - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Z

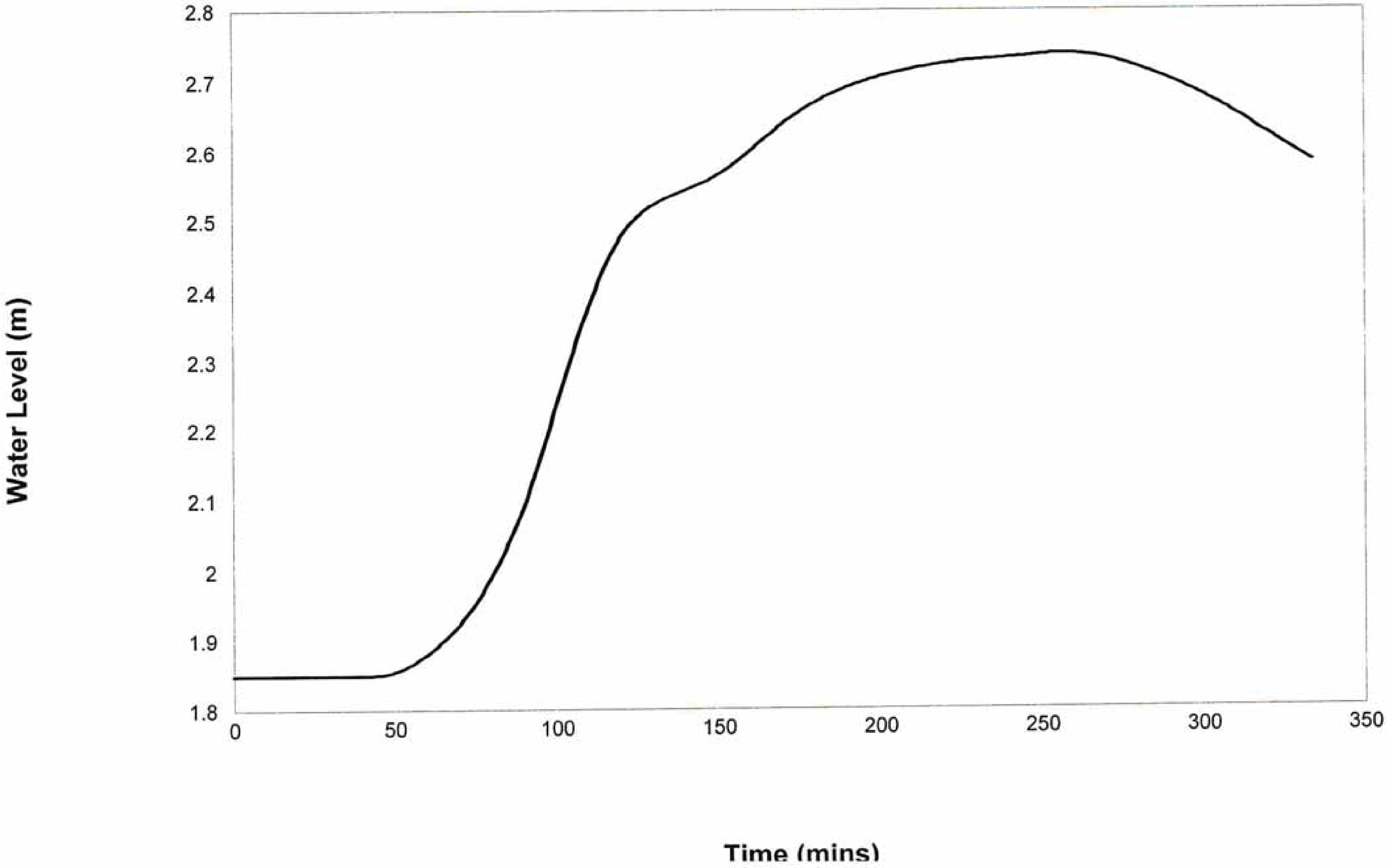


3asin 3 Infiltration Hydrograph - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zon

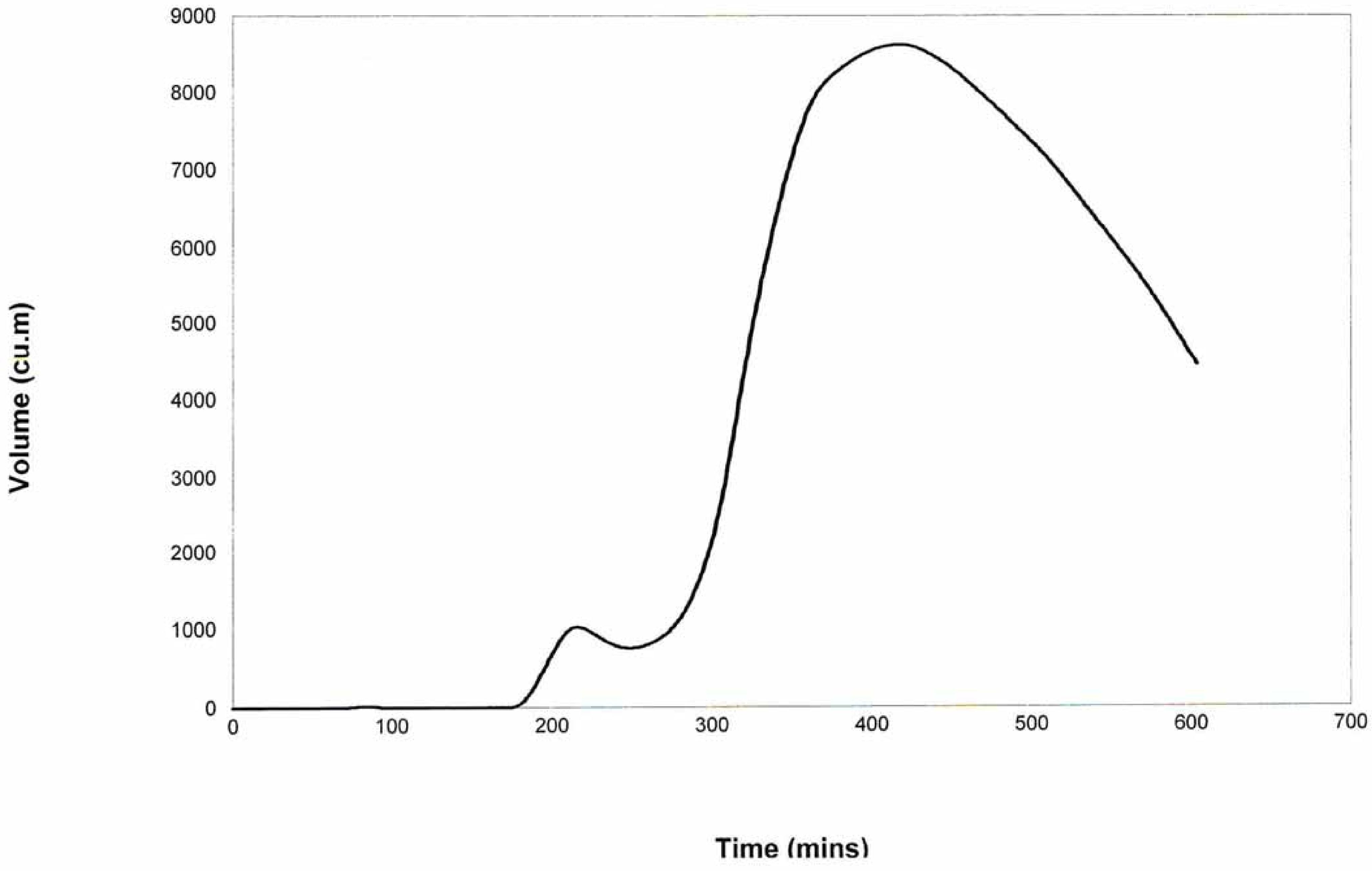



Basin 4
Volume (cu.m)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
Elevation (m)

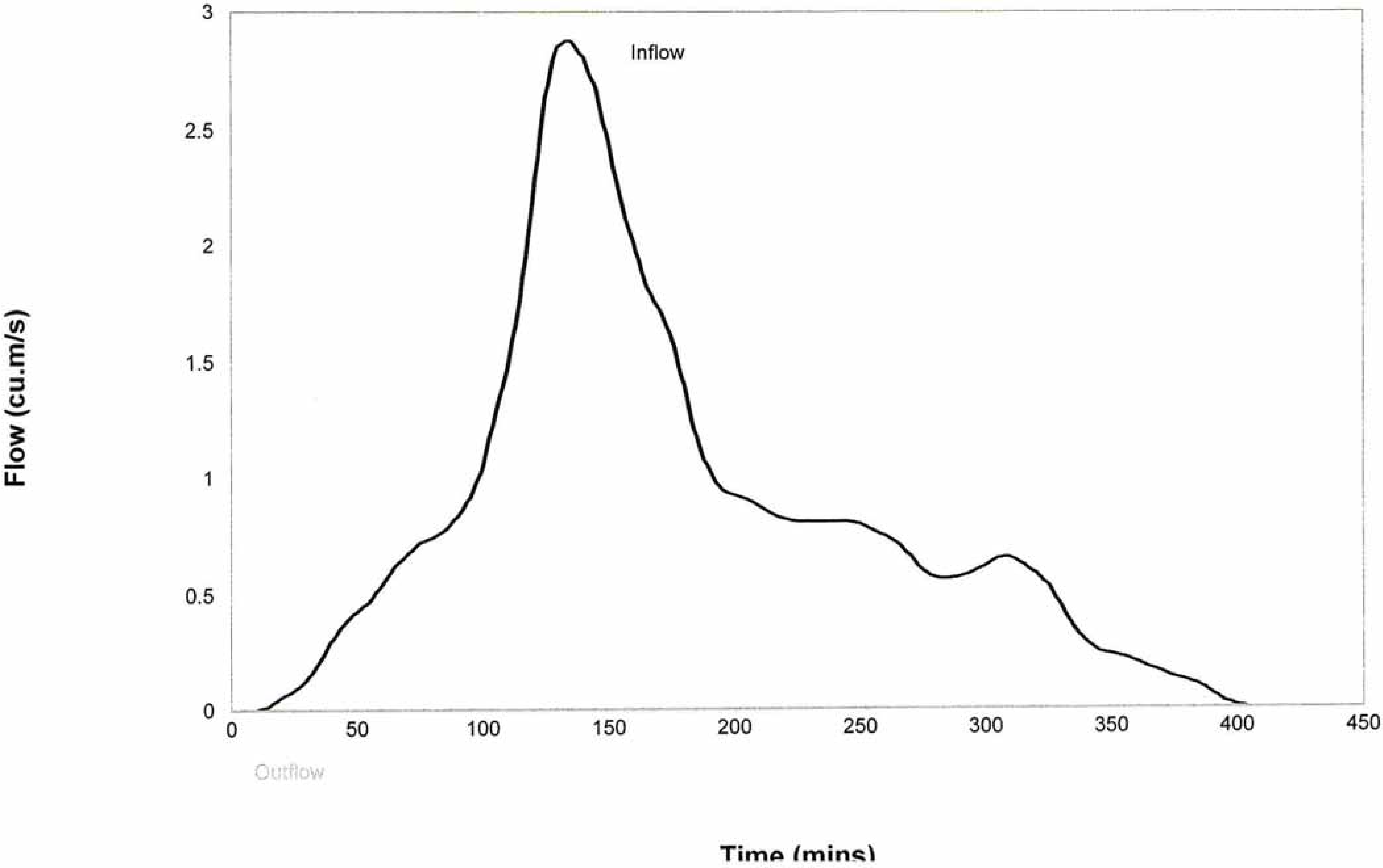
Basin 4 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



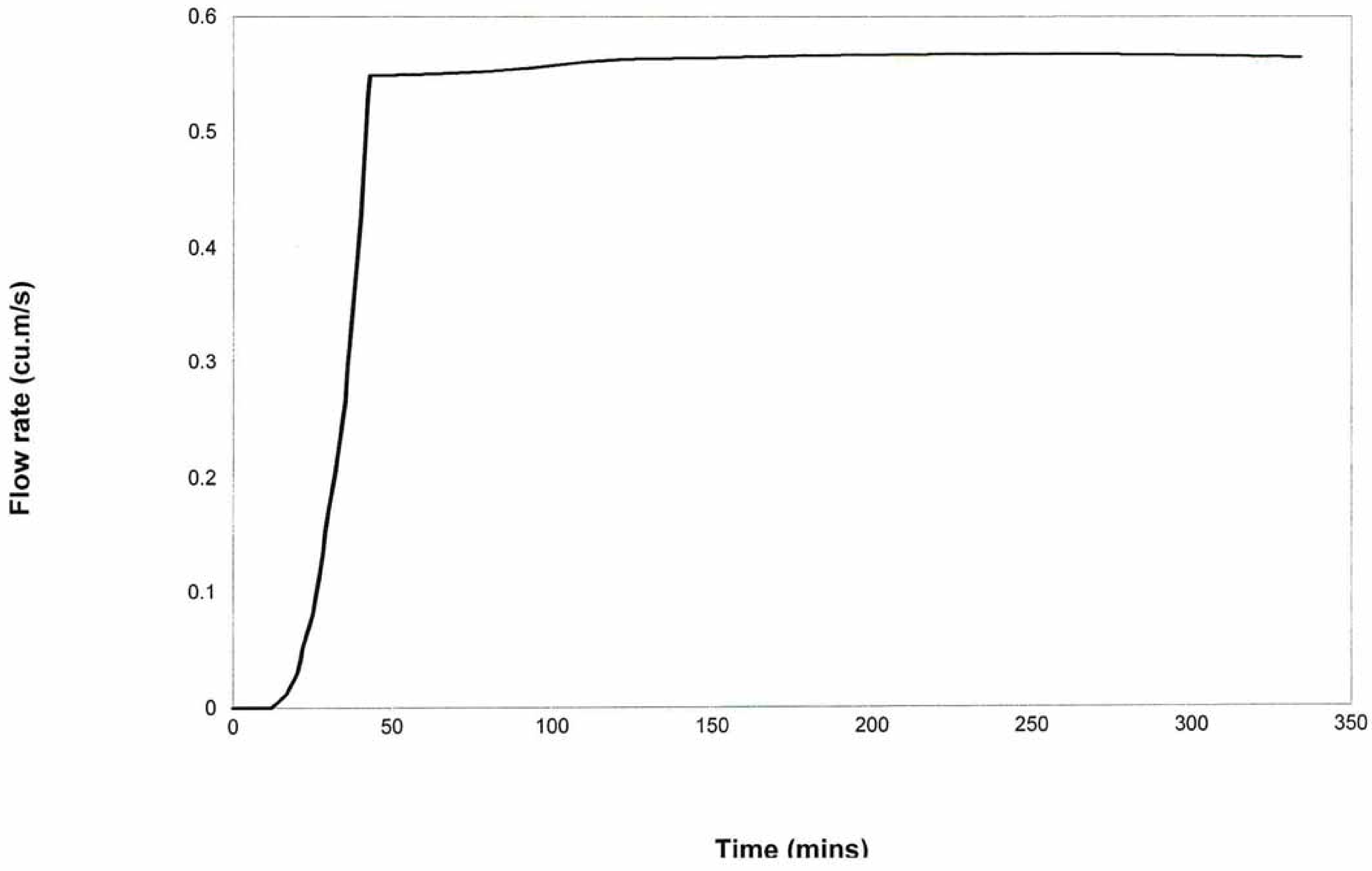
Basin 4 Storage Volume - AR&R 100 year, 9 hours storm, average 19.1 mm/h, Zone 1

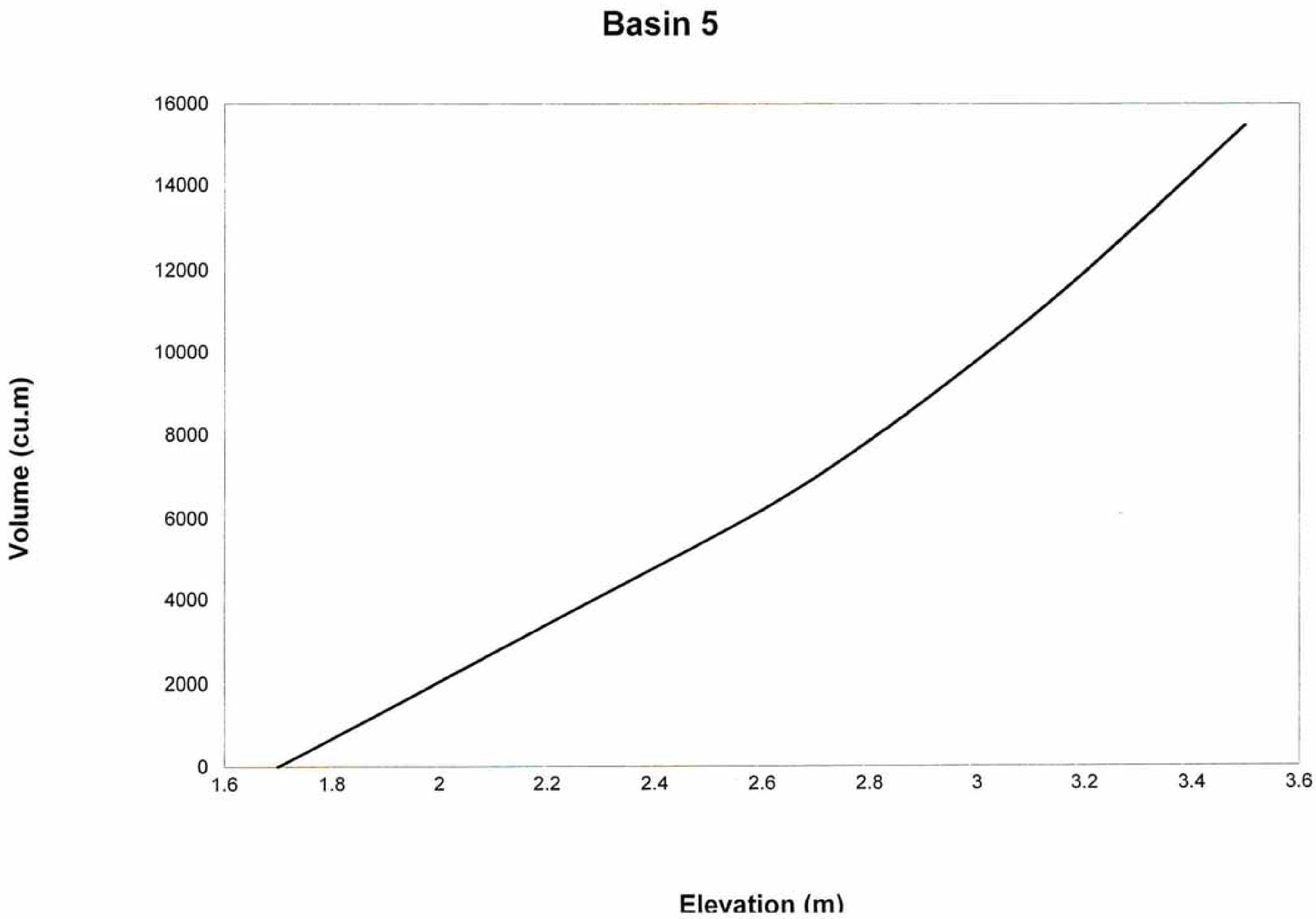


sin 4 Inflow/Outflow Hydrographs - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Z

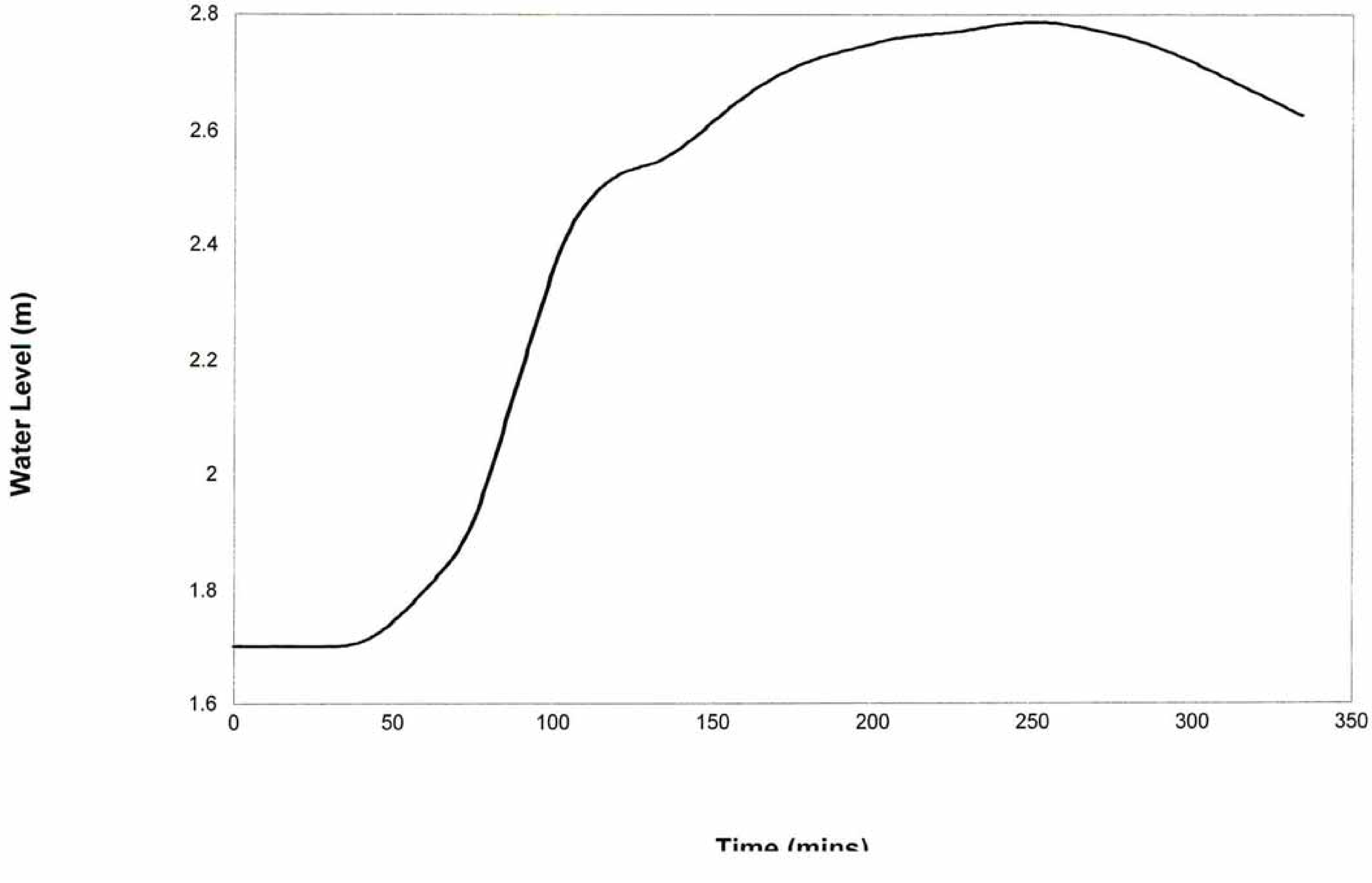


3asin 4 Infiltration Hydrograph - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zon

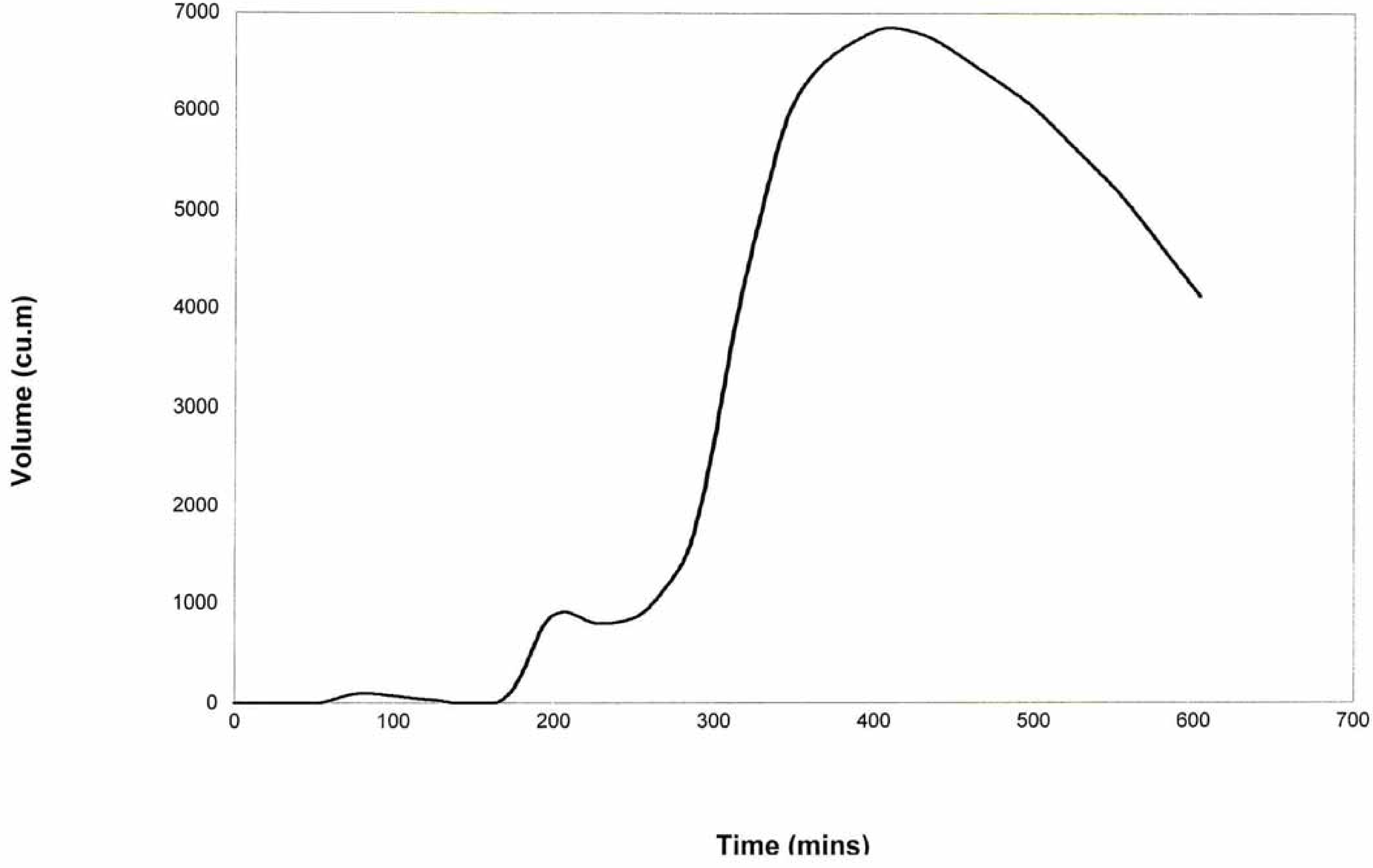



Basin 5
Volume (cu.m)
16000
14000
12000
10000
8000
6000
4000
2000
0
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
Elevation (m)

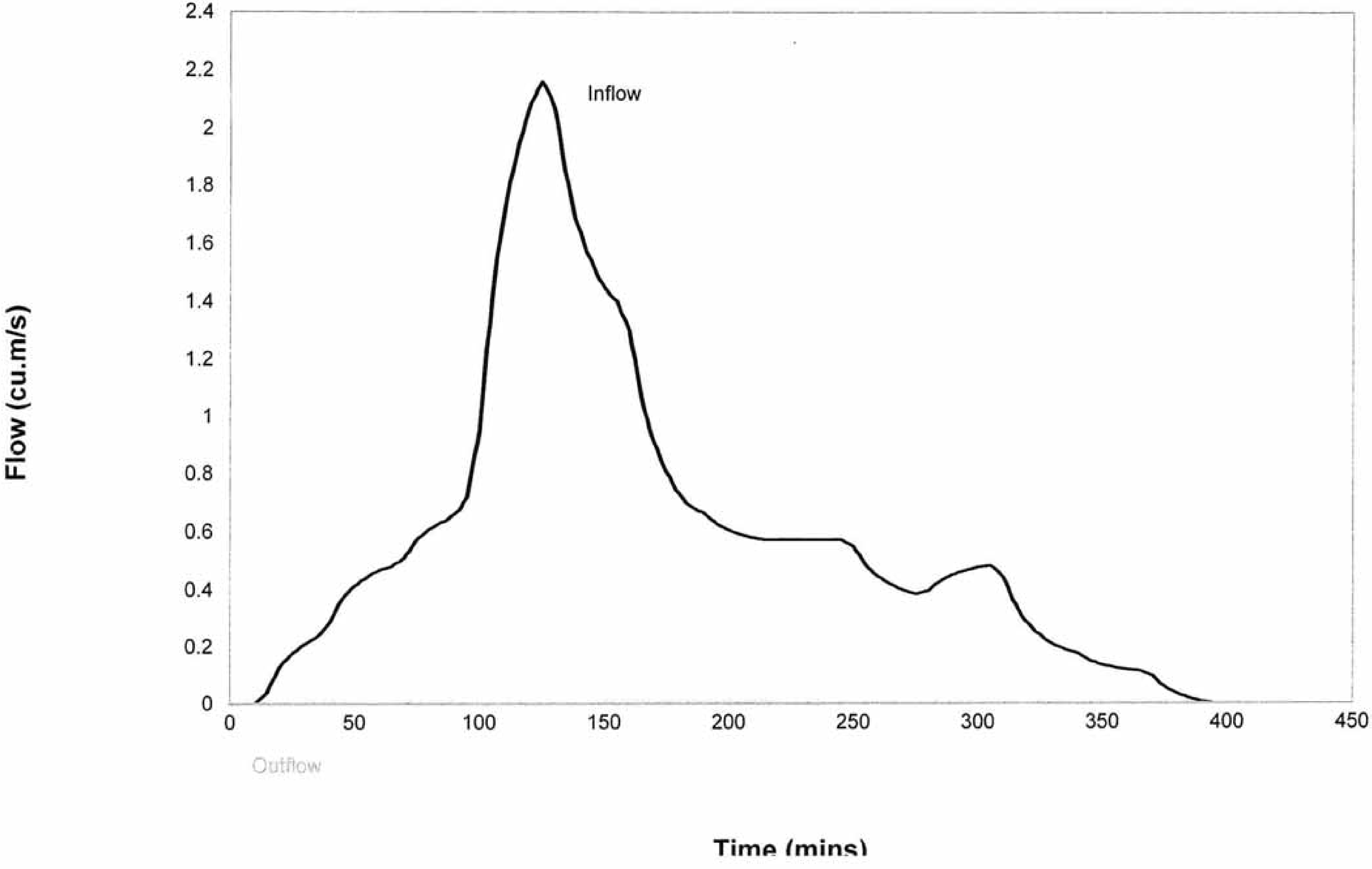
Basin 5 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



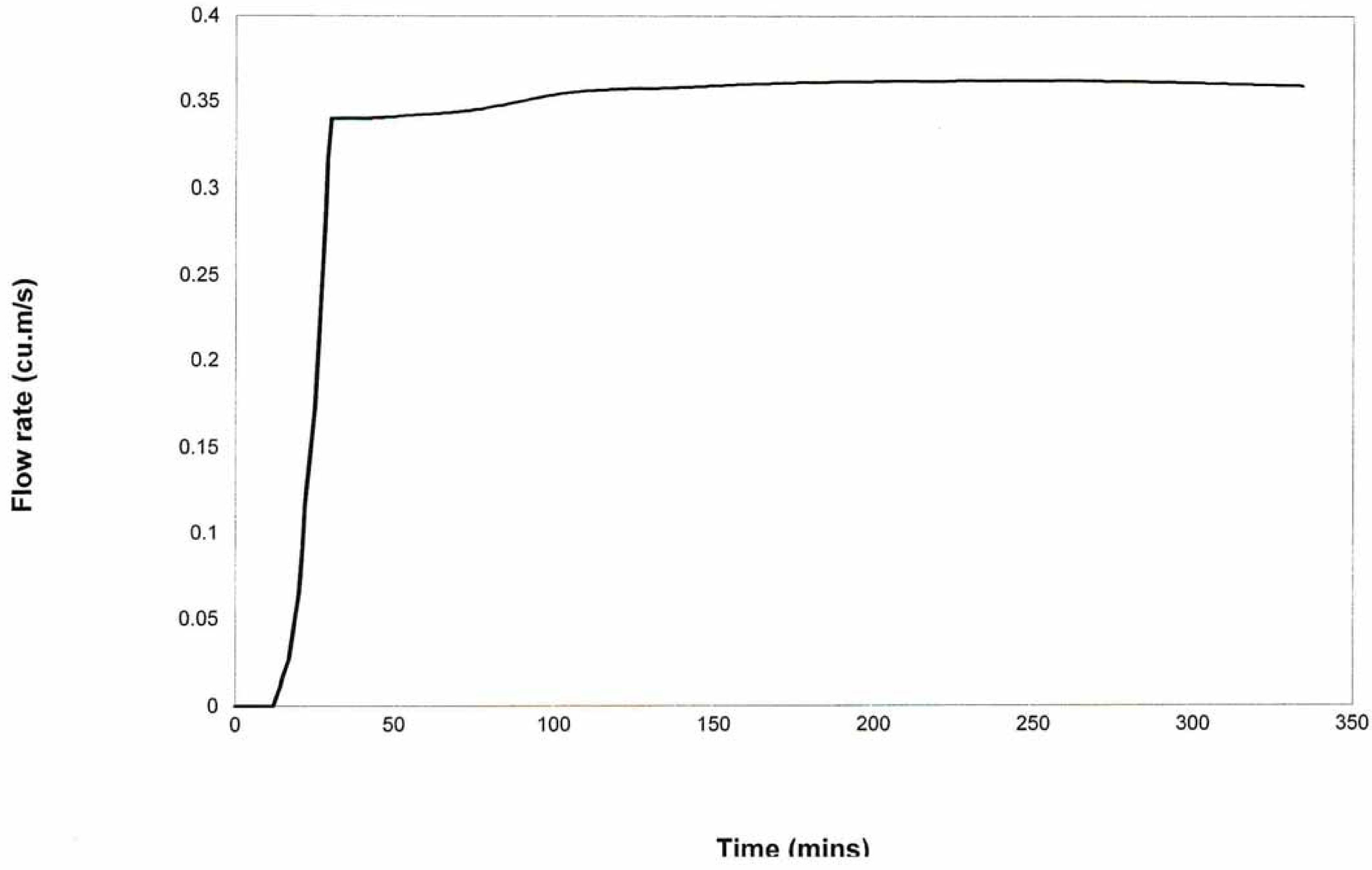
Basin 5 Storage Volume - AR&R 100 year, 9 hours storm, average 19.1 mm/h, Zone 1



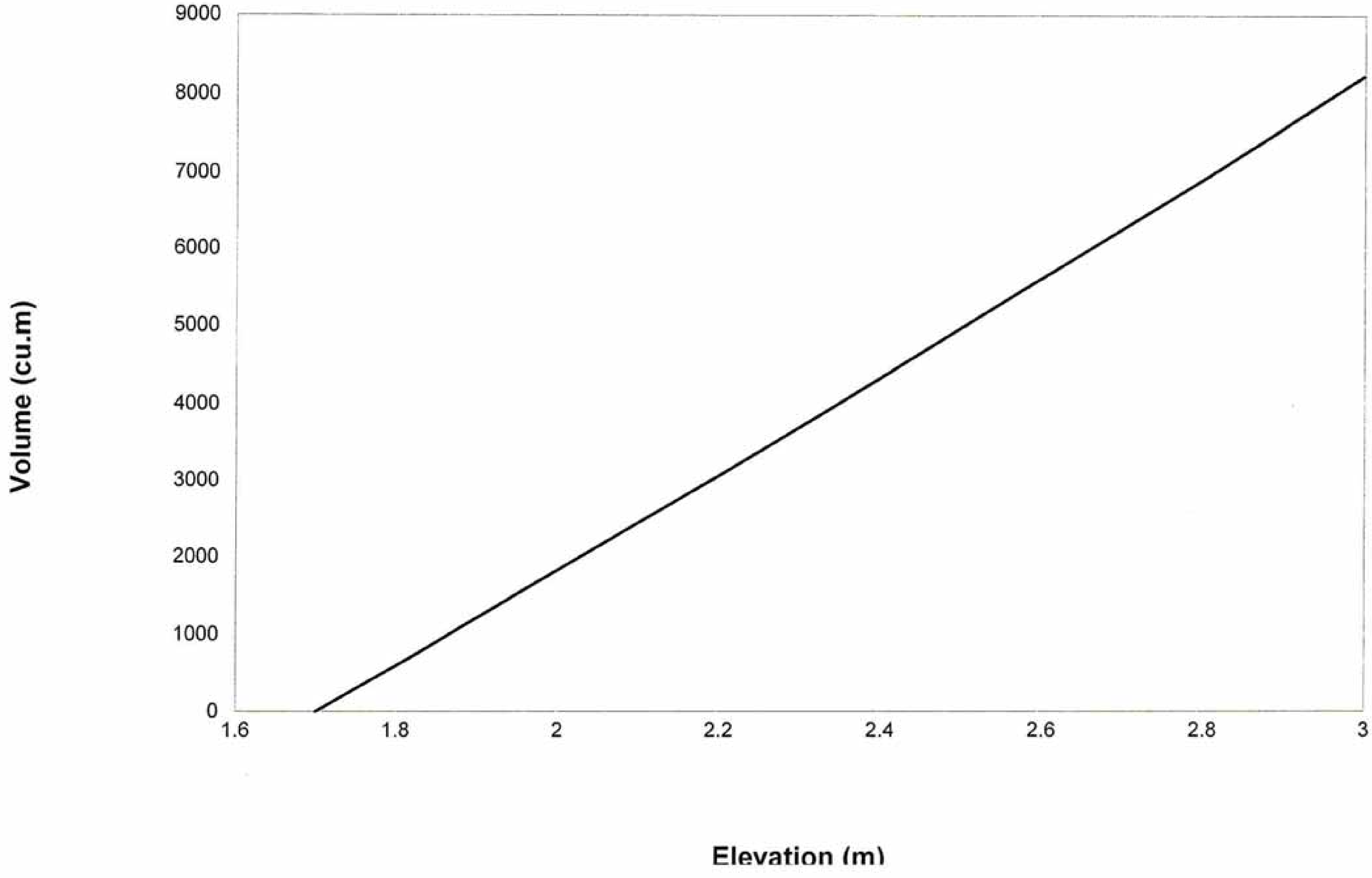
sin 5 Inflow/Outflow Hydrographs - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Z



3asin 5 Infiltration Hydrograph - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zon

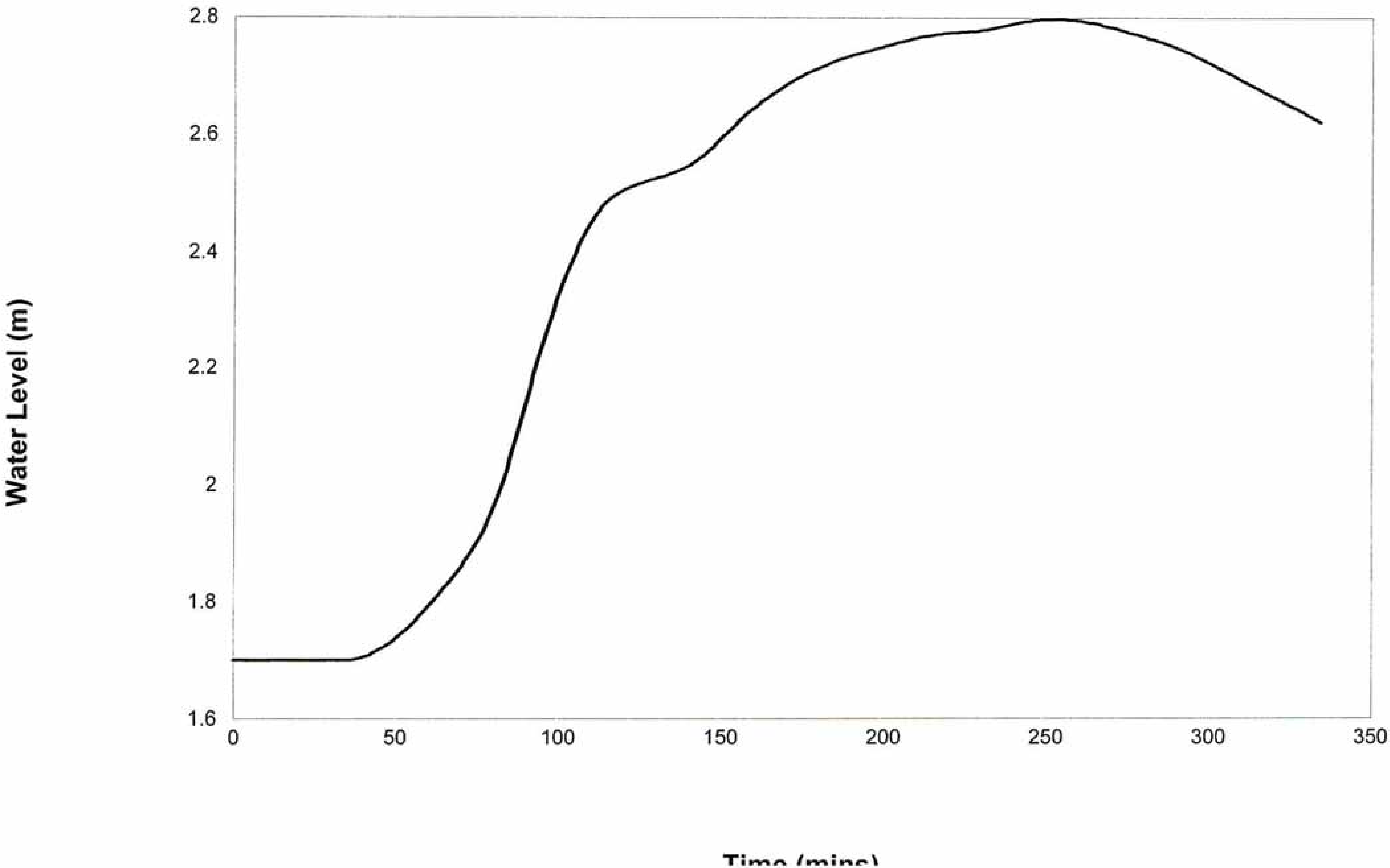


Basin 6

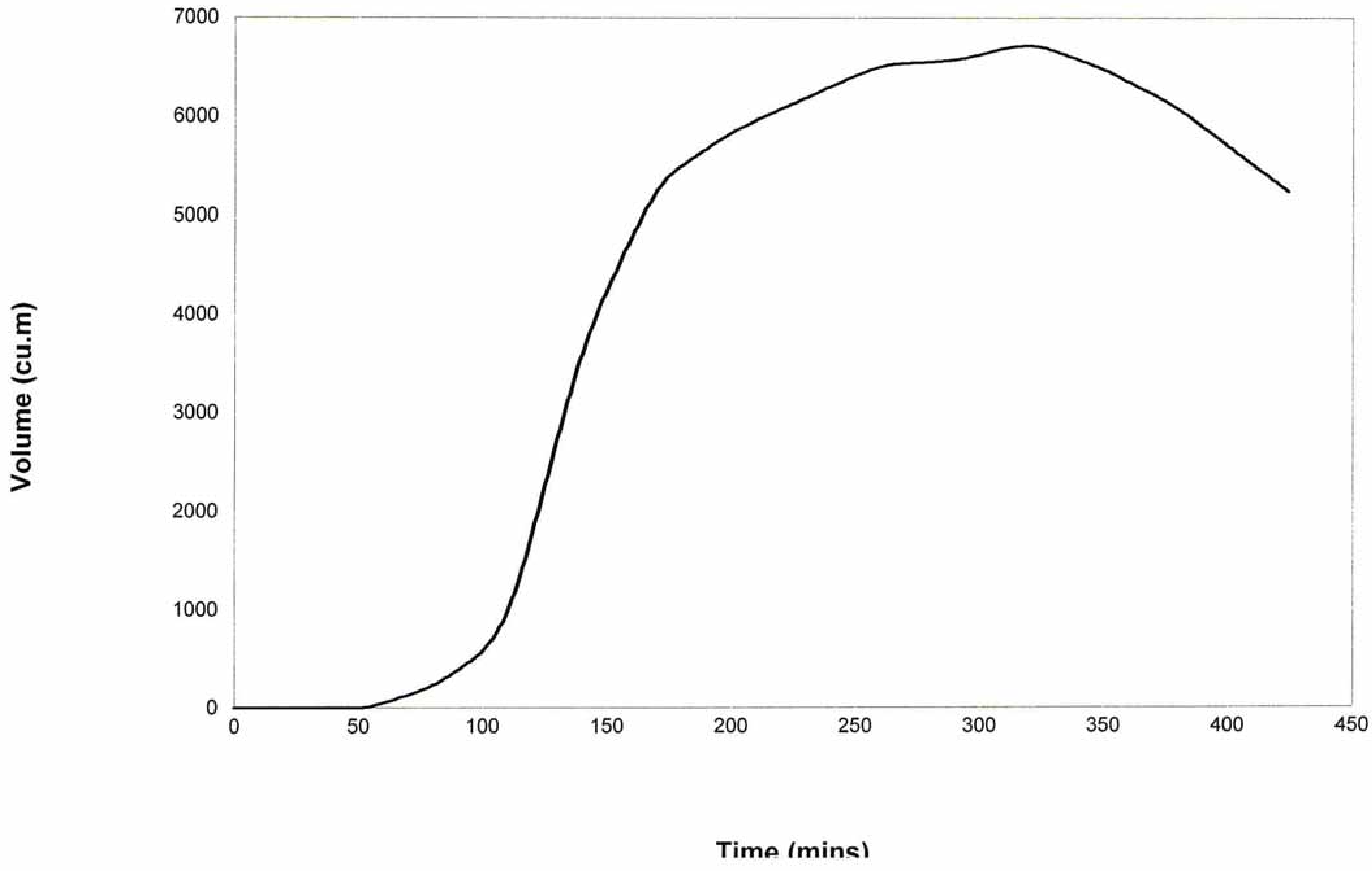


Volume (cu.m)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1.6
1.8
2
2.2
2.4
2.6
2.8
3
Elevation (m)

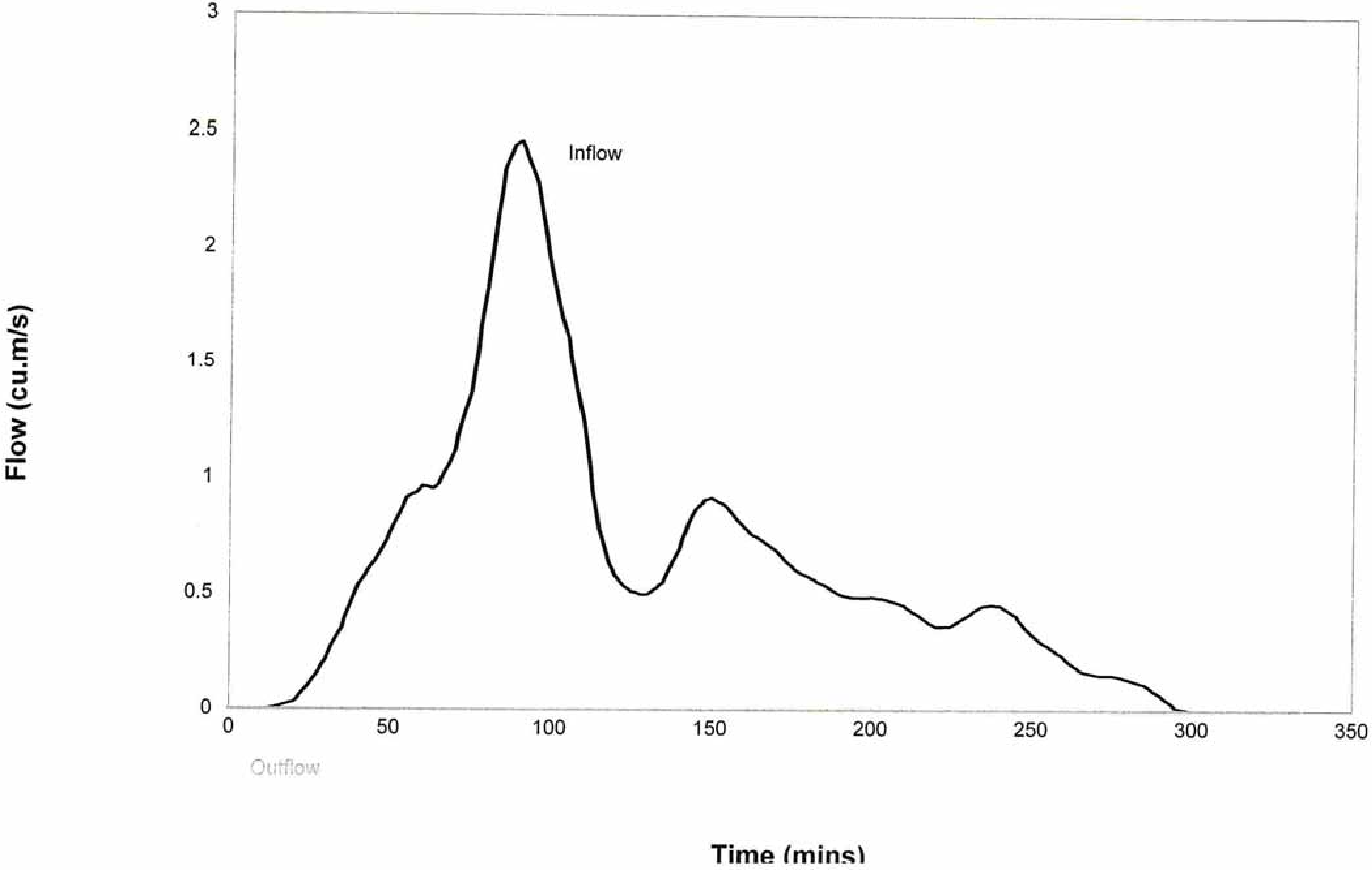
Basin 6 Water Level - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zone 1



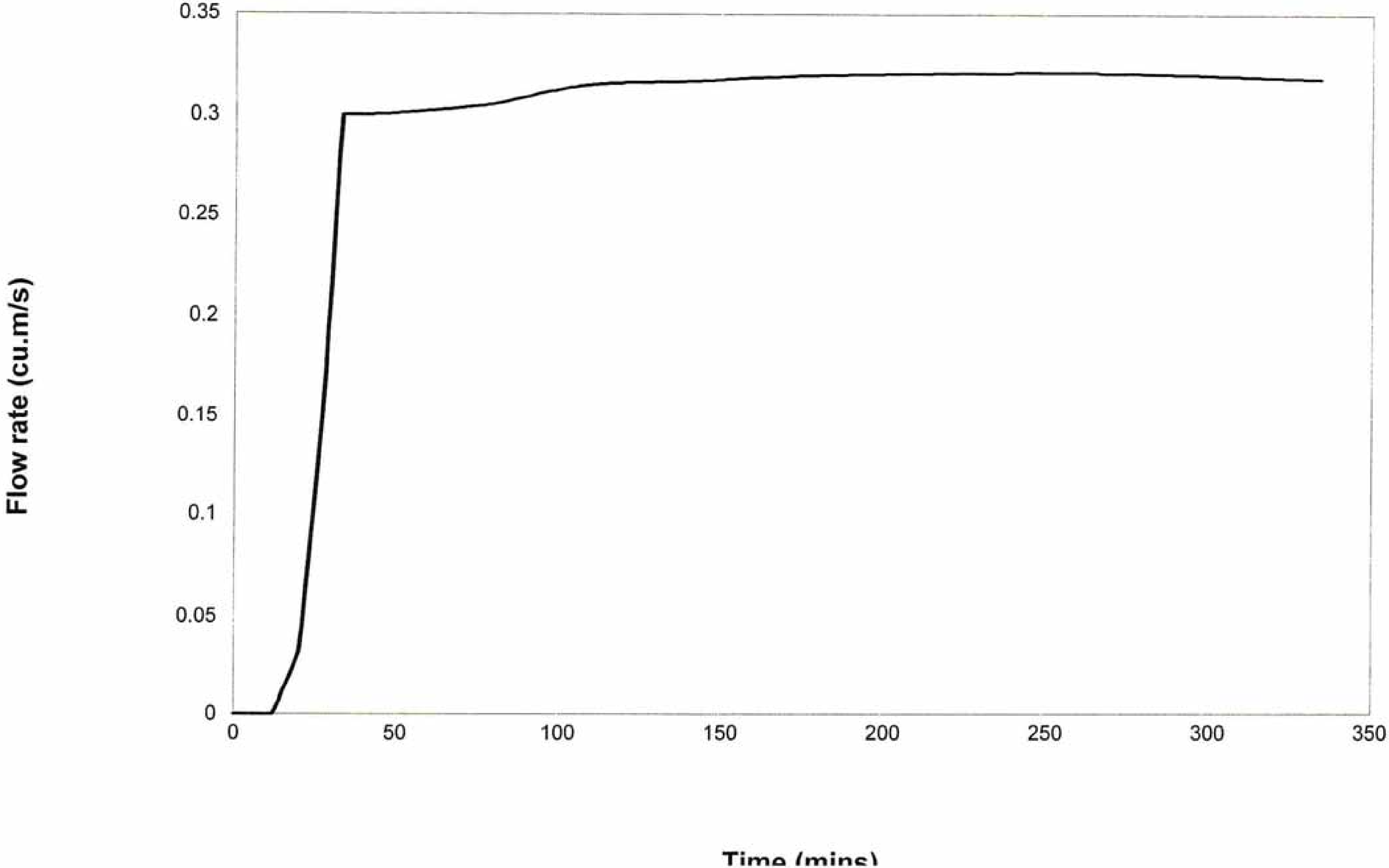
Basin 6 Storage Volume - AR&R 100 year, 6 hours storm, average 24.9 mm/h, Zone 1



sin 6 Inflow/Outflow Hydrographs - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Z



3asin 6 Infiltration Hydrograph - AR&R 100 year, 4.5 hours storm, average 30 mm/h, Zon



DRAINS results prepared 08 April, 2008 from Version 2007.19

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Cat 5	0.834	0.561	0.273	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 1	0.049	0.033	0.016	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 2	0.418	0.281	0.137	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 3	0.548	0.368	0.179	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 4	0.575	0.386	0.188	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 6	0.06	0.04	0.02	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 7	0.765	0.514	0.251	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 8	0.266	0.179	0.087	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 9	0.456	0.306	0.149	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 10	0.504	0.339	0.165	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 11	0.027	0.018	0.009	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 12	0.71	0.478	0.233	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 14	0.548	0.368	0.179	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 15	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 17	0.456	0.306	0.149	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 18	0.352	0.237	0.116	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 20	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 21	0.445	0.299	0.146	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 22	0.174	0.117	0.057	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 23	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 24	0.267	0.179	0.087	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 25	0.294	0.198	0.096	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 26	0.287	0.193	0.094	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 27	0.294	0.198	0.096	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 28	0.189	0.127	0.062	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 29	0.166	0.112	0.055	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 30	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 31	0.171	0.115	0.056	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 33	0.141	0.095	0.046	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 34	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 35	0.309	0.208	0.101	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 101	0.022	0.015	0.007	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 102	0.911	0.612	0.298	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 103	0.558	0.375	0.183	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 104	0.206	0.139	0.068	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 108	0.472	0.318	0.155	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 105	0.198	0.133	0.065	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 106	0.27	0.181	0.088	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 107	0.504	0.339	0.165	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 109	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 110	0.464	0.312	0.152	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 118	0.514	0.345	0.168	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 111	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 112	0.252	0.169	0.082	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 113	0.145	0.098	0.048	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 114	0.094	0.063	0.031	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 115	0.531	0.357	0.174	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 116	0.368	0.248	0.121	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 119	0.147	0.099	0.048	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 120	0.168	0.113	0.055	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 200	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 201	0.366	0.246	0.12	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 202	0.085	0.057	0.028	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 203	0.691	0.465	0.227	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 204	0.779	0.524	0.255	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 205	1.055	0.709	0.346	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 206	0.961	0.646	0.315	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 207	0.42	0.283	0.138	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 208	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 209	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 210	0.049	0.033	0.016	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 211	0.193	0.129	0.063	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 212	0.341	0.229	0.112	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 214	0.169	0.113	0.055	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 215	0.107	0.072	0.035	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 213	1.333	0.897	0.437	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1

Cat 301	0.694	0.466	0.227	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 302	1.267	0.852	0.415	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 303	0.799	0.537	0.262	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 304	0.541	0.363	0.177	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 305	0.592	0.398	0.194	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 320	0.328	0.221	0.108	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 327	0.439	0.295	0.144	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 306	0.444	0.298	0.145	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 307	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 308	0.406	0.273	0.133	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 309	0.274	0.184	0.09	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 323	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 324	0.606	0.408	0.199	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 325	0.395	0.265	0.129	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 310	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 311	0.324	0.218	0.106	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 314	0.514	0.345	0.168	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 312	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 313	0.436	0.293	0.143	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 315	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 316	0.005	0.004	0.002	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 317	0.23	0.155	0.075	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 318	0.508	0.341	0.166	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 319	0.125	0.084	0.041	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 321	0.067	0.045	0.022	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 322	0.226	0.152	0.074	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 401	0.259	0.174	0.085	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 402	0.441	0.297	0.145	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 404	0.06	0.04	0.02	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 405	0.346	0.233	0.113	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 406	0.198	0.133	0.065	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 407	0.494	0.332	0.162	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 409	0.232	0.156	0.076	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 501	0.05	0.034	0.017	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 502	0.371	0.25	0.122	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 504	0.316	0.212	0.103	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 505	0.261	0.176	0.086	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 503	0.035	0.024	0.012	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 506	0.21	0.141	0.069	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 507	0.33	0.222	0.108	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 508	0.138	0.093	0.045	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 509	0.57	0.384	0.187	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 510	0.766	0.515	0.251	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 511	0.267	0.18	0.088	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 512	0.229	0.154	0.075	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 513	0.356	0.239	0.117	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
Cat 514	0.308	0.207	0.101	5	8	0	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1

Outflow Volumes for Total Catchment (41.2 impervious + 27.5 pervious = 68.6 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Imperviou: cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 100	13953.75	10483.98 (	7960.50 (9	2523.48 (45.2%)
AR&R 100	21616.88	17301.67 (	12558.37 (	4743.30 (54.9%)
AR&R 100	27278.44	22265.23 (	15955.31 (	6309.92 (57.8%)
AR&R 100	31796.25	26191.50 (	18666.00 (	7525.49 (59.2%)
AR&R 100	35742.19	29451.29 (	21033.57 (	8417.72 (58.9%)
AR&R 100	39116.25	32267.97 (	23057.99 (	9209.99 (58.9%)
AR&R 100	47351.25	39172.86 (	27999.01 (	11173.85 (59.0%)
AR&R 100	54213.75	44970.79 (	32116.52 (	12854.26 (59.3%)
AR&R 100	62791.87	51790.11 (	37263.26 (	14526.84 (57.8%)
AR&R 100	69997.5	57543.81 (	41586.80 (	15957.01 (57.0%)
AR&R 100	80291.25	65428.95 (	47762.93 (	17666.02 (55.0%)
AR&R 100	92643.75	74376.51 (	55173.66 (	19202.85 (51.8%)
AR&R 100	102525.7	81321.32 (	61102.90 (	20218.42 (49.3%)
AR&R 100	117966.4	90927.25 (	70370.09 (	20557.16 (43.6%)
AR&R 100	130936.5	101126.59	78150.68 (	22975.91 (43.9%)
AR&R 100	153171	113460.96	91484.95 (	21976.01 (35.9%)
AR&R 100	169641	122040.20	101379.22	20660.98 (30.4%)
AR&R 100	184669.9	133335.74	110372.02	22963.72 (31.1%)
AR&R 100	196898.8	141037.87	117731.49	23306.38 (29.6%)
AR&R 100	216415.8	150890.13	129418.41	21471.73 (24.8%)
AR&R 100	242603.1	165797.46	145120.06	20677.40 (21.3%)
AR&R 5 ye	32253.75	23468.31 (	18940.49 (	4527.82 (35.1%)
AR&R 50 y	48723.75	39532.95 (	28822.53 (	10710.42 (55.0%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF Basin 3	0.289	0	10.912	0.046	0.03	19.52	0.6	AR&R 100 year, 3 hours storm, average 39 mm/h, Zone 1
OF 5	4.298	0	10.912	0.133	0.18	37.95	1.36	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF 1	0.049	0	10.912	0.023	0.01	11.01	0.38	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 2	1.405	0	10.912	0.085	0.08	31.3	0.94	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 3	2.153	0	10.912	0.099	0.11	33.32	1.09	AR&R 100 year, 2 hours storm, average 51 mm/h, Zone 1
OF 4	3.855	0	10.912	0.127	0.17	37.12	1.31	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF 6	0.06	0	10.912	0.024	0.01	11.64	0.4	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 7	1.19	0	10.912	0.079	0.07	30.54	0.89	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 8	0.266	0	10.912	0.044	0.03	18.89	0.59	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 9	0.631	0	10.912	0.062	0.05	25.5	0.74	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 11	0.713	0	10.912	0.066	0.05	26.76	0.76	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 12	0.027	0	10.912	0.018	0.01	9.23	0.32	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 14	0.728	0	10.912	0.066	0.05	26.76	0.77	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 17	0.551	0	1.945	0.312	0.44	2.5	1.42	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 18	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 19	0	0	10.912	0	0	0	0	
OF 20	0.785	0	10.912	0.068	0.05	27.71	0.78	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 21	1.066	0	10.912	0.076	0.07	29.74	0.86	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 22	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 23	0.448	0	10.912	0.055	0.04	22.67	0.67	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 24	0.174	0	10.912	0.037	0.02	16.37	0.53	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 25	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 26	0.27	0	10.912	0.044	0.03	18.89	0.6	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 35	0.642	0	10.912	0.063	0.05	25.82	0.74	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 28	0.729	0	10.912	0.066	0.05	26.76	0.78	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 29	1.161	0	10.912	0.079	0.07	30.34	0.89	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF 34	0.285	0	10.912	0.045	0.03	19.2	0.61	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 31	0.166	0	10.912	0.037	0.02	16.05	0.53	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 32	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 33	0.366	0	10.912	0.05	0.03	21.09	0.64	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 30	0.141	0	10.912	0.035	0.02	15.42	0.49	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 10	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 13	0.309	0	10.912	0.047	0.03	19.83	0.62	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF Basin 6	0	0	10.912	0	0	0	0	
OF 101	0.022	0	10.912	0.017	0.01	8.38	0.31	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 102	1.277	0	10.912	0.082	0.07	30.95	0.9	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 103	1.868	0	10.912	0.094	0.1	32.61	1.04	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 104	1.922	0	10.912	0.095	0.1	32.73	1.05	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF108	2.026	0	10.912	0.097	0.1	33.08	1.06	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 105	1.922	0	10.912	0.095	0.1	32.73	1.05	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 106	0.27	0	10.912	0.044	0.03	18.89	0.6	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 107	0.683	0	10.912	0.064	0.05	26.13	0.76	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 109	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 110	0.579	0	10.912	0.061	0.04	24.87	0.72	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 111	1.168	0	10.912	0.079	0.07	30.34	0.89	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 112	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 113	0.255	0	10.912	0.043	0.03	18.57	0.59	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 114	0.44	0	10.912	0.054	0.04	22.35	0.68	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 115	0.094	0	10.912	0.03	0.01	13.53	0.44	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 116	0.531	0	10.912	0.058	0.04	23.93	0.71	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 117	0.368	0	10.912	0.05	0.03	21.09	0.65	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 118	0.741	0	10.912	0.067	0.05	27.08	0.77	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 119	0.168	0	10.912	0.037	0.02	16.05	0.53	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 201	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF202	0.369	0	10.912	0.05	0.03	21.09	0.65	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF203	0.408	0	10.912	0.053	0.03	22.04	0.65	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 204	1.145	0	10.912	0.079	0.07	30.34	0.87	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 205	1.519	0	10.912	0.087	0.08	31.66	0.96	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF206	2.053	0	10.912	0.097	0.1	33.08	1.07	AR&R 100 year, 1.5 hours storm, average 61 mm/h, Zone 1
OF 207	4.092	0	10.912	0.13	0.17	37.59	1.34	AR&R 100 year, 1.5 hours storm, average 61 mm/h, Zone 1
OF Basin 5	0	0	10.912	0	0	0	0	
OF 208	0.42	0	10.912	0.053	0.04	22.04	0.67	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 209	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 210	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 211	0.049	0	10.912	0.023	0.01	11.01	0.38	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 212	0.313	0	10.912	0.047	0.03	19.83	0.63	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 215	0.522	0	10.912	0.058	0.04	23.93	0.7	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 214	0.169	0	10.912	0.037	0.02	16.05	0.54	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1

OF 216	0.107	0	10.912	0.031	0.01	14.16	0.45	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 213	1.691	0	10.912	0.091	0.09	32.13	1	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 301	0.694	0	10.912	0.065	0.05	26.45	0.76	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 302	1.726	0	10.912	0.091	0.09	32.25	1.01	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 303	3.125	0	10.912	0.116	0.14	35.57	1.23	AR&R 100 year, 1.5 hours storm, average 61 mm/h, Zone 1
OF 304	4.492	0	10.912	0.135	0.19	38.3	1.38	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF 305	4.648	0	10.912	0.137	0.19	38.54	1.4	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF 310	1.34	0	10.912	0.083	0.08	31.07	0.93	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 326	0.609	0	10.912	0.061	0.05	25.19	0.74	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 306	4.985	0	10.912	0.141	0.2	39.13	1.43	AR&R 100 year, 1 hour storm, average 79 mm/h, Zone 1
OF Basin 4	0	0	10.912	0	0	0	0	
OF 307	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 308	0.409	0	10.912	0.053	0.03	22.04	0.65	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 309	0.6	0	10.912	0.061	0.04	25.19	0.72	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 311	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 312	0.61	0	10.912	0.061	0.05	25.19	0.74	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 313	0.884	0	10.912	0.071	0.06	28.54	0.82	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 314	0.885	0	10.912	0.071	0.06	28.54	0.82	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 315	1.535	0	10.912	0.087	0.08	31.66	0.97	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 318	0.829	0	10.912	0.069	0.06	28.02	0.8	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 316	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 317	0.44	0	10.912	0.054	0.04	22.35	0.68	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 319	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 320	0.005	0	10.912	0.01	0	4.94	0.22	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 321	0.234	0	10.912	0.042	0.02	17.94	0.58	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 322	0.662	0	10.912	0.063	0.05	25.82	0.76	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 323	0.711	0	10.912	0.066	0.05	26.76	0.76	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 324	0.067	0	10.912	0.026	0.01	12.27	0.4	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 325	0.27	0	10.912	0.044	0.03	18.89	0.6	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF Basin 1	0	0	10.912	0	0	0	0	
OF 401	0.259	0	10.912	0.043	0.03	18.57	0.6	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 402	0.613	0	10.912	0.061	0.05	25.19	0.74	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 403	0	0	10.912	0	0	0	0	
OF 404	0.06	0	10.912	0.024	0.01	11.64	0.41	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 405	0.552	0	10.912	0.059	0.04	24.24	0.72	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 406	0.618	0	10.912	0.061	0.05	25.19	0.75	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 407	0.885	0	10.912	0.071	0.06	28.54	0.82	AR&R 100 year, 1.5 hours storm, average 61 mm/h, Zone 1
OF 408	0	0	10.912	0	0	0	0	
OF 409	0.232	0	10.912	0.042	0.02	17.94	0.58	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 501	0.05	0	10.912	0.024	0.01	11.33	0.36	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 512	0.405	0	10.912	0.052	0.03	21.72	0.67	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 502	0.316	0	10.912	0.048	0.03	20.15	0.61	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 503	0.826	0	10.912	0.069	0.06	28.02	0.8	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 504	0.835	0	10.912	0.07	0.06	28.33	0.79	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 505	2.362	0	10.912	0.104	0.12	33.91	1.12	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OFBasin 2	0	0	10.912	0	0	0	0	
OF 506	0.33	0	10.912	0.049	0.03	20.46	0.62	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 507	0.417	0	10.912	0.053	0.04	22.04	0.67	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 508	1.586	0	10.912	0.088	0.09	31.78	0.99	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 509	1.002	0	10.912	0.074	0.06	29.34	0.85	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 510	0.267	0	10.912	0.044	0.03	18.89	0.59	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 511	0.434	0	10.912	0.054	0.04	22.35	0.67	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1
OF 513	0.356	0	10.912	0.049	0.03	20.78	0.64	AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1
OF 514	0.61	0	10.912	0.061	0.05	25.19	0.74	AR&R 100 year, 20 minutes storm, average 139 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin 3	2.91	0	0.289	0	0.289
Basin 6	2.8	0	0	0	0
Basin 5	2.79	0	0	0	0
Basin 4	2.76	0	0	0	0
Basin 1	2.74	0	0	0	0
Basin 2	2.79	0	0	0	0

CONTINUITY CHECK for AR&R 100 year, 25 minutes storm, average 125 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
Basin 3	7384.17	2156.61	5140.23	1.2
N 5	6251.18	6251.18	0	0
N 1	38.62	38.62	0	0
N 2	1592.19	1592.19	0	0
N 3	2673.68	2673.68	0	0
N 4	5153.38	5153.38	0	0
N 6	47.21	47.21	0	0
N 7	1223.11	1223.11	0	0

N 8	210.29	210.29	0	0
N 9	570.79	570.79	0	0
N 10	648.04	648.04	0	0
N 11	21.46	21.46	0	0
N 12	583.66	583.66	0	0
N 14	437.75	437.75	0	0
N 15	4.29	4.29	0	0
N 16	0	0	0	0
N 17	716.7	716.7	0	0
N 18	1132.99	1132.99	0	0
N 20	4.29	4.29	0	0
N 21	356.2	356.2	0	0
N 22	137.33	137.33	0	0
N 23	4.29	4.29	0	0
N 24	215.44	215.44	0	0
N 25	580.23	580.23	0	0
N 26	807.25	807.25	0	0
N 27	1441.13	1441.13	0	0
N 28	261.36	261.36	0	0
N 29	131.75	131.75	0	0
N 30	4.29	4.29	0	0
N 31	401.27	401.27	0	0
N 33	111.58	111.58	0	0
N 34	4.29	4.29	0	0
N 35	244.62	244.62	0	0
Basin 6	4617.36	1590.93	2950.69	1.6
N 101	17.17	17.17	0	0
N 102	1158.31	1158.31	0	0
N 103	1891.32	1891.32	0	0
N 104	2054.4	2054.4	0	0
N 108	2406.31	2406.31	0	0
N 105	2211.04	2211.05	0	0
N 106	213.29	213.29	0	0
N 107	612.41	612.42	0	0
N 109	4.29	4.29	0	0
N 110	504.27	504.27	0	0
N 118	1303.8	1303.8	0	0
N 111	4.29	4.29	0	0
N 112	203.42	203.42	0	0
N 113	393.11	393.11	0	0
N 114	74.67	74.67	0	0
N 115	420.58	420.58	0	0
N 116	291.4	291.4	0	0
N 119	728.72	728.72	0	0
N 120	133.04	133.04	0	0
N 200	4.29	4.29	0	0
N 201	293.55	293.55	0	0
N 202	360.5	360.5	0	0
N 203	1240.28	1240.28	0	0
N 204	1861.28	1861.28	0	0
N 205	2700.29	2700.29	0	0
N 206	5156.82	5156.82	0	0
Basin 5	5195.87	1815.04	3304.05	1.5
N 207	332.6	332.6	0	0
N 208	4.29	4.29	0	0
N 209	4.29	4.29	0	0
N 210	39.05	39.05	0	0
N 211	285.82	285.82	0	0
N 212	555.77	555.77	0	0
N 214	133.47	133.47	0	0
N 215	84.97	84.97	0	0
N 213	1696.05	1696.05	0	0
N 301	548.9	548.9	0	0
N 302	1551.42	1551.42	0	0
N 303	4001.08	4001.08	0	0
N 304	5917.72	5917.72	0	0
N 305	6385.94	6385.94	0	0
N 320	1488.77	1488.77	0	0
N 327	578.94	578.94	0	0
N 306	7315.94	7315.94	0	0
Basin 4	7315.94	2784.35	4462.59	0.9
N 307	4.29	4.29	0	0
N 308	325.31	325.31	0	0
N 309	542.46	542.46	0	0
N 323	4.29	4.29	0	0
N 324	484.1	484.1	0	0
N 325	796.53	796.53	0	0

N 310	800.82	800.82	0	0
N 311	1817.07	1817.07	0	0
N 314	760.05	760.05	0	0
N 312	4.29	4.29	0	0
N 313	349.34	349.34	0	0
N 315	4.29	4.29	0	0
N 316	4.29	4.29	0	0
N 317	186.26	186.26	0	0
N 318	587.95	587.95	0	0
N 319	686.66	686.66	0	0
N 321	53.22	53.22	0	0
N 322	231.75	231.75	0	0
Basin 1	1606.78	521.99	1056.19	1.8
N 401	205.14	205.14	0	0
N 402	554.48	554.48	0	0
N 403	0	0	0	0
N 404	47.64	47.64	0	0
N 405	504.7	504.7	0	0
N406	661.34	661.34	0	0
N 407	1052.31	1052.31	0	0
N 408	0	0	0	0
N 409	183.25	183.25	0	0
N 501	39.91	39.91	0	0
N 502	333.89	333.89	0	0
N 504	249.77	249.77	0	0
N 505	849.31	849.31	0	0
N 503	877.21	877.21	0	0
N 506	2753.51	2753.51	0	0
Basin 2	3331.16	1116.48	2159.37	1.7
N 507	260.93	260.93	0	0
N 508	370.37	370.37	0	0
N 509	1709.78	1709.78	0	0
N 510	887.94	887.94	0	0
N 511	211.58	211.58	0	0
N 512	392.68	392.68	0	0
B3 Outlet	0	0	0	0
B6 Outlet	0	0	0	0
B5 Outlet	0	0	0	0
B4 Outlet	0	0	0	0
B2 Outlet	0	0	0	0
B1 Outlet	0	0	0	0
N 513	281.53	281.53	0	0
N 514	577.65	577.65	0	0

PIT / NODE DETAILS Version 9 *INPUTS DRAINS*

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)
N 5	Node					2.5		0
N 1	Node					5		0
N 2	Node					3.38		0
N 3	Node					2.95		0
N 4	Node					2.5		0
N 6	Node					4.6		0
N 7	Node					3.73		0
N 8	Node					4.8		0
N 9	Node					4.19		0
N 10	Node					3.6		0
N 11	Node					5.4		0
N 12	Node					4		0
N 14	Node					4.24		0
N 15	Node					4.94		0
N 16	Node					4.84		0
N 17	Node					4.14		0
N 18	Node					3.34		0
N 20	Node					4.94		0
N 21	Node					4.21		0
N 22	Node					3.94		0
N 23	Node					3.6		0
N 24	Node					3.1		0
N 25	Node					2		0
N 26	Node					2.7		0
N 27	Node					2.6		0
N 28	Node					3.46		0
N 29	Node					2.95		0
N 30	Node					3.33		0
N 31	Node					3.08		0
N 33	Node					3.48		0
N 34	Node					3.9		0
N 35	Node					3.8		0
N 101	Node					4.85		0
N 102	Node					3.58		0
N 103	Node					3.18		0
N 104	Node					2.78		0
N 108	Node					2.99		0
N 105	Node					2.6		0
N 106	Node					5.4		0
N 107	Node					4.7		0
N 109	Node					4.94		0
N 110	Node					4.17		0
N 118	Node					3.61		0
N 111	Node					4.94		0
N 112	Node							0
N 113	Node					4.53		0

N 114	Node	4.6	0
N 115	Node	4.45	0
N 116	Node	4.23	0
N 119	Node	4.2	0
N 120	Node	4.46	0
N 200	Node	5.94	0
N 201	Node	4.7	0
N 202	Node	4.25	0
N 203	Node	3.6	0
N 204	Node	3.15	0
N 205	Node	2.7	0
N 206	Node	2.3	0
N 207	Node	5.47	0
N 208	Node	4.46	0
N 209	Node	3.81	0
N 210	Node	3.8	0
N 211	Node	3.9	0
N 212	Node	3.2	0
N 214	Node	4.45	0
N 215	Node	5.2	0
N 213	Node	2.8	0
N 301	Node	3.96	0
N 302	Node	3.4	0
N 303	Node	3.16	0
N 304	Node	2.5	0
N 305	Node	2.5	0
N 320	Node	3.42	0
N 327	Node	3.1	0
N 306	Node	2	0
N 307	Node	5	0
N 308	Node	4.6	0
N 309	Node	4.17	0
N 323	Node	4.85	0
N 324	Node	4.5	0
N 325	Node	4.2	0
N 310	Node	3.81	0
N 311	Node	3.3	0
N 314	Node	3.65	0
N 312	Node	5.47	0
N 313	Node	4.15	0
N 315	Node	4.46	0
N 316	Node	5.94	0
N 317	Node	5.47	0
N 318	Node	4.35	0
N 319	Node	3.97	0
N 321	Node	3.97	0
N 322	Node	3.4	0
N 401	Node	3.1	0
N 402	Node	2.99	0
N 403	Node	4.68	0

N 404	Node	4.5	0
N 405	Node	3.65	0
N406	Node	3.3	0
N 407	Node	2.5	0
N 408	Node	3.65	0
N 409	Node	4.41	0
N 501	Node	2.7	0
N 502	Node	2.4	0
N 504	Node	2.5	0
N 505	Node	2.5	0
N 503	Node	2.8	0
N 506	Node	2.5	0
N 507	Node	4.34	0
N 508	Node	3.71	0
N 509	Node	5	0
N 510	Node	3.53	0
N 511	Node	4.3	0
N 512	Node	3.2	0
B3 Outlet	Node	2.7	0
B6 Outlet	Node	2.7	0
B5 Outlet	Node	2.7	0
B4 Outlet	Node	2.7	0
B2 Outlet	Node	2.7	0
B1 Outlet	Node	2.7	0
N 513	Node	3.09	0
N 514	Node	2.4	0

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu	Outlet Type	K	Dia(mm)	Centre RL	Pit Family
Basin 3	1.7	7985	0	None				
	2	8275						
	2.5	9475						
	3	12385						
	3.5	14825						
Basin 6	1.7	6000	0	None				
	2	6200						
	3	6600						
Basin 5	1.7	6800	0	None				
	2.5	6900						
	3	10410						
	3.5	12400						
Basin 4	1.85	11000	0	None				
	2.5	11300						
	3	12800						
	3.5	13100						
Basin 1	1.7	1860	0	None				
	2.5	2680						
	3	3670						
	3.5	4490						
Basin 2	1.7	4100	0	None				

2.5	4830
3	6030
3.5	6450

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)
Cat 5	N 5	1.538	60	40	0	5	8	0
Cat 1	N 1	0.09	60	40	0	5	8	0
Cat 2	N 2	0.77	60	40	0	5	8	0
Cat 3	N 3	1.01	60	40	0	5	8	0
Cat 4	N 4	1.06	60	40	0	5	8	0
Cat 6	N 6	0.11	60	40	0	5	8	0
Cat 7	N 7	1.41	60	40	0	5	8	0
Cat 8	N 8	0.49	60	40	0	5	8	0
Cat 9	N 9	0.84	60	40	0	5	8	0
Cat 10	N 10	0.93	60	40	0	5	8	0
Cat 11	N 11	0.05	60	40	0	5	8	0
Cat 12	N 12	1.31	60	40	0	5	8	0
Cat 14	N 14	1.01	60	40	0	5	8	0
Cat 15	N 15	0.01	60	40	0	5	8	0
Cat 17	N 17	0.84	60	40	0	5	8	0
Cat 18	N 18	0.65	60	40	0	5	8	0
Cat 20	N 20	0.01	60	40	0	5	8	0
Cat 21	N 21	0.82	60	40	0	5	8	0
Cat 22	N 22	0.32	60	40	0	5	8	0
Cat 23	N 23	0.01	60	40	0	5	8	0
Cat 24	N 24	0.492	60	40	0	5	8	0
Cat 25	N 25	0.543	60	40	0	5	8	0
Cat 26	N 26	0.529	60	40	0	5	8	0
Cat 27	N 27	0.542	60	40	0	5	8	0
Cat 28	N 28	0.349	60	40	0	5	8	0
Cat 29	N 29	0.307	60	40	0	5	8	0
Cat 30	N 30	0.01	60	40	0	5	8	0
Cat 31	N 31	0.316	60	40	0	5	8	0
Cat 33	N 33	0.26	60	40	0	5	8	0
Cat 34	N 34	0.01	60	40	0	5	8	0
Cat 35	N 35	0.57	60	40	0	5	8	0
Cat 101	N 101	0.04	60	40	0	5	8	0
Cat 102	N 102	1.679	60	40	0	5	8	0
Cat 103	N 103	1.029	60	40	0	5	8	0
Cat 104	N 104	0.38	60	40	0	5	8	0
Cat 108	N 108	0.871	60	40	0	5	8	0
Cat 105	N 105	0.365	60	40	0	5	8	0
Cat 106	N 106	0.497	60	40	0	5	8	0
Cat 107	N 107	0.93	60	40	0	5	8	0
Cat 109	N 109	0.01	60	40	0	5	8	0
Cat 110	N 110	0.855	60	40	0	5	8	0
Cat 118	N 118	0.947	60	40	0	5	8	0

Cat 111	N 111	0.01	60	40	0	5	8	0
Cat 112	N 112	0.464	60	40	0	5	8	0
Cat 113	N 113	0.268	60	40	0	5	8	0
Cat 114	N 114	0.174	60	40	0	5	8	0
Cat 115	N 115	0.98	60	40	0	5	8	0
Cat 116	N 116	0.679	60	40	0	5	8	0
Cat 119	N 119	0.271	60	40	0	5	8	0
Cat 120	N 120	0.31	60	40	0	5	8	0
Cat 200	N 200	0.01	60	40	0	5	8	0
Cat 201	N 201	0.674	60	40	0	5	8	0
Cat 202	N 202	0.156	60	40	0	5	8	0
Cat 203	N 203	1.275	60	40	0	5	8	0
Cat 204	N 204	1.437	60	40	0	5	8	0
Cat 205	N 205	1.945	60	40	0	5	8	0
Cat 206	N 206	1.772	60	40	0	5	8	0
Cat 207	N 207	0.775	60	40	0	5	8	0
Cat 208	N 208	0.01	60	40	0	5	8	0
Cat 209	N 209	0.01	60	40	0	5	8	0
Cat 210	N 210	0.091	60	40	0	5	8	0
Cat 211	N 211	0.355	60	40	0	5	8	0
Cat 212	N 212	0.629	60	40	0	5	8	0
Cat 214	N 214	0.311	60	40	0	5	8	0
Cat 215	N 215	0.198	60	40	0	5	8	0
Cat 213	N 213	2.459	60	40	0	5	8	0
Cat 301	N 301	1.279	60	40	0	5	8	0
Cat 302	N 302	2.336	60	40	0	5	8	0
Cat 303	N 303	1.474	60	40	0	5	8	0
Cat 304	N 304	0.997	60	40	0	5	8	0
Cat 305	N 305	1.091	60	40	0	5	8	0
Cat 320	N 320	0.605	60	40	0	5	8	0
Cat 327	N 327	0.809	60	40	0	5	8	0
Cat 306	N 306	0.818	60	40	0	5	8	0
Cat 307	N 307	0.01	60	40	0	5	8	0
Cat 308	N 308	0.748	60	40	0	5	8	0
Cat 309	N 309	0.506	60	40	0	5	8	0
Cat 323	N 323	0.01	60	40	0	5	8	0
Cat 324	N 324	1.118	60	40	0	5	8	0
Cat 325	N 325	0.728	60	40	0	5	8	0
Cat 310	N 310	0.01	60	40	0	5	8	0
Cat 311	N 311	0.597	60	40	0	5	8	0
Cat 314	N 314	0.947	60	40	0	5	8	0
Cat 312	N 312	0.01	60	40	0	5	8	0
Cat 313	N 313	0.804	60	40	0	5	8	0
Cat 315	N 315	0.01	60	40	0	5	8	0
Cat 316	N 316	0.01	60	40	0	5	8	0
Cat 317	N 317	0.424	60	40	0	5	8	0
Cat 318	N 318	0.936	60	40	0	5	8	0
Cat 319	N 319	0.23	60	40	0	5	8	0
Cat 321	N 321	0.124	60	40	0	5	8	0
Cat 322	N 322	0.416	60	40	0	5	8	0

Cat 401	N 401	0.478	60	40	0	5	8	0
Cat 402	N 402	0.814	60	40	0	5	8	0
Cat 404	N 404	0.111	60	40	0	5	8	0
Cat 405	N 405	0.638	60	40	0	5	8	0
Cat 406	N406	0.365	60	40	0	5	8	0
Cat 407	N 407	0.911	60	40	0	5	8	0
Cat 409	N 409	0.427	60	40	0	5	8	0
Cat 501	N 501	0.093	60	40	0	5	8	0
Cat 502	N 502	0.685	60	40	0	5	8	0
Cat 504	N 504	0.582	60	40	0	5	8	0
Cat 505	N 505	0.482	60	40	0	5	8	0
Cat 503	N 503	0.065	60	40	0	5	8	0
Cat 506	N 506	0.388	60	40	0	5	8	0
Cat 507	N 507	0.608	60	40	0	5	8	0
Cat 508	N 508	0.255	60	40	0	5	8	0
Cat 509	N 509	1.052	60	40	0	5	8	0
Cat 510	N 510	1.413	60	40	0	5	8	0
Cat 511	N 511	0.493	60	40	0	5	8	0
Cat 512	N 512	0.422	60	40	0	5	8	0
Cat 513	N 513	0.656	60	40	0	5	8	0
Cat 514	N 514	0.568	60	40	0	5	8	0

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Widtł (m)

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Stor (m)
OF Basin 3	Basin 3	B3 Outlet	5	2.85	10	2	Dummy used t	0.2
OF 5	N 5	Basin 3	5				Dummy used t	0.2
OF 1	N 1	N 2	5				Dummy used t	0.2
OF 2	N 2	N 3	5				Dummy used t	0.2
OF 3	N 3	N 4	5				Dummy used t	0.2
OF 4	N 4	N 5	5				Dummy used t	0.2
OF 6	N 6	N 7	5				Dummy used t	0.2
OF 7	N 7	N 2	5				Dummy used t	0.2
OF 8	N 8	N 9	5				Dummy used t	0.2
OF 9	N 9	N 7	5				Dummy used t	0.2
OF 11	N 10	N 3	5				Dummy used t	0.2
OF 12	N 11	N 12	5				Dummy used t	0.2

OF 14	N 12	N 4	5			Dummy used t	0.2
OF 17	N 14	N 5	5			Grassed Swale	0.5
OF 18	N 15	N 14	5			Dummy used t	0.2
OF 19	N 16	N 17	5			Dummy used t	0.2
OF 20	N 17	N 18	5			Dummy used t	0.2
OF 21	N 18	Basin 3	5			Dummy used t	0.2
OF 22	N 20	N 21	5			Dummy used t	0.2
OF 23	N 21	N 17	5			Dummy used t	0.2
OF 24	N 22	N 18	5			Dummy used t	0.2
OF 25	N 23	N 24	5			Dummy used t	0.2
OF 26	N 24	N 25	5			Dummy used t	0.2
OF 35	N 25	N 26	5			Dummy used t	0.2
OF 28	N 26	N 27	5			Dummy used t	0.2
OF 29	N 27	N 4	5			Dummy used t	0.2
OF 34	N 28	N 31	5			Dummy used t	0.2
OF 31	N 29	N 25	5			Dummy used t	0.2
OF 32	N 30	N 31	5			Dummy used t	0.2
OF 33	N 31	N 27	5			Dummy used t	0.2
OF 30	N 33	N 28	5			Dummy used t	0.2
OF 10	N 34	N 10	5			Dummy used t	0.2
OF 13	N 35	N 10	5			Dummy used t	0.2
OF Basin 6	Basin 6	B6 Outlet	5	2.8	18	2 Dummy used t	0.2
OF 101	N 101	N 102	5			Dummy used t	0.2
OF 102	N 102	N 103	5			Dummy used t	0.2
OF 103	N 103	N 104	5			Dummy used t	0.2
OF 104	N 104	N 105	5			Dummy used t	0.2
OF108	N 108	Basin 6	5			Dummy used t	0.2
OF 105	N 105	Basin 6	5			Dummy used t	0.2
OF 106	N 106	N 107	5			Dummy used t	0.2
OF 107	N 107	N 119	5			Dummy used t	0.2
OF 109	N 109	N 110	5			Dummy used t	0.2
OF 110	N 110	N 118	5			Dummy used t	0.2
OF 111	N 118	N 108	5			Dummy used t	0.2
OF 112	N 111	N 112	5			Dummy used t	0.2
OF 113	N 112	N 113	5			Dummy used t	0.2
OF 114	N 113	N 118	5			Dummy used t	0.2
OF 115	N 114	N 113	5			Dummy used t	0.2
OF 116	N 115	N 102	5			Dummy used t	0.2
OF 117	N 116	N 103	5			Dummy used t	0.2
OF 118	N 119	N 108	5			Dummy used t	0.2
OF 119	N 120	N 110	5			Dummy used t	0.2
OF 201	N 200	N 201	5			Dummy used t	0.2
OF202	N 201	N 202	5			Dummy used t	0.2
OF203	N 202	N 203	5			Dummy used t	0.2
OF 204	N 203	N 204	5			Dummy used t	0.2
OF 205	N 204	N 205	5			Dummy used t	0.2
OF206	N 205	N 206	5			Dummy used t	0.2
OF 207	N 206	Basin 5	5			Dummy used t	0.2
OF Basin 5	Basin 5	B5 Outlet	5	2.8	10	2 Dummy used t	0.2
OF 208	N 207	N 203	5			Dummy used t	0.2

OF 209	N 208	N 204	5				Dummy used t	0.2
OF 210	N 209	N 205	5				Dummy used t	0.2
OF 211	N 210	Basin 5	5				Dummy used t	0.2
OF 212	N 211	N 212	5				Dummy used t	0.2
OF 215	N 212	N 213	5				Dummy used t	0.2
OF 214	N 214	N 211	5				Dummy used t	0.2
OF 216	N 215	N 213	5				Dummy used t	0.2
OF 213	N 213	N 206	5				Dummy used t	0.2
OF 301	N 301	N 302	5				Dummy used t	0.2
OF 302	N 302	N 303	5				Dummy used t	0.2
OF 303	N 303	N 304	5				Dummy used t	0.2
OF 304	N 304	N 305	5				Dummy used t	0.2
OF 305	N 305	N 306	5				Dummy used t	0.2
OF 310	N 320	N 304	5				Dummy used t	0.2
OF 326	N 327	N 306	5				Dummy used t	0.2
OF 306	N 306	Basin 4	5				Dummy used t	0.2
OF Basin 4	Basin 4	B4 Outlet	5	2.8	10	2	Dummy used t	0.2
OF 307	N 307	N 308	5				Dummy used t	0.2
OF 308	N 308	N 309	5				Dummy used t	0.2
OF 309	N 309	N 320	5				Dummy used t	0.2
OF 311	N 323	N 324	5				Dummy used t	0.2
OF 312	N 324	N 325	5				Dummy used t	0.2
OF 313	N 325	N 310	5				Dummy used t	0.2
OF 314	N 310	N 311	5				Dummy used t	0.2
OF 315	N 311	N 303	5				Dummy used t	0.2
OF 318	N 314	N 311	5				Dummy used t	0.2
OF 316	N 312	N 313	5				Dummy used t	0.2
OF 317	N 313	N 314	5				Dummy used t	0.2
OF 319	N 315	N 314	5				Dummy used t	0.2
OF 320	N 316	N 317	5				Dummy used t	0.2
OF 321	N 317	N 318	5				Dummy used t	0.2
OF 322	N 318	N 319	5				Dummy used t	0.2
OF 323	N 319	N 320	5				Dummy used t	0.2
OF 324	N 321	N 322	5				Dummy used t	0.2
OF 325	N 322	N 327	5				Dummy used t	0.2
OF Basin 1	Basin 1	B1 Outlet	5	2.8	10	2	Dummy used t	0.2
OF 401	N 401	N 402	5				Dummy used t	0.2
OF 402	N 402	Basin 1	5				Dummy used t	0.2
OF 403	N 403	N 404	5				Dummy used t	0.2
OF 404	N 404	N 405	5				Dummy used t	0.2
OF 405	N 405	N406	5				Dummy used t	0.2
OF 406	N406	N 407	5				Dummy used t	0.2
OF 407	N 407	Basin 1	5				Dummy used t	0.2
OF 408	N 408	N406	5				Dummy used t	0.2
OF 409	N 409	N 405	5				Dummy used t	0.2
OF 501	N 501	N 502	5				Dummy used t	0.2
OF 512	N 502	N 514	5				Dummy used t	0.2
OF 502	N 504	N 505	5				Dummy used t	0.2
OF 503	N 505	N 503	5				Dummy used t	0.2
OF 504	N 503	N 506	5				Dummy used t	0.2

OF 505	N 506	Basin 2	5			Dummy used t	0.2
OFBasin 2	Basin 2	B2 Outlet	5	2.8	10	2 Dummy used t	0.2
OF 506	N 507	N 508	5			Dummy used t	0.2
OF 507	N 508	N 509	5			Dummy used t	0.2
OF 508	N 509	N 506	5			Dummy used t	0.2
OF 509	N 510	N 509	5			Dummy used t	0.2
OF 510	N 511	N 512	5			Dummy used t	0.2
OF 511	N 512	N 505	5			Dummy used t	0.2
OF 513	N 513	N 510	5			Dummy used t	0.2
OF 514	N 514	Basin 2	5			Dummy used t	0.2

Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss
	388980.1	6363357		8	
	389022.1	6363759		37	
	389012.1	6363610		38	
	389008.9	6363528		39	
	388992.5	6363441		40	
	389110.6	6363745		79	
	389080.8	6363606		81	
	389217.6	6363654		87	
	389146.4	6363596		89	
	389145	6363529		96	
	389270.4	6363498		106	
	389144.6	6363445		107	
	389147.1	6363357		120	
	389222.8	6363358		133	
	389211.8	6363188		140	
	389115.3	6363203		141	
	389037.1	6363216		142	
	389221.8	6363275		152	
	389125.4	6363275		154	
	389044.5	6363270		155	
	388788.4	6363254		164	
	388860.3	6363237		166	
	388884.6	6363305		168	
	388927	6363414		170	
	388945.9	6363456		172	
	388854.3	6363466		184	
	388835.3	6363326		186	
	388835.3	6363535		192	
	388876.1	6363505		193	
	388834.3	6363405		208	
	389143.7	6363561		232	
	389145.4	6363488		236	
	389318.6	6363641		353	
	389383.4	6363496		355	
	389437.8	6363438		357	
	389492.8	6363374		359	
	389428.6	6363317		361	
	389468.8	6363350		364	
	389274	6363497		380	
	389321.4	6363440		382	
	389224.4	6363274		390	
	389302.5	6363205		392	
	389364.7	6363262		396	
	389225.3	6363357		404	
	389277.5	6363357		406	
	389292	6363345		413	

389322.4	6363371	420
389465.9	6363578	424
389542.4	6363529	429
389354.2	6363401	436
389264.7	6363180	442
389421.5	6364295	492
389424.3	6364141	494
389490.4	6364131	496
389502.9	6364026	498
389532.4	6363943	500
389553.7	6363850	503
389636.2	6363854	505
389407.9	6364033	524
389408.4	6363949	529
389392.6	6363868	533
389572.3	6364136	537
389521.5	6363675	541
389625.9	6363682	543
389471.1	6363583	552
389430.9	6363697	556
389640.7	6363757	560
389229.8	6363729	608
389240.6	6363810	610
389254.3	6363891	614
389227.7	6363986	618
389240.2	6364009	622
389160.2	6364043	626
389133	6364088	628
389158	6364101	630
389023.9	6363766	638
389054.6	6363839	640
389069.1	6363920	644
389316.1	6363647	652
389314.5	6363714	654
389328.1	6363794	658
389385.9	6363869	662
389296.8	6363885	666
389302.1	6363961	670
389400.1	6364033	679
389308.2	6364049	681
389403.6	6363950	689
389415.7	6364296	693
389339.7	6364251	695
389313.2	6364090	704
389260.7	6364089	708
389190.5	6364191	714
389102	6364135	716
388194.4	6363348	772
388212.3	6363419	774
388435.2	6363485	780

388423.9	6363444	782
388360.9	6363460	786
388303	6363476	790
388226.8	6363496	792
388314.4	6363516	802
388341.4	6363386	807
388233	6363579	831
388325.4	6363556	833
388441.8	6363539	841
388440.2	6363577	843
388438.9	6363615	847
388437.4	6363639	852
388487.9	6363852	861
388402.7	6363811	863
388428.6	6363689	867
388519.1	6363692	873
388586	6363558	883
388513.8	6363563	886
388876.5	6363230	926
389501.7	6363259	976
389710	6363963	981
388932.6	6364182	1002
388377.7	6363632	1017
388139.1	6363523	1022
388520.3	6363636	1030
388336	6363599	1038

Pit Type	x	y	HED	Crest RL	Crest Lengt	id
	388932.4	6363330	No			7
	389508.6	6363317	No			349
	389671.2	6363898	No			520
	388962.9	6364188	No			634
	388163	6363516	No			770
	388412.1	6363638	No			857

Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough

I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)

Height of S (m)	etc etc

L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

SafeDepth Minor Stor (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
0.05	0.6	1	0	927
0.05	0.6	1	0	75
0.05	0.6	1	0	64
0.05	0.6	1	0	66
0.05	0.6	1	0	68
0.05	0.6	1	0	70
0.05	0.6	1	0	83
0.05	0.6	1	0	85
0.05	0.6	1	0	91
0.05	0.6	1	0	94
0.05	0.6	1	0	100
0.05	0.6	1	0	110

0.05	0.6	1	0	114
0.4	1	1	0	123
0.05	0.6	1	0	136
0.05	0.6	1	0	146
0.05	0.6	1	0	147
0.05	0.6	1	0	148
0.05	0.6	1	0	157
0.05	0.6	1	0	158
0.05	0.6	1	0	162
0.05	0.6	1	0	174
0.05	0.6	1	0	175
0.05	0.6	1	0	215
0.05	0.6	1	0	177
0.05	0.6	1	0	178
0.05	0.6	1	0	204
0.05	0.6	1	0	190
0.05	0.6	1	0	199
0.05	0.6	1	0	200
0.05	0.6	1	0	211
0.05	0.6	1	0	234
0.05	0.6	1	0	238
0.05	0.6	1	0	978
0.05	0.6	1	0	366
0.05	0.6	1	0	368
0.05	0.6	1	0	370
0.05	0.6	1	0	375
0.05	0.6	1	0	388
0.05	0.6	1	0	377
0.05	0.6	1	0	384
0.05	0.6	1	0	386
0.05	0.6	1	0	394
0.05	0.6	1	0	399
0.05	0.6	1	0	401
0.05	0.6	1	0	409
0.05	0.6	1	0	416
0.05	0.6	1	0	418
0.05	0.6	1	0	422
0.05	0.6	1	0	426
0.05	0.6	1	0	431
0.05	0.6	1	0	440
0.05	0.6	1	0	444
0.05	0.6	1	0	508
0.05	0.6	1	0	510
0.05	0.6	1	0	512
0.05	0.6	1	0	514
0.05	0.6	1	0	516
0.05	0.6	1	0	518
0.05	0.6	1	0	523
0.05	0.6	1	0	983
0.05	0.6	1	0	526

0.05	0.6	1	0	531
0.05	0.6	1	0	535
0.05	0.6	1	0	539
0.05	0.6	1	0	545
0.05	0.6	1	0	562
0.05	0.6	1	0	554
0.05	0.6	1	0	558
0.05	0.6	1	0	547
0.05	0.6	1	0	612
0.05	0.6	1	0	616
0.05	0.6	1	0	620
0.05	0.6	1	0	624
0.05	0.6	1	0	632
0.05	0.6	1	0	650
0.05	0.6	1	0	722
0.05	0.6	1	0	636
0.05	0.6	1	0	1004
0.05	0.6	1	0	642
0.05	0.6	1	0	646
0.05	0.6	1	0	648
0.05	0.6	1	0	656
0.05	0.6	1	0	660
0.05	0.6	1	0	664
0.05	0.6	1	0	668
0.05	0.6	1	0	677
0.05	0.6	1	0	687
0.05	0.6	1	0	683
0.05	0.6	1	0	685
0.05	0.6	1	0	691
0.05	0.6	1	0	697
0.05	0.6	1	0	706
0.05	0.6	1	0	710
0.05	0.6	1	0	712
0.05	0.6	1	0	718
0.05	0.6	1	0	720
0.05	0.6	1	0	1024
0.05	0.6	1	0	776
0.05	0.6	1	0	778
0.05	0.6	1	0	784
0.05	0.6	1	0	788
0.05	0.6	1	0	794
0.05	0.6	1	0	795
0.05	0.6	1	0	798
0.05	0.6	1	0	803
0.05	0.6	1	0	809
0.05	0.6	1	0	835
0.05	0.6	1	0	924
0.05	0.6	1	0	845
0.05	0.6	1	0	850
0.05	0.6	1	0	854

0.05	0.6	1	0	859
0.05	0.6	1	0	1019
0.05	0.6	1	0	865
0.05	0.6	1	0	869
0.05	0.6	1	0	871
0.05	0.6	1	0	875
0.05	0.6	1	0	889
0.05	0.6	1	0	891
0.05	0.6	1	0	1033
0.05	0.6	1	0	1044

APPENDIX 2

MUSIC MODELLING:

Selected Input & Output Data

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	52.6	10.3E3	21.3	152	1.35E3
Residual Load	52.6	2.07E3	7.47	93.8	0.00
% Reduction	-0.1	79.9	65.0	38.5	100.0

Catchment 1 WSUD modelling - Bio-Retention 1A

All Data Statistics

9/04/2008 8:32:29

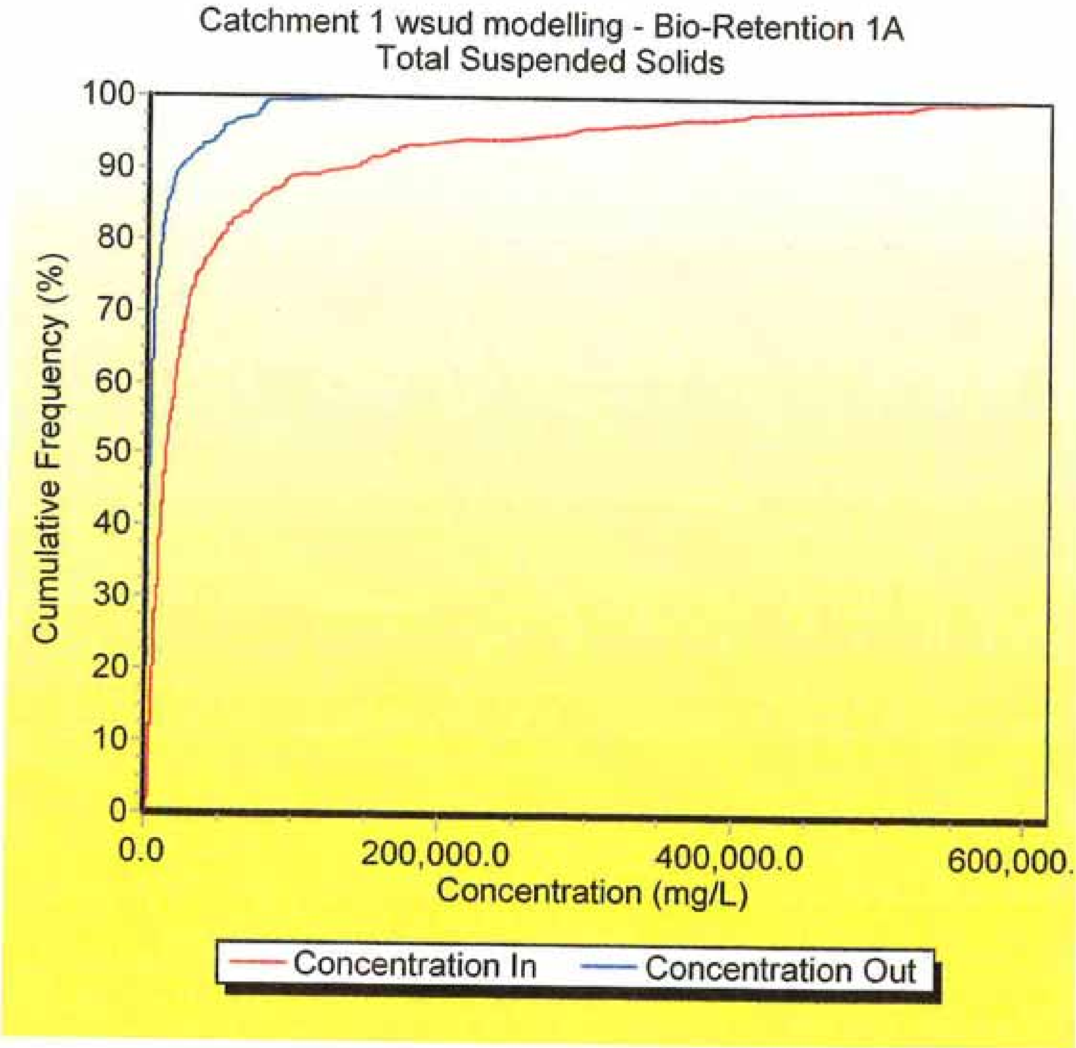
Inflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.67E-3	11.2E-3	167E-6	0.404	1.76E-6	16.0E-6	3.24E-3
TSS Concentration (mg/L)	7.46	21.8	2.86	491	0.369	1.95	5.87
Log [TSS] (mg/L)	0.534	0.374	0.456	2.69	-0.433	0.289	0.769
TP Concentration (mg/L)	73.1E-3	43.1E-3	63.8E-3	0.757	19.1E-3	48.8E-3	92.0E-3
Log [TP] (mg/L)	-1.17	0.154	-1.20	-0.121	-1.72	-1.31	-1.04
TN Concentration (mg/L)	1.30	0.290	1.26	4.69	0.628	1.05	1.52
Log [TN] (mg/L)	0.106	79.9E-3	99.7E-3	0.672	-0.202	22.0E-3	0.182
TSS Load (kg/Hour)	0.383	5.31	1.62E-3	227	12.8E-6	147E-6	79.1E-3
TP Load (kg/Hour)	1.12E-3	12.8E-3	37.9E-6	0.561	307E-9	3.59E-6	900E-6
TN Load (kg/Hour)	12.6E-3	0.112	747E-6	4.09	7.69E-6	72.5E-6	14.4E-3
Gross Pollutant Load (kg/Hour)	18.9E-3	0.112	0.00	2.91	0.00	0.00	0.00

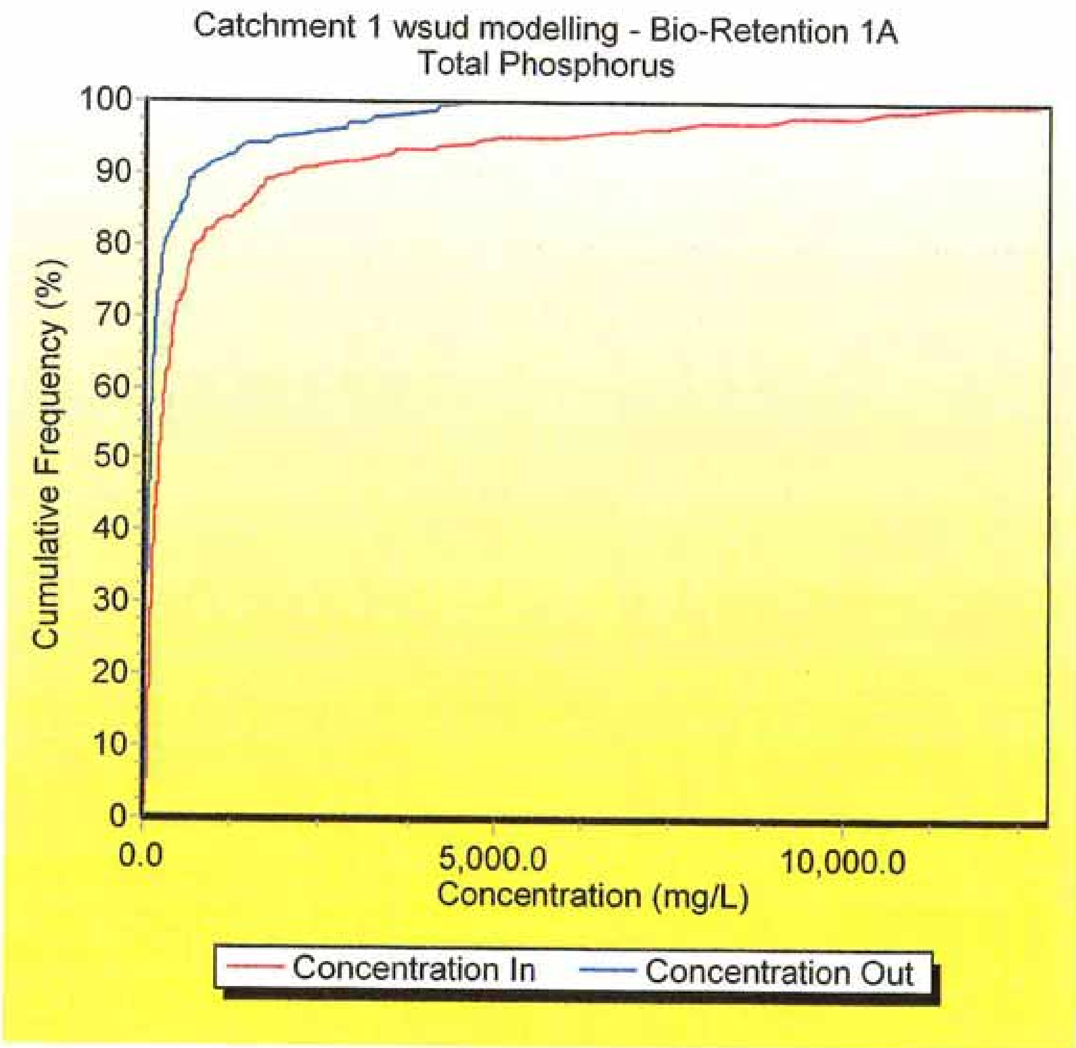
Outflow

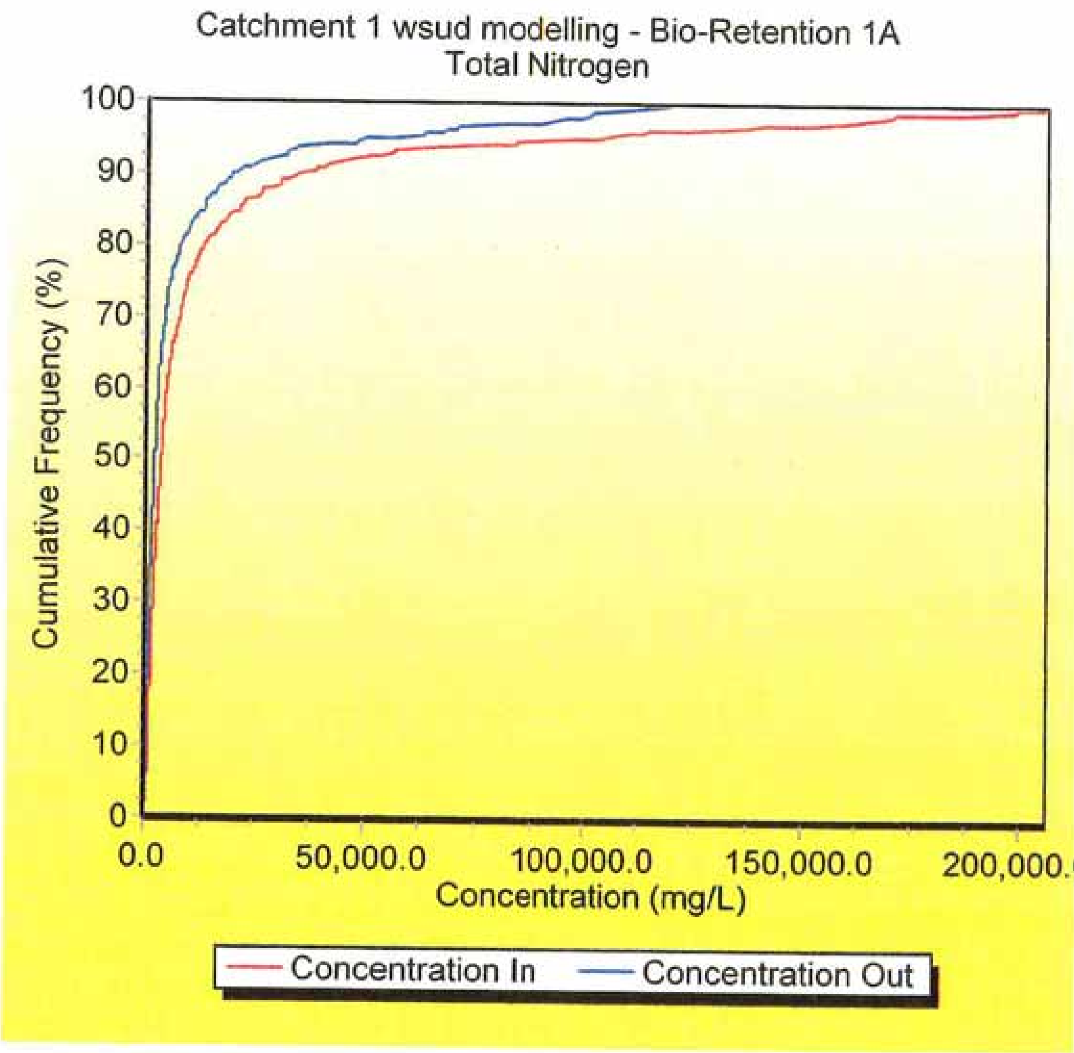
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.67E-3	11.2E-3	190E-6	0.426	2.03E-6	17.6E-6	3.46E-3
TSS Concentration (mg/L)	2.08	6.88	0.503	148	78.4E-3	0.379	4.30
Log [TSS] (mg/L)	-0.123	0.466	-0.299	2.17	-1.11	-0.422	0.634
TP Concentration (mg/L)	36.2E-3	24.8E-3	28.4E-3	0.343	8.72E-3	22.4E-3	60.4E-3
Log [TP] (mg/L)	-1.49	0.186	-1.55	-0.465	-2.06	-1.65	-1.22
TN Concentration (mg/L)	0.863	0.243	0.815	3.64	0.423	0.711	0.999
Log [TN] (mg/L)	-74.6E-3	87.8E-3	-88.8E-3	0.561	-0.374	-0.148	-648E-6
TSS Load (kg/Hour)	0.236	4.22	316E-6	205	2.80E-6	28.6E-6	54.4E-3
TP Load (kg/Hour)	852E-6	11.2E-3	18.4E-6	0.526	150E-9	1.70E-6	750E-6
TN Load (kg/Hour)	10.7E-3	0.106	543E-6	4.03	5.00E-6	49.7E-6	11.6E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Catchment 1



Catchment 1 wsud modelling - Bio-Retention 1A
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 1 wsud modelling - Bio-Retention 1A
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000.0
10,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 1 wsud modelling - Bio-Retention 1A
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
200,000.
Concentration (mg/L)
Concentration In
Concentration Out

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	52.6	10.3E3	21.3	152	1.35E3
Residual Load	45.0	934	4.99	64.8	0.00
% Reduction	14.4	90.9	76.6	57.5	100.0

Catchment 1 Load Modelling - Detention AREA 1

All Data Statistics

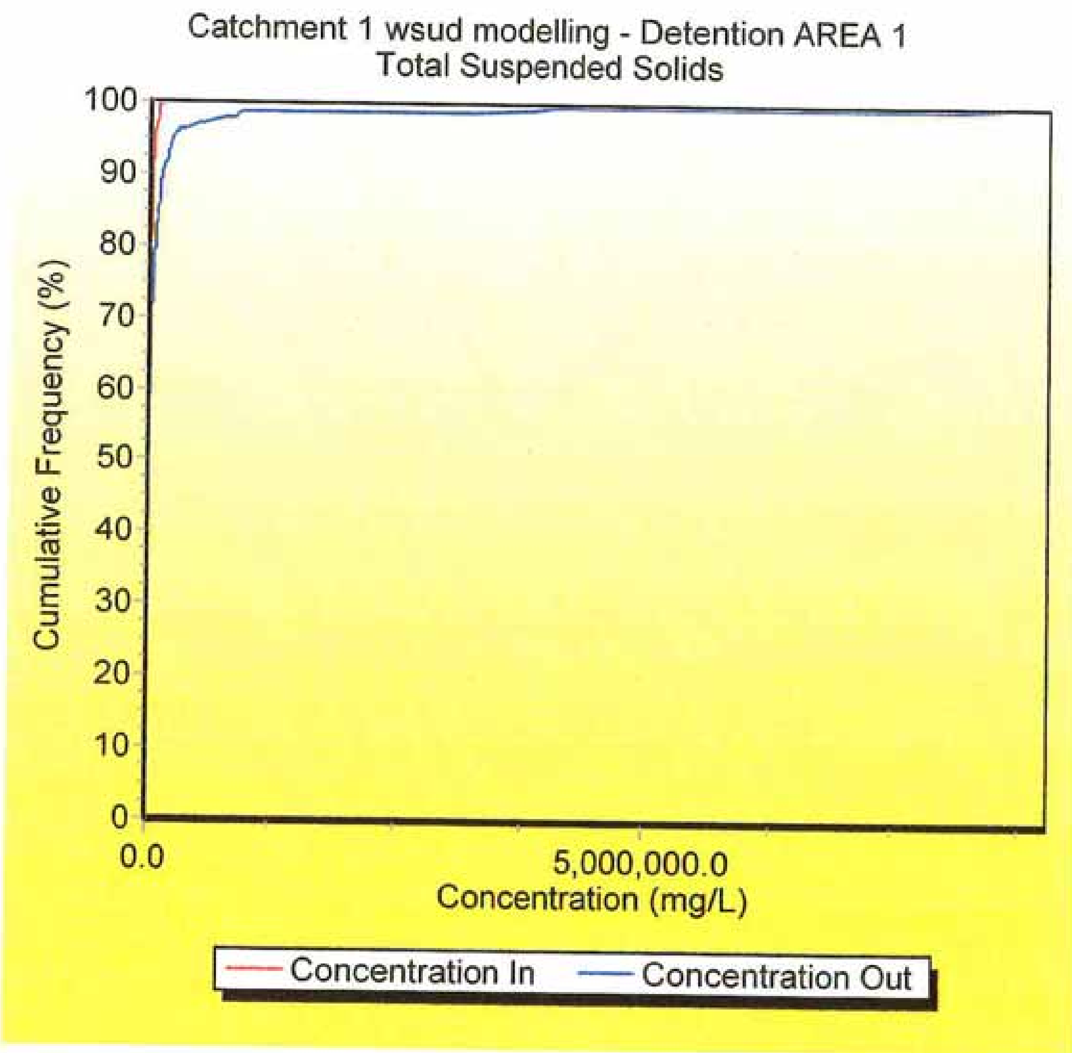
9/04/2008 8:31:21

Inflow

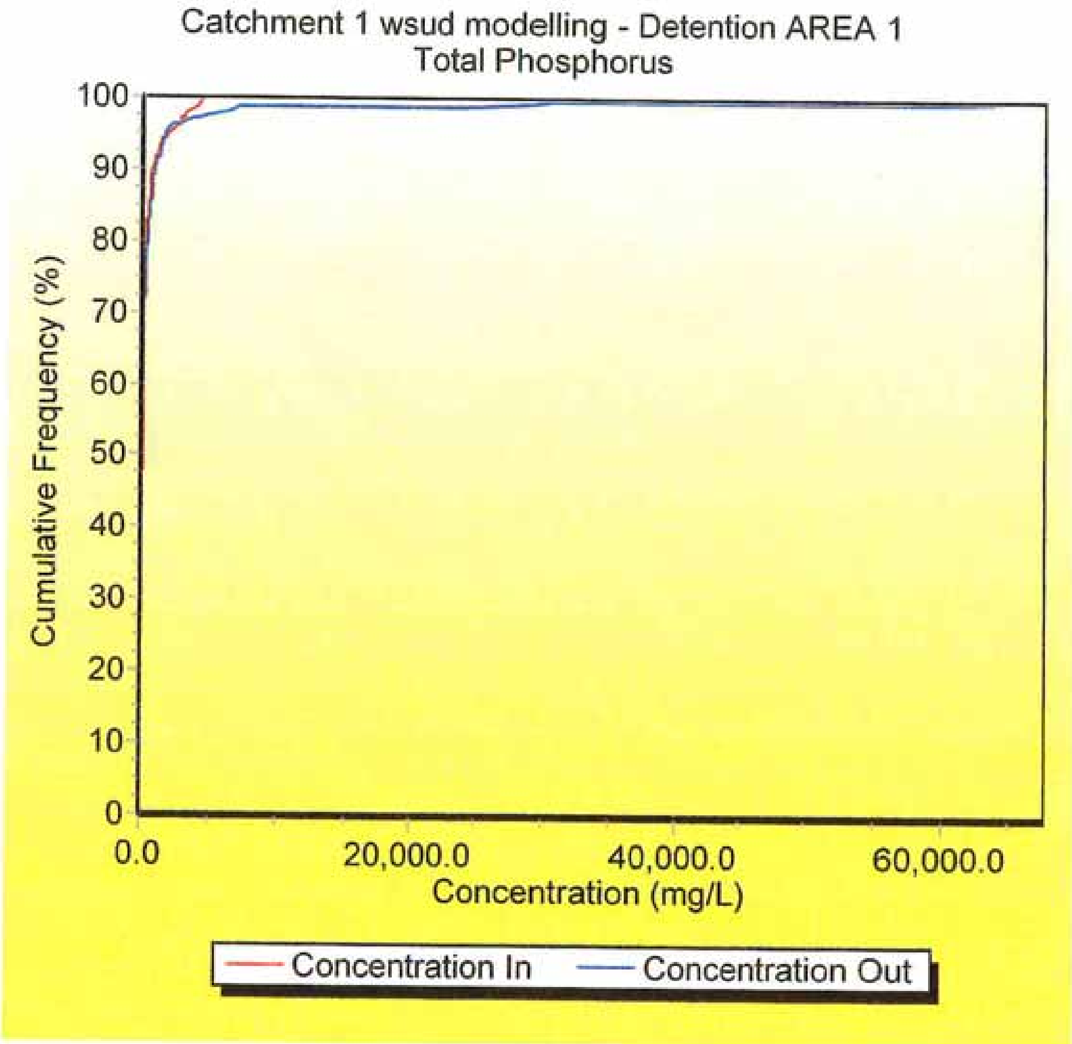
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.67E-3	11.2E-3	190E-6	0.426	2.03E-6	17.6E-6	3.46E-3
TSS Concentration (mg/L)	2.08	6.88	0.503	148	78.4E-3	0.379	4.30
Log [TSS] (mg/L)	-0.123	0.466	-0.299	2.17	-1.11	-0.422	0.634
TP Concentration (mg/L)	36.2E-3	24.8E-3	28.4E-3	0.343	8.72E-3	22.4E-3	60.4E-3
Log [TP] (mg/L)	-1.49	0.186	-1.55	-0.465	-2.06	-1.65	-1.22
TN Concentration (mg/L)	0.863	0.243	0.815	3.64	0.423	0.711	0.999
Log [TN] (mg/L)	-74.6E-3	87.8E-3	-88.8E-3	0.561	-0.374	-0.148	-648E-6
TSS Load (kg/Hour)	0.236	4.22	316E-6	205	2.80E-6	28.6E-6	54.4E-3
TP Load (kg/Hour)	852E-6	11.2E-3	18.4E-6	0.526	150E-9	1.70E-6	750E-6
TN Load (kg/Hour)	10.7E-3	0.106	543E-6	4.03	5.00E-6	49.7E-6	11.6E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

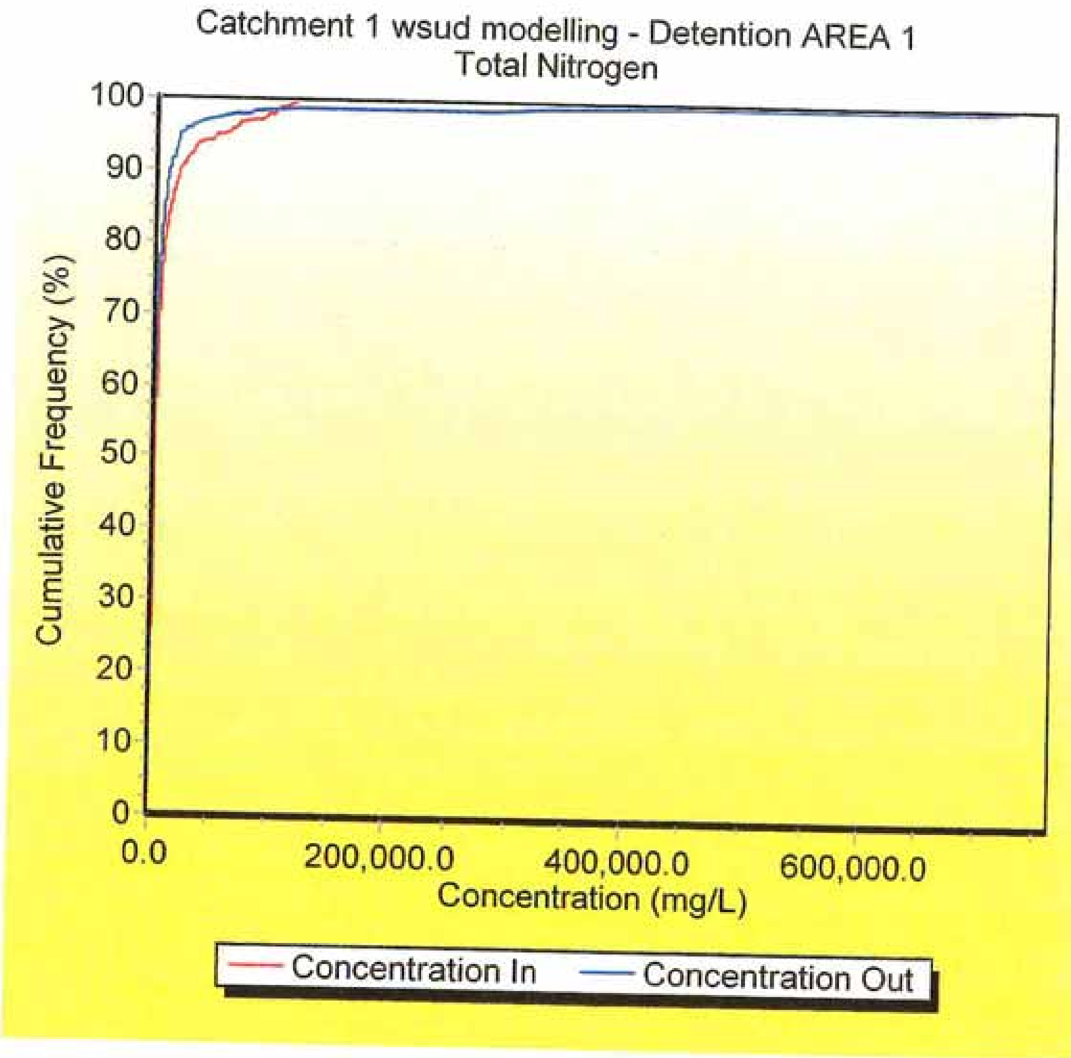
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.43E-3	6.78E-3	0.00	0.117	0.00	0.00	3.00E-3
TSS Concentration (mg/L)	5.63	6.66	0.00	47.5	0.00	0.00	12.1
Log [TSS] (mg/L)	1.10	66.7E-3	1.08	1.68	1.08	1.08	1.10
TP Concentration (mg/L)	40.9E-3	46.1E-3	0.00	0.174	0.00	0.00	90.6E-3
Log [TP] (mg/L)	-1.04	30.4E-3	-1.04	-0.760	-1.05	-1.05	-1.03
TN Concentration (mg/L)	0.511	0.591	0.00	2.50	0.00	0.00	1.22
Log [TN] (mg/L)	54.7E-3	69.4E-3	26.5E-3	0.398	260E-6	6.41E-3	0.143
TSS Load (kg/Hour)	0.107	0.824	0.00	19.2	0.00	0.00	0.133
TP Load (kg/Hour)	570E-6	3.34E-3	0.00	68.5E-3	0.00	0.00	988E-6
TN Load (kg/Hour)	7.39E-3	42.9E-3	0.00	0.844	0.00	0.00	12.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 1 wsud modelling - Detention AREA 1
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 1 wsud modelling - Detention AREA 1
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 1 wsud modelling - Detention AREA 1
Total Nitrogen
100
90
80
70
60
50
40
30
20
10
0
Cumulative Frequency (%)
0.0
200,000.0
400,000.0
600,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	52.6	10.3E3	21.3	152	1.35E3
Residual Load	41.3	277	2.65	51.4	0.00
% Reduction	21.4	97.3	87.6	66.3	100.0

Catchment 1 wsud modelling - Wetland AREA 1

All Data Statistics

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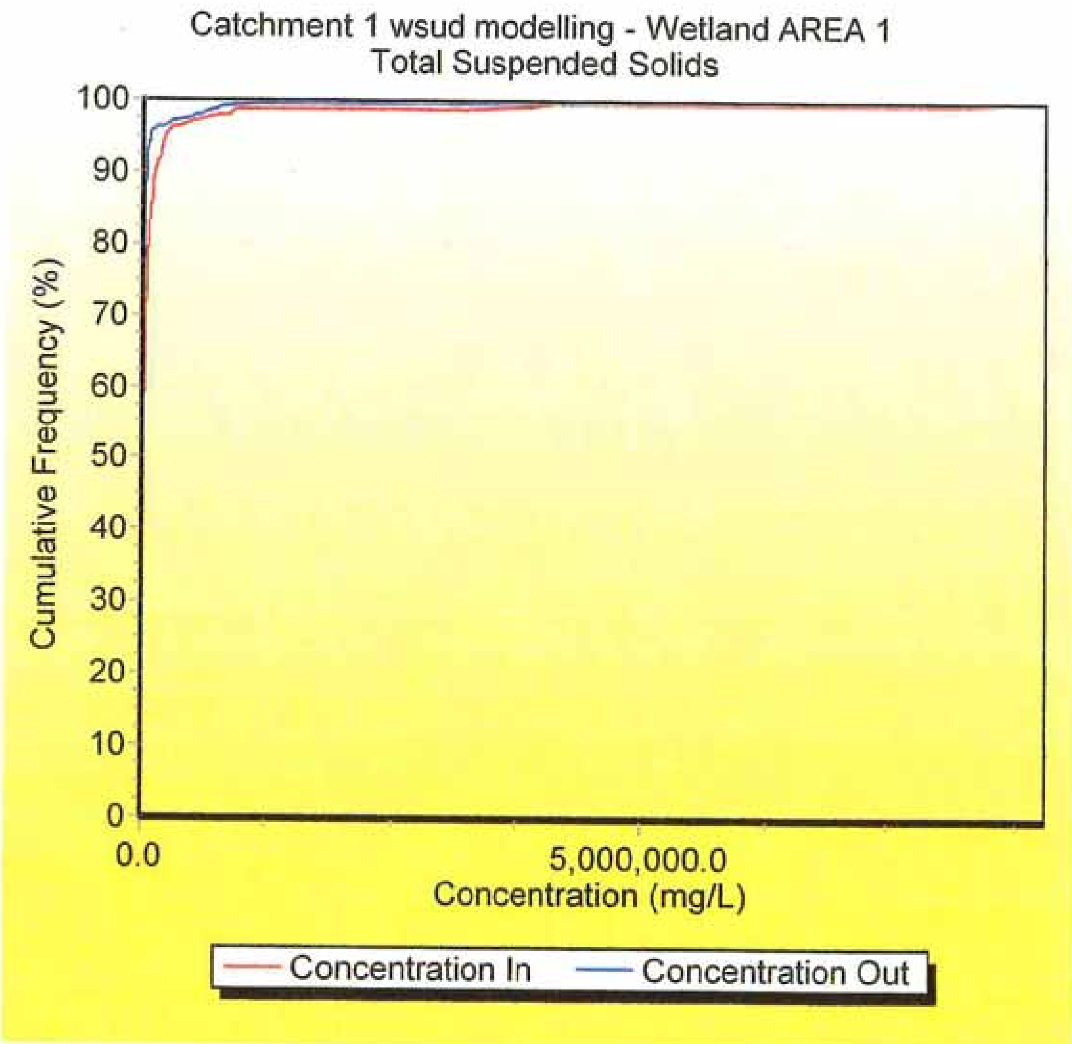
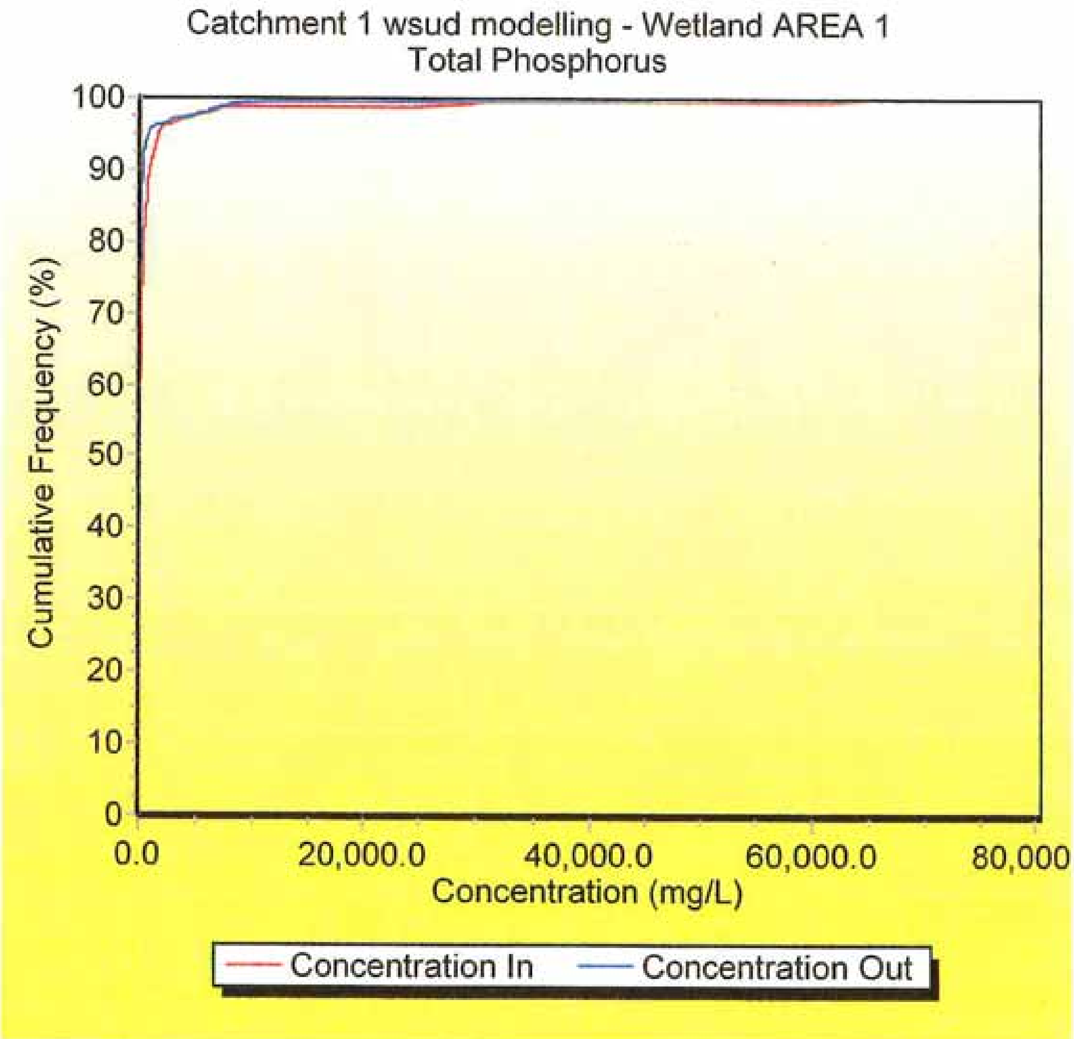
Inflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.43E-3	6.78E-3	0.00	0.117	0.00	0.00	3.00E-3
TSS Concentration (mg/L)	5.63	6.66	0.00	47.5	0.00	0.00	12.1
Log [TSS] (mg/L)	1.10	66.7E-3	1.08	1.68	1.08	1.08	1.10
TP Concentration (mg/L)	40.9E-3	46.1E-3	0.00	0.174	0.00	0.00	90.6E-3
Log [TP] (mg/L)	-1.04	30.4E-3	-1.04	-0.760	-1.05	-1.05	-1.03
TN Concentration (mg/L)	0.511	0.591	0.00	2.50	0.00	0.00	1.22
Log [TN] (mg/L)	54.7E-3	69.4E-3	26.5E-3	0.398	260E-6	6.41E-3	0.143
TSS Load (kg/Hour)	0.107	0.824	0.00	19.2	0.00	0.00	0.133
TP Load (kg/Hour)	570E-6	3.34E-3	0.00	68.5E-3	0.00	0.00	988E-6
TN Load (kg/Hour)	7.39E-3	42.9E-3	0.00	0.844	0.00	0.00	12.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

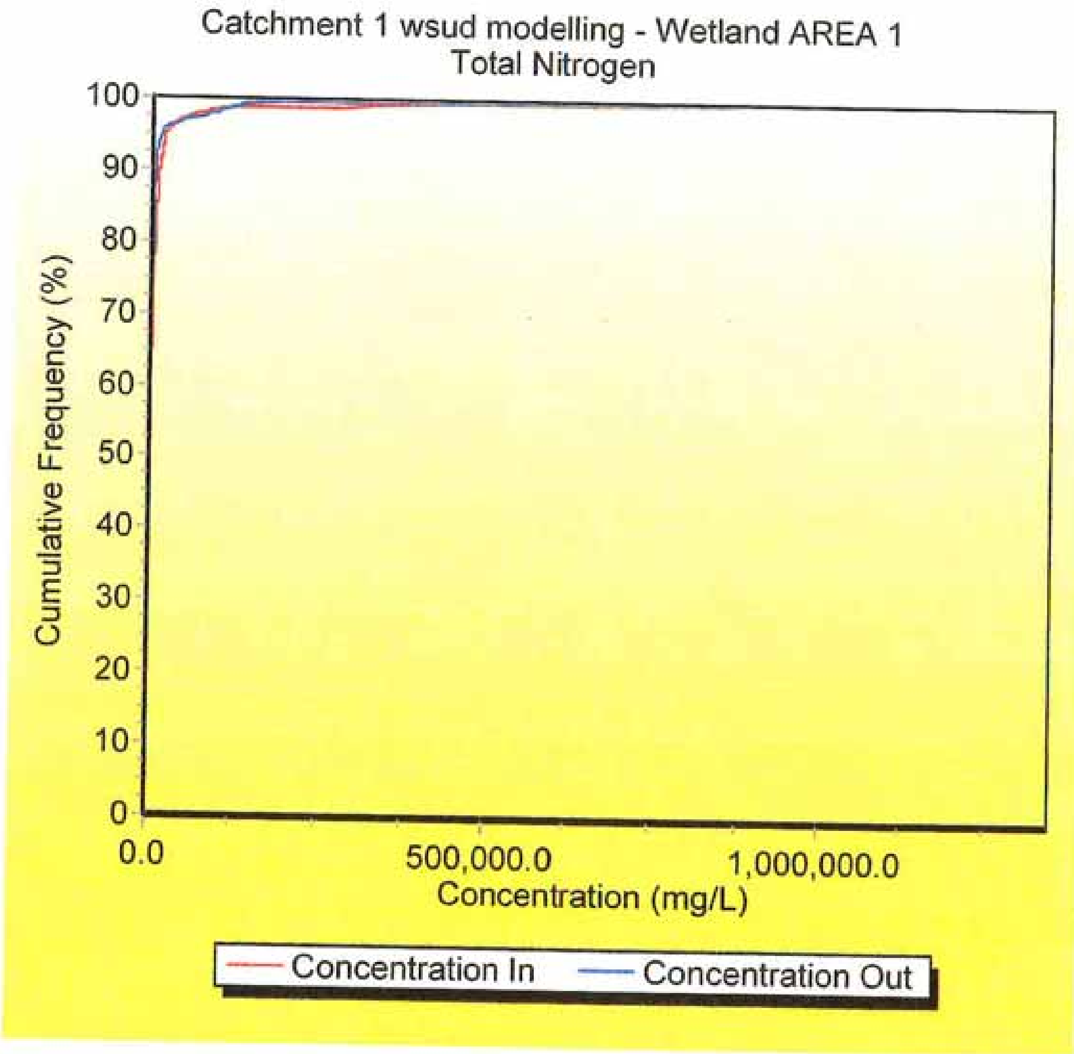
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.31E-3	5.38E-3	0.00	57.7E-3	0.00	0.00	2.74E-3
TSS Concentration (mg/L)	1.68	2.74	0.00	10.4	0.00	0.00	6.07
Log [TSS] (mg/L)	0.786	23.4E-3	0.782	1.02	0.779	0.780	0.786
TP Concentration (mg/L)	16.7E-3	27.2E-3	0.00	81.2E-3	0.00	0.00	60.7E-3
Log [TP] (mg/L)	-1.22	13.2E-3	-1.22	-1.09	-1.22	-1.22	-1.21
TN Concentration (mg/L)	0.287	0.471	0.00	1.92	0.00	0.00	1.02
Log [TN] (mg/L)	17.3E-3	39.0E-3	7.00E-3	0.282	3.02E-3	3.32E-3	29.7E-3
TSS Load (kg/Hour)	31.6E-3	0.149	0.00	2.14	0.00	0.00	59.9E-3
TP Load (kg/Hour)	302E-6	1.33E-3	0.00	16.8E-3	0.00	0.00	599E-6
TN Load (kg/Hour)	5.87E-3	28.5E-3	0.00	0.359	0.00	0.00	10.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 1 wsud modelling - Wetland AREA 1
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 1 wsud modelling - Wetland AREA 1
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
80,000
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 1 wsud modelling - Wetland AREA 1
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500,000.0
1,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban
ID,1,2,3,4
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),0.65,1.04,1.44,2.16
Area Impervious (ha),0.38834649122807,0.621354385964912,0.866715789473684,1.30007368421053
Area Pervious (ha),0.26165350877193,0.418645614035088,0.573284210526316,0.859926315789474
Field Capacity (mm),80,80,80,80
Pervious Area Infiltration Capacity coefficient - a,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.42,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0
OUT - Mean Annual Flow (ML/yr),6.46,10.3,14.3,21.5
OUT - TSS Mean Annual Load (kg/yr),1.23E3,1.97E3,2.94E3,4.13E3
OUT - TP Mean Annual Load (kg/yr),2.51,4.16,5.82,8.85
OUT - TN Mean Annual Load (kg/yr),18.3,30.9,41.3,62.0
OUT - Gross Pollutant Mean Annual Load (kg/yr),166,265,367,551

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention 1A,Bio-Retention,Bio-Retention,Bio-Retention,Detention AREA 1,Wetland AREA 1
ID,5,6,7,8,9,10
Node Type,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,PondNode,WetlandNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0
Hi-flow bypass rate (cum/sec),100,100,100,100,100,100

```
Inlet pond volume, , , , ,0,0
Area (sqm),80,70,80,70,6250,4000
Extended detention depth (m),0.8,0.8,0.8,0.8,0.4,1
Permanent pool volume (cum), , , , ,2500,50
Proportion vegetated, , , , ,0.1,0.5
Equivalent pipe diameter (mm), , , , ,300,200
Overflow weir width (m),2,2,2,2,2,3
Notional Detention Time (hrs), , , , ,5.24,11.9
Orifice discharge coefficient, , , , ,0.6,0.6
Weir coefficient,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,3,3,3,2,5
Total Suspended Solids k (m/yr),8000,8000,8000,8000,400,1500
Total Suspended Solids C* (mg/L),20,20,20,20,12,6
Total Suspended Solids C** (mg/L), , , , ,12,6
Total Phosphorus  k (m/yr),6000,6000,6000,6000,300,1000
Total Phosphorus C* (mg/L),0.13,0.13,0.13,0.13,0.09,0.06
Total Phosphorus C** (mg/L), , , , ,0.09,0.06
Total Nitrogen k (m/yr),500,500,500,500,40,150
Total Nitrogen C* (mg/L),1.4,1.4,1.4,1.4,1,1
Total Nitrogen C** (mg/L), , , , ,1,1
Threshold hydraulic loading for C** (m/yr), , , , ,3500,3500
Extraction for Re-use,Off,Off,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , , , ,
Constant Daily Re-use Demand (kL), , , , , ,
User-defined Annual Re-use Demand (ML), , , , , ,
Percentage of User-defined Annual Re-use Demand Jan, , , , , ,
Percentage of User-defined Annual Re-use Demand Feb, , , , , ,
Percentage of User-defined Annual Re-use Demand Mar, , , , , ,
Percentage of User-defined Annual Re-use Demand Apr, , , , , ,
Percentage of User-defined Annual Re-use Demand May, , , , , ,
Percentage of User-defined Annual Re-use Demand Jun, , , , , ,
Percentage of User-defined Annual Re-use Demand Jul, , , , , ,
Percentage of User-defined Annual Re-use Demand Aug, , , , , ,
Percentage of User-defined Annual Re-use Demand Sep, , , , , ,
Percentage of User-defined Annual Re-use Demand Oct, , , , , ,
Percentage of User-defined Annual Re-use Demand Nov, , , , , ,
Percentage of User-defined Annual Re-use Demand Dec, , , , , ,
Filter area (sqm),80,70,80,70, ,
Filter depth (m),0.6,0.6,0.6,0.6, ,
Filter median particle diameter (mm),5,5,5,5, ,
Saturated hydraulic conductivity (mm/hr),100,100,100,100, ,
Voids ratio,0.3,0.3,0.3,0.3, ,
Length (m), , , , , ,
Bed slope, , , , , ,
Base Width (m), , , , , ,
Top width (m), , , , , ,
Vegetation height (m), , , , , ,
Proportion of upstream impervious area treated, , , , , ,
Seepage Rate (mm/hr),0,0,0,0,0,0
Evap Loss as proportion of PET, , , , ,1,1.25
Depth in metres below the drain pipe,0,0,0,0, ,
IN - Mean Annual Flow (ML/yr),52.6,10.3,35.8,21.5,52.6,45.0
IN - TSS Mean Annual Load (kg/yr),3.36E3,1.97E3,4.08E3,4.13E3,2.07E3,934
IN - TP Mean Annual Load (kg/yr),9.80,4.16,9.71,8.85,7.47,4.99
IN - TN Mean Annual Load (kg/yr),110,30.9,88.2,62.0,93.8,64.8
IN - Gross Pollutant Mean Annual Load (kg/yr),166,265,367,551,0.00,0.00
OUT - Mean Annual Flow (ML/yr),52.6,10.3,35.8,21.5,45.0,41.3
OUT - TSS Mean Annual Load (kg/yr),2.07E3,349,1.78E3,1.14E3,934,277
OUT - TP Mean Annual Load (kg/yr),7.47,1.47,5.83,3.88,4.99,2.65
OUT - TN Mean Annual Load (kg/yr),93.8,21.2,70.7,47.0,64.8,51.4
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

No Other nodes

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage
```

Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,2,6,1,7,3,4,8,5,9
Target node ID,6,5,5,5,7,8,7,9,10
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , , , ,
Muskingum theta, , , , , , , , ,
IN - Mean Annual Flow (ML/yr),10.3,10.3,6.46,35.8,14.3,21.5,21.5,52.6,45.0
IN - TSS Mean Annual Load (kg/yr),1.97E3,349,1.23E3,1.78E3,2.94E3,4.13E3,1.14E3,2.07E3,934
IN - TP Mean Annual Load (kg/yr),4.16,1.47,2.51,5.83,5.82,8.85,3.88,7.47,4.99
IN - TN Mean Annual Load (kg/yr),30.9,21.2,18.3,70.7,41.3,62.0,47.0,93.8,64.8
IN - Gross Pollutant Mean Annual Load (kg/yr),265,0.00,166,0.00,367,551,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),10.3,10.3,6.46,35.8,14.3,21.5,21.5,52.6,45.0
OUT - TSS Mean Annual Load (kg/yr),1.97E3,349,1.23E3,1.78E3,2.94E3,4.13E3,1.14E3,2.07E3,934
OUT - TP Mean Annual Load (kg/yr),4.16,1.47,2.51,5.83,5.82,8.85,3.88,7.47,4.99
OUT - TN Mean Annual Load (kg/yr),30.9,21.2,18.3,70.7,41.3,62.0,47.0,93.8,64.8
OUT - Gross Pollutant Mean Annual Load (kg/yr),265,0.00,166,0.00,367,551,0.00,0.00,0.00

Catchment 2

Bio-Retention 2A

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Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	47.3	8.48E3	18.2	133	1.22E3
Residual Load	47.4	1.68E3	6.94	82.0	0.00
% Reduction	-0.2	80.1	61.9	38.4	100.0

Catchment 2 wsud modelling - Bio-Retention 2A

All Data Statistics

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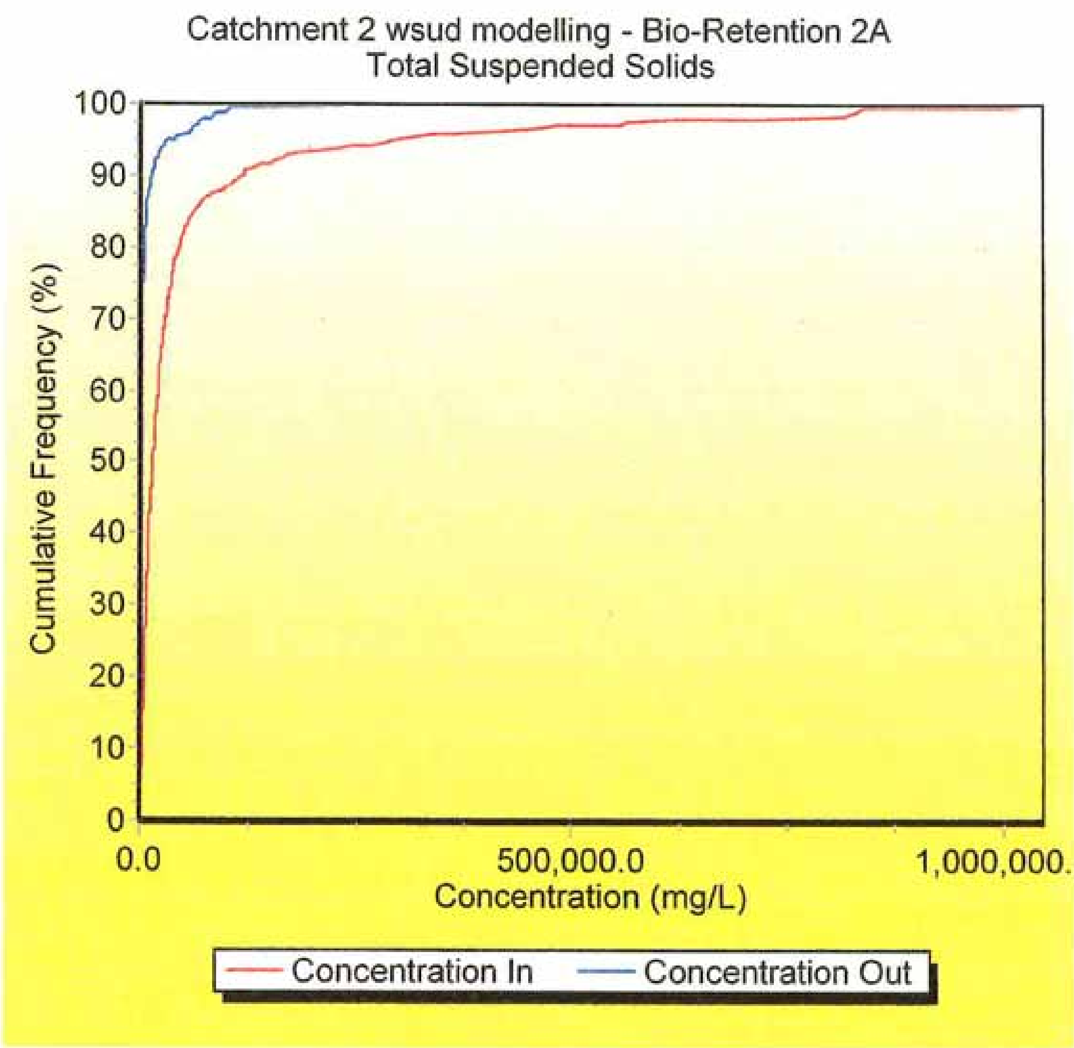
Inflow

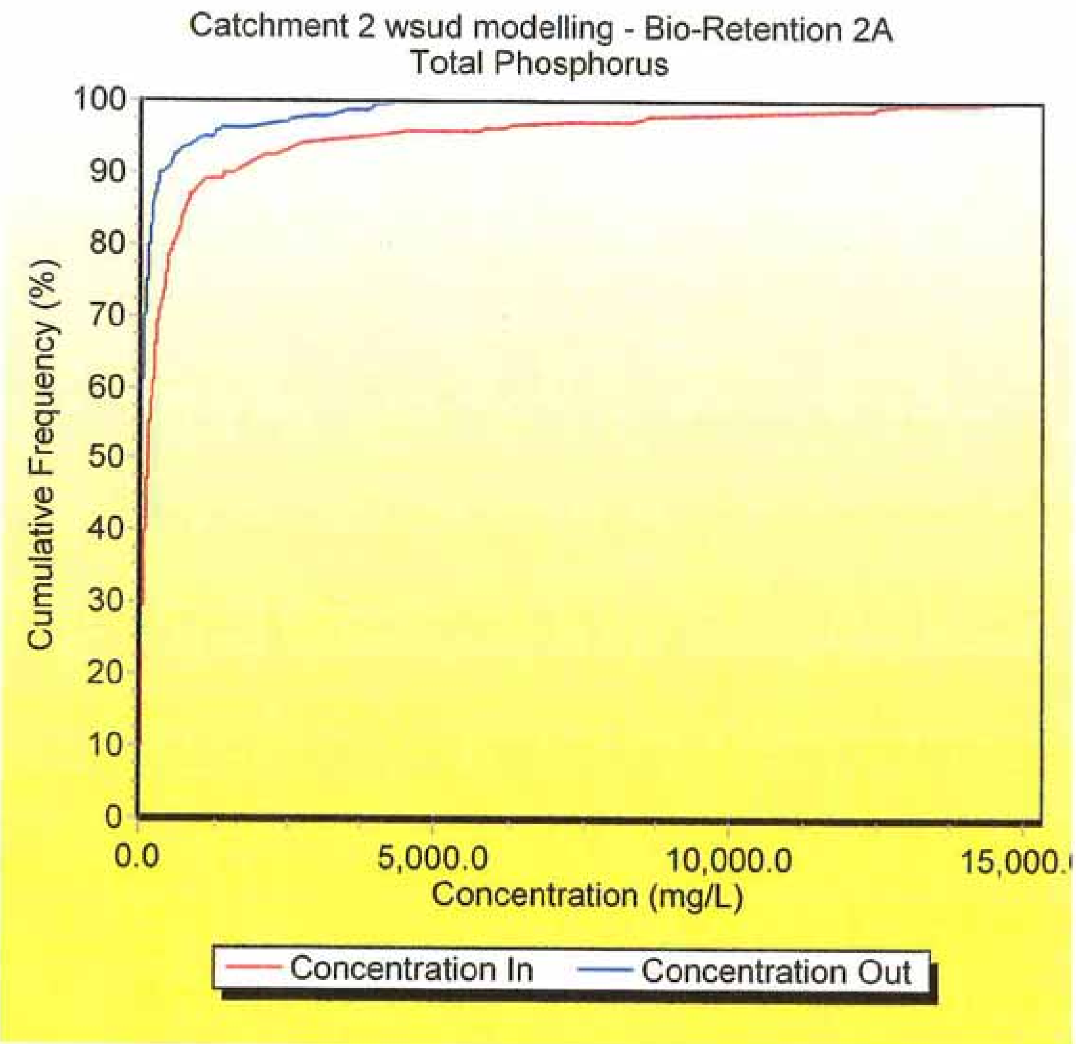
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.50E-3	9.73E-3	296E-6	0.356	1.89E-6	22.2E-6	1.83E-3
TSS Concentration (mg/L)	10.5	40.0	3.28	1.05E3	65.4E-3	1.95	6.58
Log [TSS] (mg/L)	0.583	0.417	0.516	3.02	-1.18	0.289	0.819
TP Concentration (mg/L)	67.1E-3	69.7E-3	53.8E-3	1.33	9.41E-3	36.0E-3	89.2E-3
Log [TP] (mg/L)	-1.25	0.213	-1.27	0.124	-2.03	-1.44	-1.05
TN Concentration (mg/L)	1.05	0.382	0.966	7.36	0.422	0.801	1.32
Log [TN] (mg/L)	4.40E-3	0.112	-14.8E-3	0.867	-0.375	-96.4E-3	0.119
TSS Load (kg/Hour)	0.348	3.81	3.14E-3	197	10.5E-6	221E-6	27.4E-3
TP Load (kg/Hour)	1.02E-3	10.5E-3	52.4E-6	0.528	224E-9	3.90E-6	410E-6
TN Load (kg/Hour)	10.3E-3	98.3E-3	1.05E-3	4.92	4.85E-6	79.8E-6	6.60E-3
Gross Pollutant Load (kg/Hour)	33.5E-3	0.199	0.00	5.15	0.00	0.00	0.00

Outflow

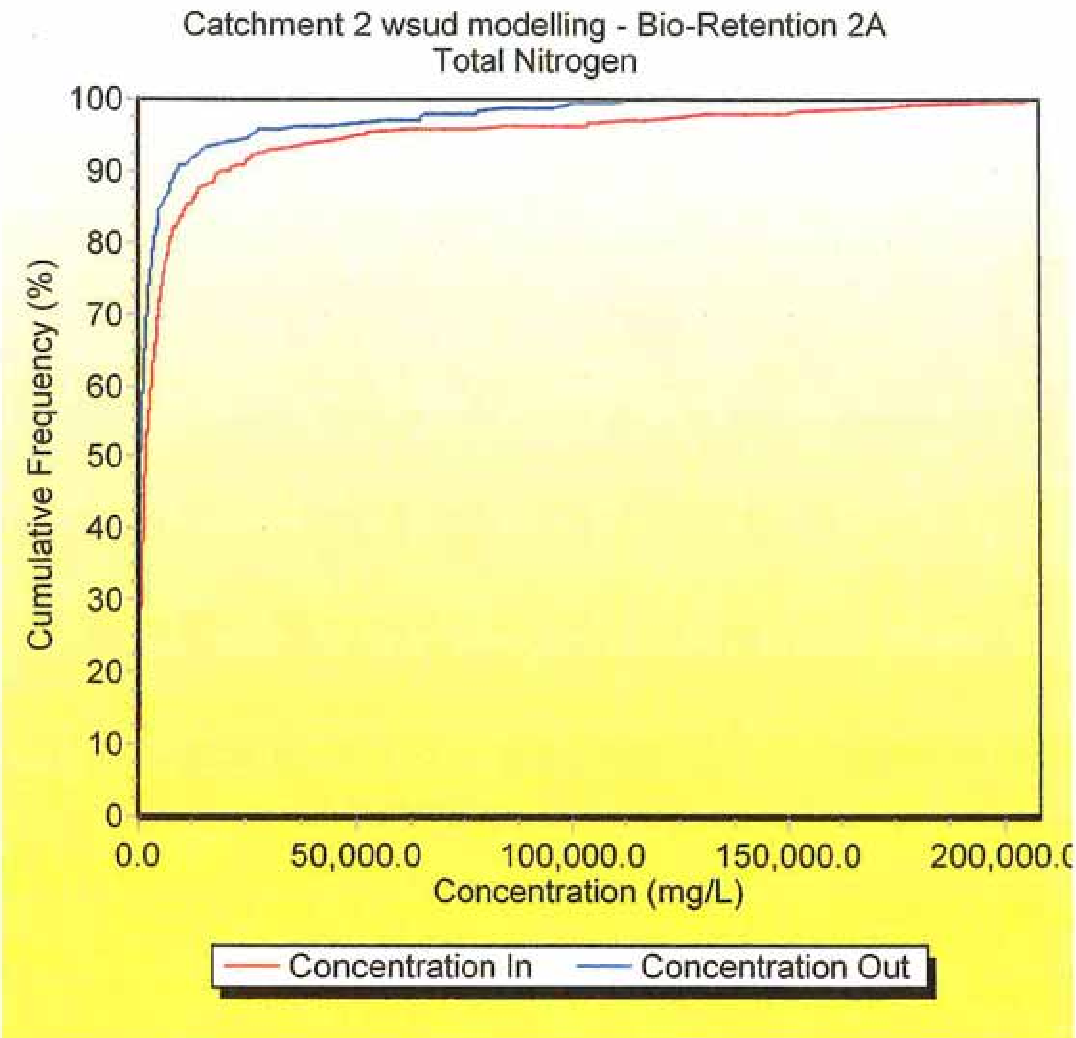
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.50E-3	9.72E-3	589E-6	0.350	1.89E-6	28.7E-6	1.76E-3
TSS Concentration (mg/L)	4.15	7.65	2.87	159	52.2E-3	0.367	10.7
Log [TSS] (mg/L)	0.226	0.586	0.457	2.20	-1.28	-0.436	1.03
TP Concentration (mg/L)	47.1E-3	32.9E-3	50.6E-3	0.509	5.22E-3	17.1E-3	87.6E-3
Log [TP] (mg/L)	-1.42	0.283	-1.30	-0.293	-2.28	-1.77	-1.06
TN Concentration (mg/L)	0.817	0.296	0.778	3.56	0.297	0.573	1.13
Log [TN] (mg/L)	-0.108	0.126	-0.109	0.552	-0.527	-0.242	51.8E-3
TSS Load (kg/Hour)	0.192	2.90	6.12E-3	138	1.79E-6	47.7E-6	67.4E-3
TP Load (kg/Hour)	793E-6	9.25E-3	108E-6	0.399	89.7E-9	2.06E-6	555E-6
TN Load (kg/Hour)	9.36E-3	93.5E-3	1.77E-3	4.22	3.22E-6	66.5E-6	6.65E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 2 wsud modelling - Bio-Retention 2A
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500,000.0
1,000,000.
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 2 wsud modelling - Bio-Retention 2A
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000.0
10,000.0
15,000.
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 2 wsud modelling - Bio-Retention 2A
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Detention AREA 2

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	72.4	13.3E3	28.4	206	1.86E3
Residual Load	60.3	1.24E3	6.70	83.7	0.00
% Reduction	16.7	90.7	76.4	59.3	100.0

Catchment 2 wsud modelling - Detention AREA 2

All Data Statistics

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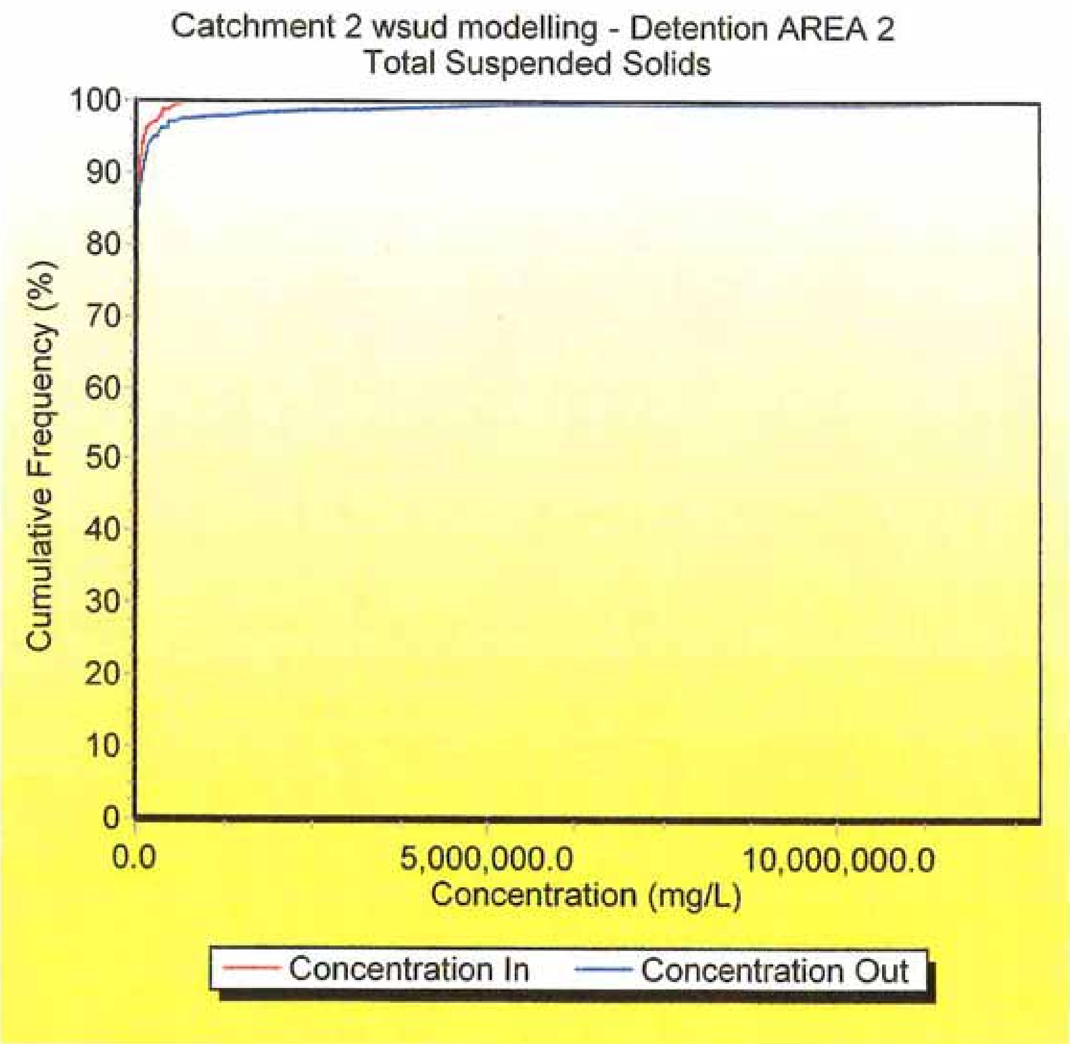
Inflow

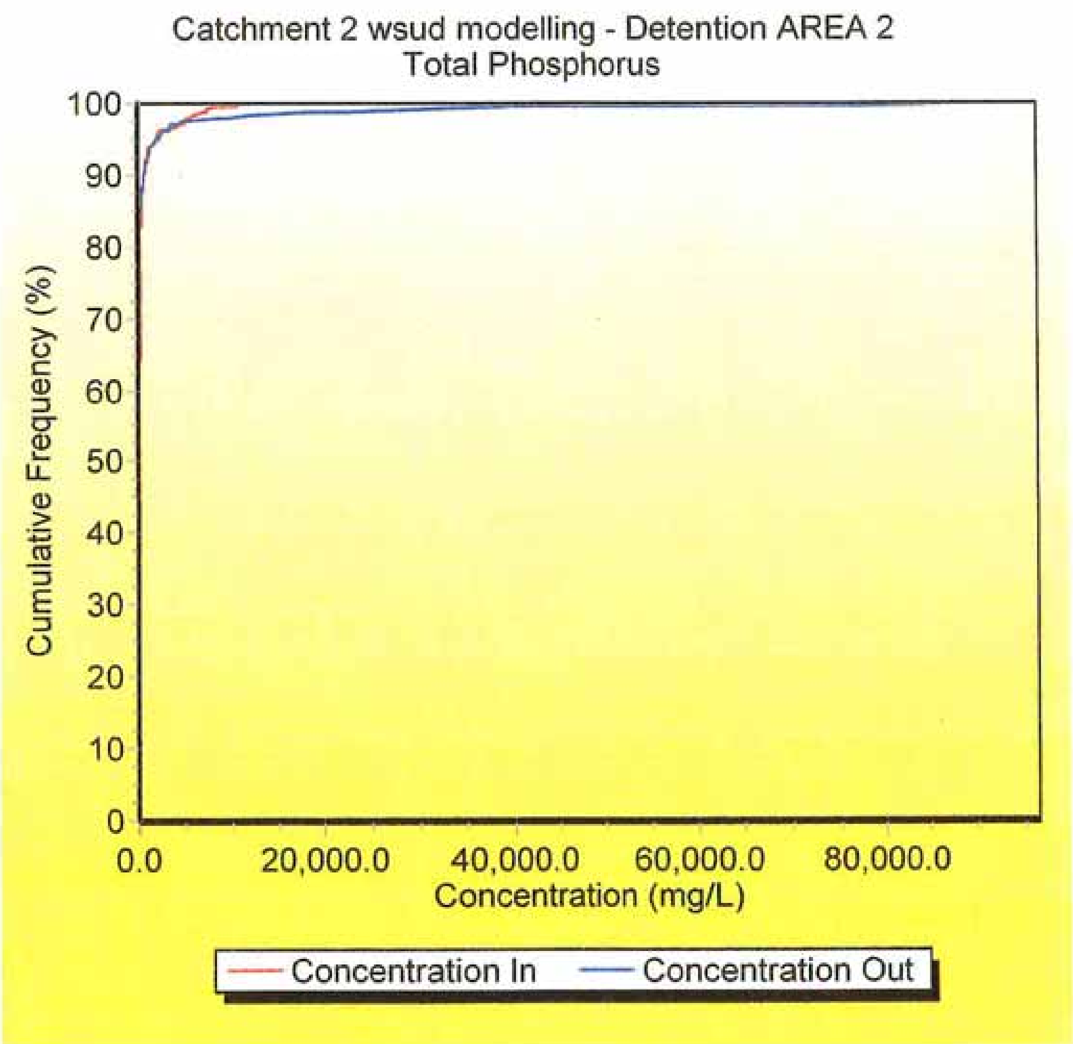
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	2.30E-3	15.1E-3	706E-6	0.541	2.90E-6	43.0E-6	2.61E-3
TSS Concentration (mg/L)	10.8	36.0	3.60	1.33E3	0.136	2.23	10.2
Log [TSS] (mg/L)	0.668	0.400	0.556	3.12	-0.866	0.348	1.01
TP Concentration (mg/L)	72.8E-3	60.8E-3	59.1E-3	1.58	8.36E-3	41.8E-3	92.0E-3
Log [TP] (mg/L)	-1.19	0.191	-1.23	0.199	-2.08	-1.38	-1.04
TN Concentration (mg/L)	1.08	0.383	0.992	9.53	0.411	0.826	1.33
Log [TN] (mg/L)	15.8E-3	0.109	-3.30E-3	0.979	-0.387	-83.2E-3	0.123
TSS Load (kg/Hour)	0.559	6.53	8.65E-3	280	20.1E-6	421E-6	92.9E-3
TP Load (kg/Hour)	1.64E-3	17.6E-3	146E-6	0.852	294E-9	7.74E-6	798E-6
TN Load (kg/Hour)	16.5E-3	0.153	2.32E-3	6.43	8.70E-6	156E-6	11.1E-3
Gross Pollutant Load (kg/Hour)	41.7E-3	0.247	0.00	6.40	0.00	0.00	0.00

Outflow

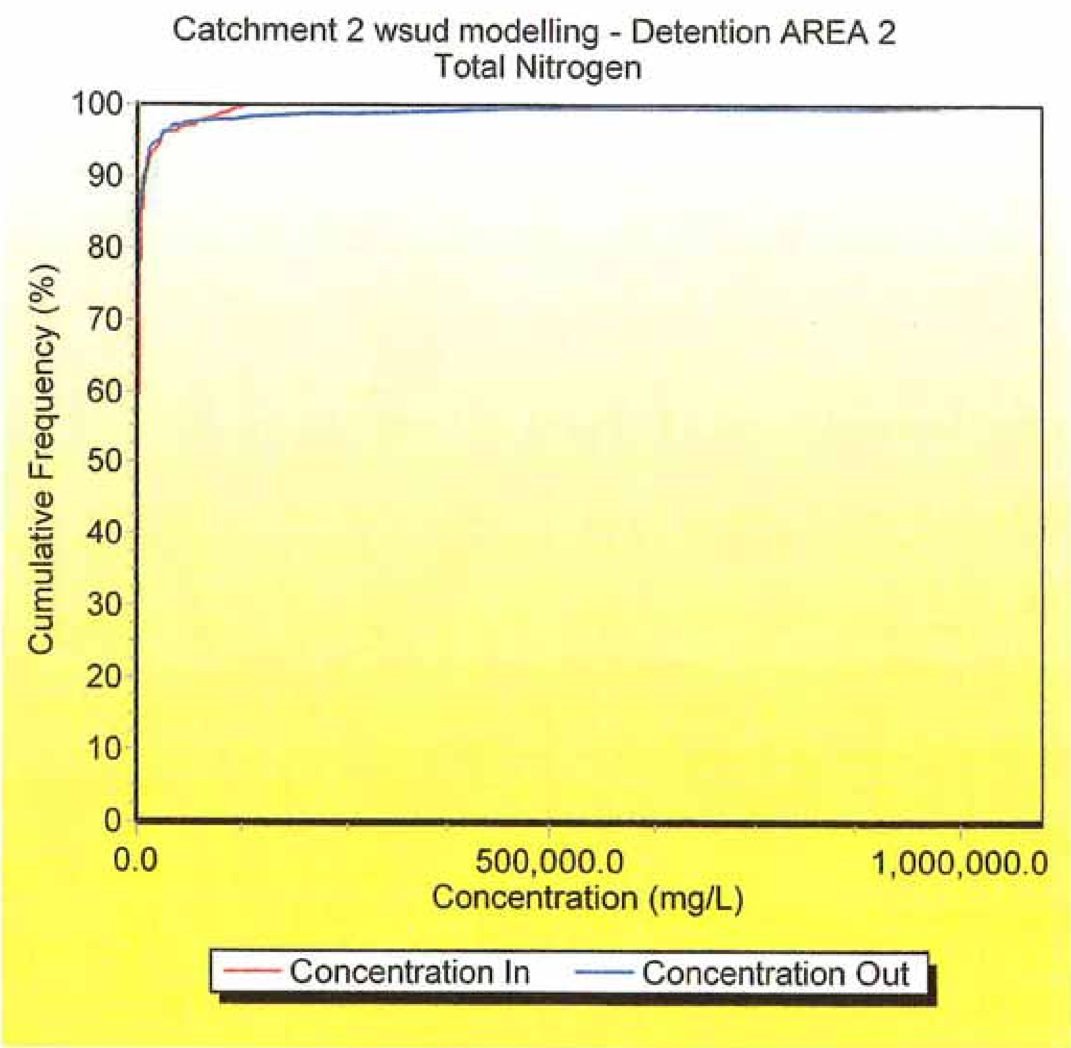
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.91E-3	8.03E-3	216E-6	0.116	0.00	0.00	2.43E-3
TSS Concentration (mg/L)	7.60	6.60	12.0	48.2	0.00	0.00	12.3
Log [TSS] (mg/L)	1.10	61.1E-3	1.08	1.68	1.08	1.08	1.11
TP Concentration (mg/L)	55.3E-3	45.5E-3	90.2E-3	0.171	0.00	0.00	91.4E-3
Log [TP] (mg/L)	-1.04	28.2E-3	-1.04	-0.766	-1.05	-1.04	-1.03
TN Concentration (mg/L)	0.694	0.585	1.03	2.12	0.00	0.00	1.25
Log [TN] (mg/L)	58.0E-3	61.8E-3	33.0E-3	0.327	210E-6	10.7E-3	0.144
TSS Load (kg/Hour)	0.141	0.931	9.37E-3	19.9	0.00	0.00	0.111
TP Load (kg/Hour)	765E-6	3.95E-3	70.3E-6	68.9E-3	0.00	0.00	815E-6
TN Load (kg/Hour)	9.55E-3	47.3E-3	853E-6	0.805	0.00	0.00	10.8E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 2 wsud modelling - Detention AREA 2
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
10,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 2 wsud modelling - Detention AREA 2
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
80,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 2 wsud modelling - Detention AREA 2
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500,000.0
1,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Wetland AREA 2

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Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	72.4	13.3E3	28.4	206	1.86E3
Residual Load	60.2	1.08E3	6.15	82.4	0.00
% Reduction	16.8	91.8	78.3	60.0	100.0

Catchment 2 wsud modelling - Wetland AREA 2

All Data Statistics

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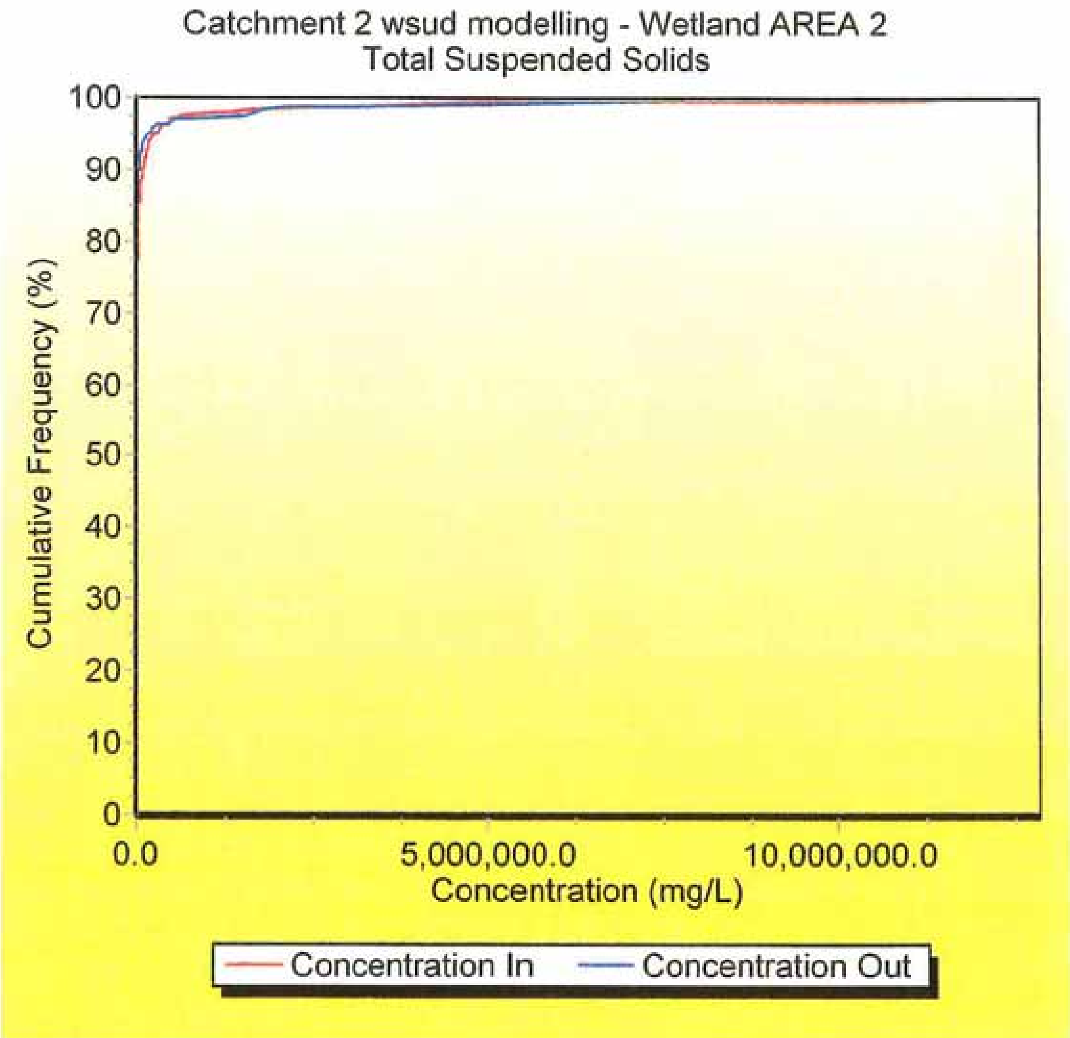
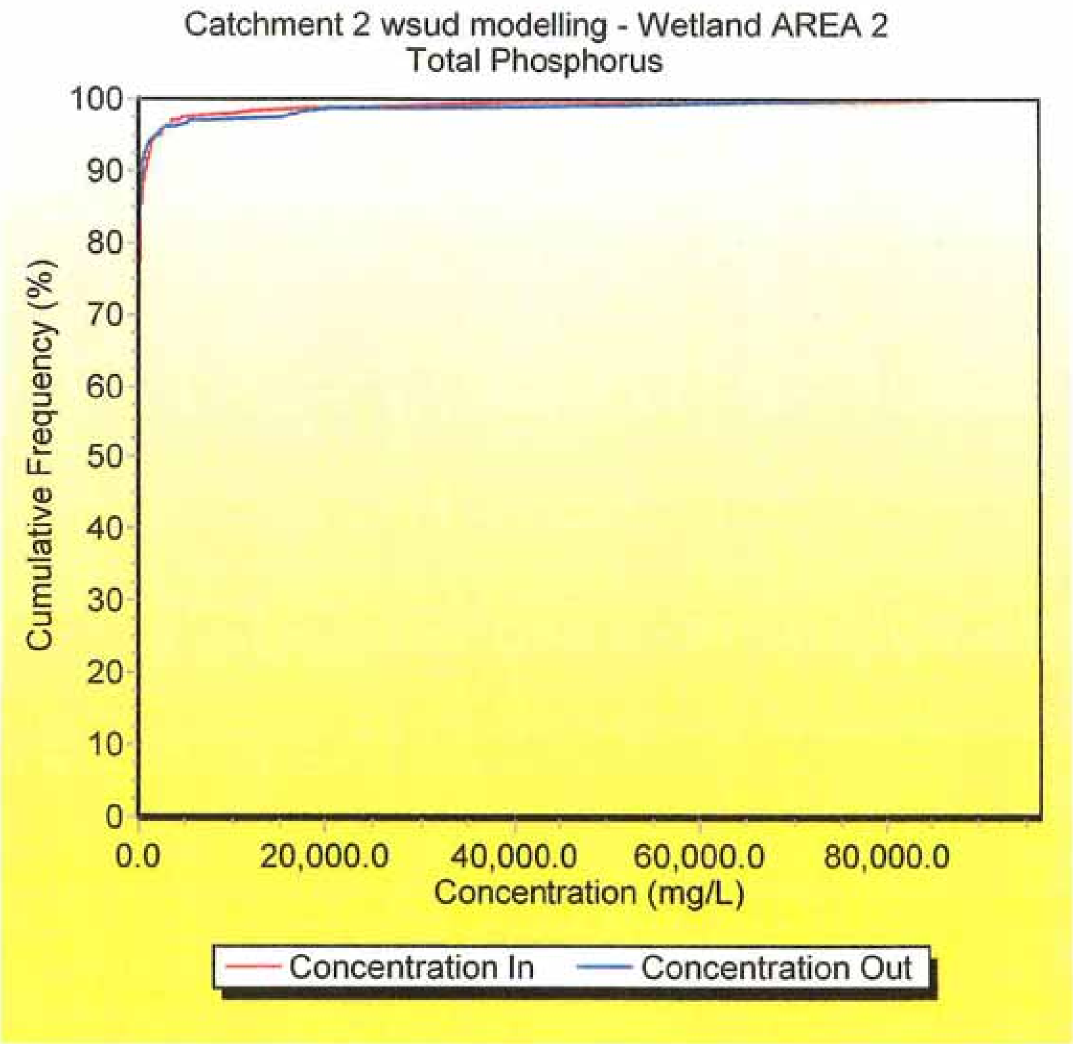
Inflow

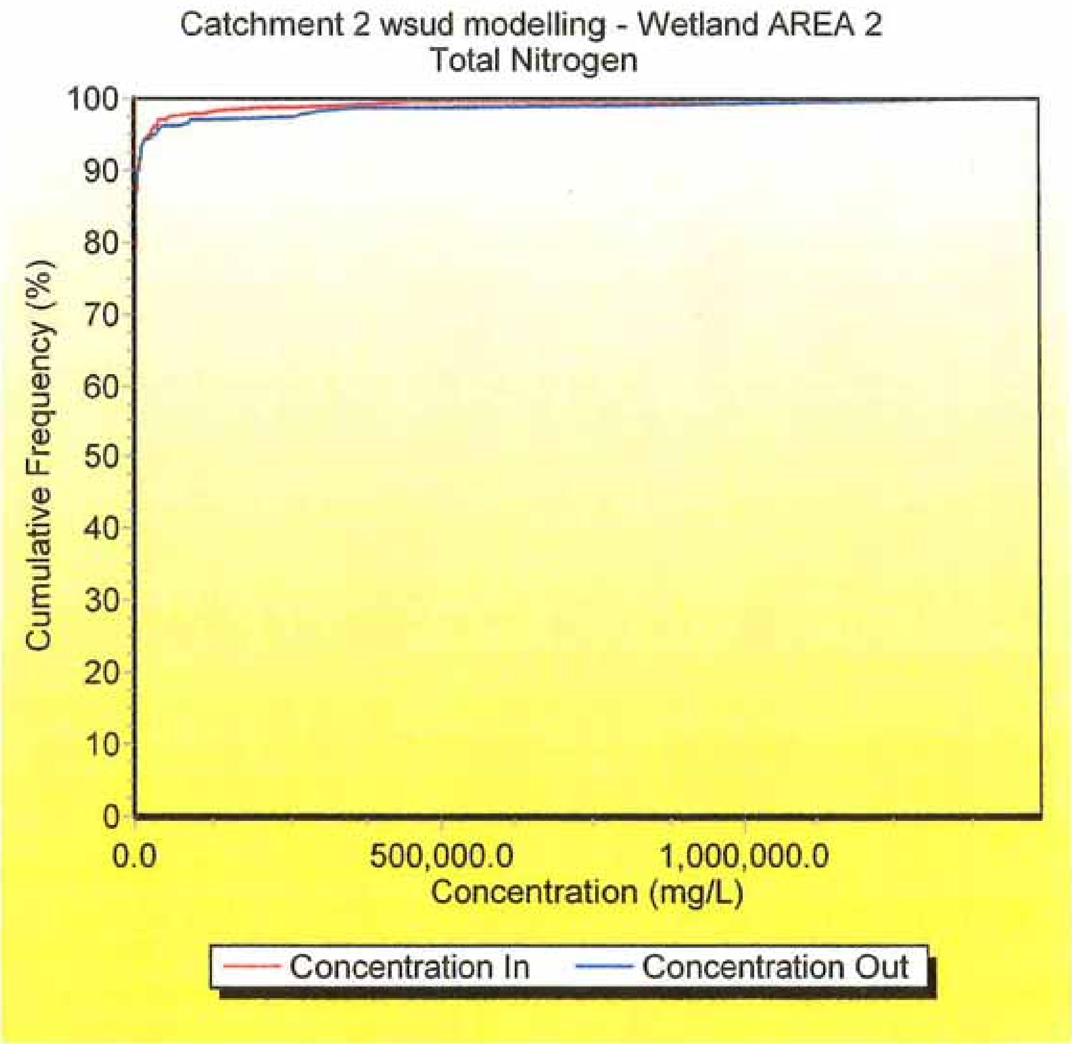
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.91E-3	8.03E-3	216E-6	0.116	0.00	0.00	2.43E-3
TSS Concentration (mg/L)	7.60	6.60	12.0	48.2	0.00	0.00	12.3
Log [TSS] (mg/L)	1.10	61.1E-3	1.08	1.68	1.08	1.08	1.11
TP Concentration (mg/L)	55.3E-3	45.5E-3	90.2E-3	0.171	0.00	0.00	91.4E-3
Log [TP] (mg/L)	-1.04	28.2E-3	-1.04	-0.766	-1.05	-1.04	-1.03
TN Concentration (mg/L)	0.694	0.585	1.03	2.12	0.00	0.00	1.25
Log [TN] (mg/L)	58.0E-3	61.8E-3	33.0E-3	0.327	210E-6	10.7E-3	0.144
TSS Load (kg/Hour)	0.141	0.931	9.37E-3	19.9	0.00	0.00	0.111
TP Load (kg/Hour)	765E-6	3.95E-3	70.3E-6	68.9E-3	0.00	0.00	815E-6
TN Load (kg/Hour)	9.55E-3	47.3E-3	853E-6	0.805	0.00	0.00	10.8E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	1.91E-3	8.03E-3	209E-6	0.118	0.00	0.00	2.46E-3
TSS Concentration (mg/L)	4.59	4.70	6.05	47.1	0.00	0.00	8.52
Log [TSS] (mg/L)	0.863	0.120	0.818	1.67	0.778	0.779	0.983
TP Concentration (mg/L)	41.6E-3	35.5E-3	60.8E-3	0.169	0.00	0.00	76.6E-3
Log [TP] (mg/L)	-1.16	64.4E-3	-1.18	-0.772	-1.22	-1.22	-1.09
TN Concentration (mg/L)	0.677	0.573	1.02	2.11	0.00	0.00	1.22
Log [TN] (mg/L)	49.8E-3	59.9E-3	25.1E-3	0.324	64.5E-6	6.41E-3	0.130
TSS Load (kg/Hour)	0.124	0.886	4.56E-3	18.9	0.00	0.00	76.4E-3
TP Load (kg/Hour)	702E-6	3.83E-3	45.8E-6	66.6E-3	0.00	0.00	681E-6
TN Load (kg/Hour)	9.40E-3	46.5E-3	787E-6	0.787	0.00	0.00	10.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 2 wsud modelling - Wetland AREA 2
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
10,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 2 wsud modelling - Wetland AREA 2
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
80,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 2 wsud modelling - Wetland AREA 2
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500,000.0
1,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban
ID,1,3,5,6,8,12,13,14,19
Node
Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),0.39,0.71,1.43,1.15,1.51,0.94,0.57,0.34,0.25
Area Impervious
(ha),0.233007894736842,0.427339035087719,0.860696929824561,0.687074561403509,0.9
08847807017544,0.561608771929825,0.34055,0.203135087719298,0.152686403508772
Area Pervious
(ha),0.156992105263158,0.282660964912281,0.569303070175439,0.462925438596491,0.6
01152192982456,0.378391228070175,0.22945,0.136864912280702,0.0973135964912281
Field Capacity (mm),80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient -
a,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log
mg/L),2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log
mg/L),-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log
mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log
mg/L),0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log
mg/L),1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log
mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log
mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log
mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12

```
Baseflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow (ML/yr),3.87,7.05,14.2,11.4,15.0,9.34,5.66,3.38,2.51
OUT - TSS Mean Annual Load
(kg/yr),647,1.34E3,2.83E3,2.14E3,2.53E3,1.77E3,1.01E3,577,449
OUT - TP Mean Annual Load (kg/yr),1.38,2.86,5.91,4.73,5.51,3.65,2.21,1.22,0.922
OUT - TN Mean Annual Load (kg/yr),11.4,19.9,41.6,33.7,40.1,26.4,15.9,9.72,7.18
OUT - Gross Pollutant Mean Annual Load
(kg/yr),99.5,181,365,293,385,240,145,86.7,64.3

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention,Detention AREA 2,Bio-Retention
2A,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Ret
ention,Wetland AREA 2
ID,2,4,7,9,10,11,15,16,17,18
Node
Type,BioRetentionNode,PondNode,BioRetentionNode,BioRetentionNode,BioRetentionNod
e,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,WetlandNod
e
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate (cum/sec),100,100,100,100,100,100,100,100,100,100
Inlet pond volume, ,0, , , , , , , ,0
Area (sqm),80,10000,80,80,80,50,50,50,80,50
Extended detention depth (m),0.8,0.5,0.8,0.8,0.8,0.8,0.8,0.8,0.8,1
Permanent pool volume (cum), ,5000, , , , , , , ,50
Proportion vegetated, ,0.1, , , , , , , ,0.5
Equivalent pipe diameter (mm), ,300, , , , , , , ,200
Overflow weir width (m),2,2,2,2,2,2,2,2,2,3
Notional Detention Time (hrs), ,9.37, , , , , , , ,0.149
Orifice discharge coefficient, ,0.6, , , , , , , ,0.6
Weir coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,2,3,3,3,3,3,3,3,5
Total Suspended Solids k (m/yr),8000,400,8000,8000,8000,8000,8000,8000,8000,1500
Total Suspended Solids C* (mg/L),20,12,20,20,20,20,20,20,20,6
Total Suspended Solids C** (mg/L), ,12, , , , , , , ,6
Total Phosphorus  k (m/yr),6000,300,6000,6000,6000,6000,6000,6000,6000,1000
Total Phosphorus C* (mg/L),0.13,0.09,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.06
Total Phosphorus C** (mg/L), ,0.09, , , , , , , ,0.06
Total Nitrogen k (m/yr),500,40,500,500,500,500,500,500,500,150
Total Nitrogen C* (mg/L),1.4,1,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1
Total Nitrogen C** (mg/L), ,1, , , , , , , ,1
Threshold hydraulic loading for C** (m/yr), ,3500, , , , , , , ,3500
Extraction for Re-use,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , , , , , , , , ,
Constant Daily Re-use Demand (kL), , , , , , , , , , ,
User-defined Annual Re-use Demand (ML), , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jan, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Feb, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Mar, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Apr, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand May, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jun, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jul, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Aug, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Sep, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Oct, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Nov, , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Dec, , , , , , , , , , ,
Filter area (sqm),20, ,20,20,20,20,20,20,20,
Filter depth (m),1, ,1,1,1,1,1,1,1,
Filter median particle diameter (mm),5, ,5,5,5,5,5,5,5,
Saturated hydraulic conductivity (mm/hr),100, ,100,100,100,100,100,100,100,
Voids ratio,0.3, ,0.3,0.3,0.3,0.3,0.3,0.3,0.3,
Length (m), , , , , , , , , ,
```

Bed slope, , , , , , , , , ,
Base Width (m), , , , , , , , , , ,
Top width (m), , , , , , , , , , ,
Vegetation height (m), , , , , , , , , , ,
Proportion of upstream impervious area treated, , , , , , , , , , ,
Seepage Rate (mm/hr),0,0,0,0,0,0,0,0,0,0
Evap Loss as proportion of PET, ,1, , , , , , , ,1.25
Depth in metres below the drain pipe,0, ,0,0,0,0,0,0,0,
IN - Mean Annual Flow (ML/yr),10.9,72.6,47.4,24.3,26.9,9.34,5.66,9.05,9.06,60.3
IN - TSS Mean Annual Load
(kg/yr),1.98E3,4.90E3,3.05E3,2.93E3,1.46E3,1.77E3,1.01E3,719,209,1.24E3
IN - TP Mean Annual Load
(kg/yr),4.24,14.3,8.95,6.96,4.72,3.65,2.21,1.93,0.993,6.70
IN - TN Mean Annual Load
(kg/yr),31.3,144,90.0,58.2,52.9,26.4,15.9,19.8,14.5,83.7
IN - Gross Pollutant Mean Annual Load
(kg/yr),281,365,293,385,64.3,240,145,86.7,0.00,0.00
OUT - Mean Annual Flow (ML/yr),10.9,60.3,47.4,24.4,26.9,9.34,5.67,9.06,9.06,60.2
OUT - TSS Mean Annual Load
(kg/yr),381,1.24E3,1.68E3,1.01E3,800,399,142,209,107,1.08E3
OUT - TP Mean Annual Load
(kg/yr),1.49,6.70,6.94,3.80,3.49,1.45,0.704,0.993,0.731,6.15
OUT - TN Mean Annual Load
(kg/yr),20.8,83.7,82.0,45.7,44.9,18.1,10.1,14.5,11.4,82.4
OUT - Gross Pollutant Mean Annual Load
(kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

No Other nodes

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,3,2,5,6,7,8,9,11,12,10,13,14,15,16,17,4,19
Target node ID,2,2,4,4,7,4,9,10,9,11,7,15,16,16,17,7,18,10
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , , , , , , , , , , , , , ,
Muskingum theta, , , , , , , , , , , , , , , , , , ,
IN - Mean Annual Flow
(ML/yr),3.87,7.05,10.9,14.2,11.4,47.4,15.0,24.4,9.34,9.34,26.9,5.66,3.38,5.67,9.06,9.06,60.3,2.51
IN - TSS Mean Annual Load
(kg/yr),647,1.34E3,381,2.83E3,2.14E3,1.68E3,2.53E3,1.01E3,399,1.77E3,800,1.01E3,577,142,209,107,1.24E3,449
IN - TP Mean Annual Load
(kg/yr),1.38,2.86,1.49,5.91,4.73,6.94,5.51,3.80,1.45,3.65,3.49,2.21,1.22,0.704,0.993,0.731,6.70,0.922
IN - TN Mean Annual Load
(kg/yr),11.4,19.9,20.8,41.6,33.7,82.0,40.1,45.7,18.1,26.4,44.9,15.9,9.72,10.1,14.5,11.4,83.7,7.18
IN - Gross Pollutant Mean Annual Load
(kg/yr),99.5,181,0.00,365,293,0.00,385,0.00,0.00,240,0.00,145,86.7,0.00,0.00,0.00,0.00,64.3
OUT - Mean Annual Flow
(ML/yr),3.87,7.05,10.9,14.2,11.4,47.4,15.0,24.4,9.34,9.34,26.9,5.66,3.38,5.67,9.06,9.06,60.3,2.51
OUT - TSS Mean Annual Load
(kg/yr),647,1.34E3,381,2.83E3,2.14E3,1.68E3,2.53E3,1.01E3,399,1.77E3,800,1.01E3,577,142,209,107,1.24E3,449
OUT - TP Mean Annual Load
(kg/yr),1.38,2.86,1.49,5.91,4.73,6.94,5.51,3.80,1.45,3.65,3.49,2.21,1.22,0.704,0.993,0.731,6.70,0.922
OUT - TN Mean Annual Load

(kg/yr),11.4,19.9,20.8,41.6,33.7,82.0,40.1,45.7,18.1,26.4,44.9,15.9,9.72,10.1,14
.5,11.4,83.7,7.18
OUT - Gross Pollutant Mean Annual Load
(kg/yr),99.5,181,0.00,365,293,0.00,385,0.00,0.00,240,0.00,145,86.7,0.00,0.00,0.0
0,0.00,64.3

Catchment 3

Bio-Retention 3C

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	86.3	16.8E3	35.3	241	2.22E3
Residual Load	86.5	3.49E3	12.3	147	0.00
% Reduction	-0.2	79.2	65.2	38.8	100.0

Catchment 3 wsud modelling - Bio-Retention 3C

All Data Statistics

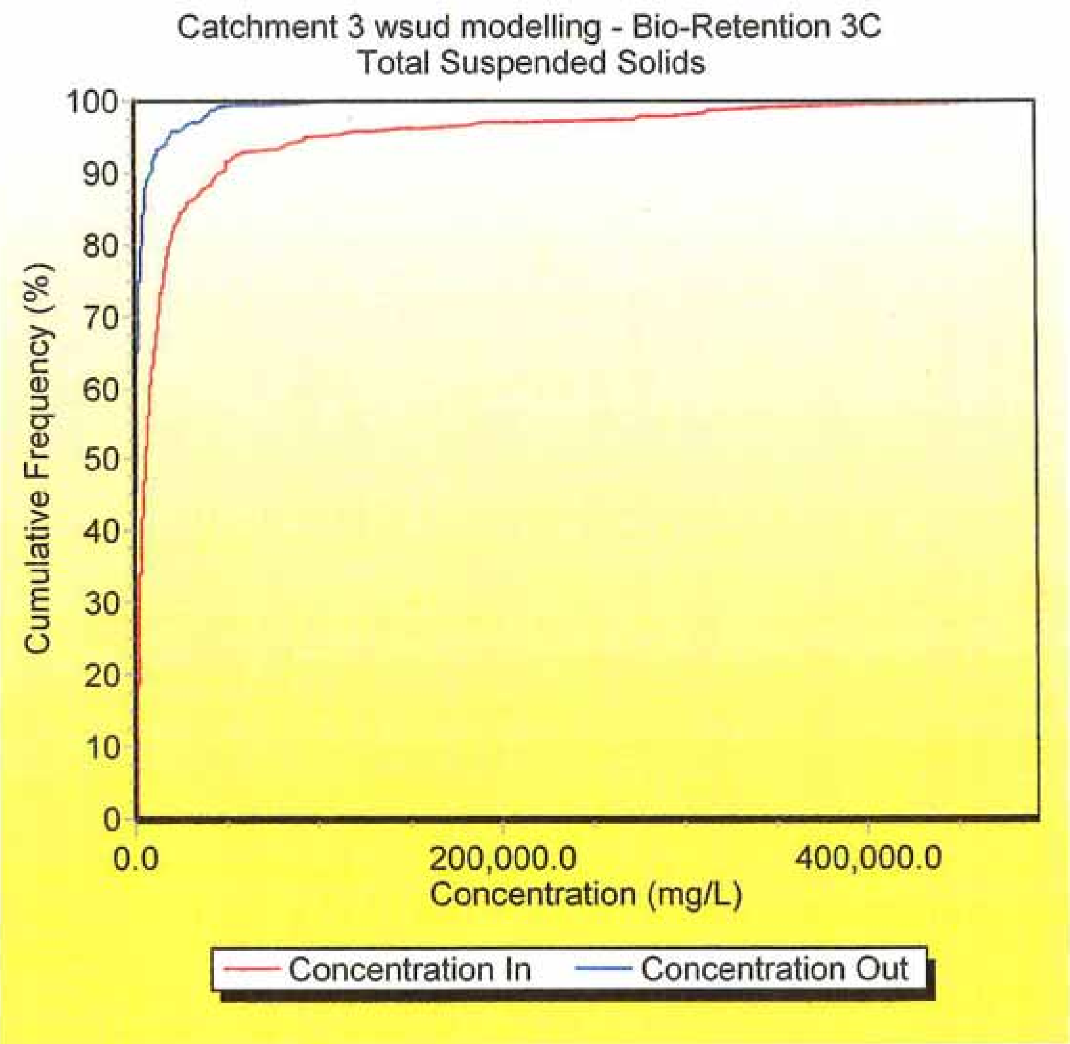
9/04/2008 8:19:04 AM

Inflow

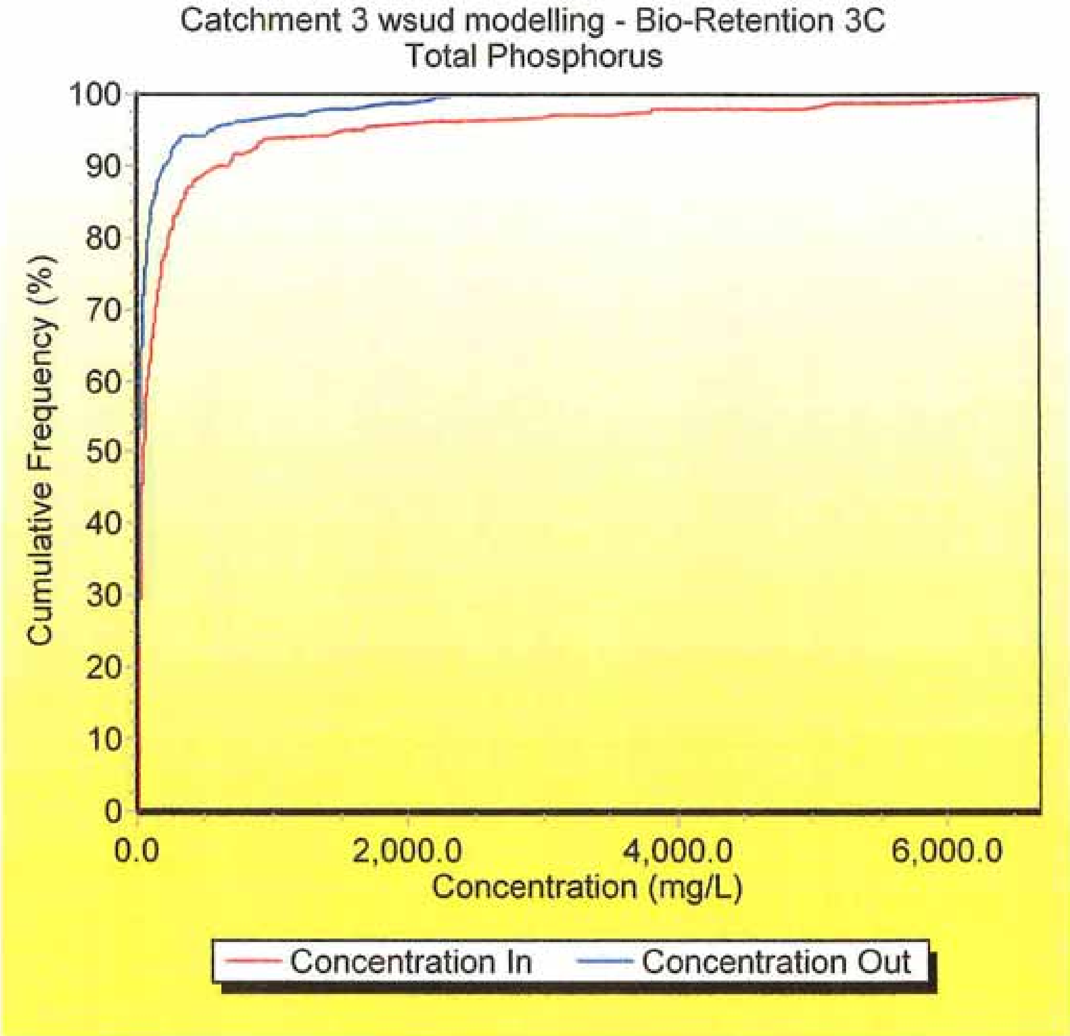
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	2.74E-3	18.7E-3	712E-6	0.653	3.45E-6	47.3E-6	2.63E-3
TSS Concentration (mg/L)	10.7	29.7	3.66	791	0.439	2.55	9.72
Log [TSS] (mg/L)	0.679	0.390	0.564	2.90	-0.358	0.407	0.988
TP Concentration (mg/L)	76.3E-3	55.3E-3	62.8E-3	1.09	15.7E-3	50.7E-3	90.1E-3
Log [TP] (mg/L)	-1.16	0.170	-1.20	39.0E-3	-1.80	-1.29	-1.05
TN Concentration (mg/L)	1.17	0.346	1.10	4.63	0.489	0.888	1.42
Log [TN] (mg/L)	54.7E-3	0.101	42.3E-3	0.666	-0.311	-51.4E-3	0.153
TSS Load (kg/Hour)	0.778	8.54	8.96E-3	316	25.4E-6	506E-6	93.2E-3
TP Load (kg/Hour)	2.16E-3	21.4E-3	150E-6	0.798	576E-9	10.0E-6	808E-6
TN Load (kg/Hour)	20.6E-3	0.170	2.48E-3	5.63	12.4E-6	192E-6	12.6E-3
Gross Pollutant Load (kg/Hour)	47.2E-3	0.280	0.00	7.26	0.00	0.00	0.00

Outflow

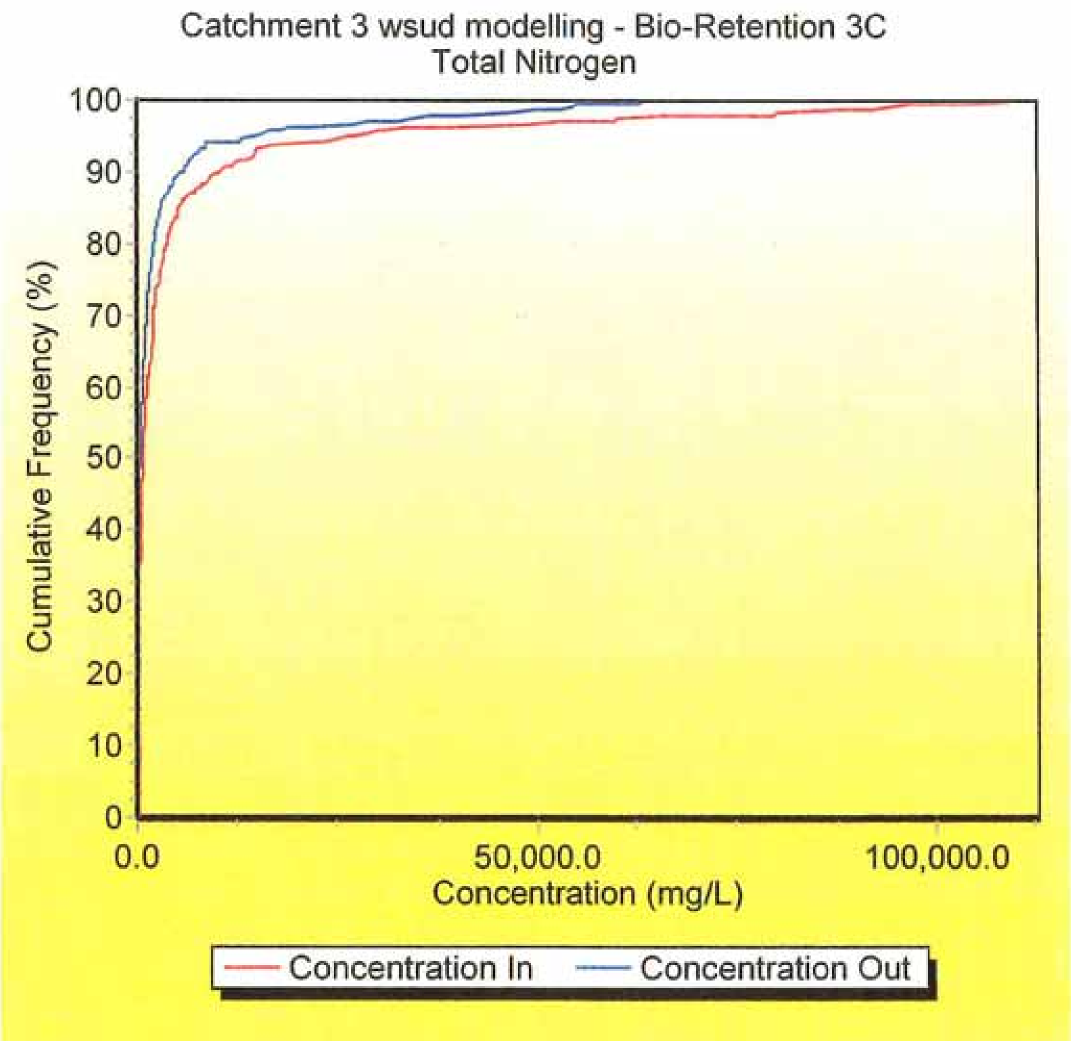
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	2.74E-3	18.6E-3	743E-6	0.666	3.46E-6	52.3E-6	4.32E-3
TSS Concentration (mg/L)	2.09	7.60	0.510	133	64.8E-3	0.381	3.10
Log [TSS] (mg/L)	-0.135	0.436	-0.292	2.12	-1.19	-0.419	0.492
TP Concentration (mg/L)	32.0E-3	27.3E-3	24.3E-3	0.407	6.57E-3	20.3E-3	51.9E-3
Log [TP] (mg/L)	-1.56	0.193	-1.61	-0.391	-2.18	-1.69	-1.29
TN Concentration (mg/L)	0.735	0.278	0.670	3.34	0.298	0.538	1.00
Log [TN] (mg/L)	-0.153	0.118	-0.174	0.524	-0.525	-0.269	380E-6
TSS Load (kg/Hour)	0.399	6.51	1.32E-3	250	4.12E-6	81.2E-6	52.3E-3
TP Load (kg/Hour)	1.40E-3	17.9E-3	60.6E-6	0.721	244E-9	4.26E-6	832E-6
TN Load (kg/Hour)	16.8E-3	0.164	1.57E-3	5.79	7.94E-6	128E-6	14.8E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 3 wsud modelling - Bio-Retention 3C
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 3 wsud modelling - Bio-Retention 3C
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
2,000.0
4,000.0
6,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 3 wsud modelling - Bio-Retention 3C
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Basin 3

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	171	32.4E3	68.4	478	4.38E3
Residual Load	158	2.95E3	16.9	218	0.00
% Reduction	7.6	90.9	75.3	54.4	100.0

Catchment 3 wsud modelling - Basin 3

All Data Statistics

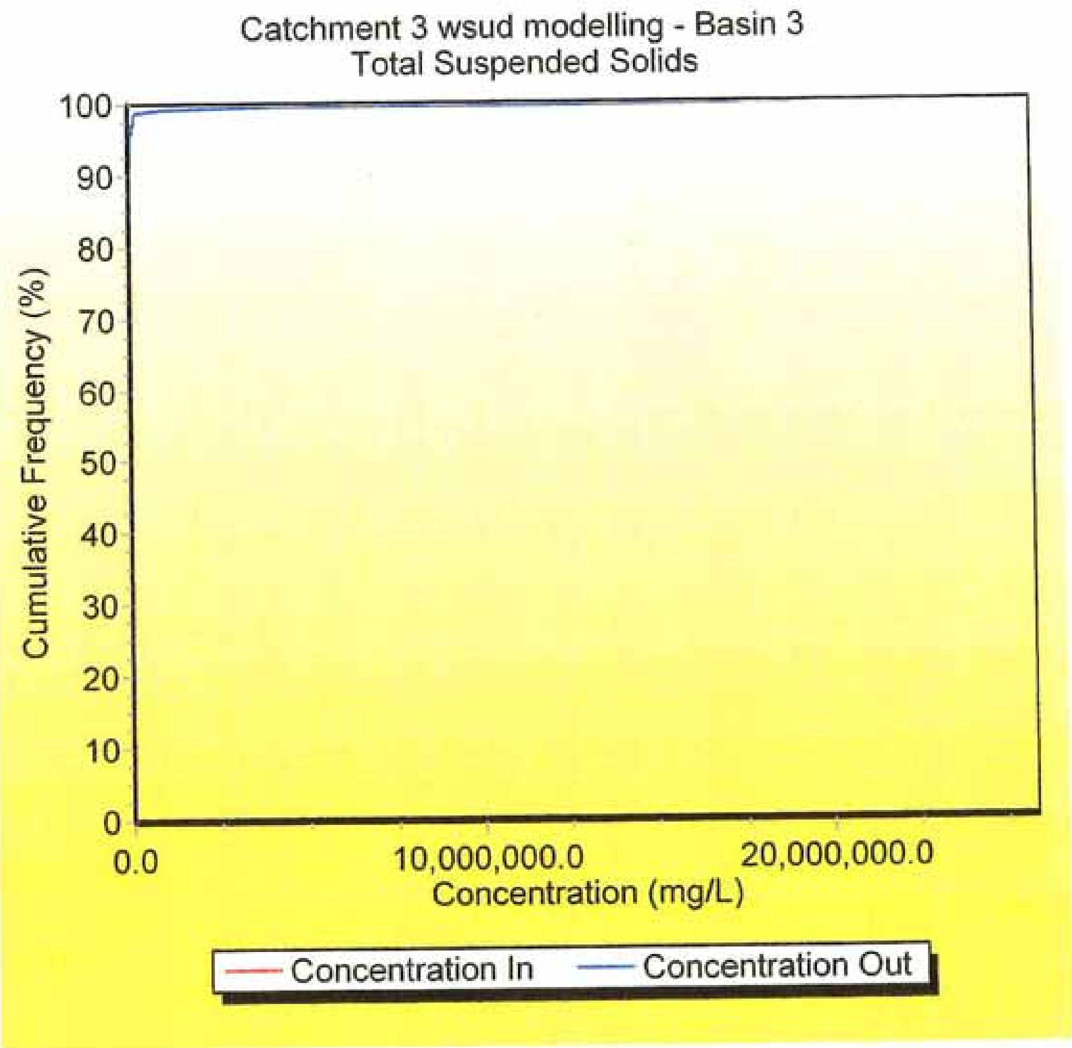
9/04/2008 8:17:04 AM

Inflow

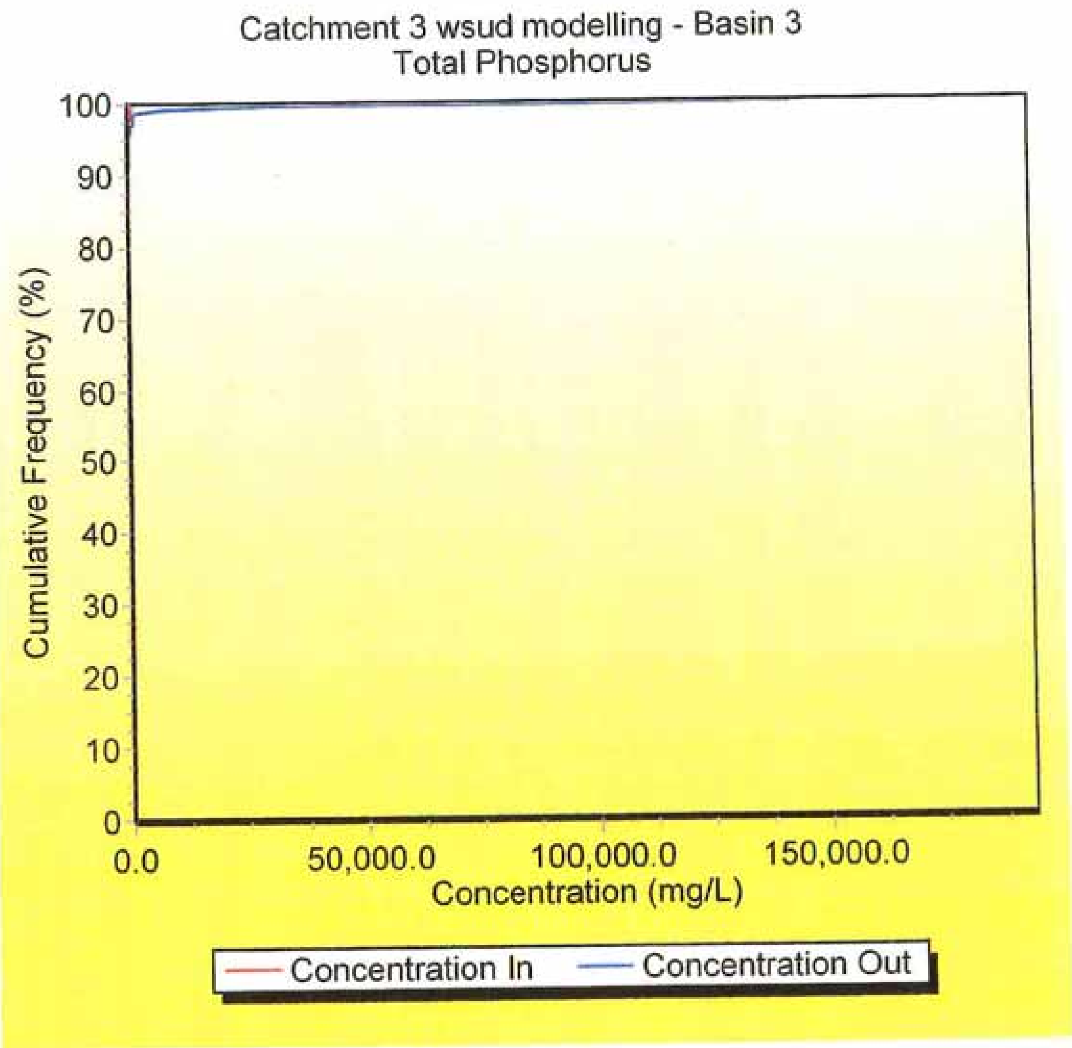
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.42E-3	35.8E-3	1.46E-3	1.39	6.83E-6	100E-6	8.18E-3
TSS Concentration (mg/L)	2.86	6.43	1.39	123	97.4E-3	0.366	5.15
Log [TSS] (mg/L)	81.9E-3	0.526	0.143	2.09	-1.01	-0.436	0.712
TP Concentration (mg/L)	38.9E-3	25.5E-3	34.5E-3	0.317	9.19E-3	21.1E-3	60.4E-3
Log [TP] (mg/L)	-1.47	0.209	-1.46	-0.499	-2.04	-1.68	-1.22
TN Concentration (mg/L)	0.789	0.250	0.713	2.98	0.373	0.652	1.04
Log [TN] (mg/L)	-0.117	99.6E-3	-0.147	0.474	-0.428	-0.186	16.7E-3
TSS Load (kg/Hour)	0.683	11.3	7.86E-3	500	8.55E-6	144E-6	0.152
TP Load (kg/Hour)	2.64E-3	32.3E-3	178E-6	1.43	502E-9	8.25E-6	1.79E-3
TN Load (kg/Hour)	33.0E-3	0.328	3.64E-3	13.7	15.9E-6	249E-6	29.3E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

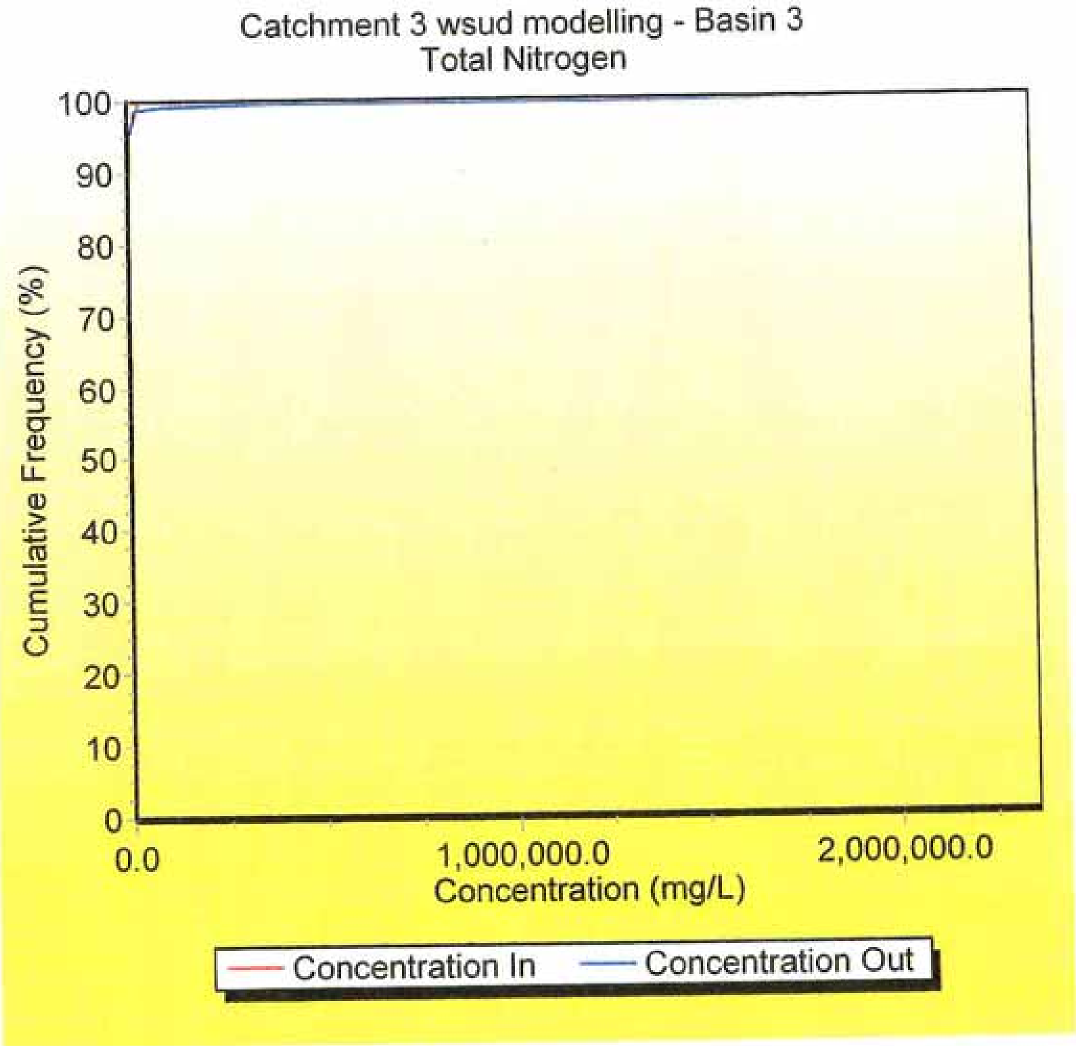
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.00E-3	16.3E-3	996E-6	0.189	0.00	0.00	8.35E-3
TSS Concentration (mg/L)	9.02	6.25	12.0	36.4	0.00	0.00	12.6
Log [TSS] (mg/L)	1.10	63.9E-3	1.08	1.56	1.08	1.08	1.12
TP Concentration (mg/L)	65.5E-3	42.5E-3	90.2E-3	0.146	0.00	0.00	92.9E-3
Log [TP] (mg/L)	-1.04	29.3E-3	-1.04	-0.835	-1.05	-1.05	-1.02
TN Concentration (mg/L)	0.846	0.571	1.06	1.97	0.00	0.00	1.37
Log [TN] (mg/L)	71.3E-3	67.7E-3	48.8E-3	0.294	90.9E-6	9.16E-3	0.175
TSS Load (kg/Hour)	0.337	1.63	43.3E-3	22.8	0.00	0.00	0.378
TP Load (kg/Hour)	1.93E-3	7.44E-3	325E-6	94.0E-3	0.00	0.00	2.78E-3
TN Load (kg/Hour)	24.9E-3	95.3E-3	4.08E-3	1.21	0.00	0.00	35.9E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 3 wsud modelling - Basin 3
Total Suspended Solids
100
90
80
70
60
50
40
30
20
10
0
Cumulative Frequency (%)
0.0
10,000,000.0
20,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 3 wsud modelling - Basin 3
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 3 wsud modelling - Basin 3
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
1,000,000.0
2,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Wetland 3

9/04/2008 8:16:00 AM

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	171	32.4E3	68.4	478	4.38E3
Residual Load	158	2.70E3	16.0	216	0.00
% Reduction	7.7	91.7	76.6	54.8	100.0

Catchment 3 wsud modelling - Wetland 3

All Data Statistics

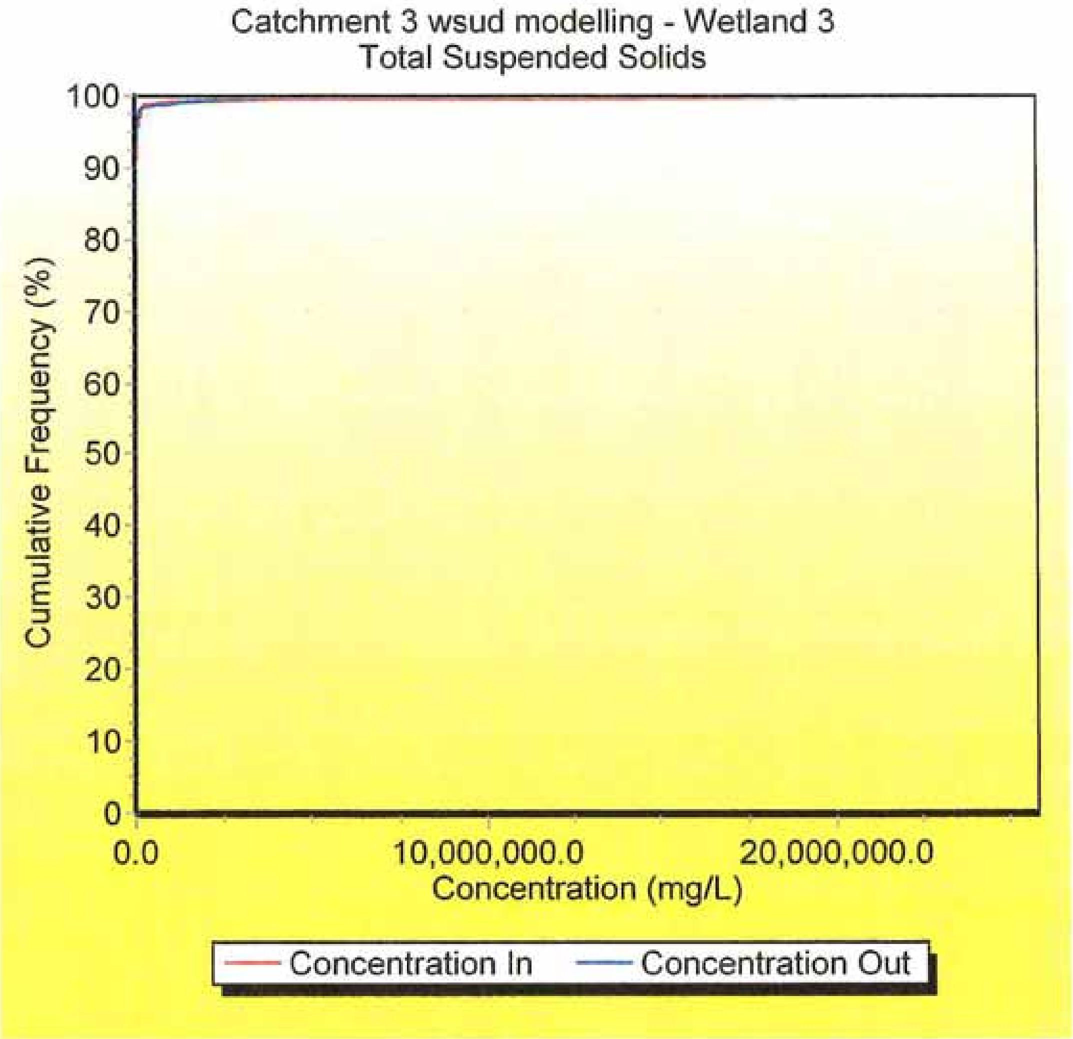
9/04/2008 8:15:50 AM

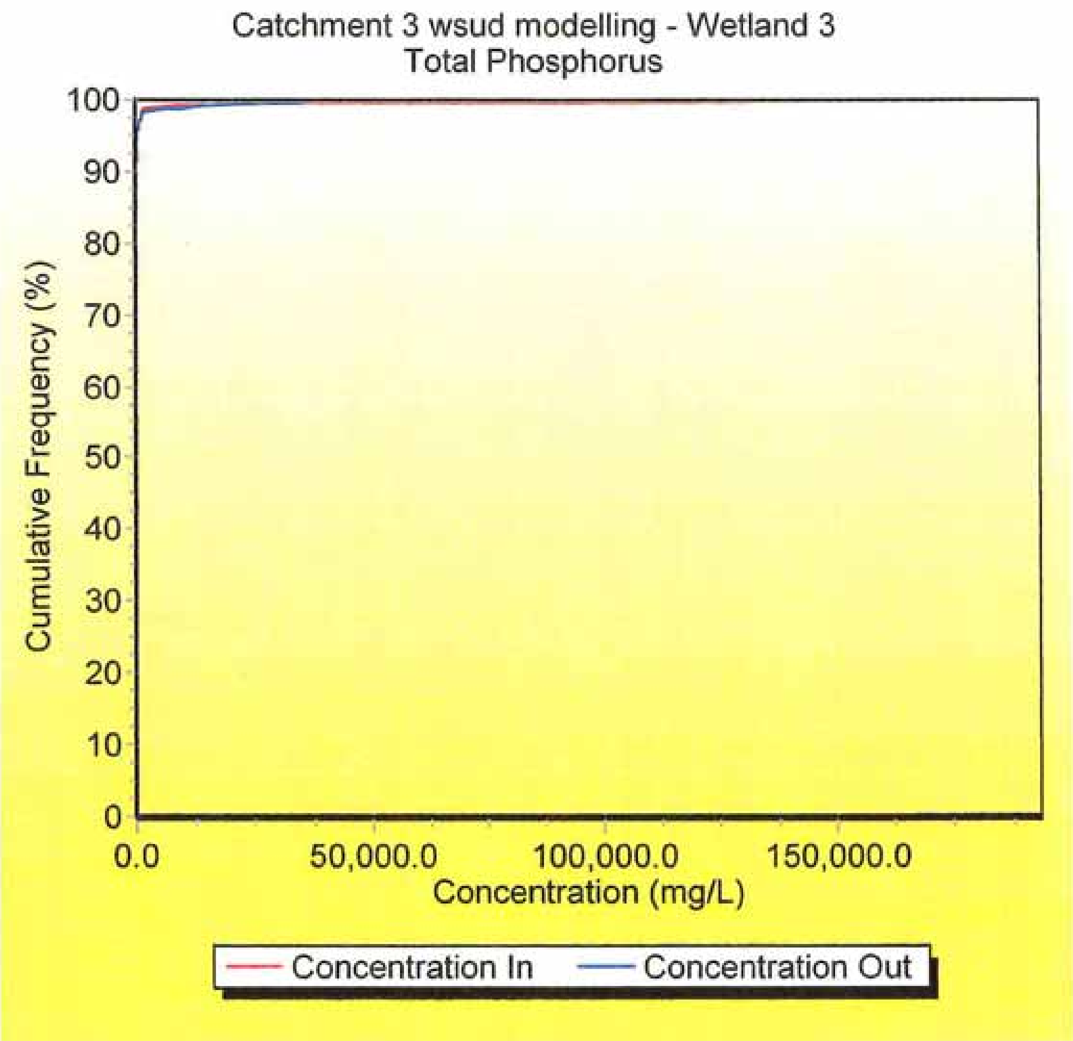
Inflow

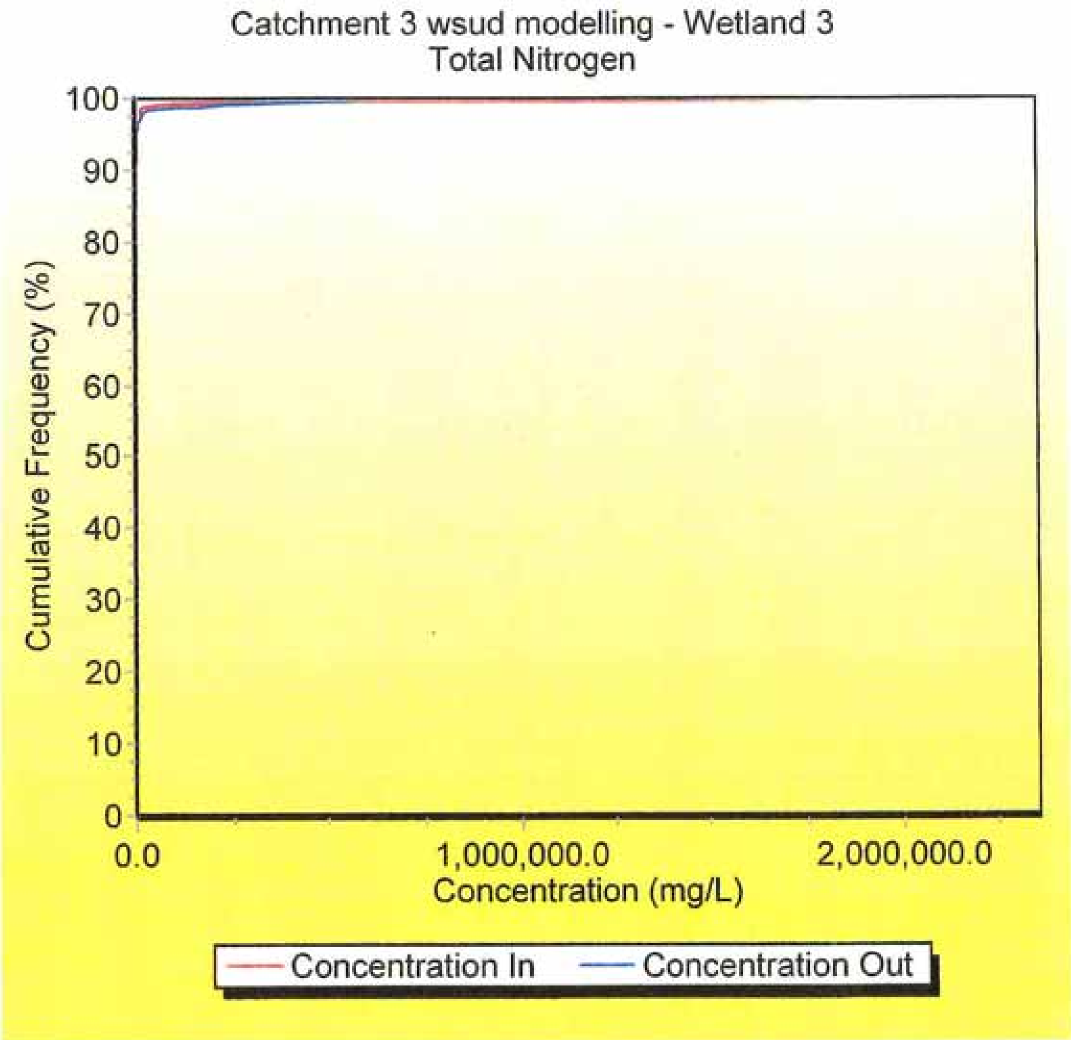
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.00E-3	16.3E-3	996E-6	0.189	0.00	0.00	8.35E-3
TSS Concentration (mg/L)	9.02	6.25	12.0	36.4	0.00	0.00	12.6
Log [TSS] (mg/L)	1.10	63.9E-3	1.08	1.56	1.08	1.08	1.12
TP Concentration (mg/L)	65.5E-3	42.5E-3	90.2E-3	0.146	0.00	0.00	92.9E-3
Log [TP] (mg/L)	-1.04	29.3E-3	-1.04	-0.835	-1.05	-1.05	-1.02
TN Concentration (mg/L)	0.846	0.571	1.06	1.97	0.00	0.00	1.37
Log [TN] (mg/L)	71.3E-3	67.7E-3	48.8E-3	0.294	90.9E-6	9.16E-3	0.175
TSS Load (kg/Hour)	0.337	1.63	43.3E-3	22.8	0.00	0.00	0.378
TP Load (kg/Hour)	1.93E-3	7.44E-3	325E-6	94.0E-3	0.00	0.00	2.78E-3
TN Load (kg/Hour)	24.9E-3	95.3E-3	4.08E-3	1.21	0.00	0.00	35.9E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.00E-3	16.3E-3	991E-6	0.187	0.00	0.00	8.32E-3
TSS Concentration (mg/L)	6.11	4.99	6.93	36.0	0.00	0.00	10.2
Log [TSS] (mg/L)	0.914	0.125	0.887	1.56	0.778	0.785	1.04
TP Concentration (mg/L)	53.0E-3	35.7E-3	68.1E-3	0.145	0.00	0.00	83.8E-3
Log [TP] (mg/L)	-1.13	65.6E-3	-1.14	-0.837	-1.22	-1.21	-1.06
TN Concentration (mg/L)	0.829	0.558	1.05	1.97	0.00	0.00	1.34
Log [TN] (mg/L)	63.5E-3	64.3E-3	40.5E-3	0.294	65.1E-6	7.28E-3	0.151
TSS Load (kg/Hour)	0.308	1.59	25.0E-3	22.5	0.00	0.00	0.310
TP Load (kg/Hour)	1.83E-3	7.35E-3	245E-6	92.7E-3	0.00	0.00	2.53E-3
TN Load (kg/Hour)	24.7E-3	94.6E-3	3.99E-3	1.20	0.00	0.00	35.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 3 wsud modelling - Wetland 3
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000,000.0
20,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 3 wsud modelling - Wetland 3
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 3 wsud modelling - Wetland 3
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
1,000,000.0
2,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban
,Urban,Urban,Urban,Urban,Urban,Urban
ID,1,5,8,9,13,17,18,20,21,22,24,27,29,32,33,36,37,39
Node
Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area
(ha),0.49,1.28,0.54,1.04,1.45,1.34,1.46,0.54,1,0.62,1.5,0.57,0.97,0.89,0.76,0.45
,1.13,1.15
Area Impervious
(ha),0.294924122807018,0.770414035087719,0.325018421052632,0.625961403508772,0.8
66311403508772,0.806527192982456,0.872285964912281,0.325018421052632,0.597456140
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Area Pervious
(ha),0.195075877192982,0.509585964912281,0.214981578947368,0.414038596491228,0.5
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22807,0.302566666666667,0.179151315789474,0.454874561403509,0.462925438596491
Field Capacity (mm),80,80,80,80,80,80,80,80,80,80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient -
a,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent -
b,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity
(mm),120,120,120,120,120,120,120,120,120,120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of
Capacity),30,30,30,30,30,30,30,30,30,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth
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Groundwater Daily Recharge Rate
(%),25,25,25,25,25,25,25,25,25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log
mg/L),2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
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Stormflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
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Stormflow Total Suspended Solids Serial
Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log
mg/L),-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0
.45,-0.45,-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log
mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
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Stormflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
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Stormflow Total Phosphorus Serial
Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log
mg/L),0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42
,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation

Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic ,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17 ,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic ,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0 .82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19 ,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic ,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32 ,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12 ,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic ,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow (ML/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0. 00,0.00,0.00,0.00
OUT - TSS Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0. 00,0.00,0.00,0.00
OUT - TP Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0. 00,0.00,0.00,0.00
OUT - TN Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0. 00,0.00,0.00,0.00
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0. 00,0.00,0.00,0.00

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention,Basin 3,Wetland 3,Bio-Retention,Bio-Retention 3A,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Ret ention,Bio-Retention,Bio-Retention 3C,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention 3B,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention
ID,2,3,4,6,7,10,11,12,14,15,16,19,23,25,26,28,30,31,34,35,38,40
Node Type,BioRetentionNode,PondNode,WetlandNode,BioRetentionNode,BioRetentionNode,Bio RetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNod e,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetenti onNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRe tentionNode,BioRetentionNode,BioRetentionNode

Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate
(cum/sec),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,10
0,100,100,100,100
Inlet pond volume, ,0,0, , , , , , , , , , , , , , , , ,
Area (sqm),80,10700,50,50,80,80,50,50,80,10,50,80,150,80,50,50,50,80,80,50,80,80
Extended detention depth
(m),0.8,1.15,1,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0
.8,0.8,0.8
Permanent pool volume (cum), ,12300,50, , , , , , , , , , , , , , , , , ,
Proportion vegetated, ,0.1,0.5, , , , , , , , , , , , , , , , , ,
Equivalent pipe diameter (mm), ,300,200, , , , , , , , , , , , , , , , , ,
Overflow weir width (m),2,2,3,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2
Notional Detention Time (hrs), ,15.2,0.149, , , , , , , , , , , , , , , , , ,
Orifice discharge coefficient, ,0.6,0.6, , , , , , , , , , , , , , , , , ,
Weir
coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,
1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,2,5,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3
Total Suspended Solids k
(m/yr),8000,400,1500,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000
,8000,8000,8000,8000,8000,8000,8000
Total Suspended Solids C*
(mg/L),20,12,6,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20
Total Suspended Solids C** (mg/L), ,12,6, , , , , , , , , , , , , , , , , ,
Total Phosphorus k
(m/yr),6000,300,1000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000
,6000,6000,6000,6000,6000,6000,6000
Total Phosphorus C*
(mg/L),0.13,0.09,0.06,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.1
3,0.13,0.13,0.13,0.13,0.13,0.13,0.13
Total Phosphorus C** (mg/L), ,0.09,0.06, , , , , , , , , , , , , , , , , ,
Total Nitrogen k
(m/yr),500,40,150,500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,50
0,500,500,500
Total Nitrogen C*
(mg/L),1.4,1,1,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1
.4,1.4,1.4
Total Nitrogen C** (mg/L), ,1,1, , , , , , , , , , , , , , , , , ,
Threshold hydraulic loading for C** (m/yr), ,3500,3500, , , , , , , , , , , , ,
, , , , , ,
Extraction for
Re-use,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,O
ff,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , , , , , , , , , , , , , ,
, , , , ,
Constant Daily Re-use Demand (kL), ,
User-defined Annual Re-use Demand (ML), , , , , , , , , , , , , , , , , , , ,
,
Percentage of User-defined Annual Re-use Demand Jan, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Feb, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Mar, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Apr, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand May, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jun, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jul, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Aug, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Sep, , , , , , , , , , , , ,
, , , , , , , ,
Percentage of User-defined Annual Re-use Demand Oct, , , , , , , , , , , , ,

, , , , , , ,
Percentage of User-defined Annual Re-use Demand Nov, ,
Percentage of User-defined Annual Re-use Demand Dec, ,
Filter area (sqm),20, , ,20,20,20,20,20,20,20,20,20,150,20,20,20,20,20,20,20,20,20
Filter depth (m),1, , ,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Filter median particle diameter (mm),5, , ,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
Saturated hydraulic conductivity (mm/hr),100, , ,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100
Voids ratio,0.3, , ,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3
Length (m), ,
Bed slope, ,
Base Width (m), ,
Top width (m), ,
Vegetation height (m), ,
Proportion of upstream impervious area treated, ,
Seepage Rate (mm/hr),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Evap Loss as proportion of PET, ,1,1.25, , , , , , , , , , , , , , , , , , ,
Depth in metres below the drain pipe,0, , ,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
IN - Mean Annual Flow (ML/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TSS Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TP Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TN Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TSS Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TP Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TN Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

Other nodes
Location,Junction
ID,41
Node Type,JunctionNode
IN - Mean Annual Flow (ML/yr),0.00
IN - TSS Mean Annual Load (kg/yr),0.00
IN - TP Mean Annual Load (kg/yr),0.00
IN - TN Mean Annual Load (kg/yr),0.00
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00
OUT - Mean Annual Flow (ML/yr),0.00
OUT - TSS Mean Annual Load (kg/yr),0.00
OUT - TP Mean Annual Load (kg/yr),0.00

OUT - TN Mean Annual Load (kg/yr),0.00
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00

Links
Location,Drainage Link
Source node
ID,1,2,3,5,6,7,9,8,10,13,17,16,15,18,20,21,22,24,27,26,25,30,29,32,33,34,35,36,37,38,39,40,14,19,11,12,23,31,41,28
Target node
ID,2,3,4,6,7,3,10,11,12,14,16,15,14,19,19,23,23,25,26,25,28,31,30,30,34,35,30,35,38,23,40,19,19,23,41,41,41,3,3,31
Muskingum-Cunge Routing,Not Routed
Muskingum K, ,
Muskingum theta, ,
IN - Mean Annual Flow (ML/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TSS Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TP Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - TN Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TSS Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TP Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - TN Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.

00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

Catchment 4

Bio-Retention 4A

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Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	144	27.2E3	56.4	403	3.69E3
Residual Load	144	5.35E3	20.8	250	0.00
% Reduction	-0.2	80.3	63.1	38.1	100.0

Catchment 4 wsud modelling - Bio-Retention 4A

All Data Statistics

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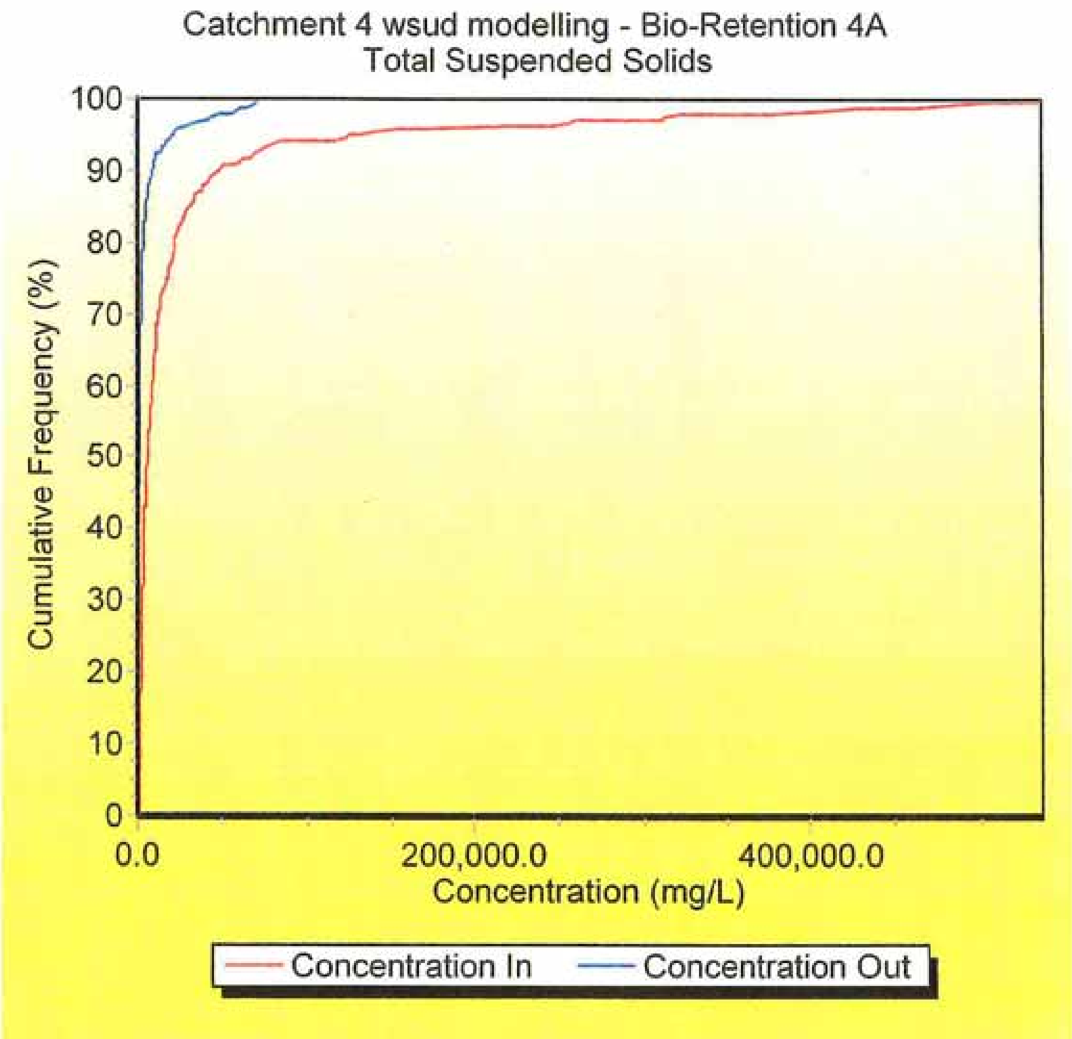
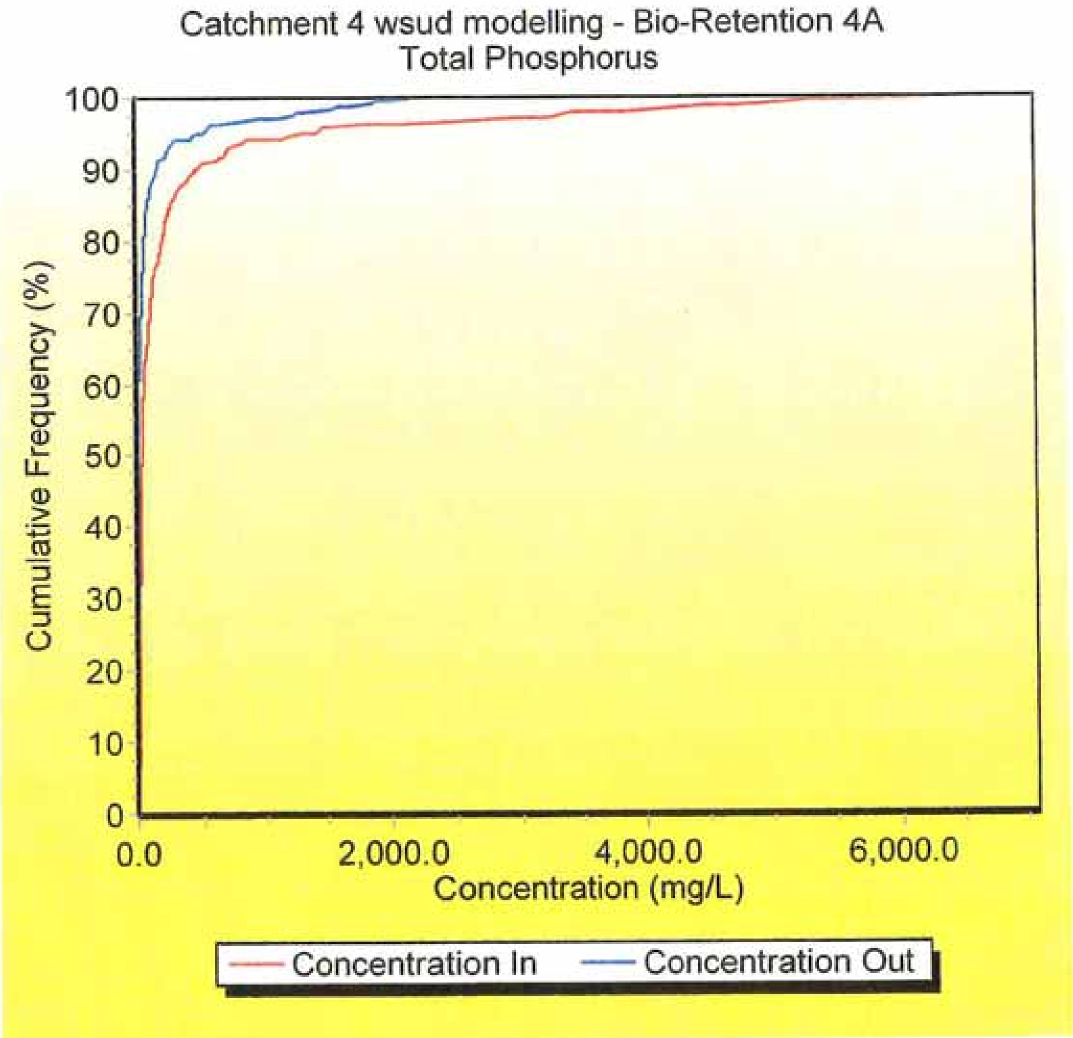
Inflow

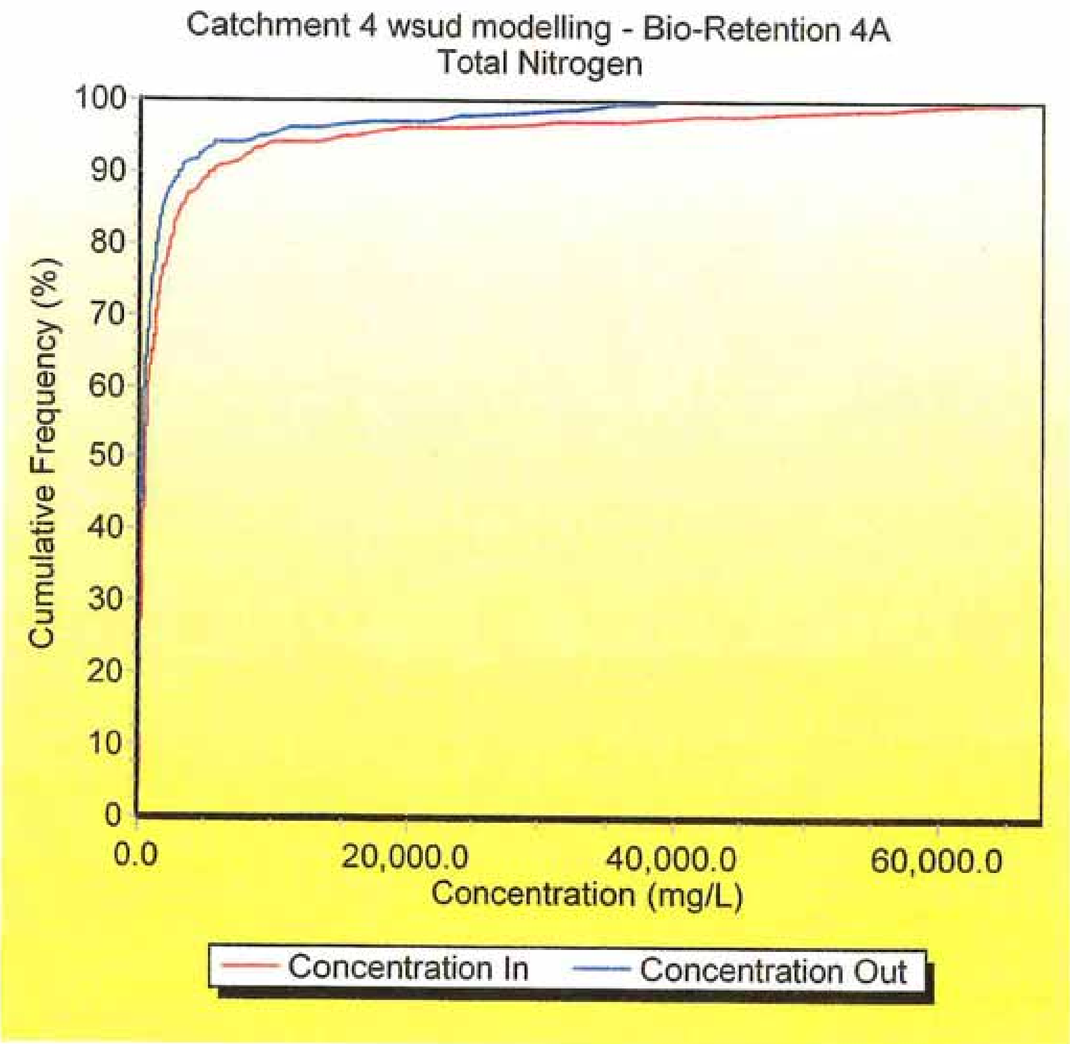
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.56E-3	30.5E-3	1.10E-3	1.14	5.76E-6	91.0E-6	5.25E-3
TSS Concentration (mg/L)	14.9	23.4	10.9	750	3.06	10.0	13.7
Log [TSS] (mg/L)	1.09	0.188	1.04	2.88	0.486	1.00	1.14
TP Concentration (mg/L)	0.116	37.1E-3	0.109	1.02	52.3E-3	0.101	0.126
Log [TP] (mg/L)	-0.945	79.1E-3	-0.963	7.67E-3	-1.28	-0.994	-0.898
TN Concentration (mg/L)	1.32	0.258	1.29	6.06	0.936	1.13	1.41
Log [TN] (mg/L)	0.115	62.9E-3	0.111	0.782	-28.9E-3	54.3E-3	0.148
TSS Load (kg/Hour)	0.814	10.6	48.3E-3	505	215E-6	3.58E-3	0.232
TP Load (kg/Hour)	2.93E-3	28.3E-3	465E-6	1.30	2.18E-6	36.3E-6	2.10E-3
TN Load (kg/Hour)	32.0E-3	0.281	5.15E-3	11.9	26.0E-6	432E-6	23.8E-3
Gross Pollutant Load (kg/Hour)	31.7E-3	0.189	0.00	4.88	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.56E-3	30.6E-3	1.15E-3	1.15	5.79E-6	101E-6	4.85E-3
TSS Concentration (mg/L)	3.77	7.13	1.65	123	0.429	1.48	6.99
Log [TSS] (mg/L)	0.380	0.317	0.218	2.09	-0.368	0.169	0.844
TP Concentration (mg/L)	52.6E-3	24.0E-3	45.0E-3	0.383	20.1E-3	40.6E-3	70.6E-3
Log [TP] (mg/L)	-1.30	0.126	-1.35	-0.417	-1.70	-1.39	-1.15
TN Concentration (mg/L)	0.867	0.252	0.793	3.54	0.573	0.758	1.04
Log [TN] (mg/L)	-73.5E-3	88.6E-3	-0.101	0.549	-0.242	-0.120	15.5E-3
TSS Load (kg/Hour)	0.611	9.17	7.12E-3	475	30.3E-6	562E-6	0.112
TP Load (kg/Hour)	2.37E-3	26.3E-3	188E-6	1.24	848E-9	15.4E-6	1.19E-3
TN Load (kg/Hour)	28.5E-3	0.272	3.30E-3	11.8	16.2E-6	285E-6	16.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 4 wsud modelling - Bio-Retention 4A
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Bio-Retention 4A
Total Phosphorus
100
90
80
70
60
50
40
30
20
10
0
Cumulative Frequency (%)
0.0
2,000.0
4,000.0
6,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 4 wsud modelling - Bio-Retention 4A
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Swale 4B

9/04/2008 7:42:39

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	146	27.8E3	57.6	411	3.76E3
Residual Load	146	4.83E3	23.4	266	0.00
% Reduction	-0.2	82.7	59.4	35.2	100.0

Catchment 4 wsud modelling - Swale 4B

All Data Statistics

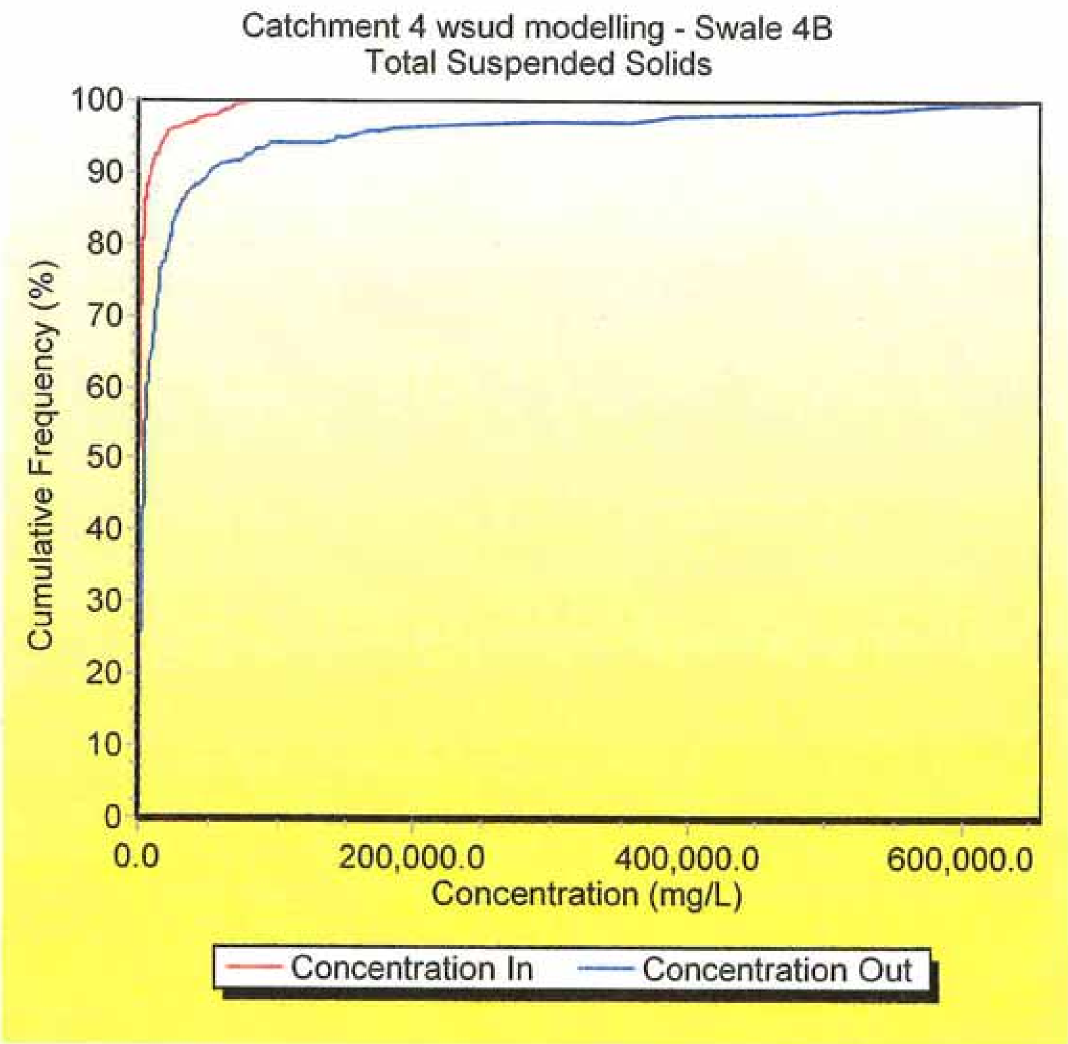
9/04/2008 7:42:28 AI

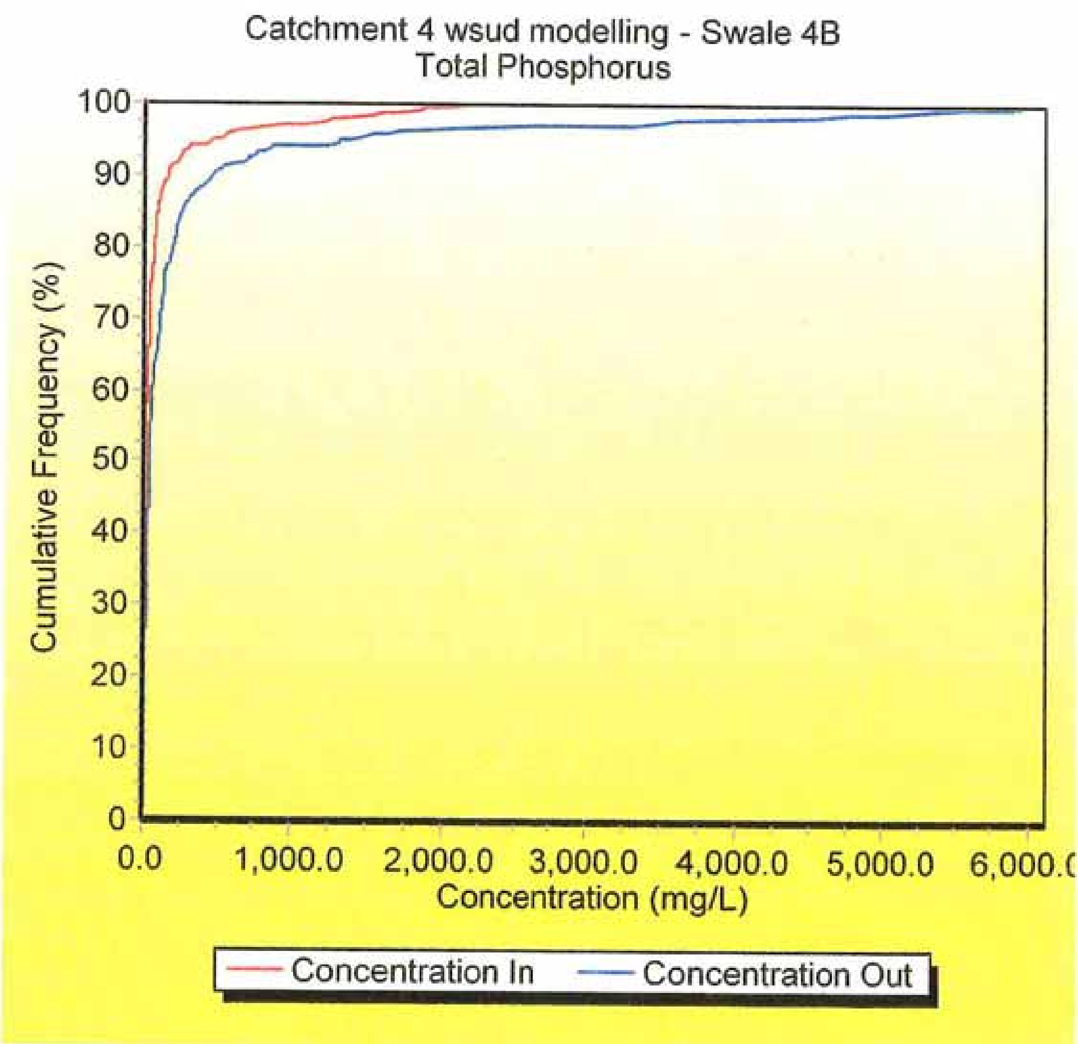
Inflow

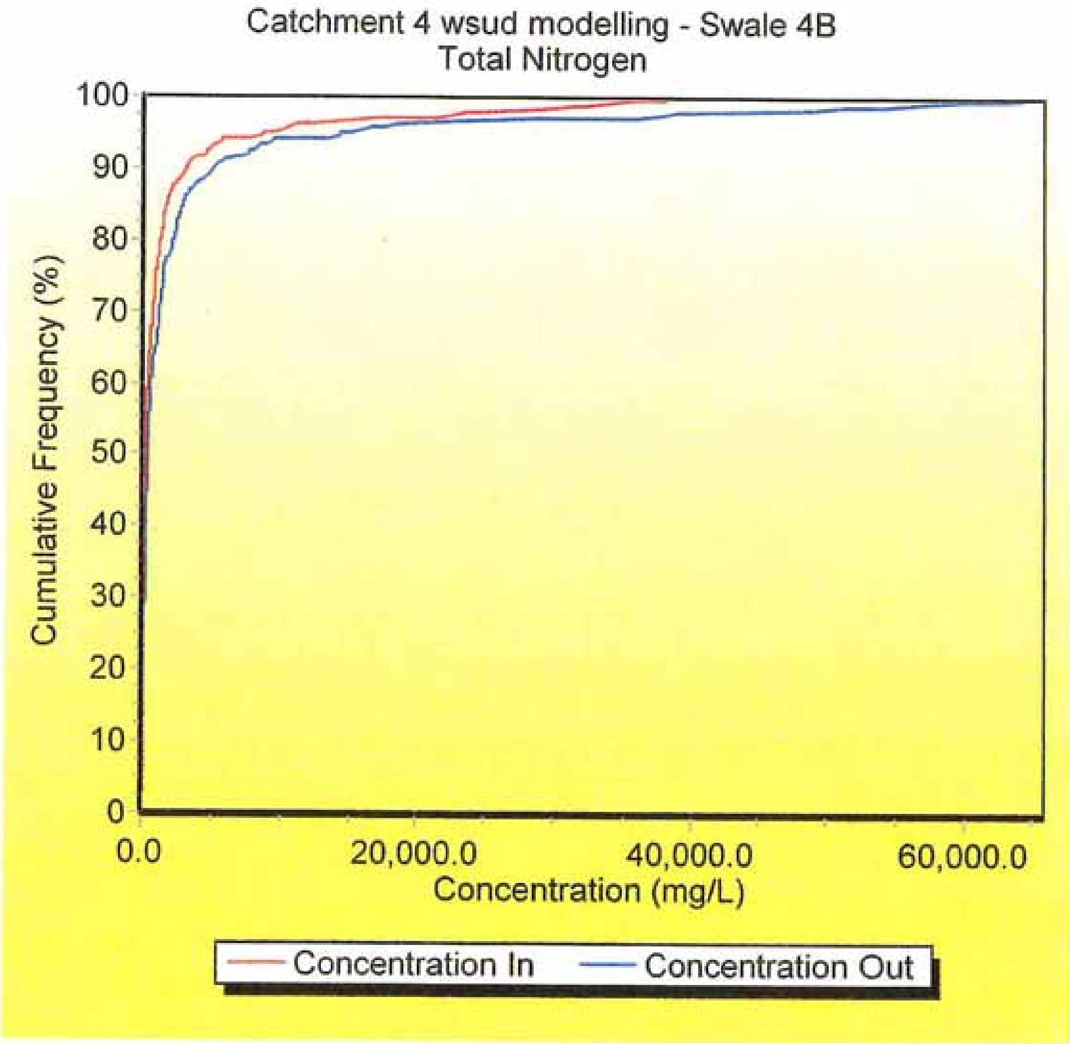
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.65E-3	31.1E-3	1.17E-3	1.18	5.90E-6	102E-6	4.91E-3
TSS Concentration (mg/L)	3.81	7.11	1.65	122	0.463	1.48	7.20
Log [TSS] (mg/L)	0.385	0.319	0.219	2.09	-0.334	0.171	0.857
TP Concentration (mg/L)	53.0E-3	23.7E-3	45.3E-3	0.366	21.3E-3	41.0E-3	71.8E-3
Log [TP] (mg/L)	-1.30	0.125	-1.34	-0.437	-1.67	-1.39	-1.14
TN Concentration (mg/L)	0.874	0.250	0.800	3.26	0.593	0.763	1.06
Log [TN] (mg/L)	-69.6E-3	88.1E-3	-96.9E-3	0.513	-0.227	-0.118	25.7E-3
TSS Load (kg/Hour)	0.628	9.63	7.20E-3	489	31.0E-6	568E-6	0.116
TP Load (kg/Hour)	2.42E-3	27.1E-3	191E-6	1.27	869E-9	15.7E-6	1.21E-3
TN Load (kg/Hour)	29.1E-3	0.278	3.37E-3	12.1	16.7E-6	293E-6	17.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.65E-3	31.0E-3	1.16E-3	1.21	0.00	103E-6	5.03E-3
TSS Concentration (mg/L)	14.4	3.51	14.0	102	0.00	14.0	14.0
Log [TSS] (mg/L)	1.15	52.4E-3	1.15	2.01	1.15	1.15	1.15
TP Concentration (mg/L)	0.130	6.26E-3	0.130	0.280	0.00	0.130	0.130
Log [TP] (mg/L)	-0.885	14.6E-3	-0.886	-0.552	-0.892	-0.886	-0.886
TN Concentration (mg/L)	1.34	0.154	1.36	2.83	0.00	1.17	1.40
Log [TN] (mg/L)	0.124	43.5E-3	0.133	0.452	48.5E-3	67.1E-3	0.146
TSS Load (kg/Hour)	0.551	7.73	58.7E-3	420	0.00	5.20E-3	0.253
TP Load (kg/Hour)	2.67E-3	24.2E-3	545E-6	1.17	0.00	48.3E-6	2.35E-3
TN Load (kg/Hour)	30.4E-3	0.268	5.61E-3	12.1	0.00	520E-6	21.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 4 wsud modelling - Swale 4B
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Swale 4B
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
1,000.0
2,000.0
3,000.0
4,000.0
5,000.0
6,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 4 wsud modelling - Swale 4B
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Bio-Retention 4B

9/04/2008 7:50:56 A

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	161	30.9E3	63.8	452	4.12E3
Residual Load	161	5.89E3	23.2	273	0.00
% Reduction	-0.2	80.9	63.6	39.5	100.0

Catchment 4 wsud modelling - Bio-Retention 4B

All Data Statistics

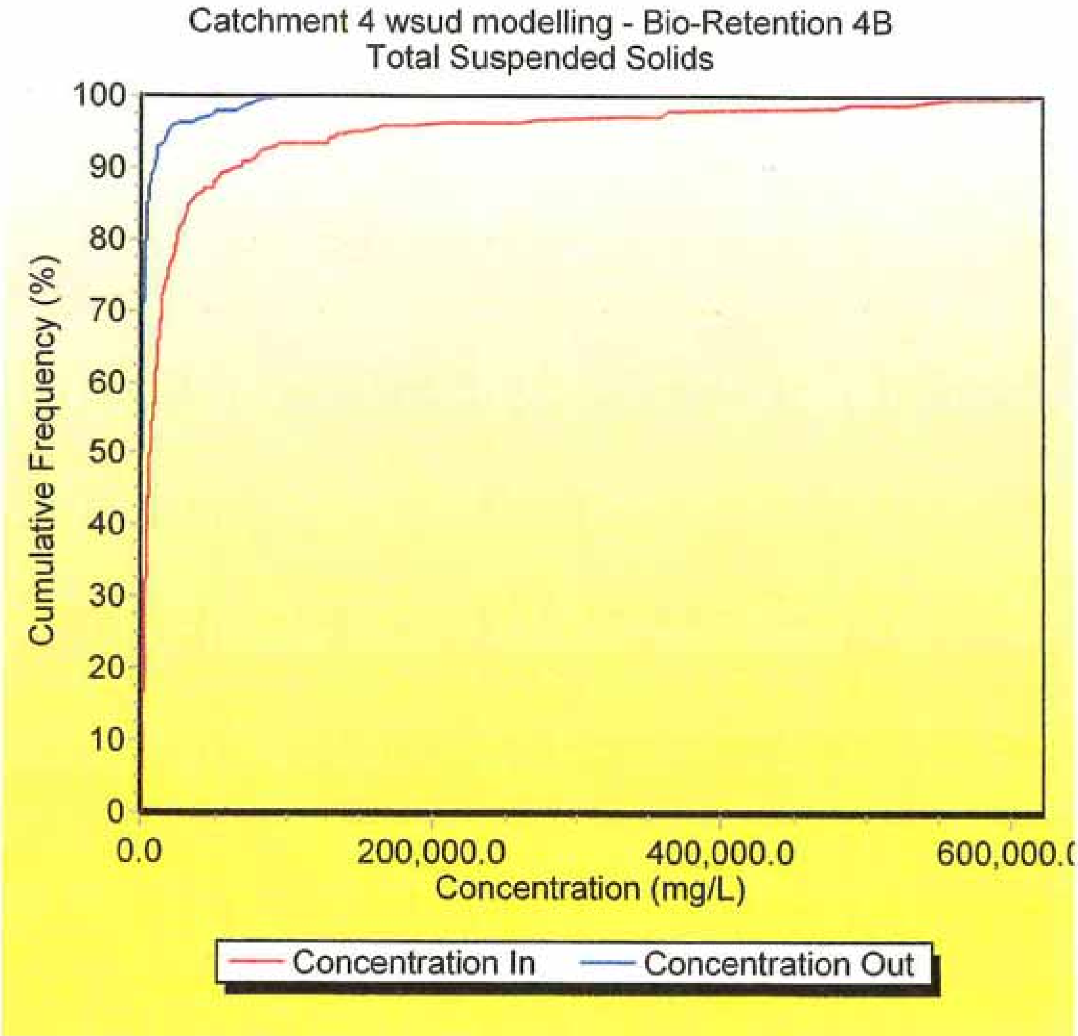
9/04/2008 7:41:03 AM

Inflow

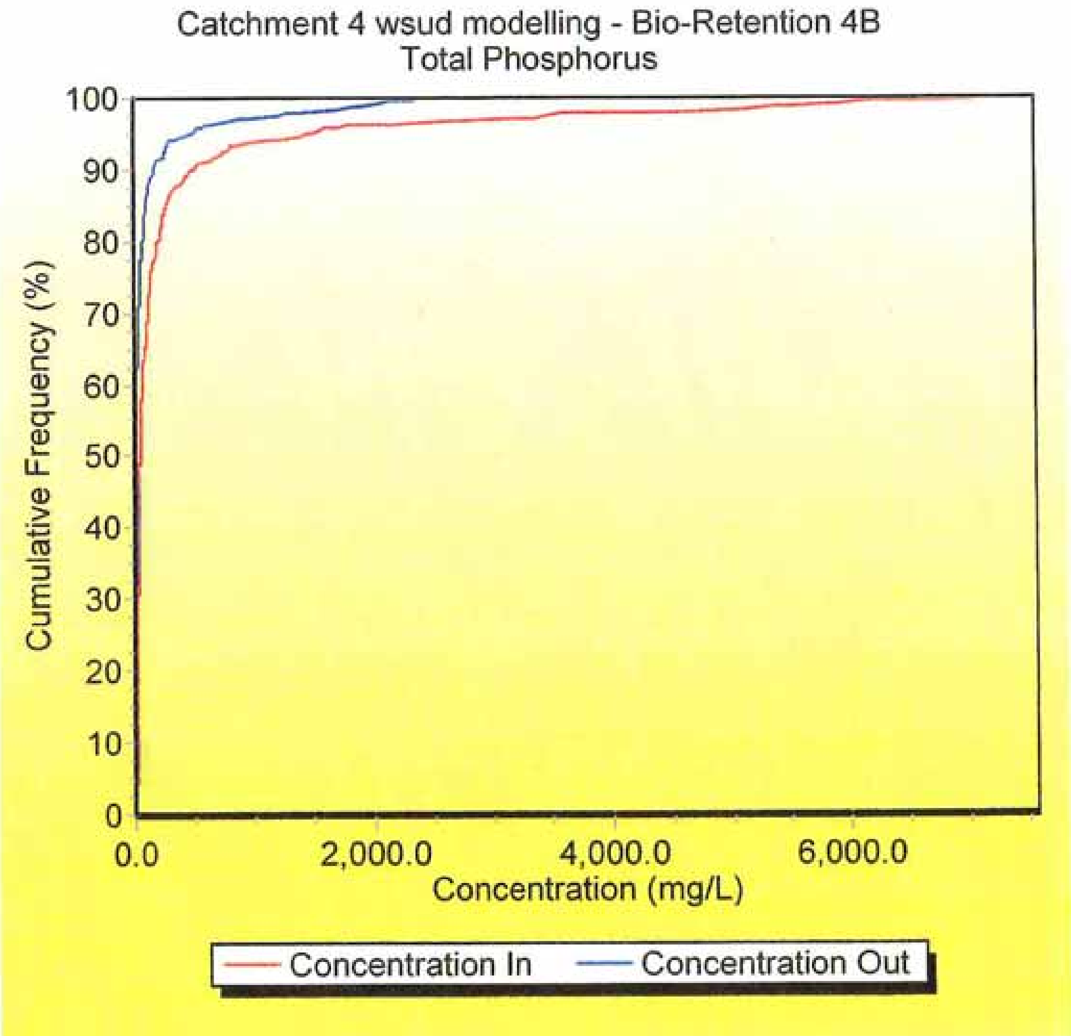
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.10E-3	33.9E-3	1.24E-3	1.30	6.49E-6	113E-6	5.42E-3
TSS Concentration (mg/L)	18.3	24.5	14.0	550	7.55	13.6	15.0
Log [TSS] (mg/L)	1.19	0.175	1.15	2.74	0.878	1.13	1.18
TP Concentration (mg/L)	0.138	41.4E-3	0.131	1.14	92.0E-3	0.128	0.143
Log [TP] (mg/L)	-0.867	69.3E-3	-0.884	55.5E-3	-1.04	-0.893	-0.846
TN Concentration (mg/L)	1.40	0.261	1.39	6.58	1.02	1.18	1.53
Log [TN] (mg/L)	0.142	62.0E-3	0.144	0.818	9.73E-3	72.3E-3	0.186
TSS Load (kg/Hour)	0.898	10.7	62.9E-3	472	314E-6	5.70E-3	0.311
TP Load (kg/Hour)	3.38E-3	29.6E-3	592E-6	1.30	2.92E-6	53.7E-6	2.73E-3
TN Load (kg/Hour)	35.1E-3	0.305	6.16E-3	14.3	33.1E-6	586E-6	24.8E-3
Gross Pollutant Load (kg/Hour)	41.9E-3	0.249	0.00	6.45	0.00	0.00	0.00

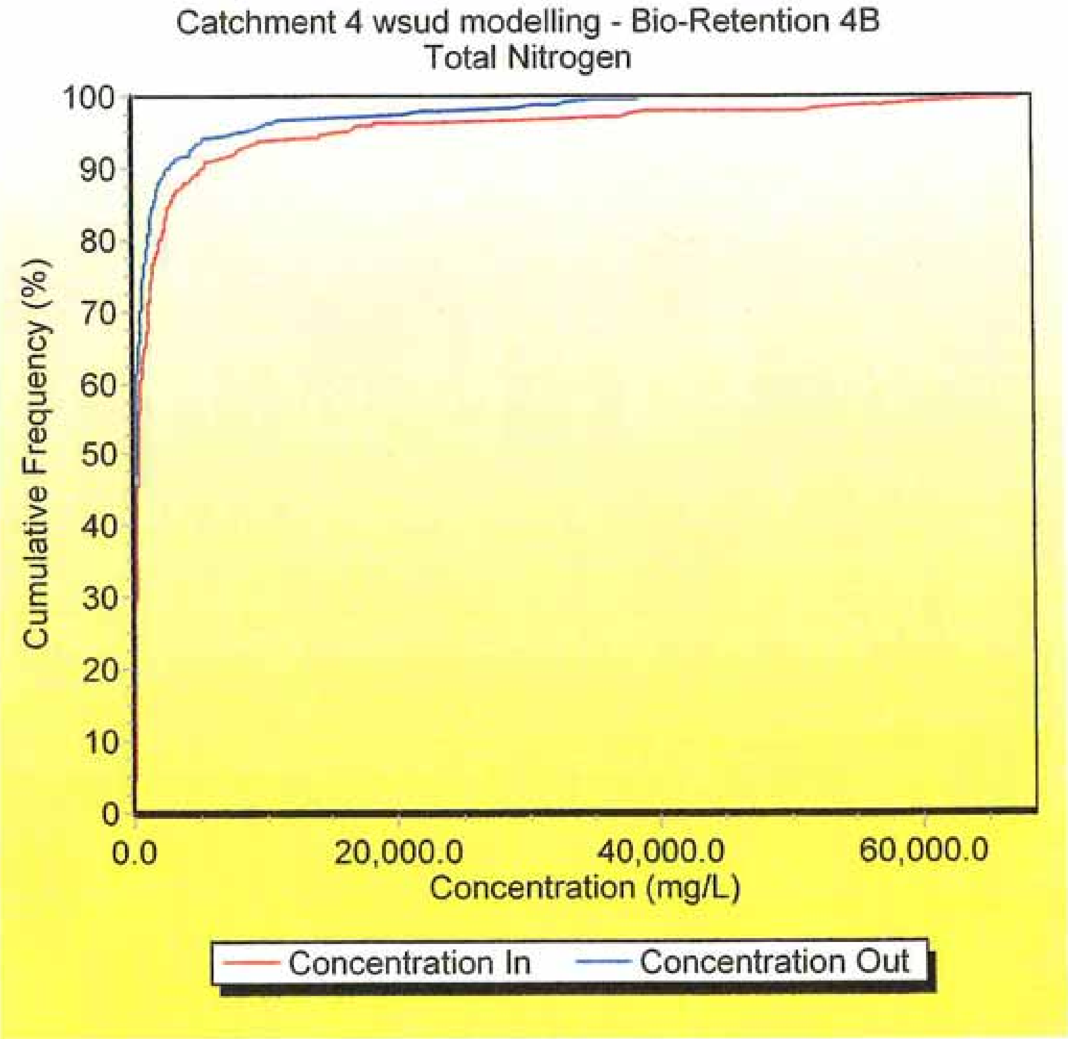
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.10E-3	34.0E-3	1.34E-3	1.31	6.54E-6	122E-6	5.07E-3
TSS Concentration (mg/L)	4.21	7.08	1.98	117	1.85	1.91	7.60
Log [TSS] (mg/L)	0.459	0.291	0.297	2.07	0.267	0.282	0.881
TP Concentration (mg/L)	58.7E-3	22.9E-3	51.5E-3	0.272	37.6E-3	49.6E-3	74.9E-3
Log [TP] (mg/L)	-1.25	0.109	-1.29	-0.566	-1.42	-1.30	-1.13
TN Concentration (mg/L)	0.918	0.232	0.860	3.09	0.647	0.793	1.07
Log [TN] (mg/L)	-46.4E-3	80.1E-3	-65.7E-3	0.490	-0.189	-0.101	28.5E-3
TSS Load (kg/Hour)	0.672	9.55	9.57E-3	468	45.1E-6	867E-6	0.130
TP Load (kg/Hour)	2.65E-3	27.8E-3	246E-6	1.24	1.15E-6	22.4E-6	1.32E-3
TN Load (kg/Hour)	31.2E-3	0.294	4.01E-3	13.5	20.5E-6	384E-6	17.6E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 4 wsud modelling - Bio-Retention 4B
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Bio-Retention 4B
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
2,000.0
4,000.0
6,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 4 wsud modelling - Bio-Retention 4B
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
60,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Detention AREA 4

9/04/2008 7:38:19

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	161	30.9E3	63.8	452	4.12E3
Residual Load	134	2.14E3	13.6	178	0.00
% Reduction	16.8	93.1	78.7	60.7	100.0

Catchment 4 wsud modelling - Detention AREA 4

All Data Statistics

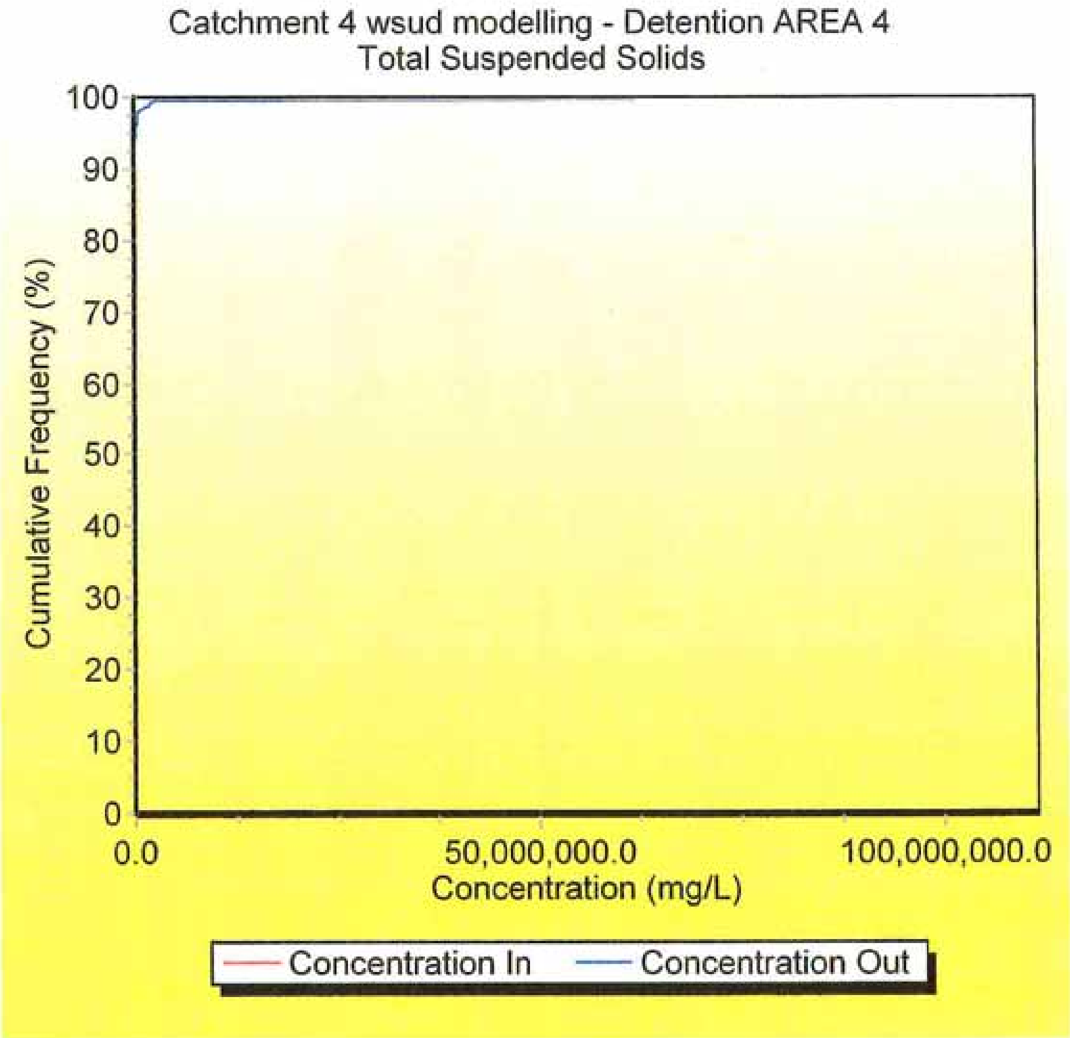
9/04/2008 7:38:08 A

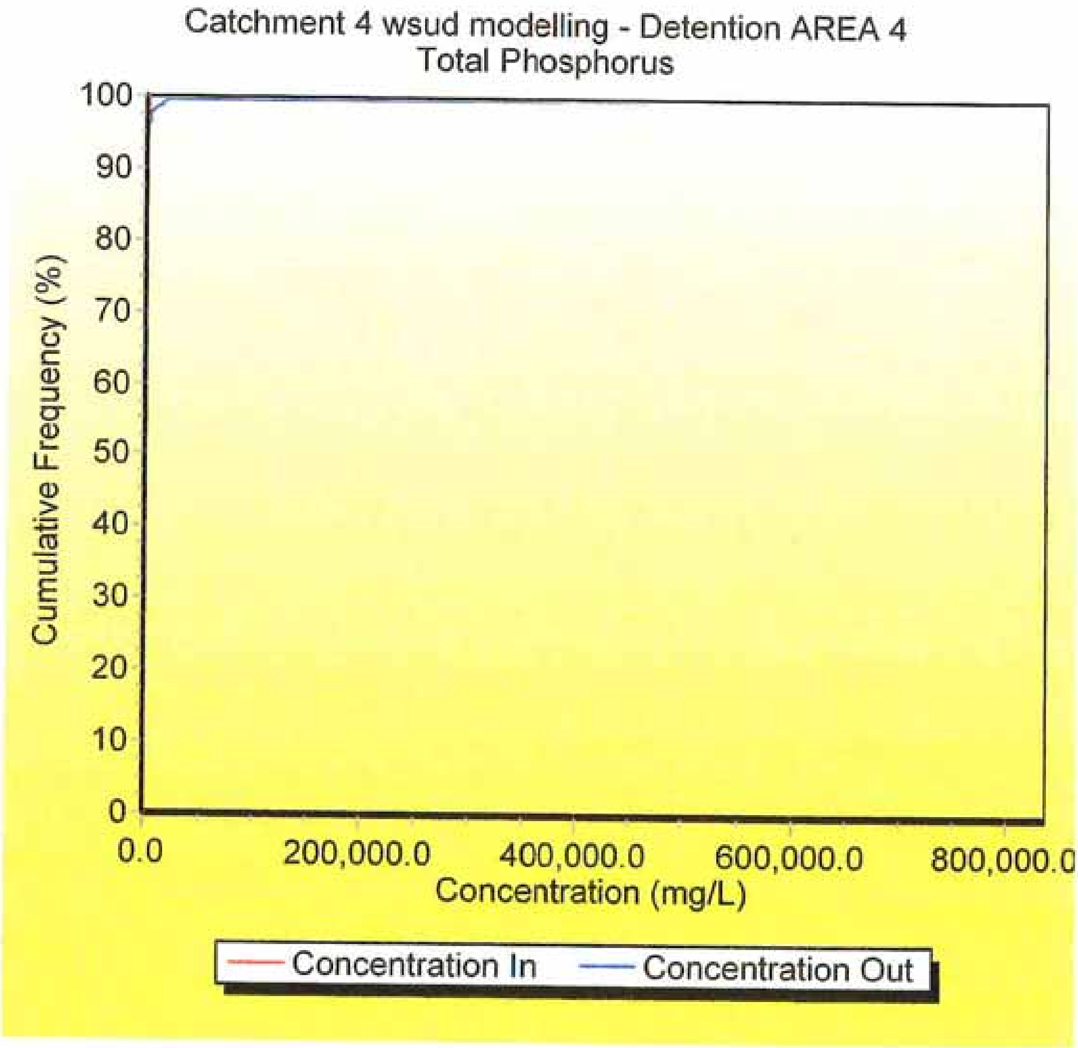
Inflow

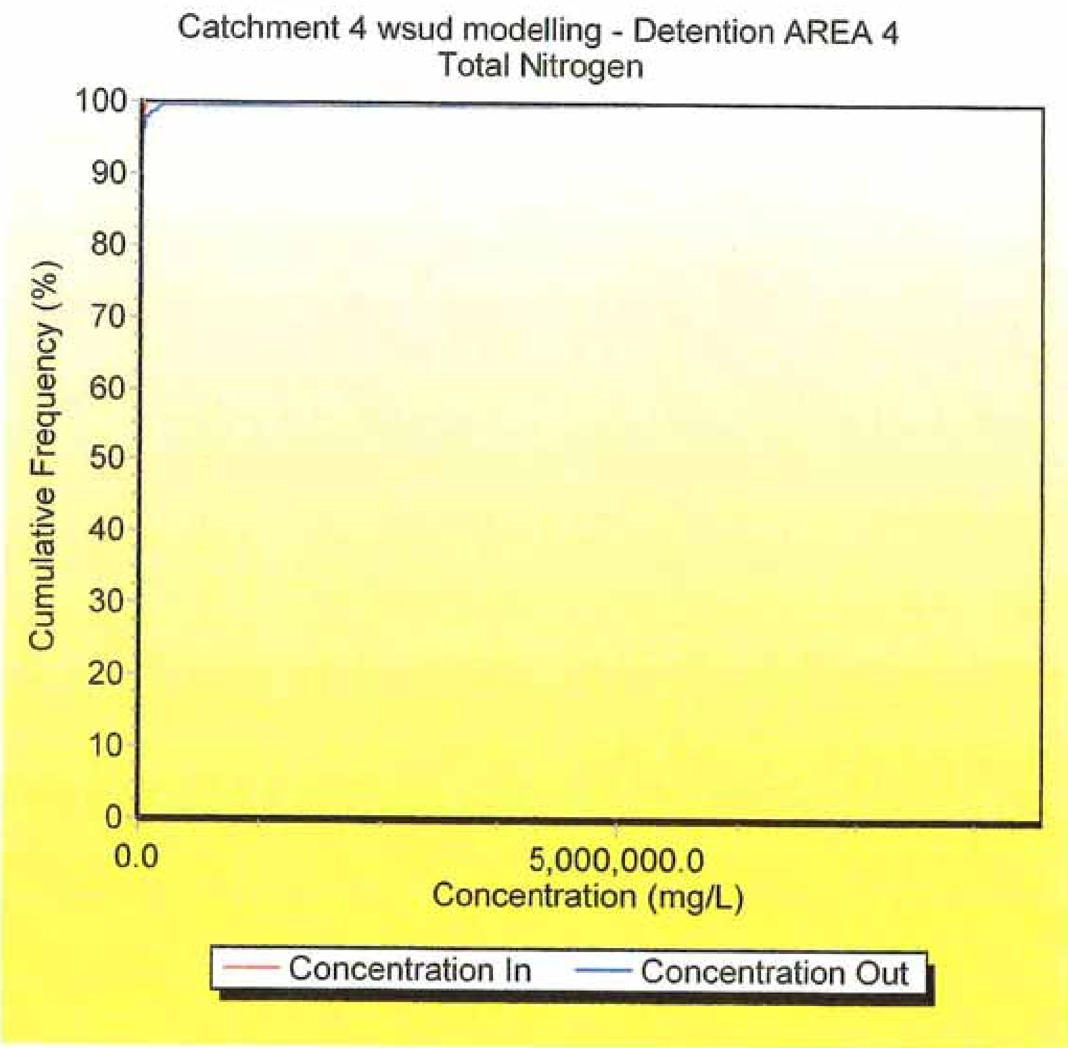
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	5.10E-3	34.0E-3	1.34E-3	1.31	6.54E-6	122E-6	5.07E-3
TSS Concentration (mg/L)	4.21	7.08	1.98	117	1.85	1.91	7.60
Log [TSS] (mg/L)	0.459	0.291	0.297	2.07	0.267	0.282	0.881
TP Concentration (mg/L)	58.7E-3	22.9E-3	51.5E-3	0.272	37.6E-3	49.6E-3	74.9E-3
Log [TP] (mg/L)	-1.25	0.109	-1.29	-0.566	-1.42	-1.30	-1.13
TN Concentration (mg/L)	0.918	0.232	0.860	3.09	0.647	0.793	1.07
Log [TN] (mg/L)	-46.4E-3	80.1E-3	-65.7E-3	0.490	-0.189	-0.101	28.5E-3
TSS Load (kg/Hour)	0.672	9.55	9.57E-3	468	45.1E-6	867E-6	0.130
TP Load (kg/Hour)	2.65E-3	27.8E-3	246E-6	1.24	1.15E-6	22.4E-6	1.32E-3
TN Load (kg/Hour)	31.2E-3	0.294	4.01E-3	13.5	20.5E-6	384E-6	17.6E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.24E-3	13.7E-3	353E-6	0.178	0.00	0.00	6.41E-3
TSS Concentration (mg/L)	7.28	6.24	12.0	30.9	0.00	0.00	12.1
Log [TSS] (mg/L)	1.09	42.5E-3	1.08	1.49	1.08	1.08	1.10
TP Concentration (mg/L)	53.7E-3	45.2E-3	90.2E-3	0.134	0.00	0.00	91.0E-3
Log [TP] (mg/L)	-1.04	19.3E-3	-1.04	-0.874	-1.05	-1.04	-1.04
TN Concentration (mg/L)	0.658	0.564	1.02	1.77	0.00	0.00	1.20
Log [TN] (mg/L)	46.2E-3	51.9E-3	26.0E-3	0.248	233E-6	7.82E-3	0.115
TSS Load (kg/Hour)	0.244	1.04	15.3E-3	17.3	0.00	0.00	0.280
TP Load (kg/Hour)	1.55E-3	5.62E-3	115E-6	80.6E-3	0.00	0.00	2.10E-3
TN Load (kg/Hour)	20.3E-3	75.6E-3	1.35E-3	1.08	0.00	0.00	25.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 4 wsud modelling - Detention AREA 4
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000,000.0
100,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Detention AREA 4
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
800,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Detention AREA 4
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Wetland AREA 4

9/04/2008 7:36:53 A

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	161	30.9E3	63.8	452	4.12E3
Residual Load	134	1.95E3	12.9	177	0.00
% Reduction	16.8	93.7	79.8	60.9	100.0

Catchment 4 wsud modelling - Wetland AREA 4

All Data Statistics

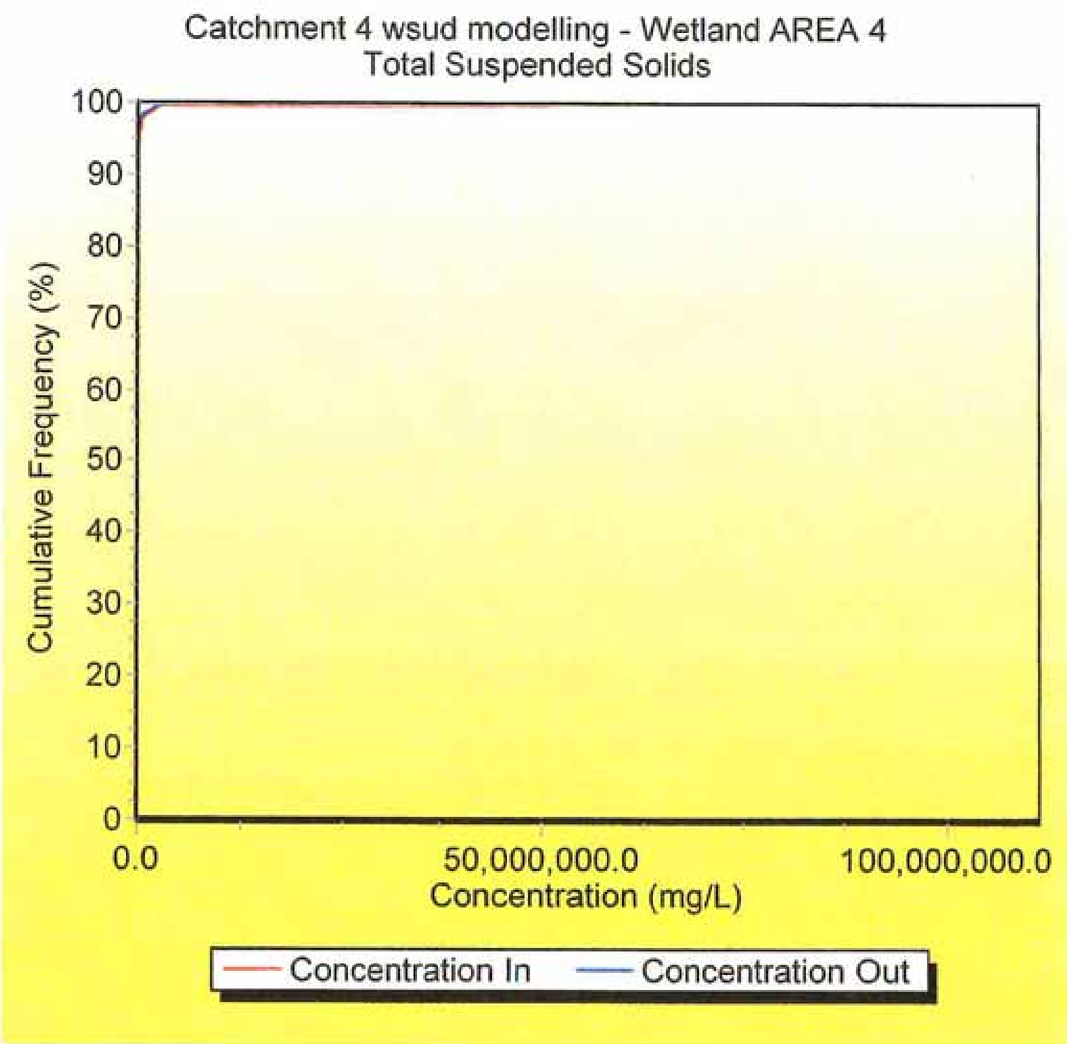
9/04/2008 7:36:33 A

Inflow

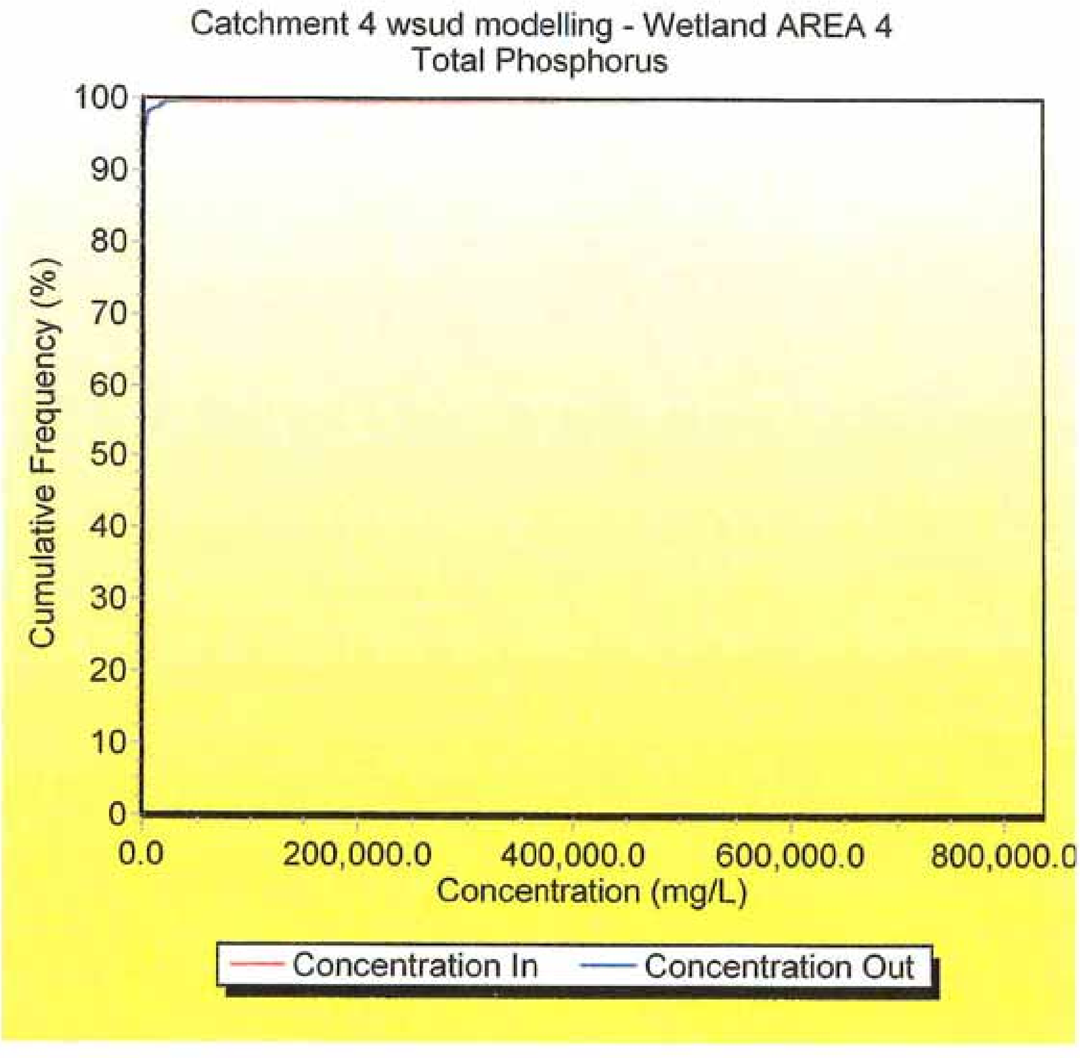
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.24E-3	13.7E-3	353E-6	0.178	0.00	0.00	6.41E-3
TSS Concentration (mg/L)	7.28	6.24	12.0	30.9	0.00	0.00	12.1
Log [TSS] (mg/L)	1.09	42.5E-3	1.08	1.49	1.08	1.08	1.10
TP Concentration (mg/L)	53.7E-3	45.2E-3	90.2E-3	0.134	0.00	0.00	91.0E-3
Log [TP] (mg/L)	-1.04	19.3E-3	-1.04	-0.874	-1.05	-1.04	-1.04
TN Concentration (mg/L)	0.658	0.564	1.02	1.77	0.00	0.00	1.20
Log [TN] (mg/L)	46.2E-3	51.9E-3	26.0E-3	0.248	233E-6	7.82E-3	0.115
TSS Load (kg/Hour)	0.244	1.04	15.3E-3	17.3	0.00	0.00	0.280
TP Load (kg/Hour)	1.55E-3	5.62E-3	115E-6	80.6E-3	0.00	0.00	2.10E-3
TN Load (kg/Hour)	20.3E-3	75.6E-3	1.35E-3	1.08	0.00	0.00	25.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

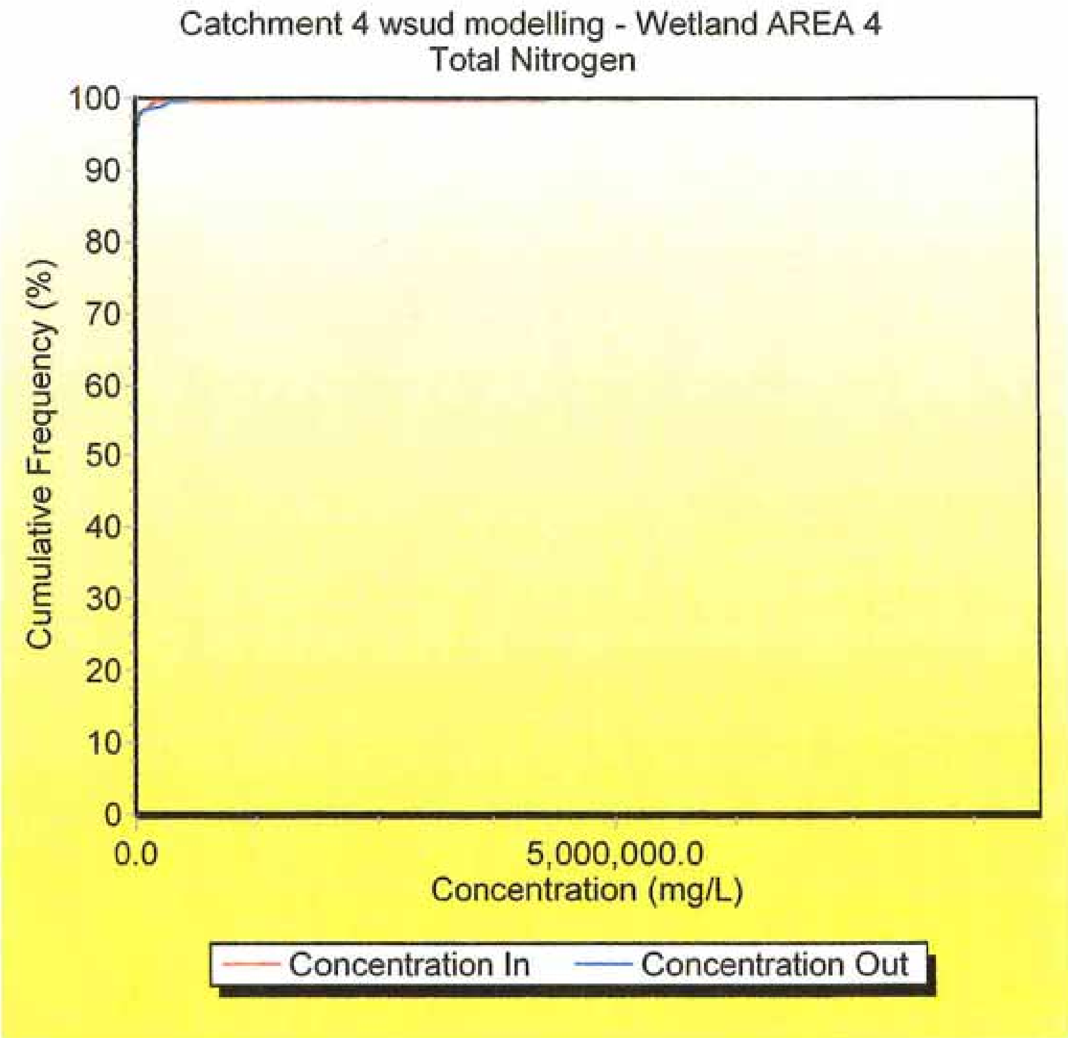
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	4.24E-3	13.7E-3	346E-6	0.175	0.00	0.00	6.40E-3
TSS Concentration (mg/L)	4.90	4.66	6.18	30.5	0.00	0.00	9.73
Log [TSS] (mg/L)	0.906	0.113	0.892	1.48	0.778	0.785	1.04
TP Concentration (mg/L)	43.3E-3	37.5E-3	62.3E-3	0.133	0.00	0.00	82.0E-3
Log [TP] (mg/L)	-1.14	62.0E-3	-1.14	-0.878	-1.22	-1.21	-1.06
TN Concentration (mg/L)	0.650	0.559	1.02	1.77	0.00	0.00	1.18
Log [TN] (mg/L)	42.5E-3	51.3E-3	22.8E-3	0.247	62.4E-6	6.09E-3	0.110
TSS Load (kg/Hour)	0.223	1.02	7.79E-3	16.0	0.00	0.00	0.222
TP Load (kg/Hour)	1.47E-3	5.55E-3	78.5E-6	77.3E-3	0.00	0.00	1.88E-3
TN Load (kg/Hour)	20.2E-3	75.1E-3	1.31E-3	1.04	0.00	0.00	25.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 4 wsud modelling - Wetland AREA 4
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000,000.0
100,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 4 wsud modelling - Wetland AREA 4
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
800,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 4 wsud modelling - Wetland AREA 4
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
5,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban
ID,1,5,6,7,8,12,13,14,17,19,22,23,26,27,36,37,39
Node
Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area
(ha),0.67,0.66,0.83,0.96,0.62,1.93,0.95,1.1,0.88,0.77,0.72,0.81,1.14,1.32,1.44,0.27,1.09
Area Impervious
(ha),0.400295614035088,0.397244736842105,0.499565350877193,0.573557894736842,0.373169298245614,1.1616399122807,0.571791666666667,0.662074561403509,0.529659649122807,0.460041228070176,0.433357894736842,0.487527631578947,0.68615,0.788642105263158,0.866715789473684,0.161313157894737,0.656055701754386
Area Pervious
(ha),0.269704385964912,0.262755263157895,0.330434649122807,0.386442105263158,0.246830701754386,0.768360087719298,0.378208333333333,0.437925438596491,0.350340350877193,0.309958771929825,0.286642105263158,0.322472368421053,0.45385,0.531357894736842,0.573284210526316,0.108686842105263,0.433944298245614
Field Capacity (mm),80,80,80,80,80,80,80,80,80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient -
a,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent -
b,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity
(mm),120,120,120,120,120,120,120,120,120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of
Capacity),30,30,30,30,30,30,30,30,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth
(mm),10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate
(%),25,25,25,25,25,25,25,25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log
mg/L),2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial
Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log
mg/L),-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log
mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log
mg/L),0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas

tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log
mg/L),1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log
mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17
,0.17,0.17
Baseflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial
Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log
mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0
.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
,0.19,0.19
Baseflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log
mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12
,0.12,0.12
Baseflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow
(ML/yr),6.66,6.56,8.25,9.54,6.16,19.2,9.44,10.9,8.74,7.65,7.15,8.05,11.3,13.1,14
.3,2.68,10.8
OUT - TSS Mean Annual Load
(kg/yr),1.38E3,1.21E3,1.44E3,1.59E3,1.17E3,3.64E3,1.85E3,2.13E3,1.67E3,1.34E3,1.
36E3,1.51E3,2.09E3,2.30E3,2.71E3,479,2.07E3
OUT - TP Mean Annual Load
(kg/yr),2.90,2.46,2.94,3.60,2.48,7.85,3.87,4.29,3.50,2.82,2.85,3.22,4.22,4.88,5.
55,1.01,3.95
OUT - TN Mean Annual Load
(kg/yr),18.3,17.3,22.0,26.4,16.8,55.0,25.5,28.5,23.6,22.3,20.7,24.1,32.7,36.9,40
.5,7.70,33.0
OUT - Gross Pollutant Mean Annual Load
(kg/yr),171,168,212,245,158,492,242,281,225,196,184,207,291,337,367,68.9,278

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,B
io-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retenti
on,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention
4A,Swale 4B,Swale 4A,Bio-Retention 4B,Detention AREA 4,Wetland AREA
4,Bio-Retention,Bio-Retention
ID,2,3,4,9,10,11,15,16,18,20,21,24,25,28,29,30,31,32,33,34,35,38,40
Node
Type,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRete
ntionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,Bi
oRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNo
de,BioRetentionNode,BioRetentionNode,SwaleNode,SwaleNode,BioRetentionNode,PondNo
de,WetlandNode,BioRetentionNode,BioRetentionNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate

(cum/sec),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100, , ,100,100,100,100,100
Inlet pond volume, , , , , , , , , , , , , , , , , , ,0,0, ,
Area (sqm),20,50,50,50,50,50,50,50,50,80,20,50,50,50,80,80, , ,80,22225,50,20,50
Extended detention depth (m),0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.5,0.5,0.8, 0.45,1,0.8,0.8
Permanent pool volume (cum), , , , , , , , , , , , , , , , , , , ,10000,50, ,
Proportion vegetated, , , , , , , , , , , , , , , , , , ,0.1,0.5, ,
Equivalent pipe diameter (mm), , , , , , , , , , , , , , , , , , , ,300,200, ,
Overflow weir width (m),2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2, , ,2,2,3,2,2
Notional Detention Time (hrs), , , , , , , , , , , , , , , , , , , ,19.7,0.149, ,
Orifice discharge coefficient, , , , , , , , , , , , , , , , , , , ,0.6,0.6, ,
Weir coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7, , ,1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,10,10,3,2,5,3,3
Total Suspended Solids k (m/yr),8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,400,1500,8000,8000
Total Suspended Solids C* (mg/L),20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,12,6,20,20
Total Suspended Solids C** (mg/L), , , , , , , , , , , , , , , , , , ,14,14, ,12,6, ,
Total Phosphorus k (m/yr),6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,300,1000,6000,6000
Total Phosphorus C* (mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.09,0.06,0.13,0.13
Total Phosphorus C** (mg/L), , , , , , , , , , , , , , , , , , ,0.13,0.13, ,0.09,0.06, ,
Total Nitrogen k (m/yr),500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,40,150,500,500
Total Nitrogen C* (mg/L),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1,1,1.4,1.4
Total Nitrogen C** (mg/L), , , , , , , , , , , , , , , , , , ,1.4,1.4, ,1,1, ,
Threshold hydraulic loading for C** (m/yr), , , , , , , , , , , , , , , , , , ,3500,3500, ,3500,3500, ,
Extraction for Re-use,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), ,
Constant Daily Re-use Demand (kL), ,
User-defined Annual Re-use Demand (ML), ,
Percentage of User-defined Annual Re-use Demand Jan, ,
Percentage of User-defined Annual Re-use Demand Feb, ,
Percentage of User-defined Annual Re-use Demand Mar, ,
Percentage of User-defined Annual Re-use Demand Apr, ,
Percentage of User-defined Annual Re-use Demand May, ,
Percentage of User-defined Annual Re-use Demand Jun, ,
Percentage of User-defined Annual Re-use Demand Jul, ,
Percentage of User-defined Annual Re-use Demand Aug, ,
Percentage of User-defined Annual Re-use Demand Sep, ,

Percentage of User-defined Annual Re-use Demand Oct, ,
Percentage of User-defined Annual Re-use Demand Nov, ,
Percentage of User-defined Annual Re-use Demand Dec, ,
Filter area (sqm),20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,80, , ,80, , ,20,20
Filter depth (m),1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1, , ,1, , ,1,1
Filter median particle diameter (mm),5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5, , ,5, , ,5,5
Saturated hydraulic conductivity (mm/hr),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100, , ,100, , ,100,100
Voids ratio,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3, , ,0.3, , ,0.3,0.3
Length (m), , , , , , , , , , , , , , , , , , ,100,100, , , , ,
Bed slope, , , , , , , , , , , , , , , , , , ,0.03,0.03, , , , ,
Base Width (m), , , , , , , , , , , , , , , , , , ,1,1, , , , ,
Top width (m), , , , , , , , , , , , , , , , , , ,5,5, , , , ,
Vegetation height (m), , , , , , , , , , , , , , , , , , ,0.25,0.25, , , , ,
Proportion of upstream impervious area treated, ,
Seepage Rate (mm/hr),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Evap Loss as proportion of PET, ,1,1.25, ,
Depth in metres below the drain pipe,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, , ,0, , ,0,0
IN - Mean Annual Flow (ML/yr),6.66,6.66,21.5,8.25,34.9,25.3,9.44,20.4,36.8,7.65,7.66,18.5,63.4,63.4,13.1,144,146,98.3,161,161,134,2.68,21.5
IN - TSS Mean Annual Load (kg/yr),1.38E3,471,1.66E3,1.44E3,3.64E3,4.81E3,1.85E3,2.53E3,2.79E3,1.34E3,166,3.45E3,4.42E3,3.38E3,2.30E3,6.86E3,5.33E3,4.98E3,7.44E3,5.52E3,2.08E3,479,735
IN - TP Mean Annual Load (kg/yr),2.90,1.44,4.35,2.94,9.59,10.3,3.87,5.76,7.50,2.82,0.857,7.07,12.6,11.0,4.88,25.3,21.0,17.1,28.8,22.5,13.5,1.01,2.89
IN - TN Mean Annual Load (kg/yr),18.3,13.7,42.3,22.0,84.5,71.7,25.5,46.6,72.4,22.3,13.6,53.4,131,122,36.9,284,259,188,312,277,179,7.70,35.7
IN - Gross Pollutant Mean Annual Load (kg/yr),171,0.00,168,212,245,651,242,281,225,196,0.00,475,207,0.00,337,278,0.00,0.00,367,0.00,0.00,68.9,0.00
OUT - Mean Annual Flow (ML/yr),6.66,6.67,21.5,8.25,34.9,25.3,9.44,20.4,36.8,7.66,7.66,18.5,63.4,63.4,13.1,144,146,98.3,161,134,134,2.69,21.5
OUT - TSS Mean Annual Load (kg/yr),471,198,735,255,2.16E3,2.05E3,401,1.00E3,1.68E3,166,116,1.23E3,3.38E3,2.81E3,466,5.26E3,4.73E3,3.81E3,5.52E3,2.08E3,1.90E3,72.0,514
OUT - TP Mean Annual Load (kg/yr),1.44,0.839,2.89,1.05,7.07,6.00,1.47,3.30,5.81,0.857,0.687,3.58,11.0,10.0,1.80,20.7,23.3,17.1,22.5,13.5,12.8,0.348,2.44
OUT - TN Mean Annual Load (kg/yr),13.7,9.92,35.7,15.1,73.1,58.1,18.1,38.0,65.0,13.6,10.9,42.2,122,115,25.0,254,271,195,277,179,178,5.10,31.7
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

No Other nodes

Links
Location,Drainage Link,Drainage

Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,2,3,5,12,8,7,6,11,13,15,14,16,17,20,21,22,23,24,26,25,29,32,30,31,33,34,36,37,39,4,40,19,18,10,9,38,27,28
Target node ID,2,3,4,4,11,11,10,9,10,15,16,16,18,18,21,18,24,25,25,24,28,30,30,31,33,34,35,33,38,30,40,30,20,25,32,4,31,29,32
Muskingum-Cunge Routing,Not Routed
Muskingum K, ,
Muskingum theta, ,
IN - Mean Annual Flow (ML/yr),6.66,6.66,6.67,6.56,19.2,6.16,9.54,8.25,25.3,9.44,9.44,10.9,20.4,8.74,7.66,7.66,7.15,8.05,18.5,11.3,63.4,13.1,98.3,144,146,161,134,14.3,2.68,10.8,21.5,21.5,7.65,36.8,34.9,8.25,2.69,13.1,63.4
IN - TSS Mean Annual Load (kg/yr),1.38E3,471,198,1.21E3,3.64E3,1.17E3,1.59E3,1.44E3,2.05E3,1.85E3,401,2.13E3,1.00E3,1.67E3,166,116,1.36E3,1.51E3,1.23E3,2.09E3,3.38E3,466,3.81E3,5.26E3,4.73E3,5.52E3,2.08E3,2.71E3,479,2.07E3,735,514,1.34E3,1.68E3,2.16E3,255,72.0,2.30E3,2.81E3
IN - TP Mean Annual Load (kg/yr),2.90,1.44,0.839,2.46,7.85,2.48,3.60,2.94,6.00,3.87,1.47,4.29,3.30,3.50,0.857,0.687,2.85,3.22,3.58,4.22,11.0,1.80,17.1,20.7,23.3,22.5,13.5,5.55,1.01,3.95,2.89,2.44,2.82,5.81,7.07,1.05,0.348,4.88,10.0
IN - TN Mean Annual Load (kg/yr),18.3,13.7,9.92,17.3,55.0,16.8,26.4,22.0,58.1,25.5,18.1,28.5,38.0,23.6,13.6,10.9,20.7,24.1,42.2,32.7,122,25.0,195,254,271,277,179,40.5,7.70,33.0,35.7,31.7,22.3,65.0,73.1,15.1,5.10,36.9,115
IN - Gross Pollutant Mean Annual Load (kg/yr),171,0.00,0.00,168,492,158,245,212,0.00,242,0.00,281,0.00,225,0.00,0.00,184,207,0.00,291,0.00,0.00,0.00,0.00,0.00,0.00,0.00,367,68.9,278,0.00,0.00,196,0.00,0.00,0.00,0.00,337,0.00
OUT - Mean Annual Flow (ML/yr),6.66,6.66,6.67,6.56,19.2,6.16,9.54,8.25,25.3,9.44,9.44,10.9,20.4,8.74,7.66,7.66,7.15,8.05,18.5,11.3,63.4,13.1,98.3,144,146,161,134,14.3,2.68,10.8,21.5,21.5,7.65,36.8,34.9,8.25,2.69,13.1,63.4
OUT - TSS Mean Annual Load (kg/yr),1.38E3,471,198,1.21E3,3.64E3,1.17E3,1.59E3,1.44E3,2.05E3,1.85E3,401,2.13E3,1.00E3,1.67E3,166,116,1.36E3,1.51E3,1.23E3,2.09E3,3.38E3,466,3.81E3,5.26E3,4.73E3,5.52E3,2.08E3,2.71E3,479,2.07E3,735,514,1.34E3,1.68E3,2.16E3,255,72.0,2.30E3,2.81E3
OUT - TP Mean Annual Load (kg/yr),2.90,1.44,0.839,2.46,7.85,2.48,3.60,2.94,6.00,3.87,1.47,4.29,3.30,3.50,0.857,0.687,2.85,3.22,3.58,4.22,11.0,1.80,17.1,20.7,23.3,22.5,13.5,5.55,1.01,3.95,2.89,2.44,2.82,5.81,7.07,1.05,0.348,4.88,10.0
OUT - TN Mean Annual Load (kg/yr),18.3,13.7,9.92,17.3,55.0,16.8,26.4,22.0,58.1,25.5,18.1,28.5,38.0,23.6,13.6,10.9,20.7,24.1,42.2,32.7,122,25.0,195,254,271,277,179,40.5,7.70,33.0,35.7,31.7,22.3,65.0,73.1,15.1,5.10,36.9,115
OUT - Gross Pollutant Mean Annual Load (kg/yr),171,0.00,0.00,168,492,158,245,212,0.00,242,0.00,281,0.00,225,0.00,0.00,184,207,0.00,291,0.00,0.00,0.00,0.00,0.00,0.00,0.00,367,68.9,278,0.00,0.00,196,0.00,0.00,0.00,0.00,337,0.00

Catchment 5

Bio-Retention 5A

8/04/2008 5:18:58 PM

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	119	22.2E3	46.8	342	3.06E3
Residual Load	119	5.78E3	20.1	221	0.00
% Reduction	-0.2	73.9	56.9	35.4	100.0

Catchment 5 wsud modelling - Bio-Retention 5A

All Data Statistics

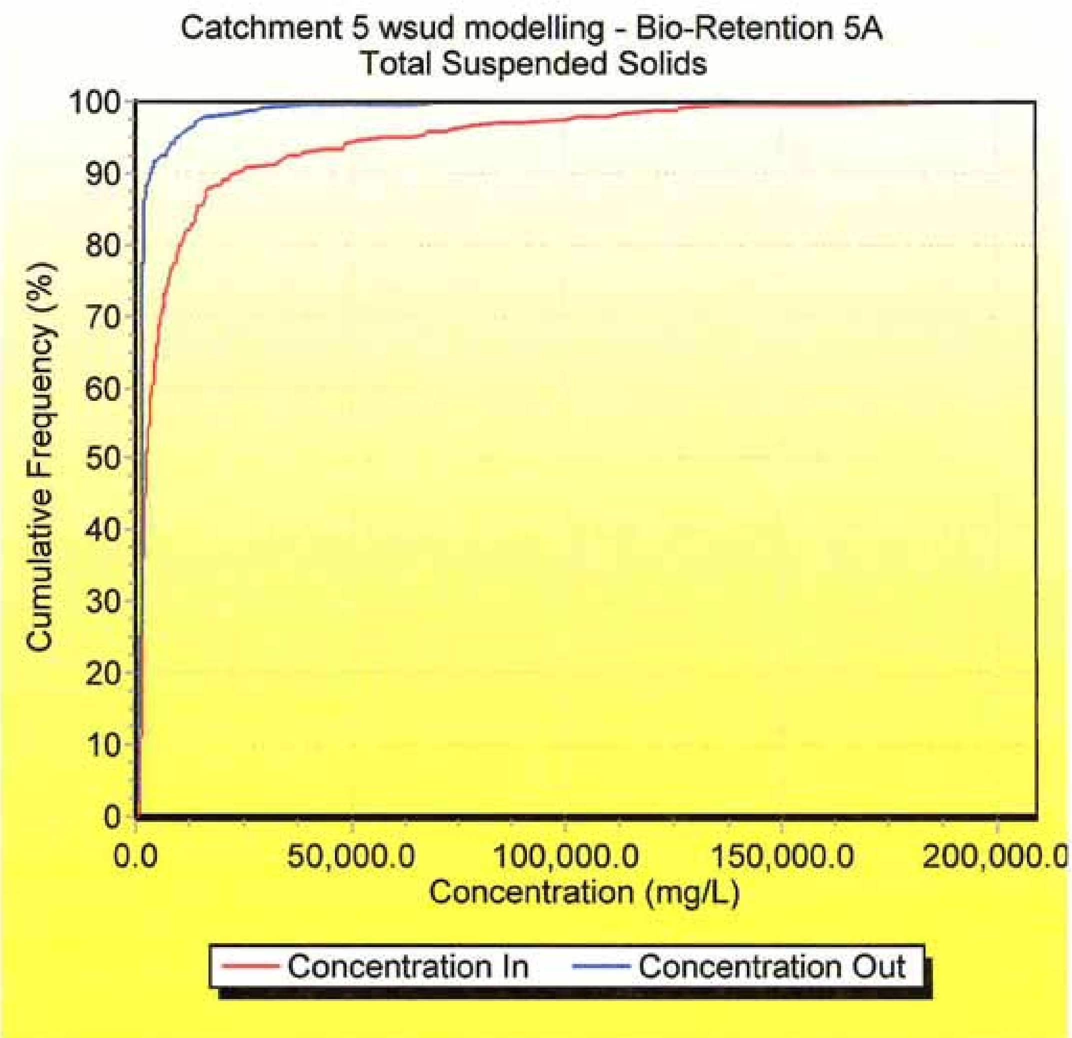
8/04/2008 5:18:50 PM

Inflow

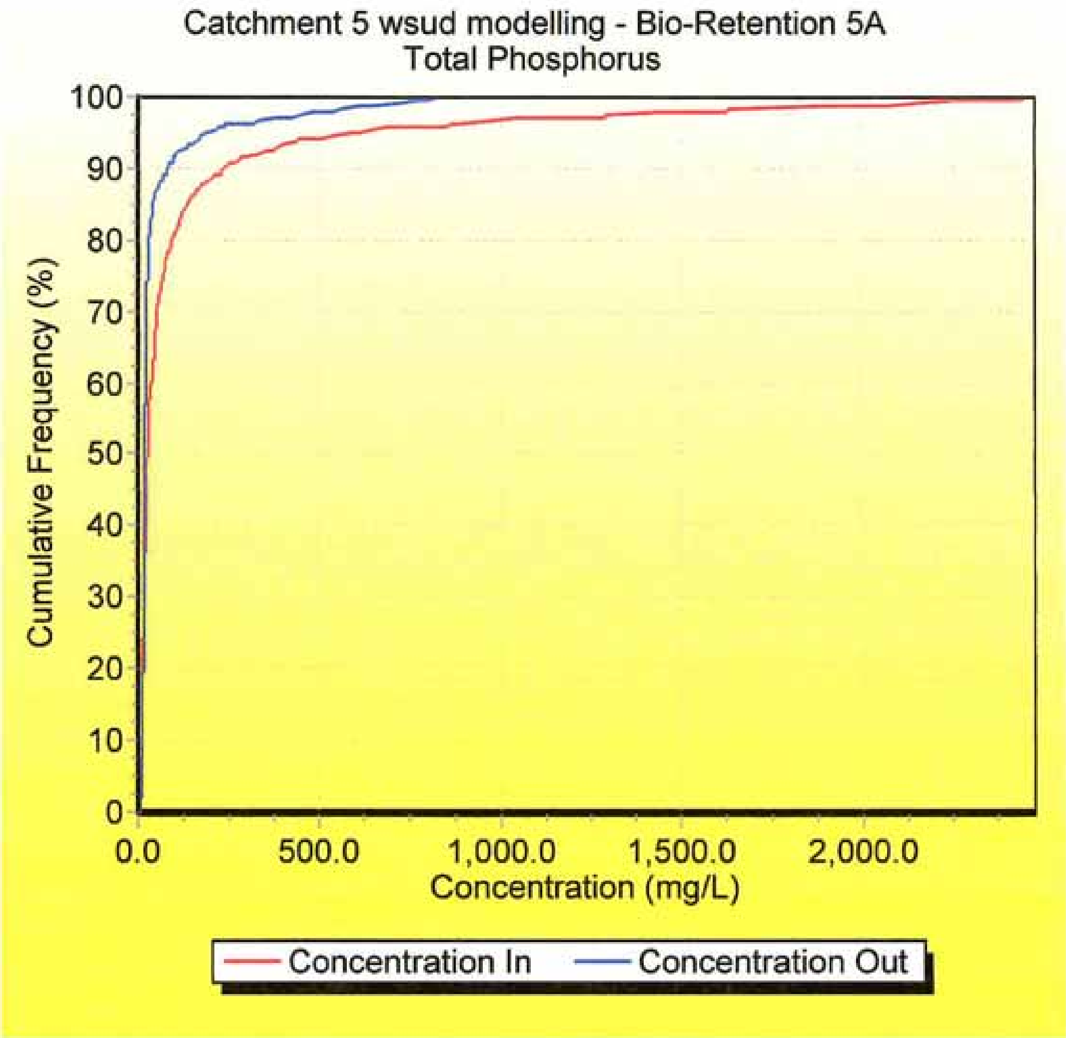
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.78E-3	25.9E-3	850E-6	0.909	4.93E-6	64.7E-6	4.29E-3
TSS Concentration (mg/L)	9.47	31.8	3.18	1.82E3	56.1E-3	0.947	12.0
Log [TSS] (mg/L)	0.550	0.531	0.502	3.26	-1.25	-23.7E-3	1.08
TP Concentration (mg/L)	59.8E-3	53.9E-3	51.4E-3	1.07	7.15E-3	22.0E-3	89.2E-3
Log [TP] (mg/L)	-1.32	0.280	-1.29	28.6E-3	-2.15	-1.66	-1.05
TN Concentration (mg/L)	0.818	0.384	0.700	4.62	0.324	0.592	1.19
Log [TN] (mg/L)	-0.116	0.142	-0.155	0.665	-0.489	-0.228	75.5E-3
TSS Load (kg/Hour)	0.789	10.0	10.3E-3	401	13.0E-6	252E-6	0.202
TP Load (kg/Hour)	2.43E-3	25.0E-3	167E-6	1.01	331E-9	5.88E-6	1.43E-3
TN Load (kg/Hour)	26.0E-3	0.248	2.09E-3	8.90	10.6E-6	152E-6	17.9E-3
Gross Pollutant Load (kg/Hour)	29.4E-3	0.175	0.00	4.52	0.00	0.00	0.00

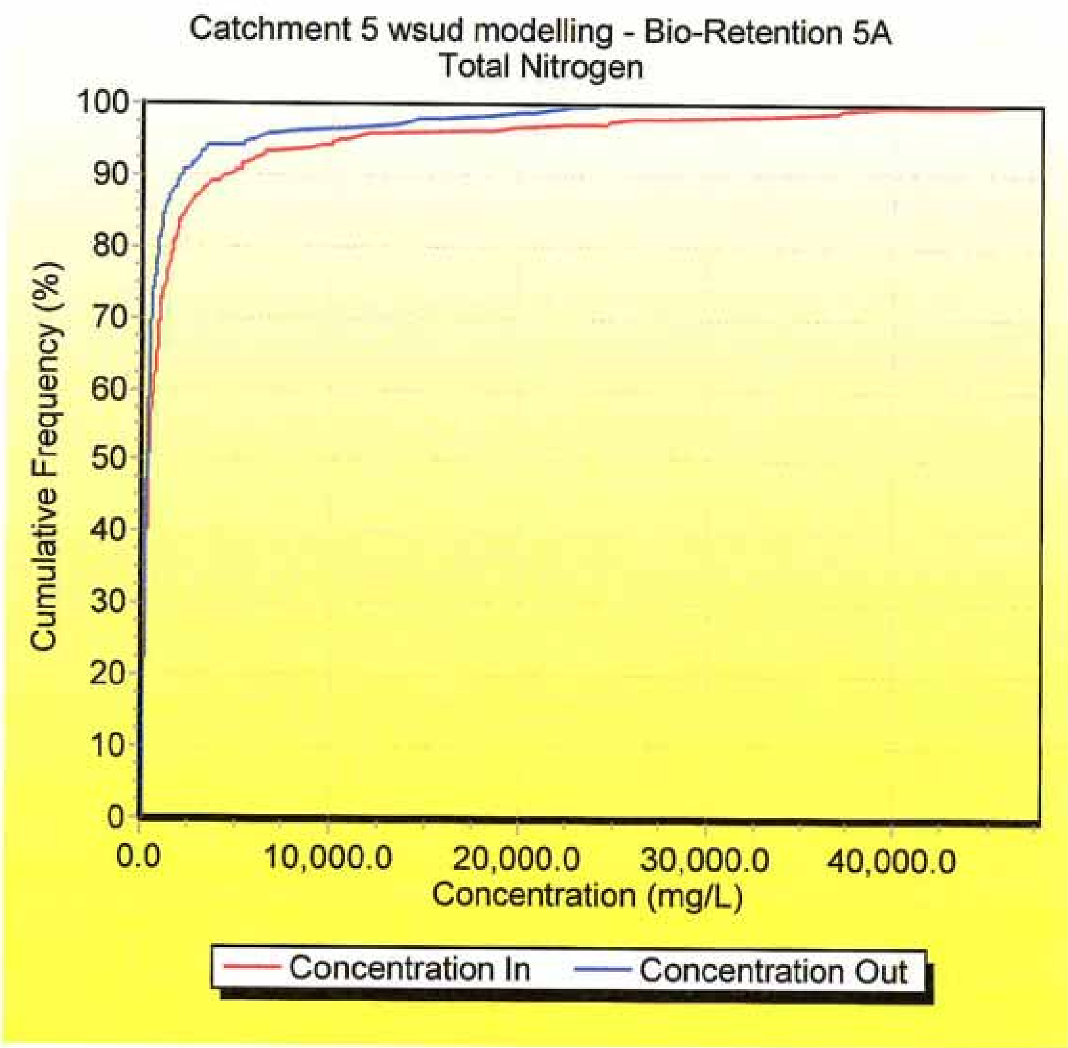
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.79E-3	25.9E-3	937E-6	0.908	4.95E-6	81.0E-6	4.17E-3
TSS Concentration (mg/L)	7.25	9.98	3.42	153	46.3E-3	0.161	15.7
Log [TSS] (mg/L)	0.371	0.806	0.535	2.18	-1.33	-0.792	1.20
TP Concentration (mg/L)	59.7E-3	42.5E-3	54.9E-3	0.315	3.41E-3	9.68E-3	0.108
Log [TP] (mg/L)	-1.38	0.423	-1.26	-0.502	-2.47	-2.01	-0.966
TN Concentration (mg/L)	0.754	0.386	0.713	3.12	0.264	0.387	1.19
Log [TN] (mg/L)	-0.168	0.192	-0.147	0.494	-0.579	-0.413	76.9E-3
TSS Load (kg/Hour)	0.660	9.05	11.6E-3	399	1.88E-6	53.4E-6	0.238
TP Load (kg/Hour)	2.30E-3	23.5E-3	186E-6	0.981	140E-9	3.15E-6	1.63E-3
TN Load (kg/Hour)	25.2E-3	0.241	2.28E-3	8.79	6.51E-6	117E-6	17.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 5 wsud modelling - Bio-Retention 5A
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
200,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 5 wsud modelling - Bio-Retention 5A
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500.0
1,000.0
1,500.0
2,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 5 wsud modelling - Bio-Retention 5A
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000.0
20,000.0
30,000.0
40,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Basin 5

8/04/2008 5:16:53 PM

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	119	22.2E3	46.8	342	3.06E3
Residual Load	110	2.32E3	12.3	158	0.00
% Reduction	7.4	89.5	73.8	53.6	100.0

Catchment 5 wsud modelling - Basin 5

All Data Statistics

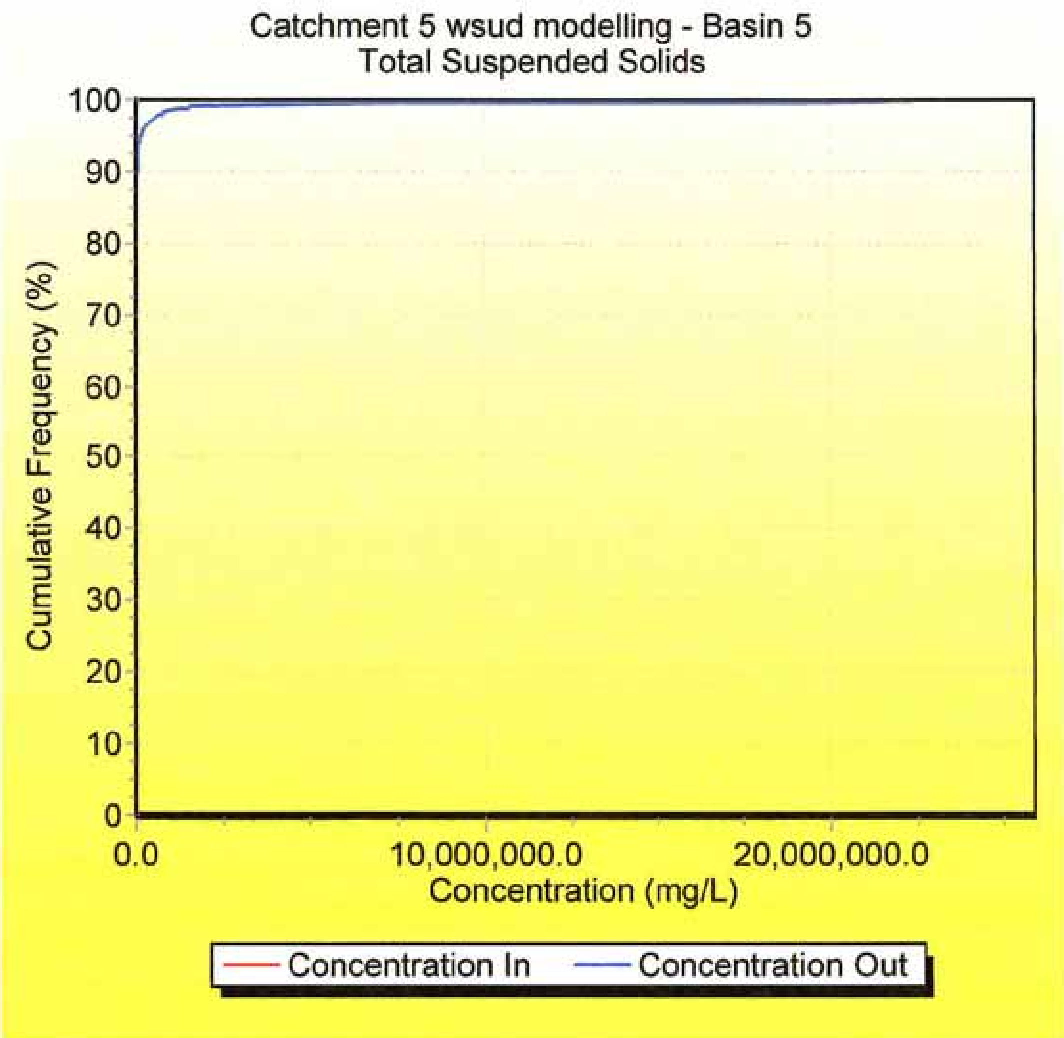
8/04/2008 5:16:44 PM

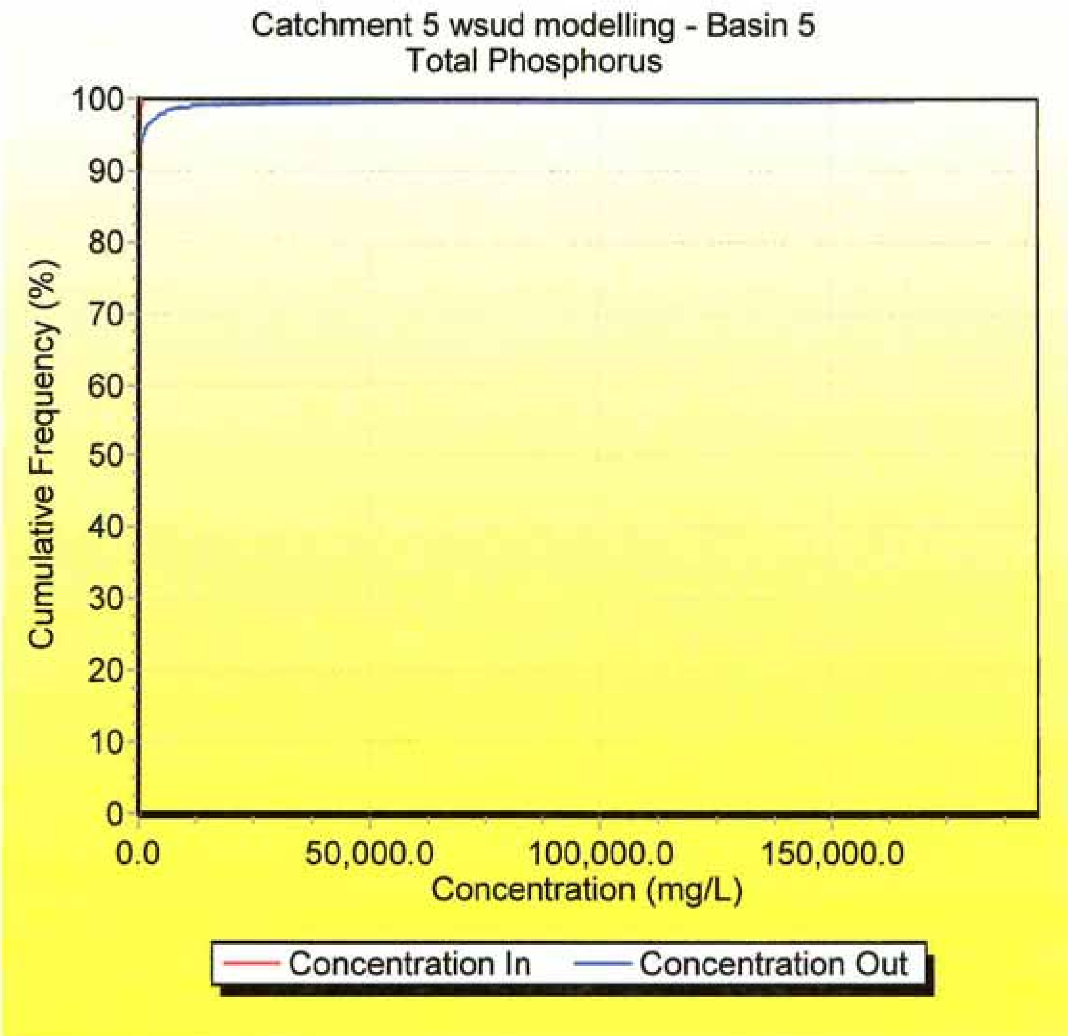
Inflow

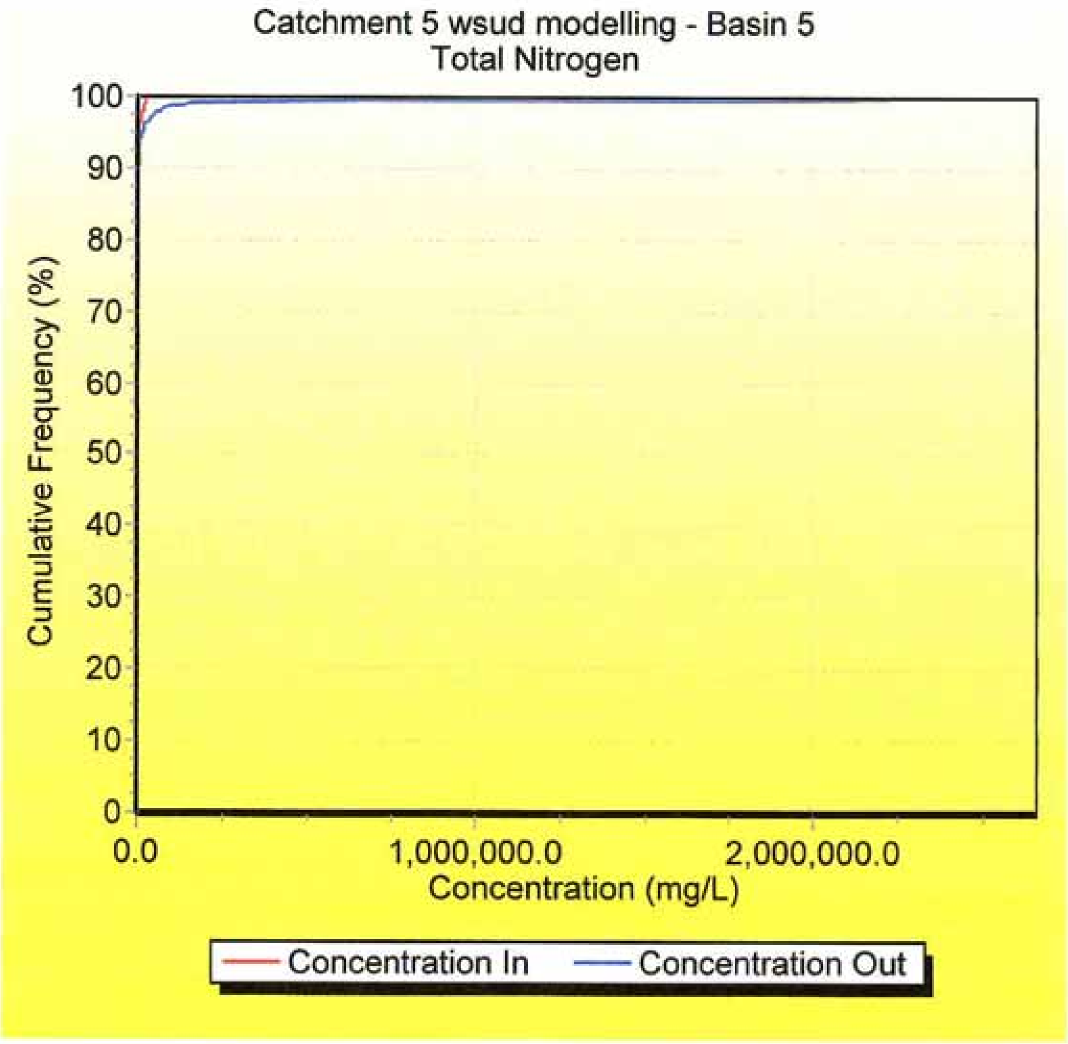
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.79E-3	25.9E-3	937E-6	0.908	4.95E-6	81.0E-6	4.17E-3
TSS Concentration (mg/L)	7.25	9.98	3.42	153	46.3E-3	0.161	15.7
Log [TSS] (mg/L)	0.371	0.806	0.535	2.18	-1.33	-0.792	1.20
TP Concentration (mg/L)	59.7E-3	42.5E-3	54.9E-3	0.315	3.41E-3	9.68E-3	0.108
Log [TP] (mg/L)	-1.38	0.423	-1.26	-0.502	-2.47	-2.01	-0.966
TN Concentration (mg/L)	0.754	0.386	0.713	3.12	0.264	0.387	1.19
Log [TN] (mg/L)	-0.168	0.192	-0.147	0.494	-0.579	-0.413	76.9E-3
TSS Load (kg/Hour)	0.660	9.05	11.6E-3	399	1.88E-6	53.4E-6	0.238
TP Load (kg/Hour)	2.30E-3	23.5E-3	186E-6	0.981	140E-9	3.15E-6	1.63E-3
TN Load (kg/Hour)	25.2E-3	0.241	2.28E-3	8.79	6.51E-6	117E-6	17.5E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.50E-3	13.2E-3	628E-6	0.179	0.00	0.00	4.31E-3
TSS Concentration (mg/L)	9.49	6.50	12.0	46.4	0.00	0.00	13.1
Log [TSS] (mg/L)	1.11	74.3E-3	1.08	1.67	1.08	1.08	1.14
TP Concentration (mg/L)	68.0E-3	42.0E-3	90.3E-3	0.161	0.00	0.00	94.6E-3
Log [TP] (mg/L)	-1.03	33.1E-3	-1.04	-0.795	-1.05	-1.04	-1.01
TN Concentration (mg/L)	0.897	0.581	1.09	2.22	0.00	0.00	1.44
Log [TN] (mg/L)	82.8E-3	73.0E-3	56.7E-3	0.346	95.6E-6	14.5E-3	0.187
TSS Load (kg/Hour)	0.265	1.54	27.4E-3	26.4	0.00	0.00	0.207
TP Load (kg/Hour)	1.40E-3	6.35E-3	205E-6	94.3E-3	0.00	0.00	1.48E-3
TN Load (kg/Hour)	18.1E-3	80.4E-3	2.65E-3	1.23	0.00	0.00	20.0E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Catchment 5 wsud modelling - Basin 5
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000,000.0
20,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 5 wsud modelling - Basin 5
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 5 wsud modelling - Basin 5
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
1,000,000.0
2,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Wetland 5

8/04/2008 5:15:11 PM

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	119	22.2E3	46.8	342	3.06E3
Residual Load	110	2.08E3	11.5	156	0.00
% Reduction	7.5	90.6	75.5	54.2	100.0

Catchment 5 wsud modelling - Wetland 5

All Data Statistics

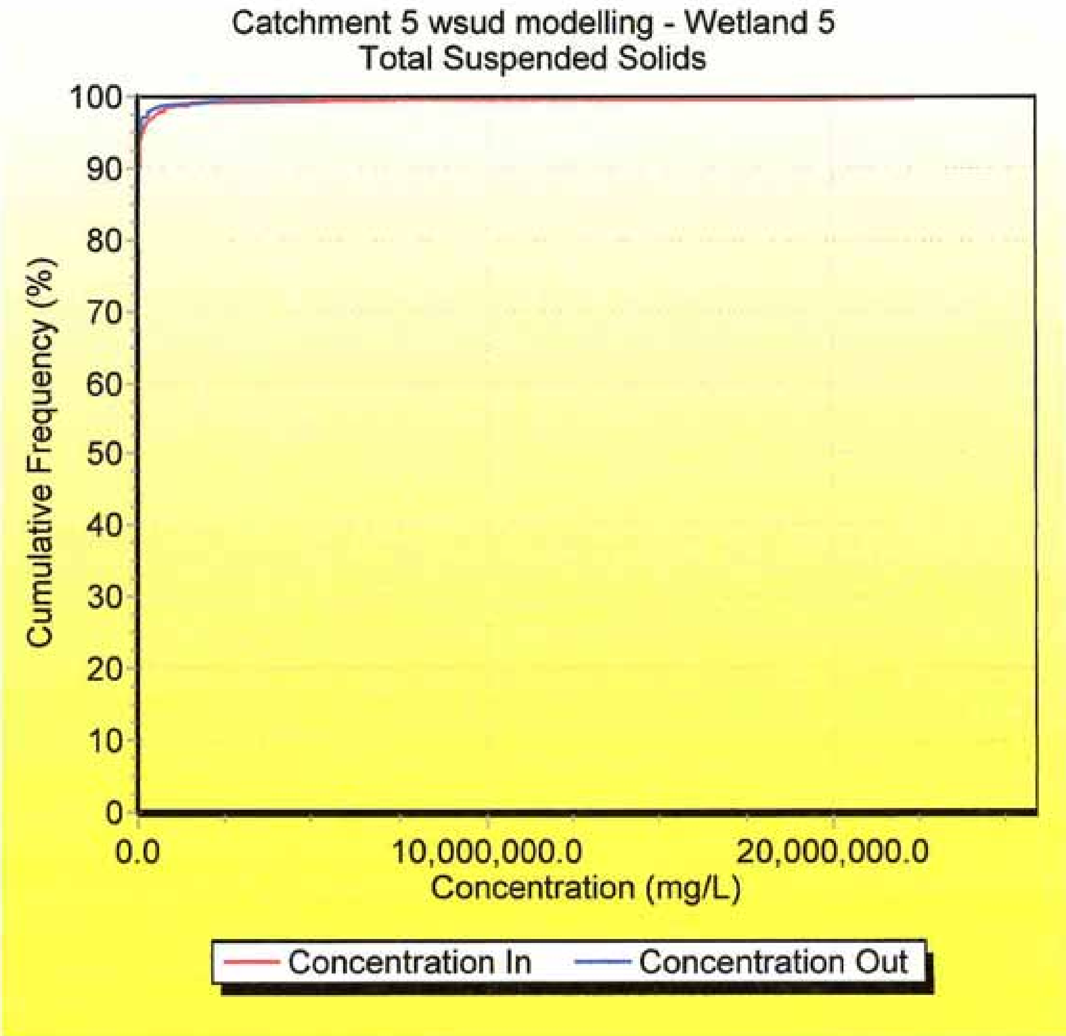
8/04/2008 5:14:54 PM

Inflow

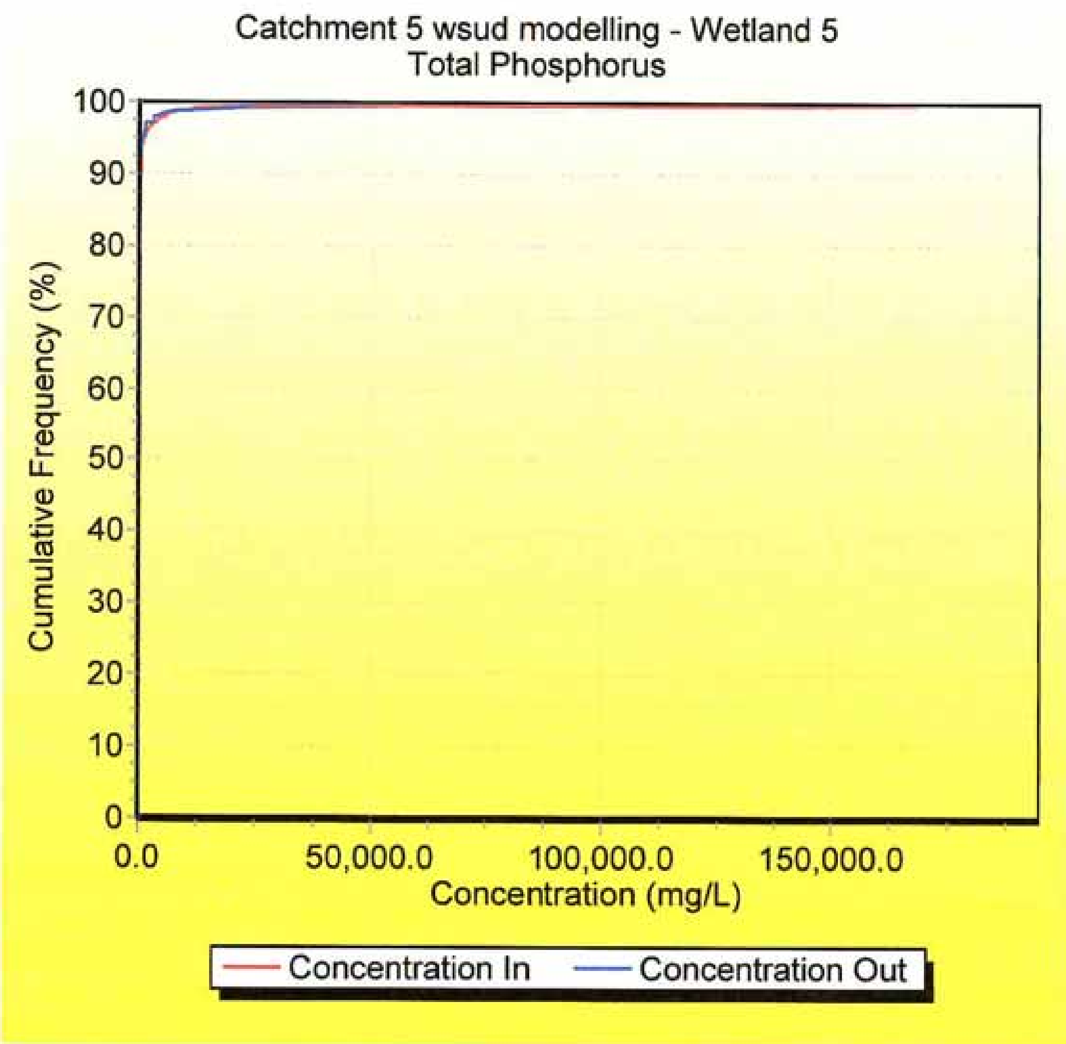
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.50E-3	13.2E-3	626E-6	0.179	0.00	0.00	4.31E-3
TSS Concentration (mg/L)	9.49	6.50	12.0	46.4	0.00	0.00	13.1
Log [TSS] (mg/L)	1.11	74.3E-3	1.08	1.67	1.08	1.08	1.14
TP Concentration (mg/L)	68.0E-3	42.0E-3	90.3E-3	0.161	0.00	0.00	94.6E-3
Log [TP] (mg/L)	-1.03	33.1E-3	-1.04	-0.795	-1.05	-1.04	-1.01
TN Concentration (mg/L)	0.897	0.581	1.09	2.22	0.00	0.00	1.44
Log [TN] (mg/L)	82.8E-3	73.0E-3	56.7E-3	0.346	95.6E-6	14.5E-3	0.187
TSS Load (kg/Hour)	0.265	1.54	27.4E-3	26.4	0.00	0.00	0.207
TP Load (kg/Hour)	1.40E-3	6.35E-3	205E-6	94.3E-3	0.00	0.00	1.48E-3
TN Load (kg/Hour)	18.1E-3	80.4E-3	2.65E-3	1.23	0.00	0.00	20.0E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

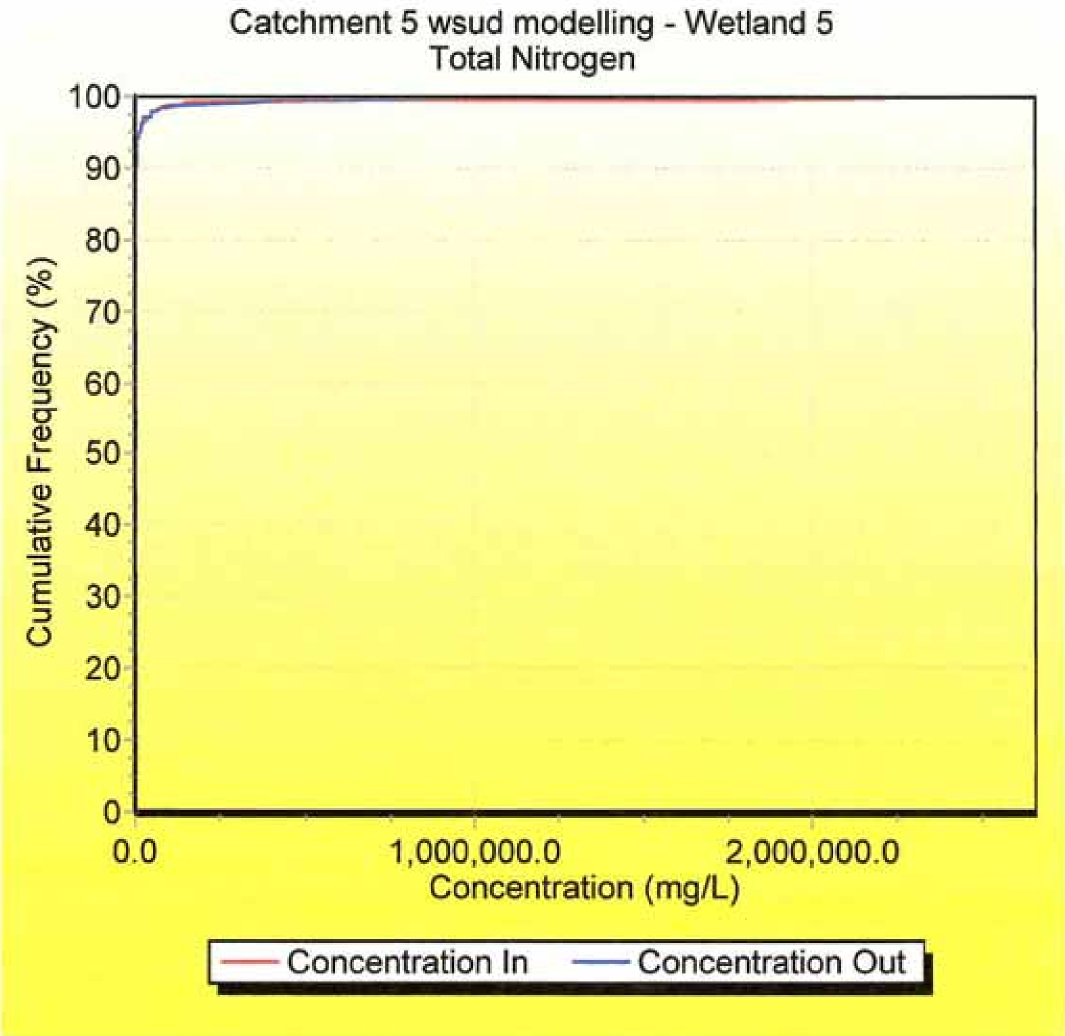
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.50E-3	13.2E-3	626E-6	0.181	0.00	0.00	4.30E-3
TSS Concentration (mg/L)	6.01	5.07	6.45	45.9	0.00	0.00	9.72
Log [TSS] (mg/L)	0.890	0.131	0.849	1.66	0.778	0.782	1.02
TP Concentration (mg/L)	52.8E-3	34.2E-3	64.7E-3	0.159	0.00	0.00	81.9E-3
Log [TP] (mg/L)	-1.15	68.2E-3	-1.16	-0.797	-1.22	-1.21	-1.07
TN Concentration (mg/L)	0.870	0.562	1.07	2.21	0.00	0.00	1.39
Log [TN] (mg/L)	71.0E-3	68.6E-3	45.6E-3	0.344	64.3E-6	10.1E-3	0.157
TSS Load (kg/Hour)	0.238	1.49	14.6E-3	25.9	0.00	0.00	0.154
TP Load (kg/Hour)	1.31E-3	6.23E-3	146E-6	92.3E-3	0.00	0.00	1.28E-3
TN Load (kg/Hour)	17.8E-3	79.5E-3	2.56E-3	1.22	0.00	0.00	19.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 5 wsud modelling - Wetland 5
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000,000.0
20,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 5 wsud modelling - Wetland 5
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 5 wsud modelling - Wetland 5
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
1,000,000.0
2,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban
ID,1,3,6,8,10,13,15,18,19,23,24,25,27
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),0.85,1.18,0.89,0.8,1.01,1.08,1.42,0.37,0.84,0.54,0.82,0.77,1.52
Area Impervious (ha),0.511603070175438,0.710225438596491,0.53567850877193,0.477964912280702,0.603430701754386,0.54,0.854678070175439,0.221058771929825,0.505584210526316,0.325018421052632,0.49354649122807,0.463452192982456,0.914866666666667
Area Pervious (ha),0.338396929824561,0.469774561403509,0.35432149122807,0.322035087719298,0.406569298245614,0.54,0.565321929824561,0.148941228070175,0.334415789473684,0.214981578947368,0.32645350877193,0.306547807017544,0.605133333333333
Field Capacity (mm),80,80,80,80,80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient - a,200,200,200,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120,120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19

Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow (ML/yr),8.44,11.7,8.84,7.95,10.0,9.77,14.1,3.68,8.35,5.36,8.15,7.65,15.1
OUT - TSS Mean Annual Load (kg/yr),1.60E3,2.10E3,1.75E3,1.56E3,1.89E3,1.55E3,2.76E3,776,1.65E3,1.11E3,1.42E3,1.35E3,2.66E3
OUT - TP Mean Annual Load (kg/yr),3.58,4.57,3.79,3.16,3.91,3.51,5.59,1.56,3.41,2.19,3.04,2.85,5.62
OUT - TN Mean Annual Load (kg/yr),24.6,35.0,26.0,21.3,28.5,29.6,38.7,11.1,23.3,14.9,23.0,20.4,45.1
OUT - Gross Pollutant Mean Annual Load (kg/yr),217,301,227,204,258,249,362,94.4,214,138,209,196,388

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention 5A,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Basin 5,Wetland 5
ID,2,4,5,7,9,11,12,14,16,17,20,21,22,26,28,29,30
Node Type,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,PondNode,WetlandNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate (cum/sec),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100,100
Inlet pond volume, , , , , , , , , , , , , , , ,0,0
Area (sqm),50,50,10,50,50,50,10,50,80,10,50,10,80,50,50,7275,50
Extended detention depth (m),0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,1.1,1
Permanent pool volume (cum), , , , , , , , , , , , , , , ,8000,50
Proportion vegetated, , , , , , , , , , , , , , , ,0.1,0.5
Equivalent pipe diameter (mm), , , , , , , , , , , , , , , ,300,200
Overflow weir width (m),2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,3
Notional Detention Time (hrs), , , , , , , , , , , , , , , ,10.1,0.149
Orifice discharge coefficient, , , , , , , , , , , , , , , ,0.6,0.6
Weir coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,2,5
Total Suspended Solids k (m/yr),8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,400,1500
Total Suspended Solids C* (mg/L),20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,12,6
Total Suspended Solids C** (mg/L), , , , , , , , , , , , , , , ,12,6
Total Phosphorus k (m/yr),6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,300,1000
Total Phosphorus C* (mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.09,0.06
Total Phosphorus C** (mg/L), , , , , , , , , , , , , , , ,0.09,0.06
Total Nitrogen k (m/yr),500,500,500,500,500,500,500,500,500,500,500,500,500,500,500,40,150

Total Nitrogen C*
(mg/L),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1,1
Total Nitrogen C** (mg/L), , , , , , , , , , , , , , , ,1,1
Threshold hydraulic loading for C** (m/yr), , , , , , , , , , , , , , , ,
,3500,3500
Extraction for
Re-use,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , , , , , , , , , , , , , , ,

Constant Daily Re-use Demand (kL), , , , , , , , , , , , , , , , ,
User-defined Annual Re-use Demand (ML), , , , , , , , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jan, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Feb, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Mar, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Apr, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand May, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Jun, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Jul, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Aug, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Sep, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Oct, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Nov, , , , , , , , , , , , , , ,
, ,
Percentage of User-defined Annual Re-use Demand Dec, , , , , , , , , , , , , , ,
, ,
Filter area (sqm),20,20,20,20,20,20,20,20,20,20,20,20,20,20,20, ,
Filter depth (m),1,1,1,1,1,1,1,1,1,1,1,1,1,1,1, ,
Filter median particle diameter (mm),5,5,5,5,5,5,5,5,5,5,5,5,5,5,5, ,
Saturated hydraulic conductivity
(mm/hr),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100, ,
Voids ratio,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3, ,
Length (m), , , , , , , , , , , , , , , , ,
Bed slope, , , , , , , , , , , , , , , , ,
Base Width (m), , , , , , , , , , , , , , , , ,
Top width (m), , , , , , , , , , , , , , , , ,
Vegetation height (m), , , , , , , , , , , , , , , , ,
Proportion of upstream impervious area treated, , , , , , , , , , , , , , , , ,
Seepage Rate (mm/hr),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Evap Loss as proportion of PET, , , , , , , , , , , , , , , ,1,1.25
Depth in metres below the drain pipe,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, ,
IN - Mean Annual Flow
(ML/yr),8.44,20.2,8.45,8.84,16.8,119,92.5,30.0,17.8,47.8,8.35,8.35,39.3,22.8,15.
1,119,110
IN - TSS Mean Annual Load
(kg/yr),1.60E3,2.36E3,350,1.75E3,1.97E3,6.91E3,4.61E3,2.40E3,3.54E3,2.18E3,1.65E
3,336,2.72E3,2.14E3,2.66E3,5.78E3,2.32E3
IN - TP Mean Annual Load
(kg/yr),3.58,5.71,1.41,3.79,4.63,21.3,15.1,6.67,7.16,7.58,3.41,1.28,7.61,5.36,5.
62,20.1,12.3
IN - TN Mean Annual Load
(kg/yr),24.6,48.7,16.7,26.0,39.4,227,176,69.0,49.9,95.0,23.3,16.1,81.9,54.6,45.1
,221,158
IN - Gross Pollutant Mean Annual Load
(kg/yr),217,301,0.00,227,204,258,138,249,457,0.00,214,0.00,209,196,388,0.00,0.00
OUT - Mean Annual Flow
(ML/yr),8.45,20.2,8.46,8.85,16.8,119,92.5,30.0,17.8,47.8,8.35,8.36,39.3,22.8,15.
1,110,110
OUT - TSS Mean Annual Load

(kg/yr),350,854,262,414,744,5.78E3,4.27E3,1.24E3,944,2.01E3,336,254,1.49E3,1.05E3,793,2.32E3,2.08E3
OUT - TP Mean Annual Load
(kg/yr),1.41,3.17,1.14,1.47,2.54,20.1,14.8,4.60,2.98,7.25,1.28,1.05,5.69,3.52,2.51,12.3,11.5
OUT - TN Mean Annual Load
(kg/yr),16.7,39.4,13.7,18.1,30.9,221,168,59.0,36.0,88.1,16.1,13.3,72.6,45.5,34.3,158,156
OUT - Gross Pollutant Mean Annual Load
(kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

No Other nodes

Links
Location,Drainage Link
Source node
ID,1,2,5,3,6,8,7,9,10,12,13,4,15,14,16,17,18,19,20,21,22,23,24,25,26,27,28,11,29
Target node
ID,2,5,4,4,7,9,9,11,11,11,14,14,16,17,17,12,16,20,21,22,12,12,22,26,22,28,26,29,30
Muskingum-Cunge Routing,Not Routed
Muskingum K, ,
Muskingum theta, ,
IN - Mean Annual Flow
(ML/yr),8.44,8.45,8.46,11.7,8.84,7.95,8.85,16.8,10.0,92.5,9.77,20.2,14.1,30.0,17.8,47.8,3.68,8.35,8.35,8.36,39.3,5.36,8.15,7.65,22.8,15.1,15.1,119,110
IN - TSS Mean Annual Load
(kg/yr),1.60E3,350,262,2.10E3,1.75E3,1.56E3,414,744,1.89E3,4.27E3,1.55E3,854,2.76E3,1.24E3,944,2.01E3,776,1.65E3,336,254,1.49E3,1.11E3,1.42E3,1.35E3,1.05E3,2.66E3,793,5.78E3,2.32E3
IN - TP Mean Annual Load
(kg/yr),3.58,1.41,1.14,4.57,3.79,3.16,1.47,2.54,3.91,14.8,3.51,3.17,5.59,4.60,2.98,7.25,1.56,3.41,1.28,1.05,5.69,2.19,3.04,2.85,3.52,5.62,2.51,20.1,12.3
IN - TN Mean Annual Load
(kg/yr),24.6,16.7,13.7,35.0,26.0,21.3,18.1,30.9,28.5,168,29.6,39.4,38.7,59.0,36.0,88.1,11.1,23.3,16.1,13.3,72.6,14.9,23.0,20.4,45.5,45.1,34.3,221,158
IN - Gross Pollutant Mean Annual Load
(kg/yr),217,0.00,0.00,301,227,204,0.00,0.00,258,0.00,249,0.00,362,0.00,0.00,0.00,94.4,214,0.00,0.00,0.00,138,209,196,0.00,388,0.00,0.00,0.00
OUT - Mean Annual Flow
(ML/yr),8.44,8.45,8.46,11.7,8.84,7.95,8.85,16.8,10.0,92.5,9.77,20.2,14.1,30.0,17.8,47.8,3.68,8.35,8.35,8.36,39.3,5.36,8.15,7.65,22.8,15.1,15.1,119,110
OUT - TSS Mean Annual Load
(kg/yr),1.60E3,350,262,2.10E3,1.75E3,1.56E3,414,744,1.89E3,4.27E3,1.55E3,854,2.76E3,1.24E3,944,2.01E3,776,1.65E3,336,254,1.49E3,1.11E3,1.42E3,1.35E3,1.05E3,2.66E3,793,5.78E3,2.32E3
OUT - TP Mean Annual Load
(kg/yr),3.58,1.41,1.14,4.57,3.79,3.16,1.47,2.54,3.91,14.8,3.51,3.17,5.59,4.60,2.98,7.25,1.56,3.41,1.28,1.05,5.69,2.19,3.04,2.85,3.52,5.62,2.51,20.1,12.3
OUT - TN Mean Annual Load
(kg/yr),24.6,16.7,13.7,35.0,26.0,21.3,18.1,30.9,28.5,168,29.6,39.4,38.7,59.0,36.0,88.1,11.1,23.3,16.1,13.3,72.6,14.9,23.0,20.4,45.5,45.1,34.3,221,158
OUT - Gross Pollutant Mean Annual Load
(kg/yr),217,0.00,0.00,301,227,204,0.00,0.00,258,0.00,249,0.00,362,0.00,0.00,0.00,94.4,214,0.00,0.00,0.00,138,209,196,0.00,388,0.00,0.00,0.00

Catchment 6

Bio-Retention 6A

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Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	108	20.9E3	43.0	304	2.77E3
Residual Load	108	4.24E3	16.7	191	0.00
% Reduction	-0.2	79.7	61.1	37.4	100.0

Catchment 6 wsud modelling - Bio-Retention 6A

All Data Statistics

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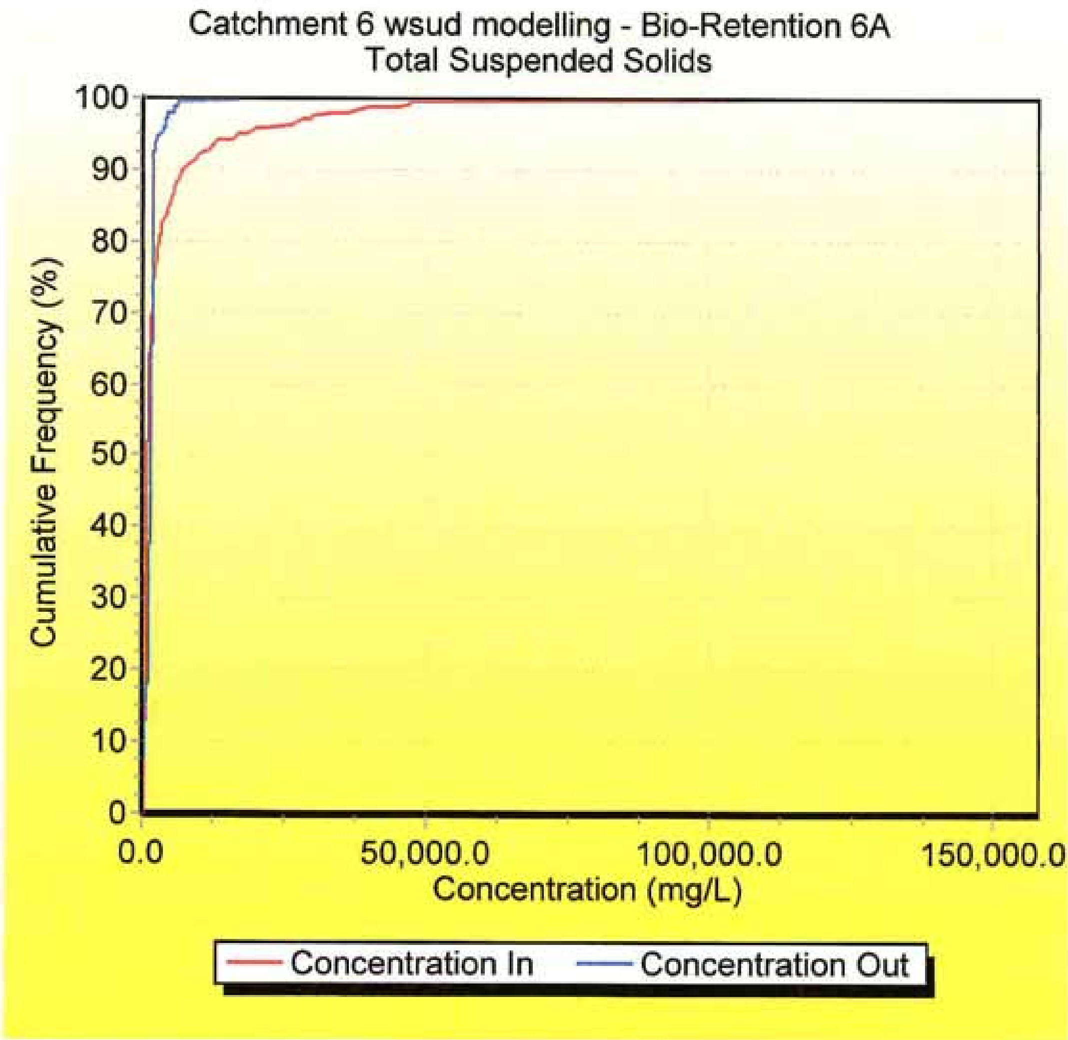
Inflow

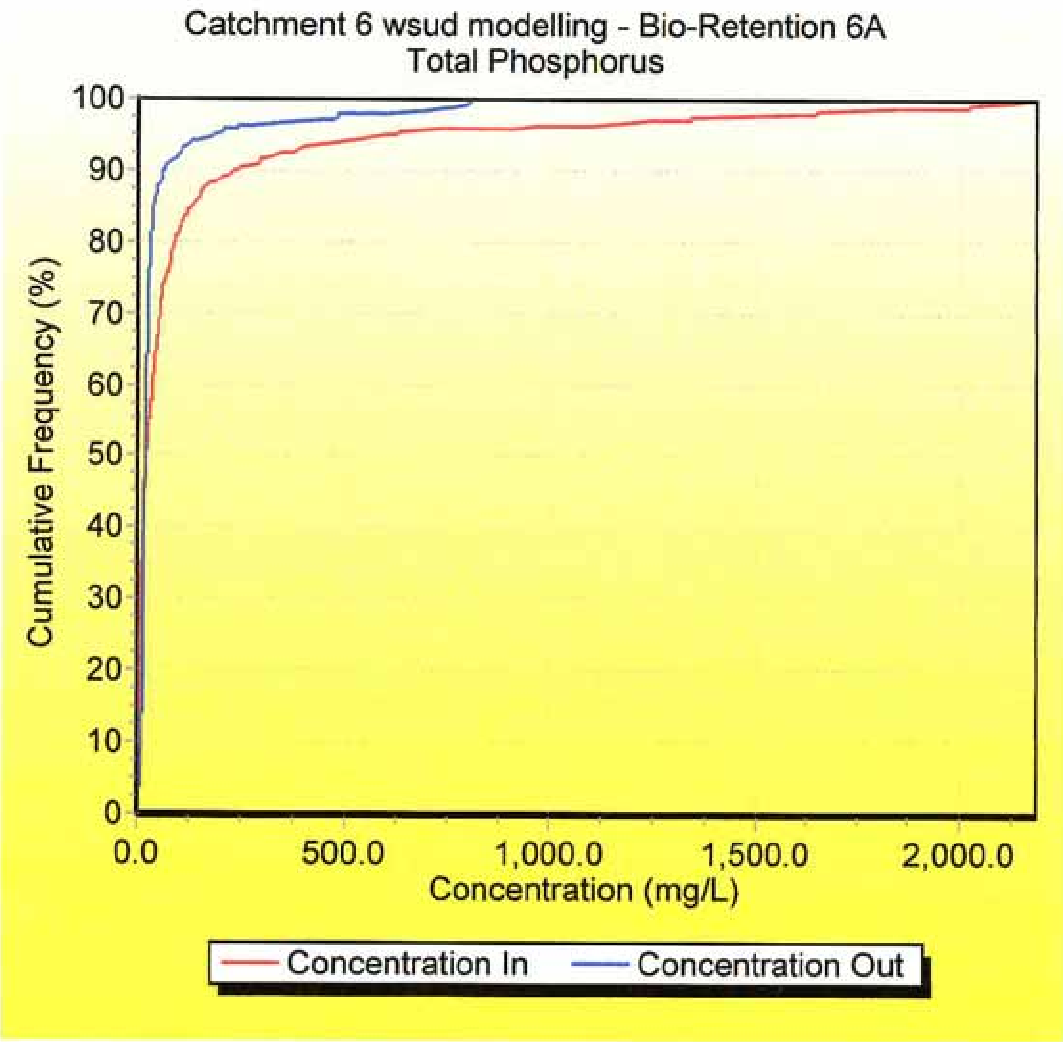
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.42E-3	22.8E-3	732E-6	0.839	4.29E-6	51.7E-6	4.83E-3
TSS Concentration (mg/L)	4.31	8.49	0.738	151	66.2E-3	0.469	10.8
Log [TSS] (mg/L)	0.219	0.570	-0.132	2.18	-1.18	-0.329	1.03
TP Concentration (mg/L)	48.5E-3	32.1E-3	34.0E-3	0.334	10.6E-3	23.3E-3	87.2E-3
Log [TP] (mg/L)	-1.38	0.234	-1.47	-0.476	-1.97	-1.63	-1.06
TN Concentration (mg/L)	0.885	0.288	0.798	3.97	0.476	0.714	1.15
Log [TN] (mg/L)	-68.1E-3	0.103	-97.9E-3	0.598	-0.322	-0.146	59.0E-3
TSS Load (kg/Hour)	0.529	8.33	1.61E-3	456	5.53E-6	98.0E-6	0.186
TP Load (kg/Hour)	1.88E-3	20.8E-3	75.7E-6	0.923	327E-9	4.96E-6	1.51E-3
TN Load (kg/Hour)	22.5E-3	0.215	2.06E-3	8.76	9.99E-6	142E-6	19.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

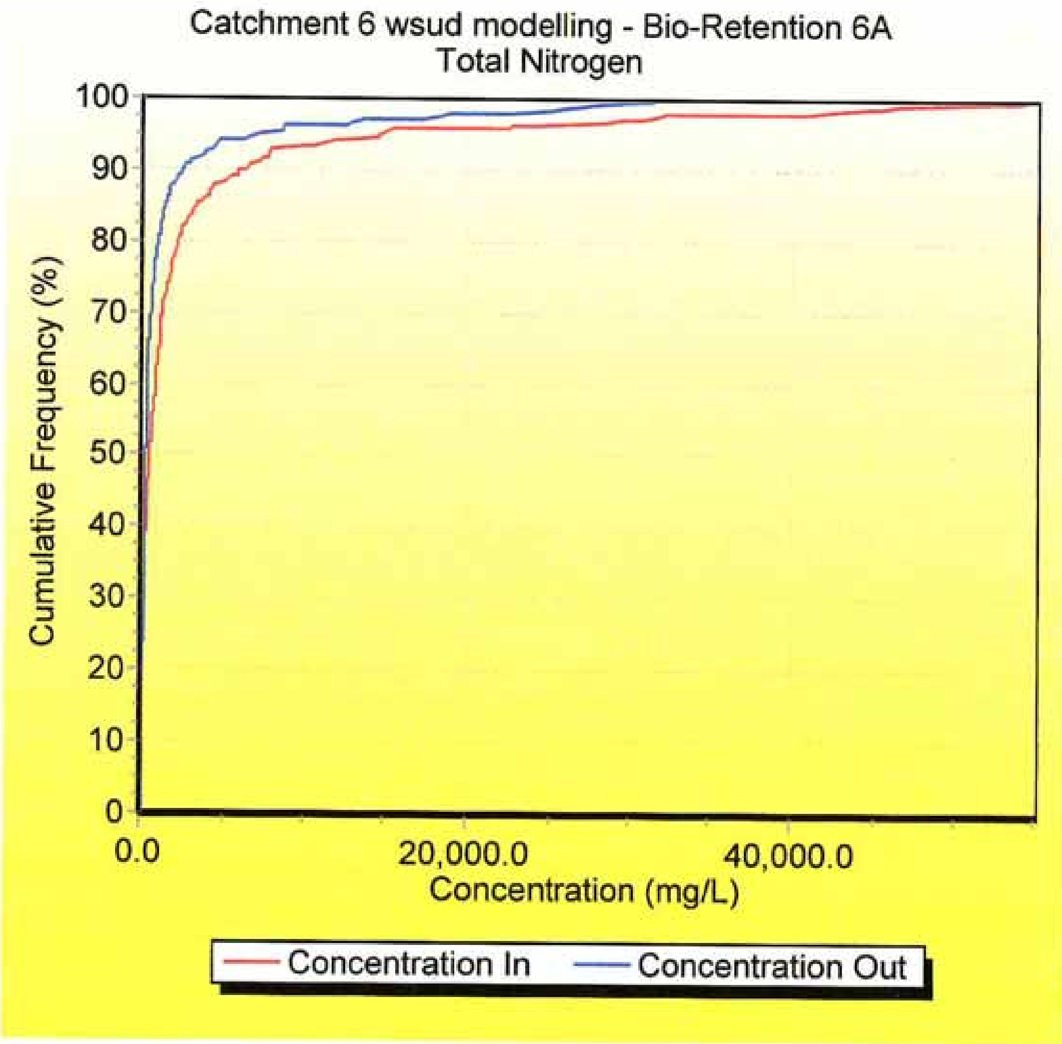
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.42E-3	22.8E-3	878E-6	0.853	4.31E-6	76.7E-6	4.76E-3
TSS Concentration (mg/L)	6.53	8.18	3.33	138	37.9E-3	73.5E-3	16.1
Log [TSS] (mg/L)	0.259	0.931	0.523	2.14	-1.42	-1.13	1.21
TP Concentration (mg/L)	58.7E-3	39.9E-3	54.4E-3	0.297	6.29E-3	9.80E-3	0.111
Log [TP] (mg/L)	-1.38	0.412	-1.26	-0.528	-2.20	-2.01	-0.954
TN Concentration (mg/L)	0.804	0.337	0.788	3.37	0.376	0.452	1.14
Log [TN] (mg/L)	-0.126	0.162	-0.103	0.528	-0.425	-0.345	57.7E-3
TSS Load (kg/Hour)	0.478	7.38	10.6E-3	423	934E-9	21.4E-6	0.278
TP Load (kg/Hour)	1.87E-3	19.4E-3	172E-6	0.911	133E-9	2.83E-6	1.91E-3
TN Load (kg/Hour)	21.7E-3	0.207	2.46E-3	8.51	6.18E-6	128E-6	19.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 6 wsud modelling - Bio-Retention 6A
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
50,000.0
100,000.0
150,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 6 wsud modelling - Bio-Retention 6A
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
500.0
1,000.0
1,500.0
2,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 6 wsud modelling - Bio-Retention 6A
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
20,000.0
40,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Basin 6

8/04/2008 4:21:47 P

Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	108	19.6E3	41.2	305	2.77E3
Residual Load	99.4	1.96E3	10.8	139	0.00
% Reduction	7.7	90.0	73.8	54.4	100.0

Catchment 6 wsud modelling - Basin 6

All Data Statistics

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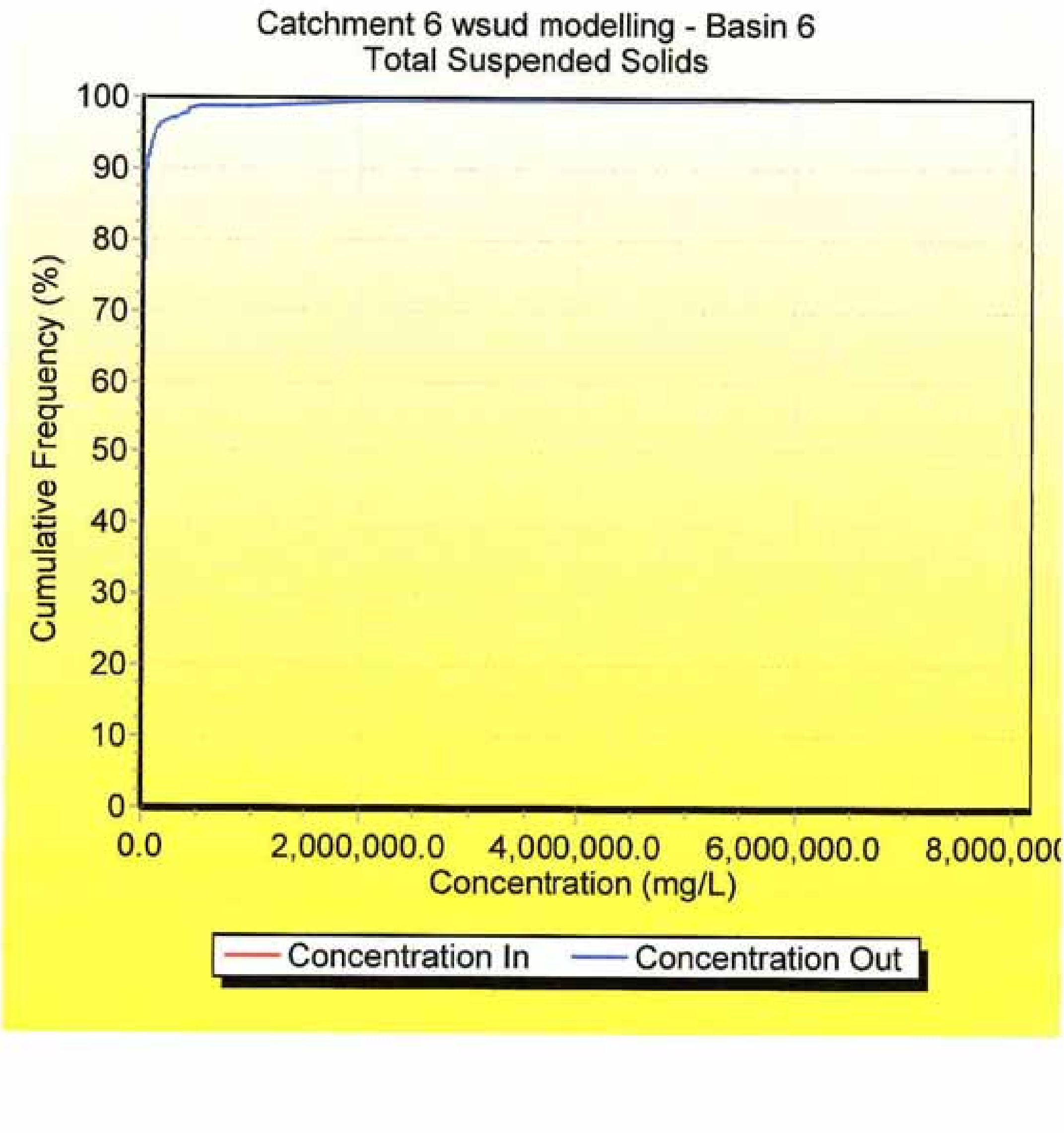
Inflow

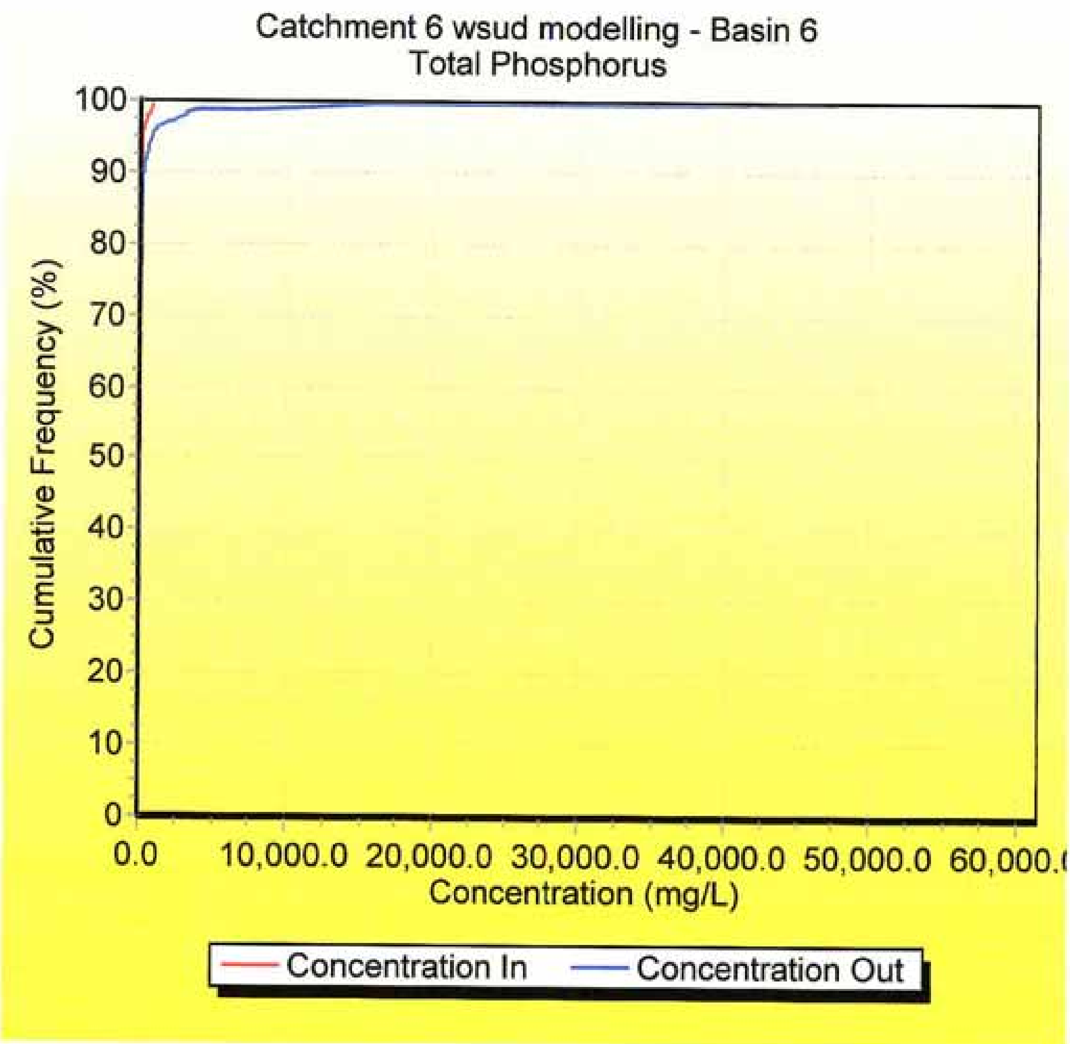
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.42E-3	22.8E-3	878E-6	0.853	4.31E-6	76.7E-6	4.76E-3
TSS Concentration (mg/L)	6.53	8.18	3.33	138	37.9E-3	73.5E-3	16.1
Log [TSS] (mg/L)	0.259	0.931	0.523	2.14	-1.42	-1.13	1.21
TP Concentration (mg/L)	58.7E-3	39.9E-3	54.4E-3	0.297	6.29E-3	9.80E-3	0.111
Log [TP] (mg/L)	-1.38	0.412	-1.26	-0.528	-2.20	-2.01	-0.954
TN Concentration (mg/L)	0.804	0.337	0.788	3.37	0.376	0.452	1.14
Log [TN] (mg/L)	-0.126	0.162	-0.103	0.528	-0.425	-0.345	57.7E-3
TSS Load (kg/Hour)	0.478	7.38	10.6E-3	423	934E-9	21.4E-6	0.278
TP Load (kg/Hour)	1.87E-3	19.4E-3	172E-6	0.911	133E-9	2.83E-6	1.91E-3
TN Load (kg/Hour)	21.7E-3	0.207	2.46E-3	8.51	6.18E-6	128E-6	19.7E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

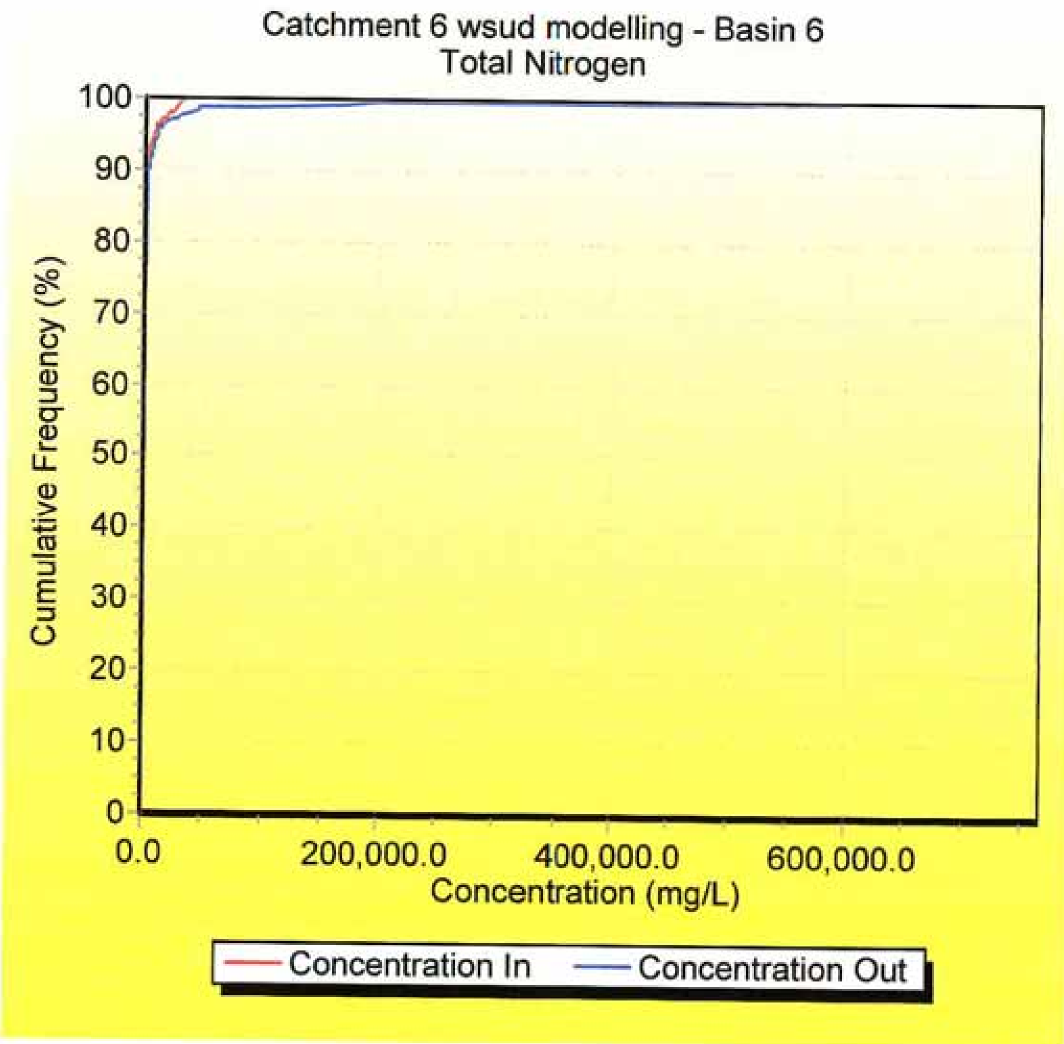
Outflow

	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.15E-3	12.1E-3	596E-6	0.172	0.00	0.00	4.75E-3
TSS Concentration (mg/L)	9.39	6.16	12.0	45.5	0.00	0.00	12.6
Log [TSS] (mg/L)	1.10	63.9E-3	1.08	1.66	1.08	1.08	1.12
TP Concentration (mg/L)	68.2E-3	41.2E-3	90.3E-3	0.155	0.00	0.00	93.1E-3
Log [TP] (mg/L)	-1.03	28.9E-3	-1.04	-0.809	-1.05	-1.04	-1.02
TN Concentration (mg/L)	0.888	0.561	1.08	2.07	0.00	0.00	1.42
Log [TN] (mg/L)	75.0E-3	68.2E-3	49.1E-3	0.317	105E-6	11.6E-3	0.173
TSS Load (kg/Hour)	0.223	1.34	25.9E-3	24.5	0.00	0.00	0.220
TP Load (kg/Hour)	1.23E-3	5.64E-3	194E-6	87.0E-3	0.00	0.00	1.62E-3
TN Load (kg/Hour)	15.9E-3	70.7E-3	2.49E-3	1.11	0.00	0.00	21.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 6 wsud modelling - Basin 6
Total Suspended Solids
100
90
80
70
60
50
40
30
20
10
0
Cumulative Frequency (%)
0.0
2,000,000.0
4,000,000.0
6,000,000.0
8,000,00
Concentration (mg/L)
Concentration In
Concentration Out


Catchment 6 wsud modelling - Basin 6
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000.0
20,000.0
30,000.0
40,000.0
50,000.0
60,000.
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 6 wsud modelling - Basin 6
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Wetland 6

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Treatment Train Effectiveness

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	108	19.6E3	41.2	305	2.77E3
Residual Load	99.3	1.74E3	10.0	137	0.00
% Reduction	7.8	91.1	75.7	55.0	100.0

Catchment 6 wsud modelling - Wetland 6

All Data Statistics

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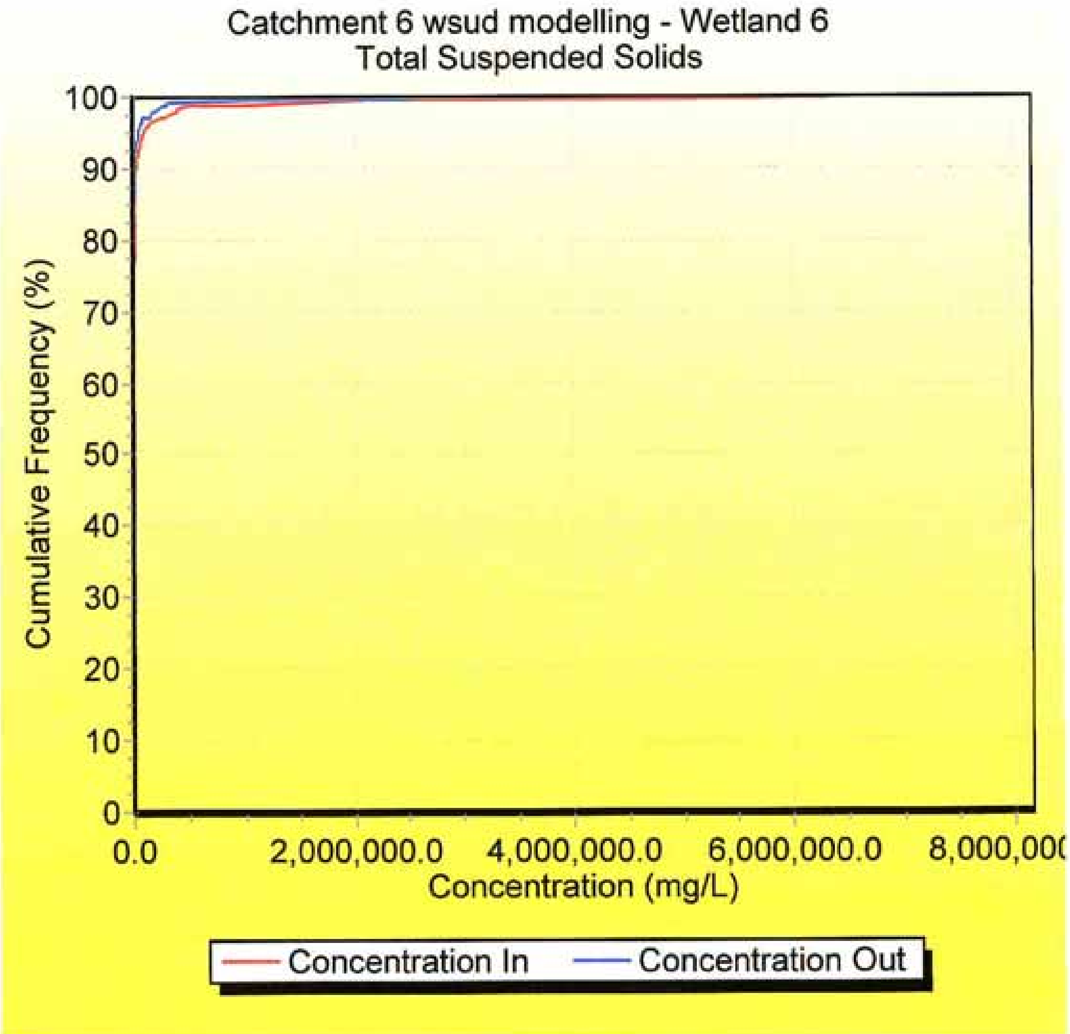
Inflow

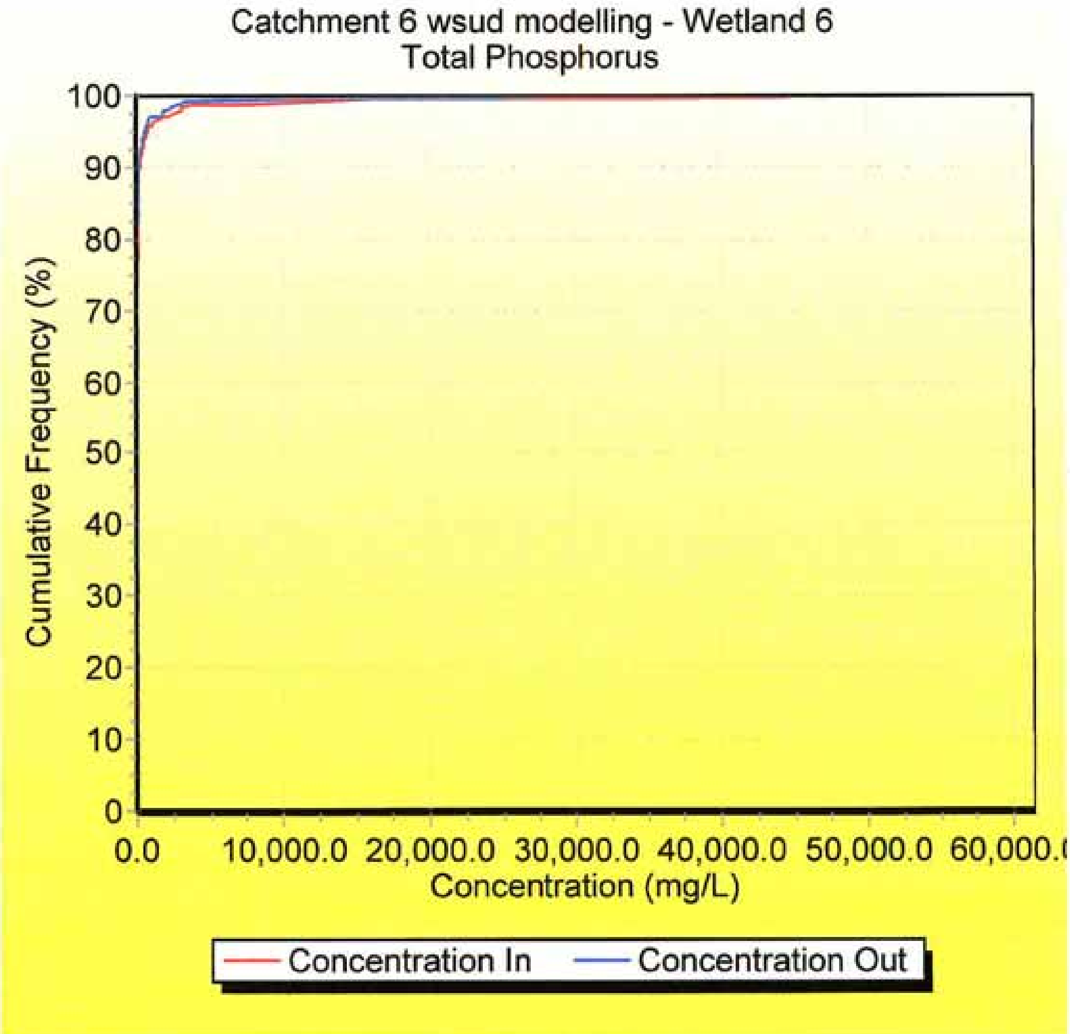
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.15E-3	12.1E-3	596E-6	0.172	0.00	0.00	4.75E-3
TSS Concentration (mg/L)	9.39	6.16	12.0	45.5	0.00	0.00	12.6
Log [TSS] (mg/L)	1.10	63.9E-3	1.08	1.66	1.08	1.08	1.12
TP Concentration (mg/L)	68.2E-3	41.2E-3	90.3E-3	0.155	0.00	0.00	93.1E-3
Log [TP] (mg/L)	-1.03	28.9E-3	-1.04	-0.809	-1.05	-1.04	-1.02
TN Concentration (mg/L)	0.888	0.561	1.08	2.07	0.00	0.00	1.42
Log [TN] (mg/L)	75.0E-3	68.2E-3	49.1E-3	0.317	105E-6	11.6E-3	0.173
TSS Load (kg/Hour)	0.223	1.34	25.9E-3	24.5	0.00	0.00	0.220
TP Load (kg/Hour)	1.23E-3	5.64E-3	194E-6	87.0E-3	0.00	0.00	1.62E-3
TN Load (kg/Hour)	15.9E-3	70.7E-3	2.49E-3	1.11	0.00	0.00	21.1E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outflow

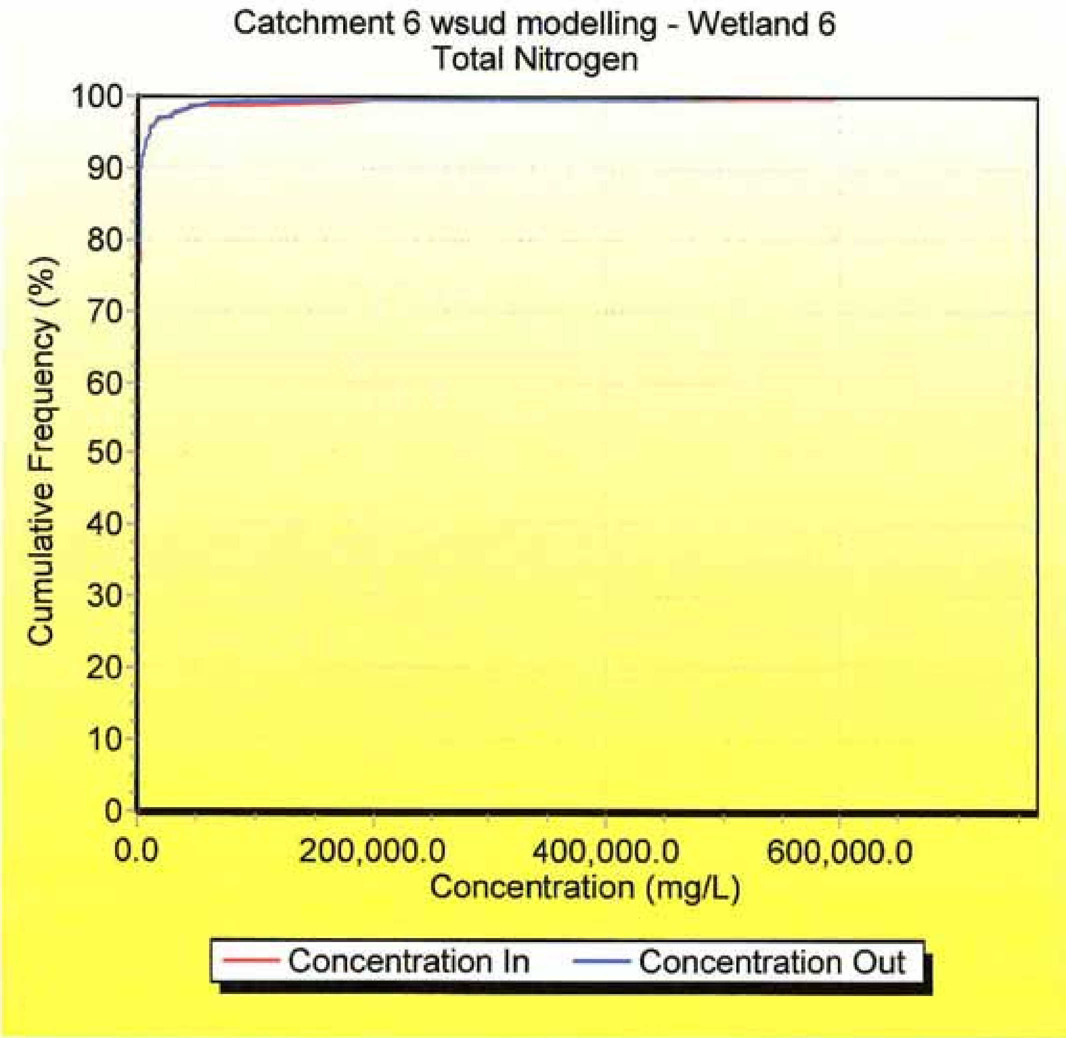
	mean	stddev	median	maximum	minimum	10 %ile	90 %ile
Flow (cubic metres/sec)	3.15E-3	12.1E-3	593E-6	0.175	0.00	0.00	4.76E-3
TSS Concentration (mg/L)	5.89	4.70	6.40	45.0	0.00	0.00	9.55
Log [TSS] (mg/L)	0.881	0.121	0.842	1.65	0.778	0.782	1.00
TP Concentration (mg/L)	52.7E-3	33.4E-3	64.3E-3	0.154	0.00	0.00	81.4E-3
Log [TP] (mg/L)	-1.15	65.0E-3	-1.17	-0.812	-1.22	-1.22	-1.08
TN Concentration (mg/L)	0.864	0.544	1.06	2.06	0.00	0.00	1.35
Log [TN] (mg/L)	64.3E-3	64.4E-3	37.9E-3	0.314	64.2E-6	8.36E-3	0.154
TSS Load (kg/Hour)	0.199	1.29	13.7E-3	24.1	0.00	0.00	0.169
TP Load (kg/Hour)	1.14E-3	5.53E-3	138E-6	85.6E-3	0.00	0.00	1.43E-3
TN Load (kg/Hour)	15.7E-3	69.8E-3	2.40E-3	1.11	0.00	0.00	20.9E-3
Gross Pollutant Load (kg/Hour)	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Catchment 6 wsud modelling - Wetland 6
Total Suspended Solids
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
2,000,000.0
4,000,000.0
6,000,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 6 wsud modelling - Wetland 6
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
10,000.0
20,000.0
30,000.0
40,000.0
50,000.0
Concentration (mg/L)
Concentration In
Concentration Out



Catchment 6 wsud modelling - Wetland 6
Total Nitrogen
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
0.0
200,000.0
400,000.0
600,000.0
Concentration (mg/L)
Concentration In
Concentration Out

Source nodes
Location,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban,Urban
ID,1,3,5,7,10,12,16,18,20,22
Node
Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSource
Node
Total Area (ha),0.76,0.49,0.6,1.06,0.99,1.64,1.64,1.14,1.35,1.17
Area Impervious
(ha),0.457433333333333,0.294924122807018,0.361131578947368,0.637999122807018,0.5
95867105263158,0.98709298245614,0.98709298245614,0.68615,0.806565789473684,0.699
023684210526
Area Pervious
(ha),0.302566666666667,0.195075877192982,0.238868421052632,0.422000877192982,0.3
94132894736842,0.65290701754386,0.652907017543859,0.45385,0.543434210526316,0.47
0976315789474
Field Capacity (mm),80,80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient -
a,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log
mg/L),2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2,2.2
Stormflow Total Suspended Solids Standard Deviation (log
mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log
mg/L),-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45,-0.45
Stormflow Total Phosphorus Standard Deviation (log
mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log
mg/L),0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log
mg/L),1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log
mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log
mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log
mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log

mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log
mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochas
tic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow (ML/yr),7.55,4.87,5.96,10.5,9.84,16.3,16.3,11.3,13.4,11.6
OUT - TSS Mean Annual Load
(kg/yr),1.46E3,931,1.25E3,1.75E3,1.82E3,2.88E3,2.87E3,2.13E3,2.30E3,2.22E3
OUT - TP Mean Annual Load
(kg/yr),3.00,1.85,2.42,3.98,3.90,6.26,5.90,4.42,5.02,4.44
OUT - TN Mean Annual Load
(kg/yr),21.8,14.6,16.0,29.2,26.3,45.4,45.9,33.0,37.3,35.3
OUT - Gross Pollutant Mean Annual Load
(kg/yr),194,125,153,270,253,418,418,291,344,299

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,B
io-Retention,Bio-Retention,Bio-Retention
6A,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Bio-Retention,Basin
6,Wetland 6
ID,2,4,6,8,9,11,13,14,15,17,19,21,23,24,25
Node
Type,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRete
ntionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,Bi
oRetentionNode,BioRetentionNode,BioRetentionNode,BioRetentionNode,PondNode,Wetla
ndNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate
(cum/sec),100,100,100,100,100,100,100,100,100,100,100,100,100,100,100
Inlet pond volume, , , , , , , , , , , , , ,0,0
Area (sqm),50,80,80,50,80,50,50,80,10,80,80,80,80,6800,50
Extended detention depth
(m),0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,0.8,1,1
Permanent pool volume (cum), , , , , , , , , , , , , ,6800,50
Proportion vegetated, , , , , , , , , , , , , ,0.1,0.5
Equivalent pipe diameter (mm), , , , , , , , , , , , , ,300,200
Overflow weir width (m),2,2,2,2,2,2,2,2,2,2,2,2,2,2,3
Notional Detention Time (hrs), , , , , , , , , , , , , ,9.01,0.149
Orifice discharge coefficient, , , , , , , , , , , , , ,0.6,0.6
Weir coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR cells,3,3,3,3,3,3,3,3,3,3,3,3,3,2,5
Total Suspended Solids k
(m/yr),8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,8000,400,1500
Total Suspended Solids C* (mg/L),20,20,20,20,20,20,20,20,20,20,20,20,20,12,6
Total Suspended Solids C** (mg/L), , , , , , , , , , , , , ,12,6
Total Phosphorus k
(m/yr),6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,6000,300,1000
Total Phosphorus C*
(mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.09,0.0
6
Total Phosphorus C** (mg/L), , , , , , , , , , , , , ,0.09,0.06
Total Nitrogen k
(m/yr),500,500,500,500,500,500,500,500,500,500,500,500,500,40,150
Total Nitrogen C* (mg/L),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1,1
Total Nitrogen C** (mg/L), , , , , , , , , , , , , ,1,1
Threshold hydraulic loading for C** (m/yr), , , , , , , , , , , , , ,3500,3500
Extraction for
Re-use,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , , , , , , , , , , , , ,
Constant Daily Re-use Demand (kL), , , , , , , , , , , , , , ,
User-defined Annual Re-use Demand (ML), , , , , , , , , , , , , , ,
Percentage of User-defined Annual Re-use Demand Jan, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Feb, , , , , , , , , , , , , , , Percentage of User-defined Annual Re-use Demand Mar, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Apr, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand May, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Jun, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Jul, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Aug, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Sep, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Oct, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Nov, , , , , , , , , , , , , , ,

Percentage of User-defined Annual Re-use Demand Dec, , , , , , , , , , , , , , ,

Filter area (sqm),20,20,20,20,20,20,20,20,20,20,20,20,20, ,
Filter depth (m),1,1,1,1,1,1,1,1,1,1,1,1,1, ,
Filter median particle diameter (mm),5,5,5,5,5,5,5,5,5,5,5,5,5, ,
Saturated hydraulic conductivity
(mm/hr),100,100,100,100,100,100,100,100,100,100,100,100,100, ,
Voids ratio,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3, ,
Length (m), , , , , , , , , , , , , , ,
Bed slope, , , , , , , , , , , , , , ,
Base Width (m), , , , , , , , , , , , , , ,
Top width (m), , , , , , , , , , , , , , ,
Vegetation height (m), , , , , , , , , , , , , , ,
Proportion of upstream impervious area treated, , , , , , , , , , , , , , ,
Seepage Rate (mm/hr),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Evap Loss as proportion of PET, , , , , , , , , , , , , ,1,1.25
Depth in metres below the drain pipe,0,0,0,0,0,0,0,0,0,0,0,0,0, ,
IN - Mean Annual Flow
(ML/yr),7.55,18.4,5.96,10.5,20.4,38.8,57.4,108,27.6,16.3,11.3,13.4,11.6,108,99.4
IN - TSS Mean Annual Load
(kg/yr),1.46E3,1.39E3,1.25E3,1.75E3,2.24E3,1.32E3,4.42E3,4.64E3,1.24E3,2.87E3,2.13E3,2.30E3,2.22E3,4.18E3,1.96E3
IN - TP Mean Annual Load
(kg/yr),3.00,3.61,2.42,3.98,5.56,5.28,11.9,16.5,4.09,5.90,4.42,5.02,4.44,16.4,10.8
IN - TN Mean Annual Load
(kg/yr),21.8,38.6,16.0,29.2,47.3,67.4,121,197,55.7,45.9,33.0,37.3,35.3,190,139
IN - Gross Pollutant Mean Annual Load
(kg/yr),194,125,153,270,253,0.00,418,0.00,0.00,418,291,344,299,0.00,0.00
OUT - Mean Annual Flow
(ML/yr),7.56,18.4,5.97,10.5,20.4,38.8,57.4,108,27.6,16.3,11.3,13.4,11.6,99.4,99.3
OUT - TSS Mean Annual Load
(kg/yr),294,523,170,415,794,1.15E3,3.03E3,4.18E3,1.11E3,838,402,438,461,1.96E3,1.74E3
OUT - TP Mean Annual Load
(kg/yr),1.08,2.23,0.676,1.65,3.04,5.12,9.77,16.4,3.79,2.55,1.54,1.87,1.62,10.8,10.0
OUT - TN Mean Annual Load
(kg/yr),14.6,30.6,9.45,21.0,36.7,61.9,111,190,50.1,33.3,22.4,25.5,24.1,139,137
OUT - Gross Pollutant Mean Annual Load
(kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

No Generic treatment nodes

No Other nodes

Links

Location,Drainage Link
Source node ID,1,3,5,6,7,10,8,4,9,2,12,11,13,15,16,17,18,19,20,21,22,23,14,24
Target node ID,2,4,6,4,8,9,9,11,11,4,13,14,14,13,17,15,19,15,21,13,23,14,24,25
Muskingum-Cunge Routing,Not Routed
Muskingum K, ,
Muskingum theta, ,
IN - Mean Annual Flow (ML/yr),7.55,4.87,5.96,5.97,10.5,9.84,10.5,18.4,20.4,7.56,16.3,38.8,57.4,27.6,16.3,16.3,11.3,11.3,13.4,13.4,11.6,11.6,108,99.4
IN - TSS Mean Annual Load (kg/yr),1.46E3,931,1.25E3,170,1.75E3,1.82E3,415,523,794,294,2.88E3,1.15E3,3.03E3,1.11E3,2.87E3,838,2.13E3,402,2.30E3,438,2.22E3,461,4.18E3,1.96E3
IN - TP Mean Annual Load (kg/yr),3.00,1.85,2.42,0.676,3.98,3.90,1.65,2.23,3.04,1.08,6.26,5.12,9.77,3.79,5.90,2.55,4.42,1.54,5.02,1.87,4.44,1.62,16.4,10.8
IN - TN Mean Annual Load (kg/yr),21.8,14.6,16.0,9.45,29.2,26.3,21.0,30.6,36.7,14.6,45.4,61.9,111,50.1,45.9,33.3,33.0,22.4,37.3,25.5,35.3,24.1,190,139
IN - Gross Pollutant Mean Annual Load (kg/yr),194,125,153,0.00,270,253,0.00,0.00,0.00,0.00,418,0.00,0.00,0.00,418,0.00,291,0.00,344,0.00,299,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),7.55,4.87,5.96,5.97,10.5,9.84,10.5,18.4,20.4,7.56,16.3,38.8,57.4,27.6,16.3,16.3,11.3,11.3,13.4,13.4,11.6,11.6,108,99.4
OUT - TSS Mean Annual Load (kg/yr),1.46E3,931,1.25E3,170,1.75E3,1.82E3,415,523,794,294,2.88E3,1.15E3,3.03E3,1.11E3,2.87E3,838,2.13E3,402,2.30E3,438,2.22E3,461,4.18E3,1.96E3
OUT - TP Mean Annual Load (kg/yr),3.00,1.85,2.42,0.676,3.98,3.90,1.65,2.23,3.04,1.08,6.26,5.12,9.77,3.79,5.90,2.55,4.42,1.54,5.02,1.87,4.44,1.62,16.4,10.8
OUT - TN Mean Annual Load (kg/yr),21.8,14.6,16.0,9.45,29.2,26.3,21.0,30.6,36.7,14.6,45.4,61.9,111,50.1,45.9,33.3,33.0,22.4,37.3,25.5,35.3,24.1,190,139
OUT - Gross Pollutant Mean Annual Load (kg/yr),194,125,153,0.00,270,253,0.00,0.00,0.00,0.00,418,0.00,0.00,0.00,418,0.00,291,0.00,344,0.00,299,0.00,0.00,0.00

Annex S

Water Cycle Management Report

Water Cycle Management the Proposed Urban Development at Fern Bay

Final report

For

The Aspen Group Pty Ltd

May 2007

By

Urban Water Cycle Solutions

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Summary

An urban development that includes about 950 residential allotments is proposed for a site at Fern Bay adjacent to Nelson Bay Road. The site is located in the local government area of Port Stephens. This report examines the topography and geology of the site and develops a stormwater management strategy. The stormwater management strategy incorporates the water sensitive urban design treatment train philosophy for urban development at the site. The basis of the stormwater management strategy is opportunistic utilisation of the high infiltration capacities displayed by soils on the site and, therefore, maintenance of the existing water balance.

A treatment train of stormwater management measures in keeping with the water sensitive urban design philosophy is proposed for urban development at the site. The basis of the stormwater management strategy is opportunistic utilisation of the high infiltration capacities displayed by soils on the site. The proposed design aims to maintain natural water balances at the site.

It is proposed to use pipe drainage, infiltration trenches, roads with one-way cross-falls, bio-retention swales, Gross Pollutant Traps, infiltration swales and infiltration trenches to manage stormwater quantity and quality at the site. The WSUD strategy that encourages local treatment and infiltration of stormwater will maintain the spatially varied natural water balance and the long term water quality in the aquifer. Importantly, the described WSUD system is not impact expected adversely on the quality of water in the aquifer. In addition groundwater will not be extracted or modified at this site.

Discharge of stormwater runoff via overland flow from the site to Fullerton Cove and the SEPP14 wetland is unlikely to occur. In addition, there is no recorded history of flooding at the site from the Hunter River and the topography of the land surface and surrounding road embankments make such an event unlikely. It is unlikely that the majority of site can be subjected to flooding from the Hunter River. There is also no record of the site being subjected to local flooding. It is true that the low lying areas of the site are subject to inundation following rain events. Nevertheless, it is not proposed to build the urban development in the low lying areas adjacent to Nelson Bay Road. The stormwater management strategies proposed in this report will protect the proposed urban development from local flooding whilst mitigating potential stormwater impacts of urban development on receiving environments. The proposed stormwater management strategy will not require maintenance efforts in excess of the requirements of traditional pipe drainage systems.

The use of 3 kL rainwater tanks to supply domestic toilet, laundry and outdoor water uses, and water efficient appliances will reduce household water use by about 50%. This equates to an annual reduction in mains water demand for the entire site of 101 ML.

Table of Contents

1.0 Introduction

Urban Water Cycle Solutions (Associate Professor Peter Coombes: University of Newcastle) was commissioned by Aspen Group Pty Ltd to develop an urban water cycle management strategy for the proposed urban development at Fern Bay. This strategy also employs water sensitive urban design (WSUD) techniques. The proposed urban development includes about 950 residential allotments and will be situated in the local government area of Port Stephens. This report supersedes previous reports by Urban Water Cycle Solutions that discuss this project.

The site of the proposed urban development has a land area of 205 Ha and is described as Lot 16 in DP 258848 at 85 Nelson Bay Road in Fern Bay. The proposed development site has an undulating topography that consists of sandy soils with low lying areas adjacent to Nelson Bay Road and is underlain with an unconfined aquifer. Traditional stormwater drainage practices may be unsuitable for this site necessitating the use of water sensitive urban design (WSUD) approaches to deliver sustainable stormwater management solutions.

This report considers data and stormwater management proposals from previous studies and proposes an urban water cycle management strategy that is consistent with the natural water cycle processes currently operating at the site.

2.0 Water Cycle Processes at the Site

A schematic of the water cycle processes operating at the proposed development site is shown in Figure 1. Stormwater runoff from the northern areas of the site discharges to low lying areas adjacent to Nelson Bay Road and ultimately evaporates from the low lying areas or flows via culverts under Nelson Bay Road towards Fullerton Cove.

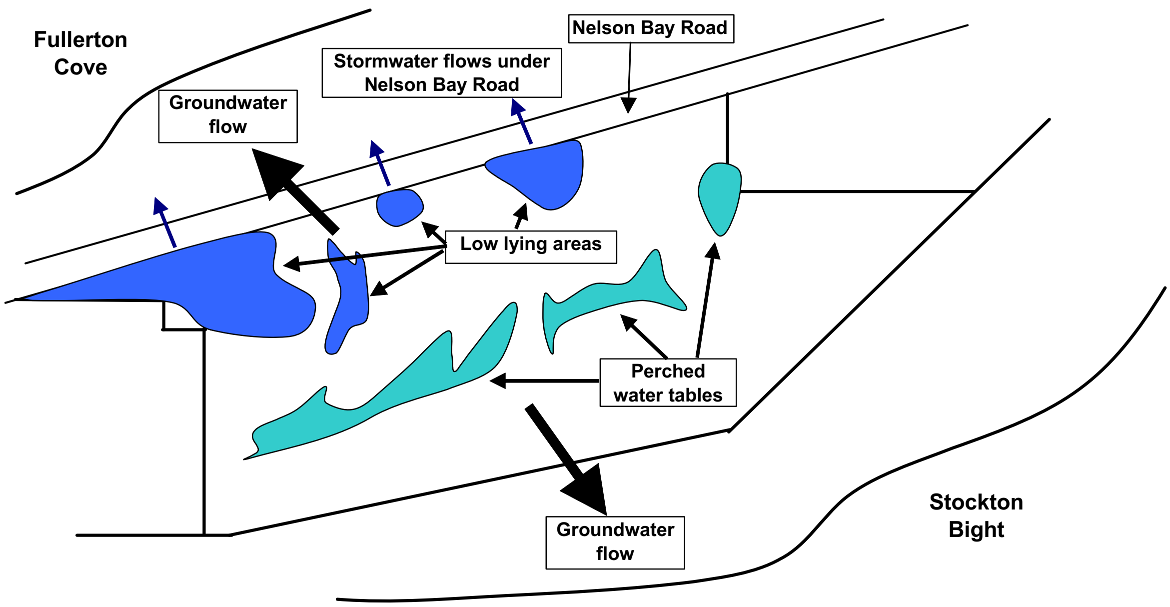

Figure 1: Schematic of the water cycle processes operating at the site

Stormwater runoff from southern and internal areas of the site discharges to a series of perched water tables located between sand dunes at the centre of the site and ultimately evaporates to the atmosphere. There may be some surface water and groundwater connectivity between the internal perched water tables and the low lying areas adjacent to Nelson Bay Road. The site is underlain by an unconfined aquifer that can maintain water levels in low lying areas and allows groundwater to drain from the low lying areas and perched water tables towards Fullerton Cove and Stockton Bight. Water is also lost from the soil profile and the aquifer via evapotranspiration processes.

The site consists of sandy soils that feed an unconfined aquifer. A majority of rain falling on the site infiltrates through the sand layer to the aquifer. The remainder of rainfall becomes stormwater runoff that flows toward the low lying areas adjacent to Nelson Bay Road and to perched water tables at the interior of the site. The majority of the remaining water is lost from these low lying areas and the soil profile by the processes of evaporation and evapotranspiration respectively. The low lying areas are surrounded by higher areas that impound water in those locations.

2.1 Geology and Soil Types

The geology at the site consists of a topsoil layer, about 0.2 m thick, of silty sand over a sand layer with a thickness that varies from 13 m to 27 m that overlays sandy clay. The sand layers at the site are underlain by rock at a depth of about 60 m. Peat has been found in the low lying areas adjacent to Nelson Bay Road. Recent investigation by Parsons Brinkahoff [2006] located gravely sand to a depth of 0.4 m overlying Aeolian sands to depths of greater than 8 m with groundwater situated at 0.8 m AHD.

The site includes moderate to steep relic sand dunes and low lying swamp areas with levels less than 2 m AHD [RCA, 2006]. Soil types in the low lying areas adjacent to Nelson Bay Road consist of organic top soil and swamp deposit materials. Estuarine flats are situated west of Nelson Bay Road.

The sand layer is made up of medium to fine grained sand that contains few fine particles. High infiltration rates should be expected from this sand layer although the silt content in the topsoil layer may impede the infiltration of water into the sand layer. Observations from Coffey Partners [1992; 1996] indicate that 75% to 90% of rainfall falling on the site is infiltrated into the sand layer.

Coffey Partners [1992; 1996] also observed infiltration rates at the ground surface and at depths of 1.5 m. Infiltration rates were found to vary from 0.81 m/hour to 0.17 m/hour at various locations with a single low reading of 0.054 m/hour at the ground surface in an area subject to compaction that was devoid of vegetation. The following conclusions can be draw from the observations:

- High infiltration rates are expected in the sand layer
- Lower infiltration rates can be expected in filled or turfed areas
- Lower infiltration rates can also be expected in areas that are not vegetated or subject to high use that results in densification of the topsoil layer.
- Infiltration rates from the low lying areas near Nelson Bay Road into the aquifer will be limited by the presence of peat.

Modelling used to analyse stormwater management options for the site should use ILSAX soil parameter 1 (initial infiltration rate: 125 mm/hour; saturated infiltration rate: 25 mm/hour) to account for the densification of the topsoil created by urban development. An average infiltration rate of 450 mm/hour can be conservatively used to account for the performance of stormwater management facilities that direct stormwater into the sand layer below the topsoil layer and for areas not subject to high use. The ILSAX soil type 1 parameters should also be use to describe infiltration from the low lying areas adjacent to Nelson Bay Road unless some of the peat layer is removed. The low lying areas near Nelson Bay Road have a low to moderate risk of containing acid sulphate solis and, therefore, removal of peat from these areas is not recommended.

2.2 Groundwater Considerations

Studies by Coffey Partners [1992; 1996] and Douglas Partners [1998] indicate that the site overlays an unconfined aquifer with depths up to 15 m. Groundwater at the site flows northeast towards the Stockton Bight and southwest toward Fullerton Cove at 16 – 22 m^2/day. All studies show that groundwater levels vary with ground surface levels. Groundwater levels are more likely to be higher in locations where the ground surface levels are higher. Average groundwater levels located under low lying areas are shown in Table 1.

Table 1: average groundwater levels under low lying areas

Date	Report	Average water level {m (AHD)}	Annual rain depth (mm)
1992	Coffey Partners [1992]	1.57	1,335
1995	Coffey Partners [1996]	1.0	961
1997	Douglas Partners [1998]	0.18	1,210
2006	RCA [2006]	0.7 – 1.2	1,138
2006	Parsons Brinkahoff [2006]	0.8	1,138

The average groundwater levels at the site will be significant for the assessment of the performance of infiltration measures used to manage stormwater at the site. Note that observations from Coffey Partners [1992; 1996] are derived from bores in a variety of locations whilst the observations reported by Douglas Partners [1998] are targeted to low lying areas.

More recent investigation of ground water levels by RCA [2006] showed that levels varied from 0.25 m to 0.9 m AHD. Ground water levels were elevated where ground surfaces levels were higher.

The proposed stormwater management strategy does not intercept or extract groundwater and therefore does not require a licence in accordance with Part 5 of the NSW Water Act of 1912.
A comprehensive WSUD strategy for stormwater management is proposed that will protect groundwater resources. The fundamental driver for the WSUD strategy is to maintain natural groundwater regimes and quality. Nevertheless, it is agreed that a stormwater management strategy in a location with an underlying aquifer should aim to maintain the natural water balance across the site and the quality of water in that aquifer. The carefully designed WSUD strategy that encourages local treatment and infiltration of stormwater will maintain the spatially varied natural water balance and the long term water quality in the aquifer.

Importantly, the described WSUD system will not impact adversely on the quality of water in the aquifer. This conclusion can be drawn from the discussion in this report, the Australian Runoff Quality guidelines and a range of publications. Also note that the sand layer at the site will produce significant additional cleansing of stormwater prior to entry to the groundwater system.

The analysis of groundwater processes and the infiltration basin at the Figtree Place project by Coombes [2002, Chapter 2] is recommended reading. Long term monitoring of the infiltration of urban stormwater runoff via an infiltration basin into the sand aquifer did not lead to decreased ground water quality; indeed the quality of groundwater under the Figtree Place site was improved.

In accordance with the above discussions and acknowledging that groundwater will not be extracted or modified at this site, additional assessment in relation to the following groundwater policies is not required;

- NSW Groundwater Policy Framework
- NSW Groundwater Quality Protection Policy
- NSW Groundwater Dependent Ecosystems Policy
- NSW Groundwater Quantity Policy
- Part 5 of the Water Act 1912 – licence requirements

2.3 Flooding Issues

The Lower Hunter Flood Study by Lawson and Treloar using the MIKE 11 model reported the 100 year average recurrence interval (ARI) flood levels in the lower Hunter River as follows:

- 1.77 m AHD at the Longbight 2.6 cross-section which is closest to Fullerton Cove and Nelson Bay Roads
- 1.8 m AHD at the Longbight 2.1 cross-section further north.

Nelson Bay Road along the north western boundary of the site has road surface heights ranging from 2.4 m AHD to greater than 3.8 m AHD. This serves as a barrier to stormwater discharging from the site and excludes flood waters from entering the site from the estuary of the Hunter River. This road is underlain with 6 small pipes and culverts that allow a limited exchange of water between low lying areas on either side of Nelson Bay Road once the water levels exceeds 1 m AHD. Similarly Fullerton Cove Road that is situated further to the north-west also serves as a barrier to water flows to and from the area. It is noted that discharge of stormwater runoff via overland flow from the site to Fullerton Cove and the SEPP14 wetland is unlikely to occur.

In addition, there is no recorded history of flooding at the site from the Hunter River and the topography of the land surface and surrounding road embankments make such an event unlikely. Moreover, the higher ground surrounding the low lying areas adjacent to Nelson Bay Road will also act to retain any flood waters from entering the majority of the site. It is unlikely that the majority of site can be subjected to flooding from the Hunter River.

There is also no record of the site being subjected to local flooding. It is true that the low lying areas of the site are subject to inundation following rain events. Nevertheless, it is not proposed to build the urban development in the low lying areas adjacent to Nelson Bay Road. Thus both local and Hunter River flooding events are unlikely to impact on the development area given the proposed stormwater management solution. As such an assessment of the proposed development in accordance with the State Government's Flood Policy for Management of Flood Prone Land, NSW Floodplain Development Manual and the Port Stephens Council Flood Policy is not required beyond the assessments provided in this report.

Willing & Partners [1992] analysed the likely flooding impacts of urban development at the site. They assumed a stormwater management system that used conventional pipe drainage systems that discharged to basins located in the low lying areas adjacent to Nelson Bay Road and ultimately to Fullerton Cove. They estimated the likely 100 year ARI water levels adjacent to Nelson Bay Road were determined to be 2.04 m – 2.08 m AHD for a situation where the culverts under Nelson Bay Road are free draining and 2.19 m – 2.3 m AHD if Hunter River flood levels do not allow discharge of stormwater under Nelson Bay Road. The local stormwater runoff will be retained in the low lying areas adjacent to Nelson Bay Road.

However, it is significant that the Willing & Partners study assumed that sewage effluent would be discharged to the aquifer at a rate of 5,500 m^3/year, 60% of rainfall will infiltrate to the aquifer and no infiltration from the base of low lying areas. The proposed urban development will not dispose of sewage effluent to the aquifer, the actual infiltration of rainwater is expected to be 70% - 90% of rainfall and the low lying areas are expected to have some connectivity to the aquifer. In addition, it is not proposed to discharge all stormwater to the low lying areas adjacent to Nelson Bay Road via traditional stormwater drainage systems. Note that the Willing & Partners study also excluded one of the culverts passing under Nelson Bay Road. These differences will produce lesser water levels in these low lying areas. It is reasonable to assume that the 100 year ARI local flood level adjacent to Nelson Bay Road is less than 2.1 m AHD.

Stormwater runoff from low frequency rainfall events (such as 100 year ARI) will be adequately contained between Nelson Bay Road that has finished levels ranging from 2.4 m to 2.9 m AHD and the internal dune systems. The Master plan by Environmental Resource Management Australia indicates that the proposed urban development is located clear of the low lying areas adjacent to Nelson Bay Road. Planning for earthworks at the site has adopted a minimum ground level of 2.1 m AHD. Provided that a WSUD strategy that employs distributed management of stormwater in keeping with the natural water balance at the site and residential floor levels are set at minimum levels 2.5 m AHD it is unlikely that local flooding will have detrimental impacts on the proposed development.

2.4 Water Quality Issues

Urban development usually increases the proportion of impervious surfaces in a stormwater catchment and includes highly efficient drainage systems (pipes and channels) that increase runoff volumes and peak discharges to a receiving environment whilst decreasing or eliminating infiltration of rainwater into soils. Increases in stormwater runoff and efficient conveyance systems will also convey pollutants that are generated by urban development to receiving waters creating adverse environmental impacts.

The use of traditional pipe drainage and regional basin methods will result in the discharge of stormwater runoff towards Fullerton Cove. This action is likely to change the hydrological regime in the coastal wetlands situated between Fullerton Cove and the site. Increased loads of contaminants may also be discharged to this area. The combination of changed hydrological regime and contamination may have harmful impacts on the coastal wetlands. Note that coastal wetland number 821 protected by State Planning Policy 14 is located in this area.

Previous studies (such as those by Willing & Partners) recommend the extensive use of basins in low lying areas to collect stormwater discharged from urban areas via traditional pipe drainage systems. Observations commissioned by CMP&F [1996] conclude that acid sulphate soil conditions may be found in the low lying area at the south west corner of the site. Excavation of soils should be minimised in this location. Note that the majority of the site is not affected by acid sulphate soil conditions.

Water quality concerns can be minimised by limiting the discharge of stormwater runoff from the site and managing urban stormwater runoff close to the sources of runoff. This objective will minimise disturbance of the coastal wetlands, reduce the transport of contaminants from the site and avoid disturbance of the acid sulphate soil area. The use of water sensitive urban design

(WSUD) approaches that utilise the natural characteristics of the site will deliver this objective.

Infiltration of stormwater runoff throughout the urban catchment will minimise stormwater runoff from the site. Many previous reports recommend this approach [including CMP&F, 1996; and Port Stephens Council, 1997]. The use of sediment traps, bio-retention facilities and gross pollutant traps (GPT) prior to discharge of stormwater into infiltration facilities will protect the water quality in the aquifer. Excellent guidance for the management of urban stormwater quality is provided by the Australian Runoff Quality document.

3.0 Past Stormwater Management Strategies

A variety of stormwater management strategies have been proposed for urban development at the site over the last decade. Differences in the proposed strategies reflect increasing knowledge of water cycle management issues held within industry.

Initially Willing & Partners [1992] proposed the use of traditional street drainage systems that discharge stormwater runoff to infiltration and/or detention basins that overflow towards Fullerton Cove via flood ways. This proposal generated concerns about the impacts of stormwater discharges on the coastal wetlands near Fullerton Cove.

CMPS & F [1996] proposed a stormwater management strategy that would discharge all stormwater to the aquifer or the atmosphere using infiltration facilities at allotments, road reserves and open space areas, and basins that facilitate evaporation. It was also proposed to utilise groundwater for irrigation purposes at the site.

Port Stephens Council [1997] produced Development Control Plan 50 (DCP50) that provided details of the preferred stormwater management objectives at the site. It recommends the following:

- On-site collection of roof and paved surface stormwater runoff in retention infiltration devices,
- Drainage swales and infiltration basins designed to collect stormwater flows up to 100 year ARI storm events
- The creation of a stormwater management plan that:
    - Describes the operation and design of stormwater management measures
    - Address reductions in peaks stormwater discharges, erosion, siltation and pollution.

The stormwater management plan by Urban Water Cycle Solutions [2006] that was used in the development of Stages 1 and 2 at this site proposed the use of lot scale measures including rainwater tanks to capture roof runoff and infiltration trenches to direct roof and paved surface runoff to the aquifer. The street drainage systems included sediment traps, bio-retention swales and infiltration basins. Monitoring by The University of Newcastle has shown this strategy has successfully managed stormwater runoff in Stage 1 to date.

4.0 Recommended Stormwater Management Strategy

The topography and geology of the site indicate that stormwater should be managed in a series of small stormwater management precincts. Stormwater quality and quantity should be managed in each stormwater precinct that contains about 50 to 100 dwellings. The area of each stormwater management precinct will be governed by topography and town planning issues.

A WSUD stormwater treatment train philosophy should be employed within each stormwater management precinct and between the precincts. A flowchart of the proposed stormwater management strategy is shown in Figure 2.

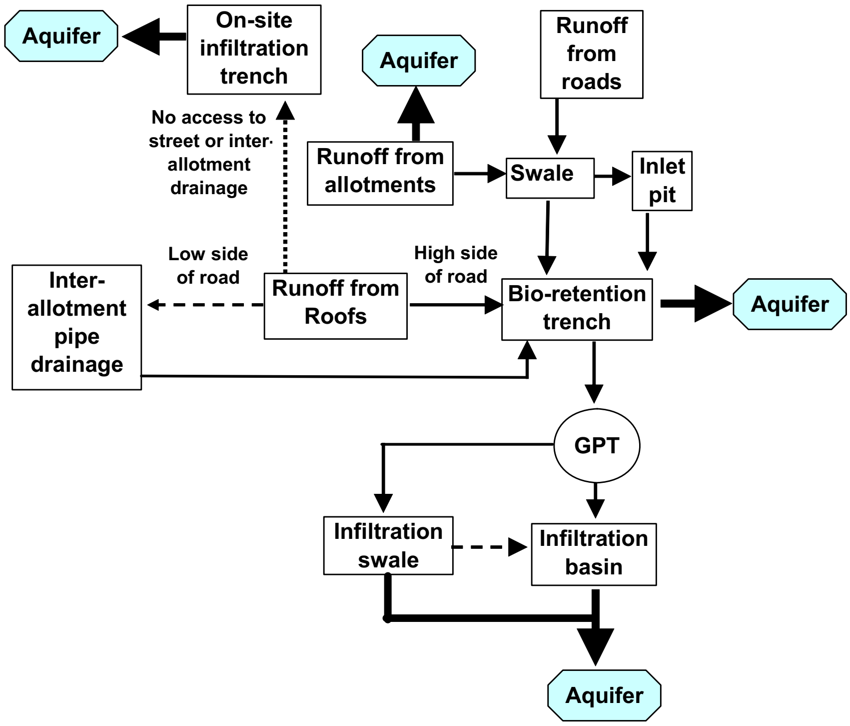

Figure 2: Flowchart of stormwater management processes within each precinct

Stormwater runoff from roofs of dwellings will be discharged to rainwater tanks used to supply laundry, toilet and outdoor uses. Overflows from the rainwater tanks and other roof runoff will be directed to infiltration trenches within allotments. Stormwater runoff from the allotments and overflows from infiltration trenches will be discharged to traditional pipe drainage systems and bio-retention trenches placed under swales located in the road reserve. The grass swales within the road reserve will collect stormwater runoff from road pavements with one-way cross-falls and excess stormwater runoff from allotments. It is expected that the majority of rain falling on allotments will infiltrate to the aquifer. Stormwater runoff that concentrates in the swales will infiltrate into the bio-retention trenches below with excess stormwater conveyed to an inlet pit.

The inlet pits distribute stormwater flows into the gravel bio-retention trenches which capture sediments, debris and litter. Stormwater is distributed within the gravel bio-retention trenches by an agricultural pipe allowing infiltration to the aquifer along the length of the trench. The trenches and the agricultural pipes convey excess stormwater toward infiltration swales and basins. Stormwater conveyed along infiltration swales and stored in infiltration basins will be discharged over a period of time into the aquifer.

Stormwater runoff from roofs of dwellings situated at the low side of roads will be discharged to inter-allotment pipe drainage systems that will convey stormwater to the nearest bio-retention trench system. Roof runoff will be discharged into on-site infiltration trenches in situations where access to a street or inter-allotment drainage system in not possible.

4.1 Street Drainage Systems

Local roads within each stormwater precinct will consist of road pavements with one-way cross falls that discharge stormwater runoff to bio-retention swale systems (see Figure 3). The bio-retention swale system will consist of a shallow grass swale with a width of 4 m and a gravel trench (0.45 m wide and 0.6 m deep) that contains a 100 mm diameter agricultural pipe.

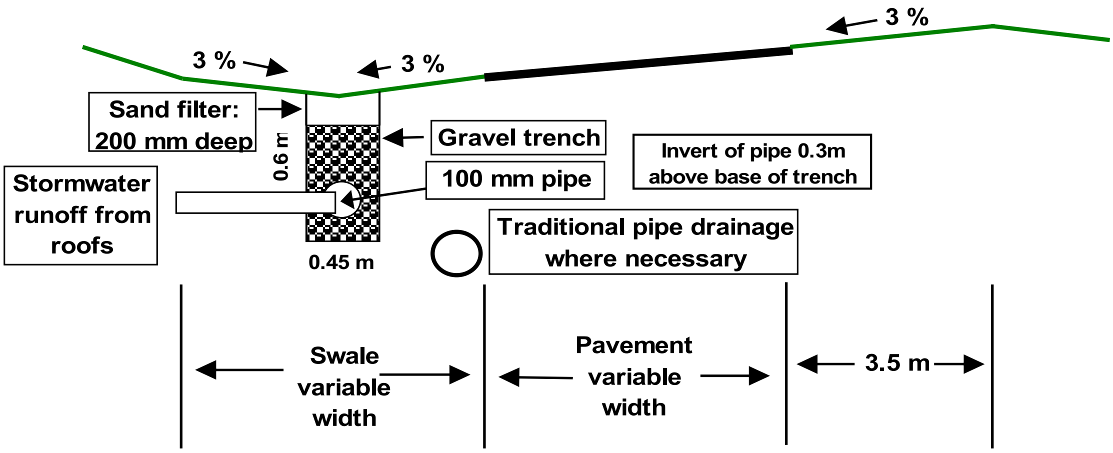

Figure 3: A typical local road cross section that includes a bio-retention swale

Stormwater runoff from road and allotment surfaces will be directed via overland flow to the swale system and infiltrated through the swale surface into the gravel trench. The trench contains a sand filter layer to a depth of 200 mm and then gravel with a nominal diameter of 20 mm to 30 mm that is surrounded by geofabric. It is important that the sand filter layer is not too thick as it will limit infiltration into the bio-retention system. Surface flows in the swale are directed to inlet pits that discharge excess stormwater into the gravel trench. Within the gravel trench stormwater infiltrates to the surrounding soil and flows downstream via the 100 mm diameter agricultural pipe. The bio-retention swale and traditional stormwater drainage system will be designed to cope with all storm events up to the 100 year ARI events. The finished surface level at each road boundary should be 100 mm about the expected maximum stormwater level in the bio-retention swales during 100 year ARI storm events.
The Australian Runoff Quality document reports that bio-retention systems can reduce stormwater runoff volumes by 51 – 100% and significantly reduce peak discharges. Very significant urban stormwater quality benefits are explained including reductions in total suspended solids, total phosphorus and total nitrogen by 73 -100%, 77 – 86% and 70 – 75% respectively. Only stormwater runoff from roofs that contain very little sediment (< 2 kg/annum/100 m^2 of roof area) will be discharged directly to the gravel trench under the swale and all other runoff will be directed to the gravel trench via the sand layer or the inlet pit. Thus the majority of sediments will be captured in the sand layer or in the inlet pits eliminating any potential to "clog" the gravel trenches with sediment. Note that it is unlikely that infiltration facilities will become clogged in a sandy soil due to a lesser proportion of fines in the soil matrix in comparison to clay soils. Note that Coffey Partners [1992; 1996] observed an absence of fine particles in the sandy soils.

Collector roads within the development that have dual carriageways will have pavements that fall towards a bio-retention swale system located at the centre of the road reserve (see Figure 5). The gravel trench and agricultural pipe system situated below the swale will allow stormwater to infiltrate to the aquifer whilst conveying excess stormwater to the nearest low point. At low points the bio-retention trench system will discharge excess stormwater to nearby infiltration swales, basins or the existing low lying areas.

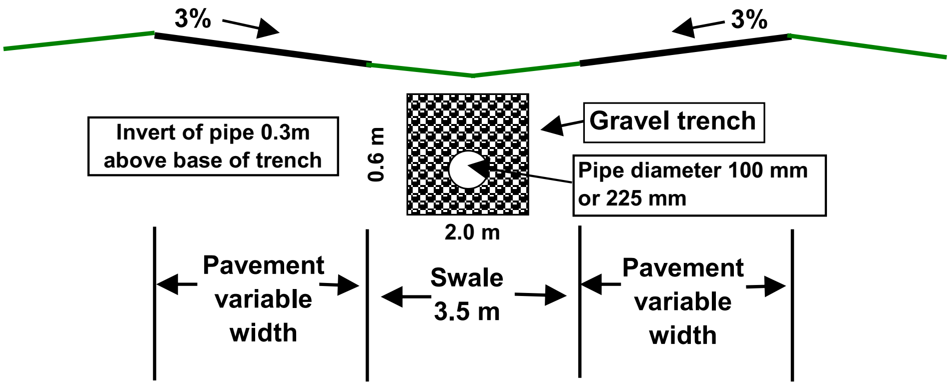

Figure 5: Bio-retention swale at the centre of dual carriageways

Stormwater pipes used to convey stormwater from bio-retention swale systems under roads will be designed to cope with runoff from all storm events up to and including the 100 year ARI events.

4.2 Inter-allotment Drainage Systems

A pipe drainage system will be provided to dispose of roof water from dwellings situated on land that falls away from road reserves. This inter-allotment drainage system will be designed in accordance with the subdivision design requirements of Port Stephens Council. Stormwater pipes in the inter-allotment drainage system will have a minimum diameter of 150 mm and be laid at a minimum grade of 1%. The inter-allotment drainage system will discharge stormwater into a bio-retention swale system.

4.3 Allotment Drainage Systems

The drainage system discharging roof water into the bio-retention swale system will have a small pit with a grated inlet installed at the site boundary. This will allow stormwater to surcharge from the roof drainage system in a situation when the gravel trench below the swale in overwhelmed by stormwater and allow inspection and cleaning of the drainage. It is important that this pit is not in the invert of the bio-retention swale to avoid sediment from the swale system blocking this house drainage input to the street stormwater system. A diagram of this system is shown in Figure 6.

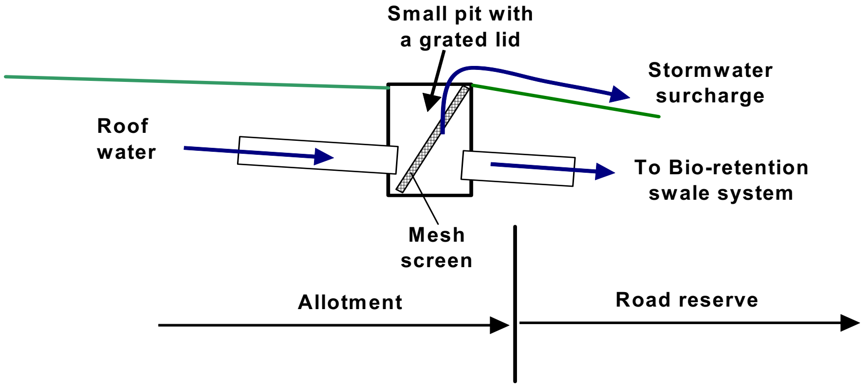

Figure 6: Details for the connection of roof drainage to the street drainage system

Overflows from rainwater tanks and roof runoff are directed to a street or inter-allotment drainage system via infiltration trenches. The infiltration trench will be filled with coarse gravel (nominal diameter of about 30 mm) surrounded in geotextile fabric, have an inflow pipe, a small pit with an inlet grate that acts as a sediment trap, a perforated distribution pipe and is placed under a 150 mm layer of sand or loam. The sediment trap prevents clogging of the trench with sediment, leaves and debris, and the geotextile fabric cleanses water as it percolates through the bottom and walls of the trench to the surrounding soil. Designs for infiltration trenches can vary provided they contain the basis principles listed above. A typical design is shown below in Figure 7.

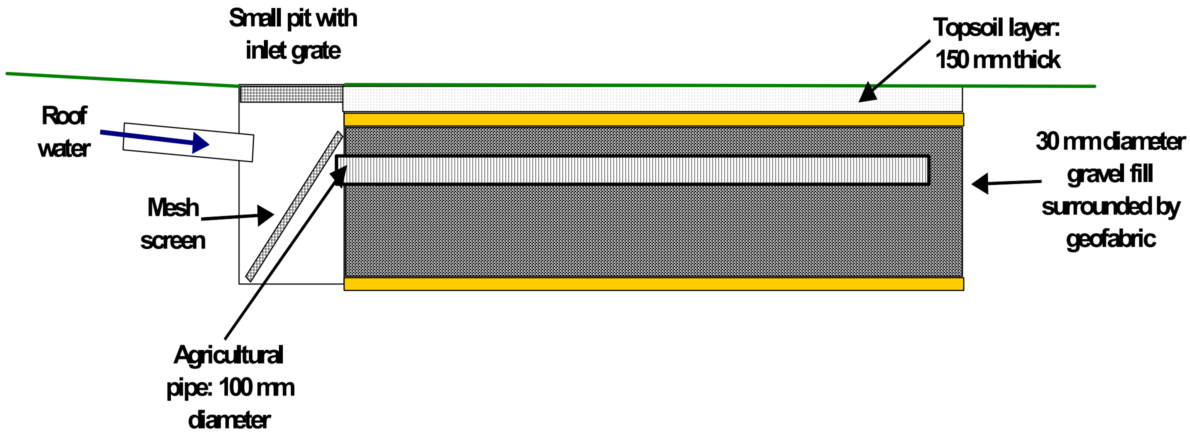

Figure 7: Details of an infiltration trench used to capture roof water on allotments

4.4 Infiltration Basins and Swales

In a situation where excess stormwater runoff passes through the WSUD treatment train, it will discharge into an infiltration swale or basin. The infiltration basin collects and stores stormwater until it dissipates to the surrounding soil via infiltration and to the environment via evaporation. These basins remove a portion of stormwater runoff thereby reducing stormwater peak discharge and volume to downstream catchments. These processes also improve the quality of stormwater discharged to the receiving environment.

The infiltration basin will be designed as a depression with good grass coverage over a layer of coarse gravel surrounded by geotextile fabric. A 150 mm layer of topsoil is usually placed between the gravel layer and the grassed surface. Stormwater entering the basin is filtered to remove sediment, leaves and debris by sediment traps, vegetated areas or GPTs. Stormwater fills the basin and the gravel layer, percolates to the soil and overflows to the low lying areas when the basin fills. A schematic of an infiltration basin is shown below in Figure 8.

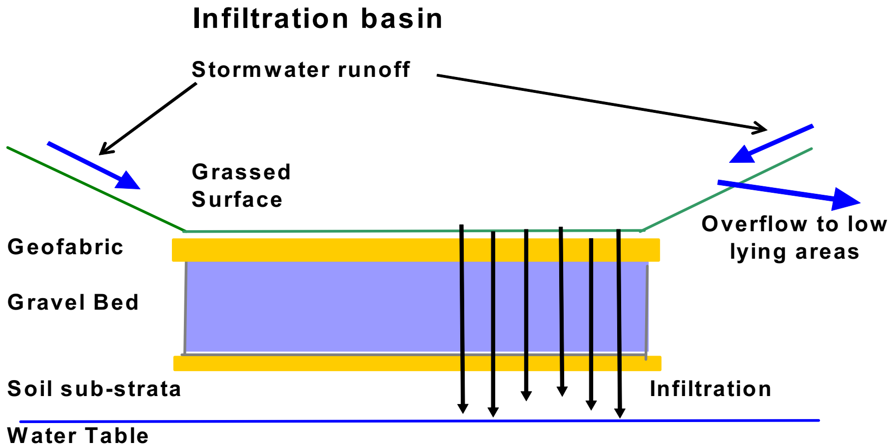

Figure 8: Design of the infiltration basin

The infiltration basins will consist of sub-surface and surface storage areas. The sub-surface storage will be filled with 20 mm to 30 mm nominal diameter gravel surrounded by geofabric. Stormwater will be stored in the void spaces between the gravel and also infiltrate into the surrounding soil. Stormwater from the subdivision drainage system will be directed to the sub-surface storage area via a grated pit that also allows surcharge into the basin. The surface storage area consists of a landscaped area surrounded by bund walls. It will contain stormwater volumes that are in excess of the storage provided by the sub-surface storage area. A schematic of an infiltration area below the basin is shown in Figure 9.

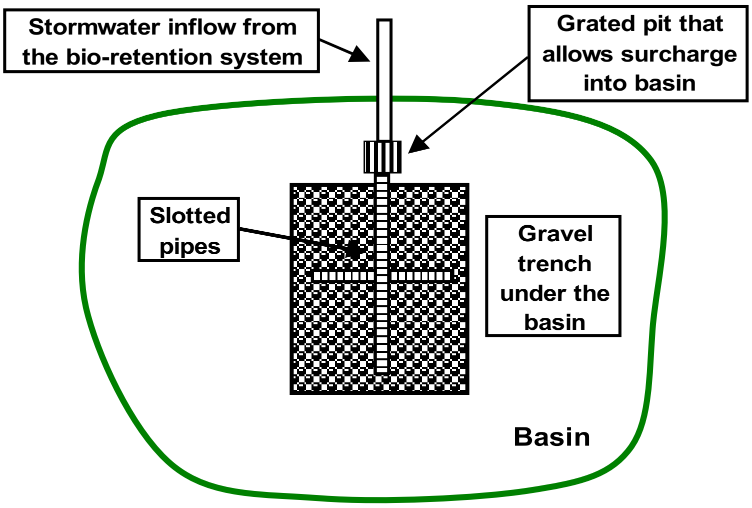

Figure 9: Schematic of a plan area of an infiltration basin

Figure 9 show that the infiltration basin also contains a grid of slotted pipes to distribute stormwater throughout the gravel trench. The design of the infiltration basins at Fern Bay is similar to the design of the infiltration basin at Figtree Place in Hamilton that continues to operate successfully [Coombes, 2002]. Table 2 summarises the long term performance of the infiltration basin at Figtree Place.

Table 2: Performance of the infiltration basin at Figtree Place

Category	Minimum	Maximum	Average
Ponding depth (mm)	1	332	76.9
Rain depth (mm)	1.43	149	18.6
Infiltration rate (mm/hr)	70	1340	394
Emptying time (hours)	0.002	19.68	3.31

Table 2 shows that the infiltration rate from the basin varied as function of the water depth in the basin from 70 mm/hour to 1,340 mm/hour. Nevertheless, the average infiltration rate recorded for the Figtree Place infiltration basin was 394 mm/hour that is consistent with the average infiltration of 450 mm/hour recorded from geotechnical testing at Fern Bay. The infiltration characteristics shown in Table 3 are therefore derived from geotechnical testing for use in all below ground infiltration devices (the trenches below the infiltration basin and bio-retention trenches) at Fern Bay.

Table 3: Horton infiltration parameters used for below ground infiltration devices

Infiltration parameters		**Initial infiltration (mm/hr) as function of AMC**			
Saturated infiltration (mm/hr)	**k**	**1**	**2**	**3**	**4**
100	2	500	430	215	120

5.0 Water Conservation Measures

The expected mains water demand of the proposed development can be reduced by the use of water efficient appliances such as 3A rated shower heads, 6/3 flush toilets and 4A rated washing machines as shown in Table 4.

Table 4: Reduction in household water use for water efficient appliances as reviewed by Coombes [2003]

Product	**Reduction in water use per product (%)**	**Reduction in average household water use (%)**
6/3 flush toilet	26	5
4A washing machine	50	11
3A shower head	20	4.5
Tap regulators	2	0.2
Total	**-**	**20.7**

Table 4 shows that the use of water efficient appliances can reduce average household water demand by about 20.7%.

In addition, the use of 2 to 3 kL rainwater tanks to supply outdoor, toilet and laundry water uses can reduce household mains water demands by 40 kL to 80 kL per annum [Coombes and Kuczera, 2003]. The use of rainwater tanks to partially supply domestic water demand is consistent with the current requirements of the BASIX regulations. The suggested configuration of a rainwater tank used in a dual water supply scheme (mains water and rainwater) used to supply toilet, laundry and outdoor water uses is shown in Figure 10 and Figure 11 displays a 3 kL slimline rainwater tank that can be installed on allotments with little available land area.

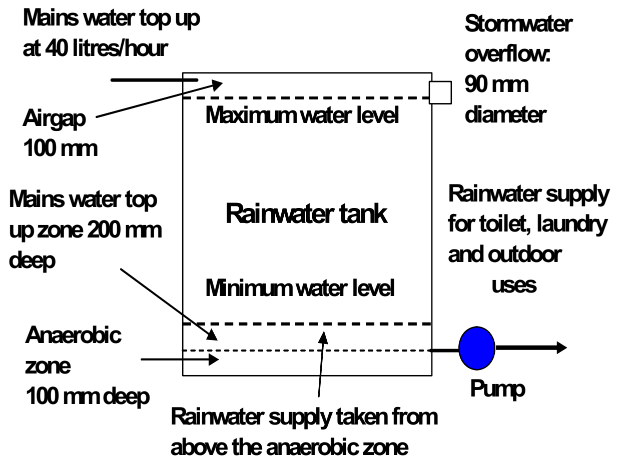

Figure 10: Configuration of rainwater tank

Figure 11: Slimline rainwater tank

Figure 10 shows that rainwater stored in the tank is used to supply domestic toilet, laundry and outdoor water uses. Runoff from roof surfaces passes through a first flush device with a capacity of 20 litres and into the rainwater tank. Whenever water levels in the rainwater tanks are drawn below a depth of 300 mm, the tanks will be topped up with mains water at a rate of 40 litres/hour. A domestic dual water supply system that includes rainwater tanks should be installed in accordance with the requirements of the Hunter Water Corporation. A suggested plumbing configuration is shown in Figure 12.

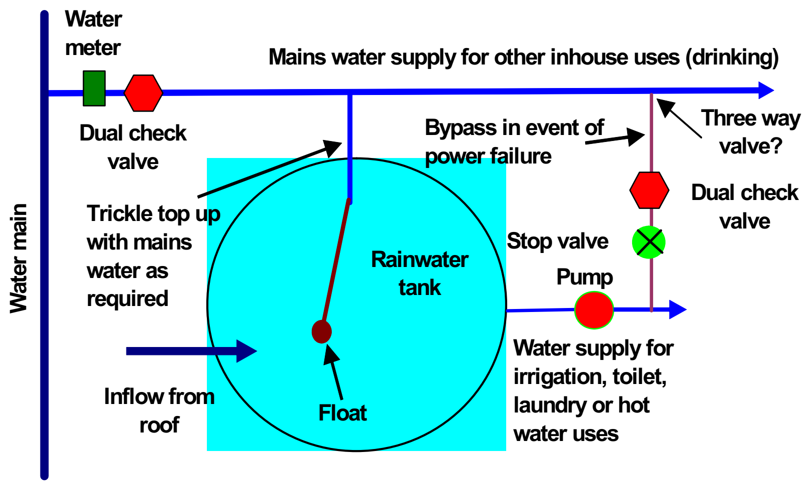

Figure 12: Configuration for a dual supply system with mains water trickle top up

The use of 3 kL rainwater tanks to supply domestic toilet, laundry and outdoor water uses, and water efficient appliances will reduce household water use by about 50%. This equates to an annual reduction in mains water demand for the entire site of 101 ML.

6.0 Analysis of the Proposed Development

The proposed layout of the urban development at Fern Bay is shown in the Master plan by Environmental Resource Management Australia. This plan divides the urban development into a number of precincts that will allow for a precinct based stormwater management strategy that is consistent with the topography and geology of the site. Stormwater quality and quantity can be managed in each stormwater precinct that contains about 50 to 100 dwellings using bio-retention swales in streets, infiltration swales, Gross Pollutant Traps (GPT) and localised infiltration basins.

A schematic of the sub-catchments used in the analysis is shown in Figure 13.

It is assumed in this study that the development should not significantly change the stormwater runoff and quality aspects of the existing stormwater catchments. The assessment of the stormwater runoff characteristics of the site in a developed state was undertaken using WUFS (Water Urban Flow Simulator) [Kuczera et al., 2000] developed at the University of Newcastle and MUSIC (Model for Urban Stormwater Improvement Conceptualisation) developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH). Note that the WUFS program is the only reliable analysis tool available to industry that can compare traditional drainage solutions to water sensitive urban design solutions or analyse combinations of both. The WUFS software was until recently freely available to industry from the website www.eng.newcastle.edu.au/~cegak in a similar mode to the availability of ILSAX. Note that both ILSAX and WUFS are freeware that are recommended for research and investigation purposes. WUFS has been developed from the ILSAX algorithms (Appendix A).

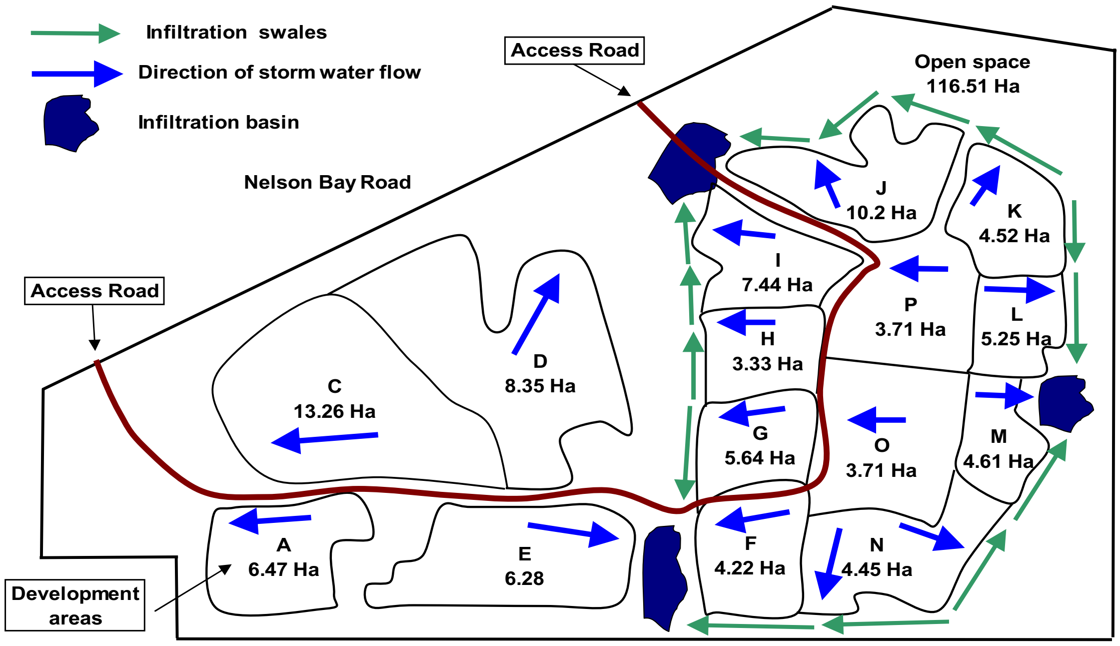

Figure 13: Proposed layout of development precincts at Fern Bay

Figure 13 shows that each of the stormwater management precincts ultimately discharge stormwater to swales located at the perimeter of the developed areas that flow toward infiltration basins. These swales are assumed to have a depth of about 0.5 m and a bottom wide of 3 m, and will serve to manage any excess stormwater runoff and provide polishing of the stormwater quality prior to entry to the infiltration basins.

Within each stormwater precinct the use of rainwater tanks, onsite infiltration trenches and bio-retention swales in the road reserves will serve to minimise stormwater runoff and to act as a treatment train to improve stormwater and groundwater quality.

6.1 Stormwater Runoff

The stormwater peak discharges from the sub-catchments shown in Figure 13 of the fully development site were modelled using the WUFS stormwater management software [Kuczera et al., 2001] developed at the University of Newcastle. (see www.eng.newcastle.edu.au/~cegak). WUFS uses the design storm approach in accordance with Australian Rainfall and Runoff [1987] requirements. The WUFS rainfall/runoff model was used to determine the combined impact of bio-retention swales in streets and infiltration basins on stormwater runoff from the development. A detailed model of the development was constructed in WUFS including all surface and underground components. Schematic of the stormwater management networks used in WUFS are shown in Figure 14.

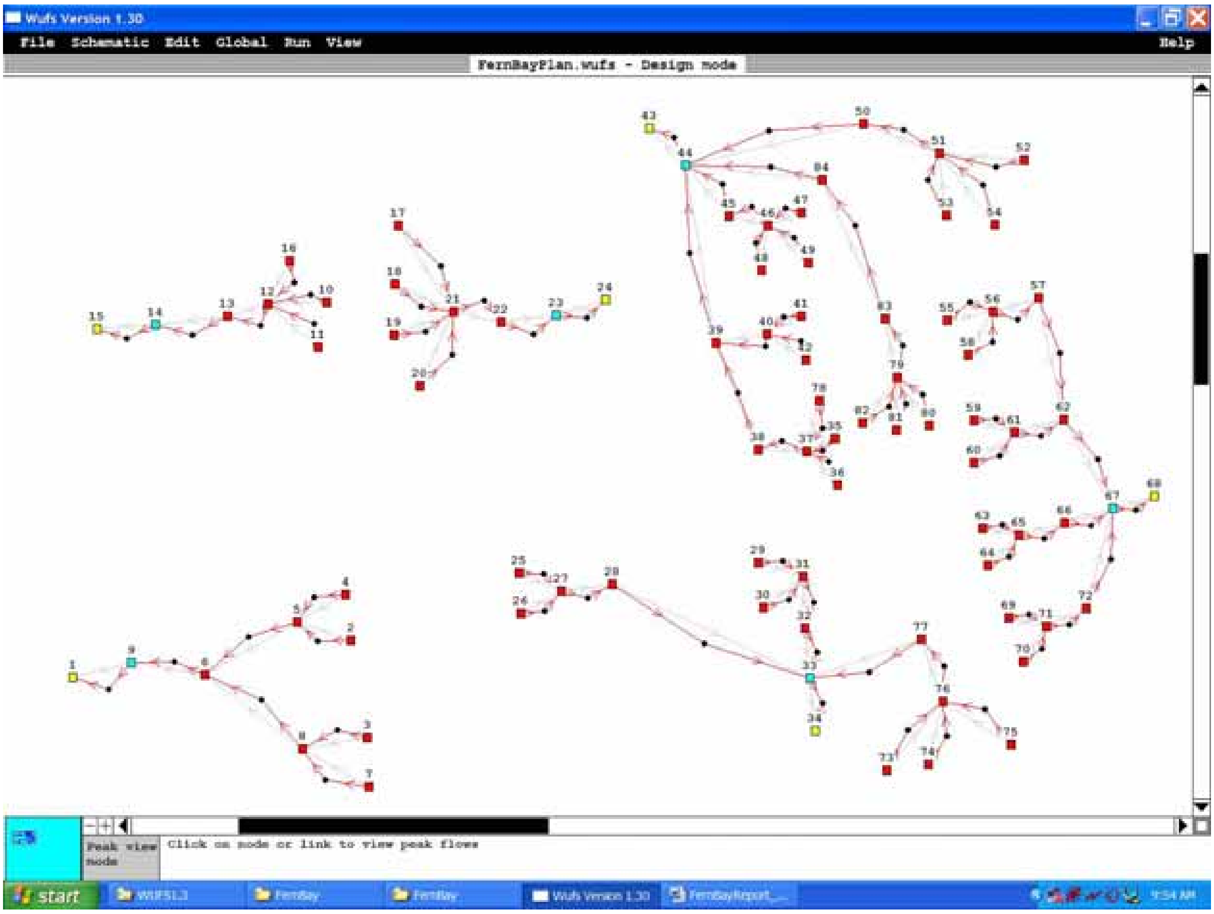

Figure 14: Schematic of stormwater drainage network used in the WUFS model

The area of the sub-catchments used in the analysis varies from 3.33 Ha to 13.26 Ha. Residential allotments were assumed to have an impervious ratio of 0.7 whilst the imperious ratio of the high density allotments was assumed to be 0.9. Each sub-catchment within the development was divided into urban, high density, road and park areas in the analysis as shown in Table 3.

Analysis of the performance of the stormwater management system was conducted using ILSAX soil type 2 on all allotments and antecedent moisture content ratio of 2.5 that conservatively represents a sandy-clay soil with initial infiltration rate of 98 mm/hour and saturated infiltration rate of 13 mm/hour. Although the site has deep sandy soil with high infiltration rates, the sandy-clay soil type has been assumed for allotments to account for the addition of turf and topsoil to the ground surface. Note that no topsoil will be imported to the site during construction of the subdivision. It was therefore assumed that ILSAX soil type 1 would reliably account for the performance of pervious areas within the road reserves. Given that the saturated infiltration rates at the site are likely to be considerably in excess of 500 mm/hour this is an extremely conservative assumption. It was assumed that the infiltration rate within the basins and swale surfaces was 100 mm/hour. Infiltration rates from the underground gravel trenches within the basins and bio-retention swales were assumed to be 430 mm/hour.

The proposed urban development shown in Figure 13 was analysed using the WUFS model for design storm events with ARI of 100 years and durations ranging from 10 to 360 minutes. Stormwater overflows from the stormwater management system and the volume of the infiltration basins required to management stormwater peak discharges in each sub-catchment are shown in Table 5. The lengths of bio-retention swales used in each sub-catchment are assumed to be half of the estimated road lengths and each infiltration basin was assumed to contain an infiltration trench with the dimensions of 20 m long, 20 m wide and 0.6 m depth that will assist the process of rapid infiltration to the aquifer. Results of the analysis are also presented in Appendix B.

Table 5: Details of sub-catchment areas and stormwater management results

Catchment	Sub-catchment areas (ha)				Road length (m)	Minimum ground Level (m)	Basin storage (m^3)	Peak discharge (m^3/S)
	Urban	Roads	High Density	Parks				
A	4.7	1.77			1180	2.5	1500	0.0
C	4.92	4.0		4.34	1510	4	2400	0.0
D	3.8	3.44	1.11		1300	2.5	2000	0.0
E	3.47	2.81			1870	3		
F	2.87	1.35			900	4		
G	2.62	1.38		1.65	920	3	1200	0.0
N	3.28	1.17			780	4.5		
O	1.75	1.91	0.44		1340	3.1		
H	2.43	0.9			600	3		
I	2.99	3.54	0.91		960	3.2	2500	0.0
J	5.37	3.92	0.91		1860	3		
P	1.75	1.91	0.44		1340	3.1		
K	3.08	1.44			960	3		
L	3.86	1.4			930	3.4	1800	0.0
M	3.39	1.22			810	4.7		
Totals	**51.07**	**30.95**	**3.82**	**7.25**			**11,400**	

Table 5 shows the 100 year ARI peak discharges from each sub-catchment were adequately managed by the bio-retention swale systems and infiltration basins ranging from 550 m^3 to 1,300 m^3. Assuming a maximum depth of 0.5 m in each basin a total land area of about 2.5 Ha will be required for the infiltration basins. This is a small proportion of the 116.51 Ha allocated for open space. Although the analysis has assumed a single infiltration basin for each group of sub-catchments it is likely that a number of small basins could be used for each sub-catchment as required by town planning and topography constraints. Note that it was assumed that each basin will overflow to low lying areas of the site. Where ever possible the invert of the infiltration basins should be greater than 1.7 m AHD to ensure that basins are higher than the 100 year ARI Hunter River flood levels that may impact on ground water levels at the site. The estimated minimum ground levels shown in Table 5 show that this is possible and it should be noted that this is a conservative requirement.

6.2 Water Quality

Quality characteristics of stormwater runoff from the sub-catchments were assessed using MUSIC and pluviograph rainfall data from the Maryville rain gauge for the years 1970, 1975 and 1990. Analysis of the Maryville pluviograph record revealed that 1970 was a low rainfall year (rainfall: 840 mm/annum), 1975 was an average rainfall year (rainfall: 939 mm/annum) and 1990 was a high rainfall year (rainfall: 1794 mm/annum). The expected concentrations of contaminants used in the water quality monitoring are shown in Table 6.

Table 6: Expected contaminant concentrations

Category	Suspended solids (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Open Space	79	0.079	0.84
Urban development	199	0.355	2.63

6.1 Water Quality Prior to Development

The annual pollutant loads in stormwater runoff from the site in a pre-development state for the high, average and low rainfall years is shown in Table 7.

Table 7: Expected stormwater quality from the site prior to development

Year	Rainfall (mm/yr)	Discharge (ML/yr)	Load (kg/yr)		
			SS	TP	TN
1970	840	0	0	0	0
1975	939	6	49.8	0.2	4.55
1990	1794	257	21,600	24.9	232

The range of average annual pollutant loads for suspended solids SS, total phosphorus TP and total nitrogen TN discharging to the low lying areas at the site in the pre-development state was expected to range from 0 kg to 21,600 kg for TSS, 0 kg to 24.9 kg for TP and 0 kg to 232 kg for TN. Annual stormwater discharges from the sub-catchments ranged from 0 ML to 257 ML.

Table 7 shows that in an average rainfall year there is very little surface stormwater runoff as expected for this site that consists of deep sand soils. In a high rainfall year some surface stormwater runoff can be expected from the site due to the high infiltration capacity of the soils being overwhelmed by rainfall.

6.2 Water Quality from the Developed Site

The annual pollutant loads in stormwater runoff from the developed site as shown in Figure 13 for the high, average and low rainfall years is shown in Table 8. A schematic of the stormwater network used in the MUSIC model is shown in Figure 15.

Table 8: Expected stormwater quality from the site prior to development

Year	Rainfall (mm/yr)	Discharge (ML/yr)	Load (kg/yr)		
			SS	TP	TN
1970	840	0	0	0	0
1975	939	3.5	29	0.116	2.66
1990	1794	104	7,410	8.32	97.1

The range of average annual pollutant loads for suspended solids SS, total phosphorus TP and total nitrogen TN discharging to the low lying areas for the developed site was expected to range from 0 kg to 7,410 kg for TSS, 0 kg to 8.32 kg for TP and 0 kg to 97.1 kg for TN. Annual stormwater discharges from the sub-catchments ranged from 0 ML to 104 ML.

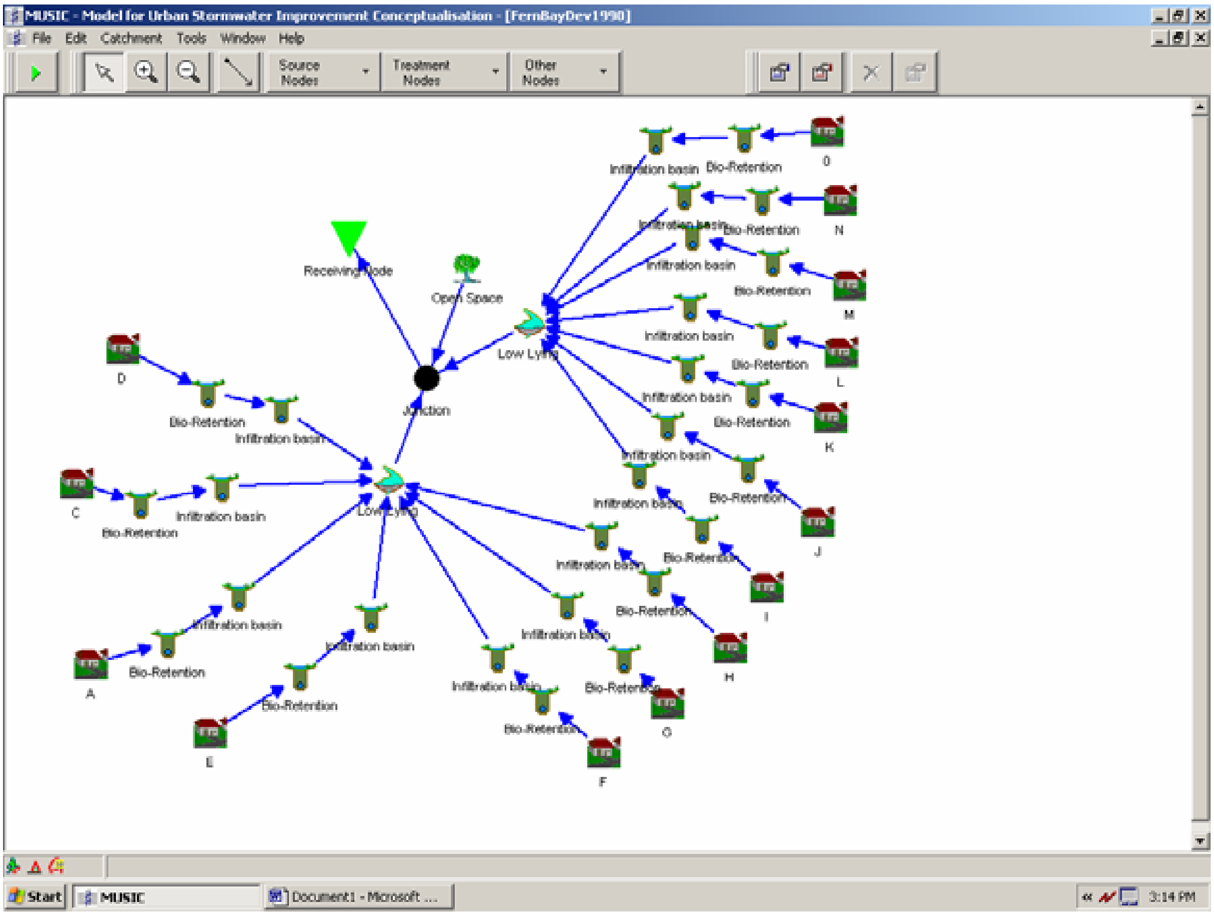

Figure 15: Stormwater management network used for the developed site in MUSIC

Table 8 shows that the proposed stormwater management system will produce small decreases in surface stormwater runoff volumes and will not increase pollutant loads in comparison to the site in a pre-development state.

7.0 Maintenance Considerations

The performance of the stormwater management system will be, to some extent, dependent on some simple maintenance procedures. It will be important to periodically remove litter and sediment from inlet pits in the street drainage system to ensure optimum operation of the WSUD treatment train. Failure to clean out inlet pits may result in decreased stormwater quality and greater water levels in the swales within road reserves. The requirement to periodically remove sediment and litter from inlet pits is also common to traditional drainage system. It is recommended that the inlet pits are emptied on a quarterly basis.

8.0 Erosion and Sediment Controls

The site contains sandy soils that may be subject to wind and soil erosion. The following management approaches should be taken to limit potential for wind and soil erosion in the proposed development:

- Construction activities should be phased to minimise erosion and minimise impacts on stormwater management measures than rely on infiltration processes
- Clearing of vegetation should be minimised

- Sediment basins, silt fences and perimeter banks should be used during construction to minimise erosion and sediment transport to receiving waters
- Sediment traps and GPTs should be installed in stormwater drainage systems
- Vegetated ground cover should be maintained or restored

9.0 Conclusions

A treatment train of stormwater management measures in keeping with the water sensitive urban design philosophy is proposed for urban development at the site. The basis of the stormwater management strategy is opportunistic utilisation of the high infiltration capacities displayed by soils on the site. The proposed design aims to maintain natural water balances at the site.

It is proposed to use pipe drainage, infiltration trenches, roads with one-way cross-falls, bio-retention swales, Gross Pollutant Traps, infiltration swales and infiltration trenches to manage stormwater quantity and quality at the site. The WSUD strategy that encourages local treatment and infiltration of stormwater will maintain the spatially varied natural water balance and the long term water quality in the aquifer. Importantly, the described WSUD system is not impact expected adversely on the quality of water in the aquifer. In addition groundwater will not be extracted or modified at this site.

Discharge of stormwater runoff via overland flow from the site to Fullerton Cove and the SEPP14 wetland is unlikely to occur. In addition, there is no recorded history of flooding at the site from the Hunter River and the topography of the land surface and surrounding road embankments make such an event unlikely. It is unlikely that the majority of site can be subjected to flooding from the Hunter River. There is also no record of the site being subjected to local flooding. It is true that the low lying areas of the site are subject to inundation following rain events. Nevertheless, it is not proposed to build the urban development in the low lying areas adjacent to Nelson Bay Road. The stormwater management strategies proposed in this report will protect the proposed urban development from local flooding whilst mitigating potential stormwater impacts of urban development on receiving environments. The proposed stormwater management strategy will not require maintenance efforts in excess of the requirements of traditional pipe drainage systems.

The use of 3 kL rainwater tanks to supply domestic toilet, laundry and outdoor water uses, and water efficient appliances will reduce household water use by about 50%. This equates to an annual reduction in mains water demand for the entire site of 101 ML.

References

Coombes P.J., and G. Kuczera, (2003). Analysis of the performance of rainwater tanks in Australian capital cities. Procedings of the 28th International Hydrology and Water Resources Symposium. Wollongong, Australia.

Coombes P.J., and Kuczera G., (2001). Rainwater tank design for water supply and stormwater management. SIA Regional Stormwater Conference. Port Stephens

Department of Land and Water Conservation (1998). The NSW Groundwater Quality Protection Policy.

Department of Land and Water Conservation (2002). The NSW State Groundwater Dependent Ecosystems Policy.

Engineers Australia. (2006). Australian Runoff Quality, Editor THF Wong.

IEAust., (1987). Australian rainfall and runoff: a guide to flood estimation. Vol. 1. The Institution of Engineers, Australia.
Kuczera, G., Williams, B., Binning, P. and Lambert, M., (2000). An education web site for free water engineering software. 3rd International Hydrology and Water Resources Symposium. Institution of Engineers Australia. Perth. Western Australia. 1048 – 1053.
Coffey Partners (1996). Proposed development; Fern Bay; Additional geotechnical work
CMPS & F (1996). Assessment of groundwater quality and acid sulphate soils
Coffey Partners (1992). Port Stephens Shire Council: Fern Bay geotechnical studies
Engineers Australia (2004). Australian Runoff Quality.
Douglas Partners (1998). Report on pavement investigation: Fernwood – stage 1 off Nelson Bay Road Fern Bay.
Port Stephens Council (1997). Fern Bay: Development Control Plan No. 50.
Port Stephens Council (2000). Local Environmental Plan 2000.
Port Stephens Council (2000). Areas affected by flooding and/or inundation.
Urban Water Cycle Solutions (2006). Stormwater Management Strategies for the Proposed Urban Development at Fern Bay. Winton Property Group.
Willing & Partners (1992). Fern Bay engineering study: stage 2 report

Appendix A: WUFS description

HYDROLOGIC ANALYSIS OF STREET DRAINAGE SYSTEMS

A street drainage system consists of a network of pipes and surface channels that drain stormwater at the scale of the road grid that traverses the urban landscape.

The principal aim of a hydrologic analysis of a street drainage system is to estimate peak flowrates and hydrographs at various points within drainage system using either design storms with a specified average recurrence interval or observed storms.

There are two fundamentally different approaches to flow estimation in urban catchments:

Rational Method

The rational method is the traditional and most widely used method for estimating peak flowrates. At a particular location in the catchment the peak flow Q (m^3/s) is given by

$$Q = C\, I_{tc}\, A \tag{1}$$

Where A is the area (m^2) drained by the location, C is a dimensionless runoff coefficient, and I_{tc} is the rainfall intensity (m/s) for a design storm with duration equal to the time of concentration t_c

It is considered by many to be a simple method that can be implemented by hand calculations. However, the reality is different:

Considerable skill is required to reliably estimate the time of concentration for a complex catchment.

The accuracy of the method is largely dependent on the procedure for estimating runoff coefficients - the current ARR (1987) runoff coefficient design curves are based on very limited field data and, as a result, there is considerable doubt about their universal applicability.

The requirement by ARR (1987) to make partial area checks considerably complicates its use.

The method concentrates on peak flowrates. It is unable to correctly simulate hydrographs which are important in the design of detention/retention devices that are used in attenuating peak flows and water quality management.

The rational method is considered to be satisfactory for the design of drainage systems whose elements are sized by peak flow considerations.

It is unable to simulate catchment response to observed storms.

Hydrograph Routing

Hydrograph routing models simulate the complete hydrograph response to either design or observed storm events. They simulate the physics of stormwater runoff more closely than does the rational method and, as a consequence, can be applied with greater confidence to ungauged catchments.

The models are computationally intensive and, therefore, have required the use of PCs. In the past, the need to use PCs was seen as a major disadvantage. However, with the widespread adoption of PCs in engineering practice, this consideration is no longer relevant.

Hydrograph routing models are intrinsically more capable of simulating complex systems than is the rational method. Because they are physically more realistic and can be used for both design and observed storm events, they should be seen as the preferred hydrologic analysis tool.

1. WUFS - A Hydrograph Routing Model

There are a range of hydrograph routing models in the literature. They are either based on the time-area method or the kinematic wave model.

Here we consider a model called WUFS which stands for **W**ater **U**rban **F**low **S**imulator.

WUFS is packaged as Windows-based software with a Web-based help system. It can be downloaded from www.eng.newcastle.edu.au/~canine. At present its only sanctioned use is for educational applications.

Like the commercial software packages such as DRAINS and its ancestor, ILSAX, WUFS uses the time area method to simulate runoff within urban subcatchments.

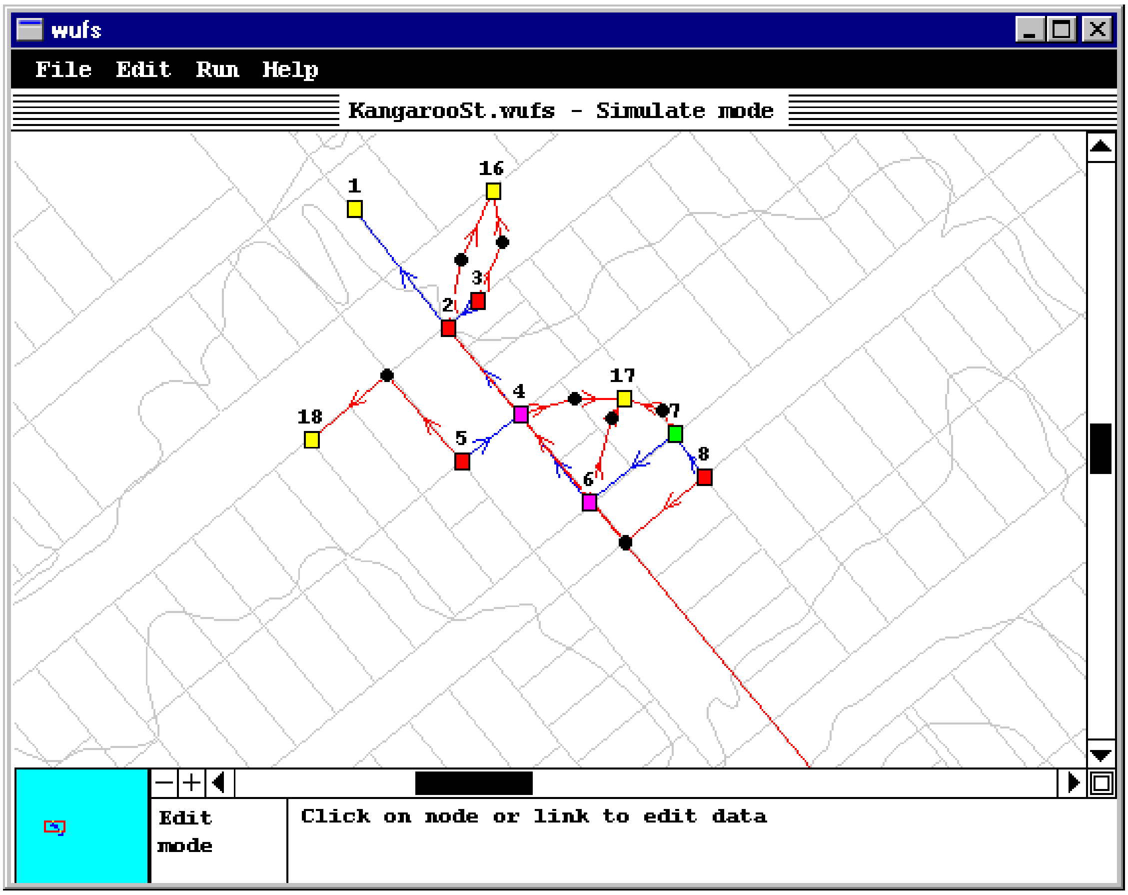

Figure A1. WUFS drainage schematic and cadastral map.

WUFS has several features that allow the (student) designer to concentrate on mastering the key concepts of urban drainage design:

It fully supports ARR (1987) design storms. All that is required is the specification of the 2- and 50-year primary duration intensities obtainable from Volume 2 of ARR (1987).

It conceptualises the drainage system as a series of nodes interconnected by links that can represent pipes and surface flow routes. The graphical user interface allows the drainage nodes and links to be overlaid over a cadastral map of the urban catchment to assist visualisation. Figure 1 illustrates a WUFS schematic of a drainage system. All nodes except outfall nodes must have one pipe and one surface overflow link leaving the node.

Nodes can be configured to simulate a variety of on-grade and sag pit configurations which connect the surface to the sub-surface pipe system.

Three simulation modes facilitate analysis of the drainage system:

1) 1) **Design mode** determines pipe diameters assuming the hydraulic grade line lies along the pipe obvert and pit losses are negligible.

2) 2) **Upgrade mode** redesigns any existing pipe to avoid pit overflows - this is preferred mode when simulating minor storms.

3) 3) **Evaluation mode** simulates pipe flow and pit overflows in the existing system - typically used in major storm simulations to assess the hydrologic flows in overflow routes.

It provides level pool routing capability for a range of detention/retention basin configurations.

2. Time-Area Simulation of Subcatchment Hydrographs

WUFS uses the time-area method to calculate surface runoff hydrograph at the outlet of each subcatchment that drains into a node. Each subcatchment is conceptualised as being made up of:
An impervious area such as roofs and paved surfaces from which no rainfall can infiltrate into the soil; and
A pervious area such as grass from which some rainfall can infiltrate into the soil.
Both impervious and pervious areas have surface irregularities that must be filled before any overland flow can commence in the downslope direction. When these irregularities are distributed throughout the catchment, they are referred to as depression storage. On impervious area depression storage is of the order of 1 mm, whereas on pervious area it is highly variable with a typical lower bound of 5 mm.

2.1 Impervious Time-Area Routing

For impervious areas WUFS uses the traditional time-area method to generate overland flow hydrographs from rainfall intensity data. It is based on the observation that there is a time, denoted by t_c, at which the entire catchment contributes to the discharge at the catchment outlet.
The catchment is divided into subareas that are defined by travel time contours (isochrones) which are lines of equal overland flow travel time. In Figure A2 the catchment is shown to be subdivided into 3 subareas with isochrones Dt, 2Dt and 3Dt.

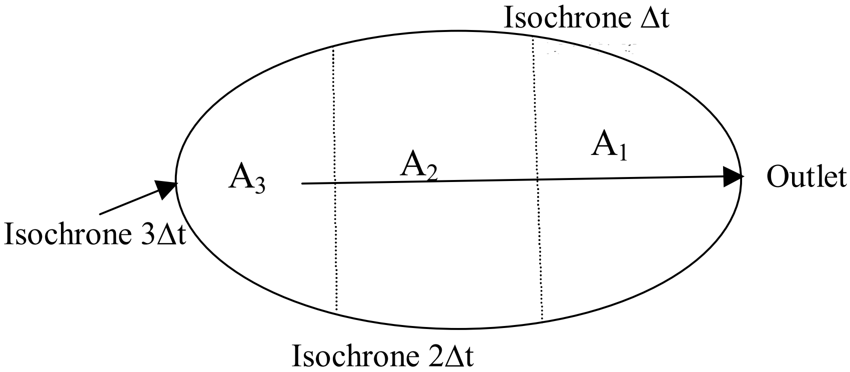

Figure A2 Schematic of catchment with time of concentration 3Dt and subdivision showing isochrones.

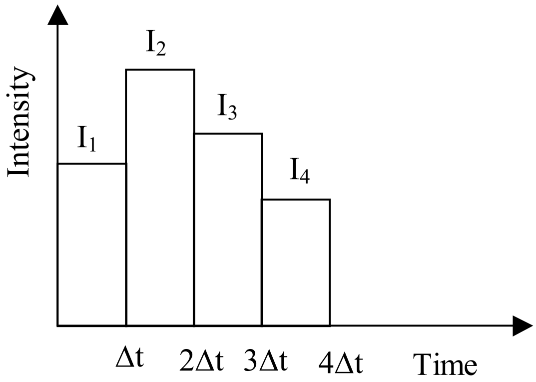

Figure A3 Storm hyetograph.

When a storm commences over the catchment the initial discharge at the outlet Q_0 is zero at time 0. Figure A3 shows the hyetograph for the storm, which consists of 4 bursts of intensity, I_1, I_2, I_3 and I_4, each with duration Dt.

In practice the depression storage is subtracted from the rainfall. This is because no overland flow can commence until depression storage is filled.

At time Dt only subarea A_1, defined as the area with a maximum travel time to the catchment outlet of Δt, contributes to the flow at the outlet. Runoff from other subareas is still travelling towards the catchment outlet.

At time Dt subarea A_1 is in equilibrium with rainfall intensity I_1 because the whole subarea is contributing to flow at the outlet of A_1. Equilibrium conditions imply that at time Dt the rate of rainfall falling on the subarea A_1I_1 equals the outflow Q_{Dt}. Remember that the subarea is impervious so that all rainfall incident on the subarea becomes runoff. The flow rate at time Dt leaving subarea A_1 as well as the catchment outlet is

$$Q_{Dt} = A_1I_1 \qquad (2)$$

where I_1 is the rainfall intensity for the time interval (0, Dt. Eqn (2) represents the familiar rational method equation for a runoff coefficient of 1.

At time 2Dt the runoff produced during time interval (0, Dt) from subarea A_2 has arrived at the outlet with a peak value of A_2I_1. During time interval (Dt, 2Dt) subarea A_1 is contributing to runoff at the outlet with a peak value of A_1I_2 occurring at time 2Dt. At time 2Dt the peak flow arriving at the outlet is

$$Q_{2Dt} = A_1I_2 + A_2I_1 \qquad (3)$$

A similar argument for the remainder of the storm produces the following scheme for the impervious area runoff hydrograph

$$
\begin{aligned}
Q_0 &= 0 \\
Q_{Dt} &= A_1 I_1 \\
Q_{2Dt} &= A_1 I_2 + A_2 I_1 \\
Q_{3Dt} &= A_1 I_3 + A_2 I_2 + A_3 I_1 \\
Q_{4Dt} &= A_1 I_4 + A_2 I_3 + A_3 I_2 \\
Q_{5Dt} &= A_2 . I_4 + A_3 . I_3 \\
Q_{6Dt} &= A_3 I_4 \\
Q_{7Dt} &= 0 \qquad (4)
\end{aligned}
$$

The time-area method is a generalisation of the rational method and is similar in concept to the convolution of the unit hydrograph.

The construction of eqn (4) made the implicit assumption that the travel time or time of concentration of each subarea is independent of discharge; that is, flow velocity is independent of discharge. Although this assumption is at variance with the kinematic wave theory of overland flow, experimental observation of small urban subcatchments indicates that the time-area method provides remarkably consistent results.

WUFS further simplifies application of the time-area method by assuming that the time-area diagram is linear; that is, the travel time to the outlet is proportional to the area drained by the outlet. Figure A4 illustrates the linear time-area diagram.

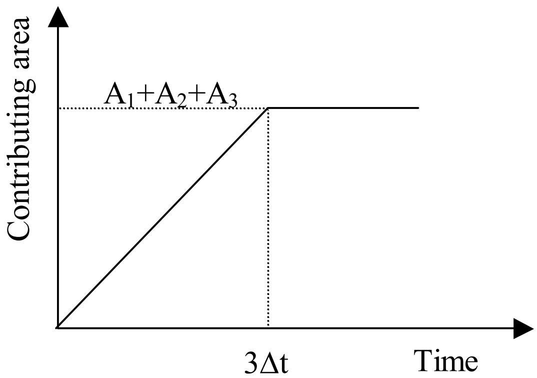

Figure A4 Linear time-area diagram for a contributing area of $A_1+A_2+A_3$ and a travel time of 3Dt.

The practical implication of the time-area method as implemented in WUFS is that the engineer has only to estimate the impervious area of the subcatchment and its associated time of travel. The data requirements are thus no different to those of the rational method, yet a far more useful result is obtained.

2.2 Horton Infiltration and Time Compression

Before considering pervious time-area routing it is necessary to review the soil infiltration model used by WUFS.

WUFS uses the Horton infiltration equation. When the surface experiences ponded conditions throughout the infiltration event, the Horton equation is

$$f_t = f_\infty + (f_o - f_\infty)\, e^{-k} \qquad (5)$$

where f_t is the soil infiltration capacity rate(mm/hr) at time t (hr), f_o is the initial infiltration rate, f_∞ is the soil infiltration capacity rate when the soil is saturated, and k is a decay constant (1/hr). Figure A5 illustrates the Horton curve under ponded conditions.

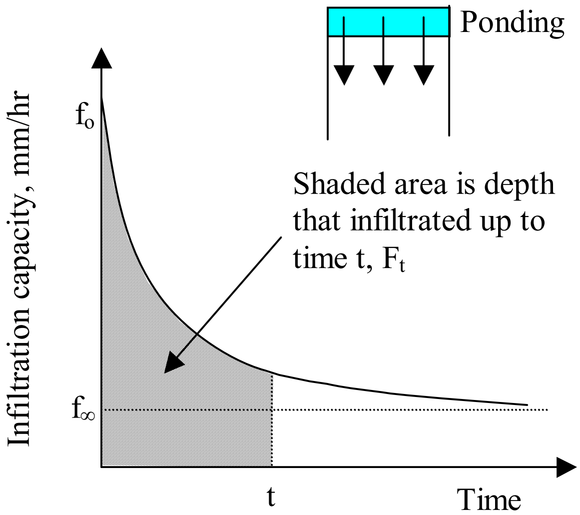

Figure A5 Horton infiltration curve under ponded conditions.

Eqn (5) is the source of much confusion in hydrologic applications. The following discussion introduces the time-compression method to demonstrate the correct use of Horton's equation.
Eqn (5) describes the maximum rate at which water can infiltrate to the soil. Under ponded conditions this equals the actual infiltration rate because there is more water trying to infiltrate the soil than the soil can accept.
However, when the rainfall rate is less than the infiltration capacity of the soil, all the rain infiltrates into the soil and no ponding occurs. Under such conditions the Horton curve given by eqn (5) would give erroneous results. In the worst case when the rainfall stops, eqn (5) continues to reduce the infiltration capacity of the soil, whereas in reality the soil's infiltration capacity remains largely unchanged because no water is infiltrating into the soil.
To solve this problem the method of time compression is used. Rather than expressing the infiltration capacity of the soil as a function of time, the method of time compression expresses f_t as a function of the cumulative depth of infiltrated water F_t (mm). Referring to Figure A5, the cumulative depth of infiltrated water up to time t, F_t, is given by the shaded area which is

$$\begin{aligned} F_t &= \int_0^t \left[f_\infty + (f_o - f_\infty) e^{-ks} \right] ds \\ &= f_\infty t + \frac{1}{k}(f_o - f_\infty)(1 - e^{-kt}) \end{aligned} \qquad (6)$$

Using eqn (5) to eliminate time t from eqn (6) yields the Horton time compression equation

$$F_t = \frac{1}{k}\left\{ f_0 - f_t - f_\infty \log_e \left[\frac{f_t - f_\infty}{f_o - f_\infty} \right] \right\} \qquad (7)$$

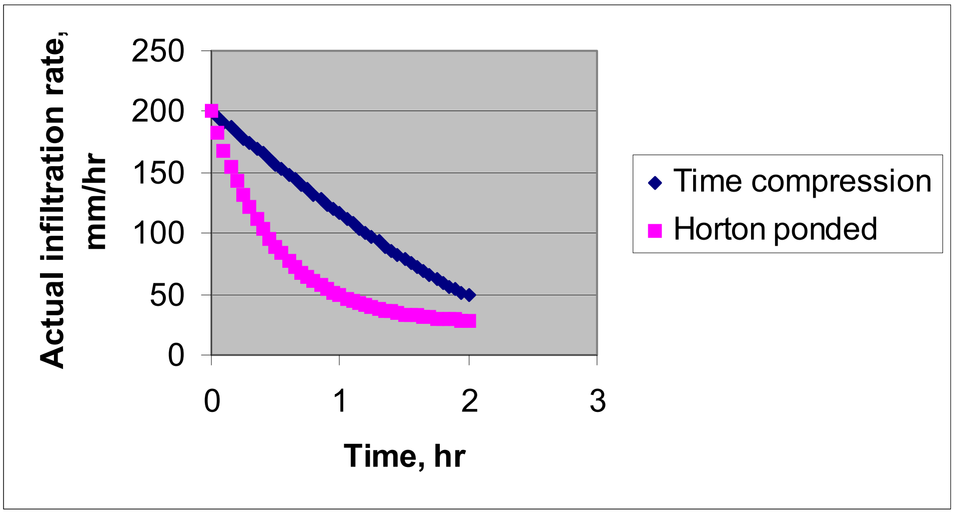

Figure A6. Comparison of Horton ponded and time-compression infiltration curves for a soil with $f_o = 200$ mm/hr, $f_\infty = 25$ mm/hr and $k = 2$ hr^{-1} subjected to a constant rainfall rate of 50 mm/hr

Eqn (7) is a nonlinear equation relating the infiltration capacity of the soil f_t to the cumulative infiltrated depth F_t - basically as F_t increases, the soil becomes wetter and hence exerts less suction which in turn reduces f_t. The change in infiltration capacity Df_t given a small change in cumulative infiltration DF_t is

$$\Delta f_t = -k\Delta F_t\left(\frac{f_t - f_\infty}{f_t}\right) \tag{8}$$

which can be used to solve eqn (7). The change in cumulative infiltration depth over the time interval (t, t+Dt) can be estimated using

$$\Delta F_t = \min\{f_t\Delta t, I_t\Delta t\} \tag{9}$$

where I_t is the current rainfall rate, f_tDt is the maximum depth of water that can infiltrate into the soil, and I_tDt is the depth of rainfall delivered over the interval (t, t+Dt).
To illustrate the importance of time compression consider the actual infiltration into a soil with $f_o = 200$ mm/hr, $f_\infty = 25$ mm/hr and $k = 2$ hr^{-1} and subjected to a constant rainfall rate of 50 mm/hr. Figure 5 compares the actual infiltration rate based on eqn (5), the ponded Horton infiltration curve, and based on eqns (8) and (9), the time compression method. Observe that the ponded Horton curve decays much faster than the time-compression curve. For most of the duration the rainfall rate of 50 mm/hr is less the infiltration capacity of the soil. As a result, the soil is not wetting as fast as it would under ponded conditions.
Explain why the time-compression Horton curve decays linearly in Figure A6. Also if the rainfall rate were 250 mm/hr, explain why the time-compression curve would be identical to the ponded Horton curve.

WUFS offers four predefined soil types whose infiltration properties are described in Table A1.

Table A1. Summary of infiltration properties of soils used in WUFS.

Soil	Description	f_∞, mm/hr	k, hr^{-1}	f_o range, mm/hr
1	Low runoff potential, high infiltration rates (consist of sand and gravel)	25	2	33.1 to 250
2	Moderate infiltration rates and moderately well drained	13	2	30.7 to 200
3	Slow infiltration rates (may have layers that impede downward movement of water)	6	2	6.6 to 125
4	High runoff potential, very slow infiltration rates (consist of clays with a permanent high water table and high swelling potential)	2	2	3 to 75

Table A2 shows the relationship between the antecedent moisture condition (AMC), soil type and initial infiltration capacity f_o. WUFS uses the AMC to define the initial dryness of the soil. The AMC can take any decimal number between 1 and 4.

Table A2. Definition of antecedent moisture condition.

AMC	Description	Initial infiltration rate f_o, mm/hr			
		1	2	3	4
1	Dry	250	200	125	75
2	Moderately dry	162	130	78	41
3	Moist	84	66	34	7
4	Wet	33	31	7	3

2.3 Pervious Time-Area Routing

For pervious areas WUFS uses a variation of the traditional time-area method. As for the impervious subcatchment, the pervious catchment is divided into subareas that are defined by time contours (isochrones) corresponding to lines of equal overland flow travel time to the outlet. The main difference is that infiltration into the soil can occur simultaneously with the movement of overland flow.

The pervious time-area method starts at the upstream subarea and works its way down to the outlet. At each subarea the hydrograph discharging into the next downstream subarea is computed. Suppose travel time over grassed area is t_c hours and the computation interval is Dt hours. Assume the time-area diagram is linear.

Subdivide the pervious area into n equal subareas such that $nDt = t_c$. Let the area of each subarea be DA. Number the subareas in consecutive order with 1 being the upstream subarea and n being the subarea discharging to the outlet.

The time-area procedure is illustrated for i^{th} sub-area during time interval (t, t+Dt). The procedure performs a water balance taking account of depression storage, infiltration and the finite travel time of overland flow. Figure A7 illustrates components of the subarea water balance:

The rainfall depth accumulating over interval (t, t+Dt) is $r_t = I_t Dt$ mm where I_t is the average rainfall intensity (mm/hr).

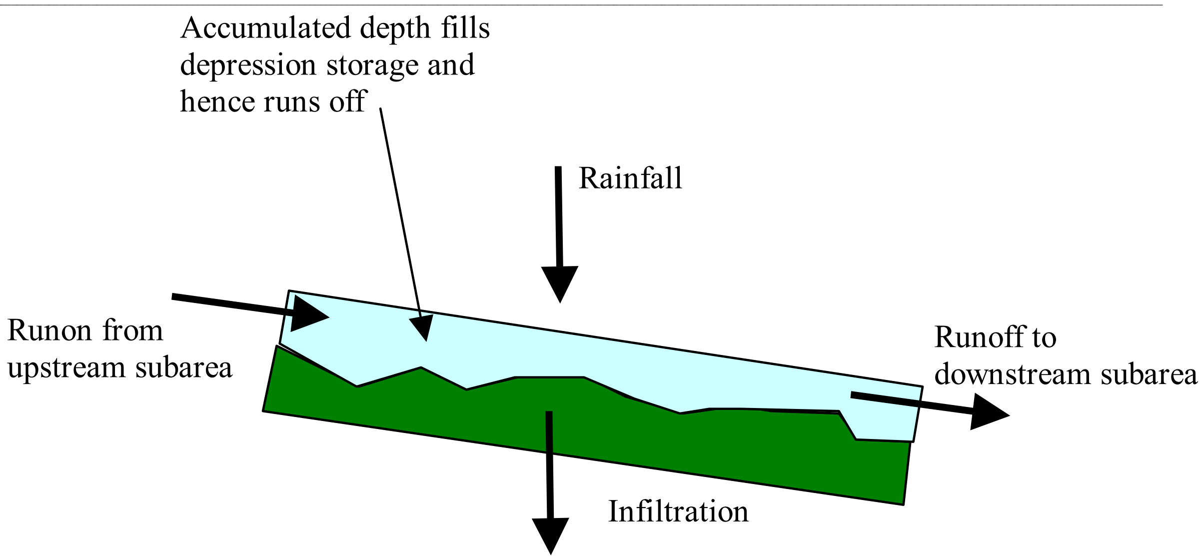

Figure A7. Schematic of pervious subarea water balance.

The cumulative infiltration depth for sub-area i at time t is F_t^i. Compute the current infiltration soil capacity f_t by solving the time-compression eqn (7).
During interval (t–Dt, t) the overland flow depth h_t^{i-1} (mm) leaves sub-area i–1 and flows into subarea i. By time t all of sub-area i-1 is contributing overland flow into subarea i. By time t+Dt all the overland flow produced in subarea i-1 during (t-Dt,t) has moved into subarea i.. This is how the lag of Dt for overland flow arises as the overland flow moves into the downstream subarea.
Hence depth of surface water (mm) over subarea i accumulating during (t, t+Dt) is

$$d_{t+\Delta t}^i = \text{Max}\left[0,\ DS_t^i + h_t^{i-1} + r_t - f_t\,\Delta t\right] \qquad (10)$$

where DS_t^i is water in the depression store at time t. Recall that the depression store represents irregularities in the surface which must be filled before overland flow can move downstream.
Update the cumulative infiltration depth at time t + Dt

$$F_{t+\Delta t}^i = F_t^i + \begin{cases} f_t\Delta t \text{ if } d_{t+\Delta t}^i > 0 \\ DS_t^i + h_t^{i-1} + r_t \text{ otherwise} \end{cases} \qquad (11)$$

Route through the depression storage as follows:
Depth of water in depression storage at time t+Dt is

$$DS_{t+\Delta t}^i = \text{Min}\left[DS_{Max}^i, d_{t+\Delta t}^i\right] \qquad (12)$$

Depth of overland flow that will completely flow into subarea i+1 during the end of interval (t+Dt, t+2Dt) is

$$h_{t+\Delta t}^i = \text{Max}\ \left[0,\ d_{t+\Delta t}^i - DS_{Max}^i\right] \qquad (13)$$

where DS_{Max}^i is the maximum depth of depression storage for subarea i.
This procedure is best illustrated by an example. Suppose the pervious subcatchment has an area of 2 ha and, for simplicity, is subdivided into 2 subareas each with a travel time Dt of 6 minutes. Table A3 presents the time-area computations for each subarea. Note that the computations start with the upstream subarea, subarea 1, which has no runon. The downstream subarea, subarea 2, receives runon from subarea 1. However, this runon is delayed by 6 minutes to account for the time of travel over subarea 1. The depression storage is 5 mm. The storm has a duration of 18 minutes with three 6-minute constant intensity bursts.

Table A3. Time-area computations for pervious area example.

Subarea	Time min	Rainfall intensity mm/hr	Rainfall depth mm	Cumulative infiltration F mm	Infiltration capacity f mm/hr	Max possible infiltration depth mm	Runon from upstream subarea	Depression storage mm	Accumulated runoff depth mm	Runoff to d/s subarea mm	Discharge to d/s subarea l/s
1	0			0.00	80.00			0.00			0.0
		75	7.5			8.00	0.00		0.00	0.00	
	6			7.50	65.00			0.00			0.0
		140	14			6.50	0.00		7.50	2.50	
	12			14.00	52.00			5.00			69.4
		120	12			5.20	0.00		11.80	6.80	
	18			19.20	41.60			5.00			188.9
		0	0			4.16	0.00		0.84	0.00	
	24			23.36	33.28			0.84			0.0
		0	0			3.33	0.00		0.00	0.00	
	30			24.20	31.60			0.00			0.0
2	0			0.00	80.00			0.00			0.0
		75	7.5			8.00	0.00		0.00	0.00	
	6			7.50	65.00			0.00			0.0
		140	14			6.50	0.00		7.50	2.50	
	12			14.00	52.00			5.00			69.4
		120	12			5.20	2.50		14.30	9.30	
	18			19.20	41.60			5.00			258.3
		0	0			4.16	6.80		7.64	2.64	
	24			23.36	33.28			5.00			73.3
		0	0			3.33	0.00		1.67	0.00	
	30			26.69	26.62			1.67			0.0

3. Pipe Hydraulic Model

WUFS employs a simple hydraulic model of pipe flow. As shown in Figure 7, WUFS assumes the hydraulic grade line coincides with the obvert of the pipe. The pipe, therefore, is flowing full but not under pressure. By assuming pit losses are negligible, the head loss between the upstream and downstream pits can be estimated independently of other pipes. Using the Darcy-Weisbach equation yields the following estimate of the maximum discharge Q_{cap} that can be conveyed by the pipe

$$Q_{cap} = \sqrt{\frac{\pi^2 g D^5 S}{8f}} \tag{14}$$

where S is pipe slope (m/m), D is pipe diameter (m) and f is the friction factor which is a function of the pipe wall roughness and Reynolds number.

3.1 Routing Through Pipe and Surface Channel System

WUFS uses a simple method for routing water through pipes and along surface overflow links. The method is called lag or time-shift routing. The method simply involves shifting the inflow hydrograph by a time interval which represents the travel time down the link. Figure A9 illustrates the lag routing.

Lag routing merely translates the hydrograph entering the link by a representative travel time. The shape of the hydrograph moving through the pipe is not changed. Therefore, any storage effects within the link are ignored. Lag routing provides a reasonable approximation in small pipes and channels where the storage volume is quickly filled by the inflow hydrograph. In systems with large pipes and channels the attenuation due to storage may become significant. In such cases lag routing leads to overestimates of peak flowrates.

The representative travel time is calculated as follows:

In pipes WUFS determines the velocity when it is flowing at capacity. The travel time is simply

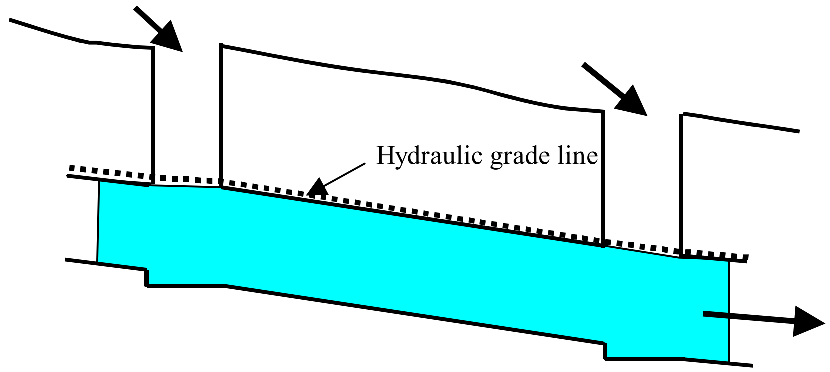

Figure A8. Pipe flowing full but not under pressure.

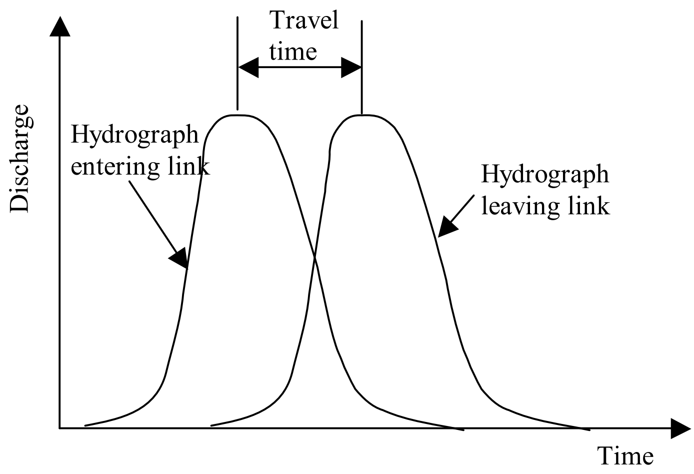

Figure A9. Lag routing

the pipe length divided by the velocity at capacity discharge.

In surface overflow links WUFS uses a user-determined travel time.

4. Modelling Pit Inlet Capacities

WUFS supports two types of pit inlet, an on-grade pit and a sag pit. These inlet types have fundamentally different hydraulic characteristics.

4.1 On-Grade Pit Inlet

An on-grade node receives surface flow from its subcatchment as well as from upstream overflows. The surface flow drains to a low point in the subcatchment. This low point freely drains meaning water will not pond but proceed further downstream.

An on-grade pit may be located at the subcatchment outlet to allow surface water to enter a subsurface pipe. The inlet capacity of the on-grade pit is determined by the flow approaching the pit. Any water unable to enter the pit can escape along the surface via the overflow link to a downstream node.

Define Q as the surface flow approaching the on-grade pit and C the flow captured by the pit. WUFS allows two formats for specifying on-grade pit inlet capacity:

$$C = \begin{cases} Q & \text{if } Q < Q_{max} \\ Q_{max} + CAP1 * (Q - Q_{max}) & \text{otherwise} \end{cases} \qquad (15)$$

All surface flows up to Q_{max} are captured by the pit. CAP1 is the fraction of surface flow in excess of Q_{max} that is captured by the pit.

$$C = \min\left(CAP1 + CAP2 * Q + CAP3 * Q^{CAP4}, Q\right) \qquad (16)$$

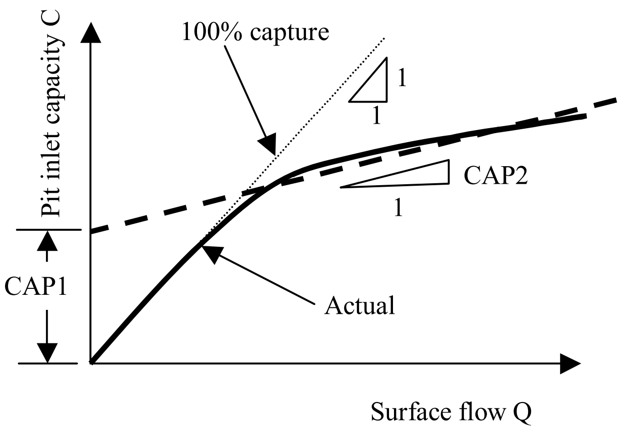

Figure 9. Fitting CAP1+CAP2*Q to actual inlet capacity relationship

This is the same equation as used by the ILSAX model. Usually CAP1 and CAP2, or CAP3 and CAP4 are fitted to data. For example, consider Figure 9 which illustrates the fitting of CAP1+CAP2*Q to an on-grade pit inlet curve. The dashed line represents the line of best fit to the actual curve not associated with 100% capture. Where the dashed line lies above the 100% capture curve, eqn. (14) indicates that the capture is Q, being the minimum of CAP1+CAP2*Q and Q.

An on-grade pit may experience blockage. The actual flow captured by the pit inlet is

$$C_{actual} = \left(1 - \frac{\%blockage}{100}\right) * C \qquad (17)$$

4.2 Upwelling

It is important to understand that the flow captured by a pit does not necessarily enter the pipe draining the pit. If the pipe capacity is exceeded upwelling will occur.
Upwelling refers to surface water that enters a pit inlet but is unable to enter the downstream pipe because the pipe capacity is inadequate. WUFS uses a simple capacity based algorithm to simulate what in fact is a complex hydraulic phenomenon.

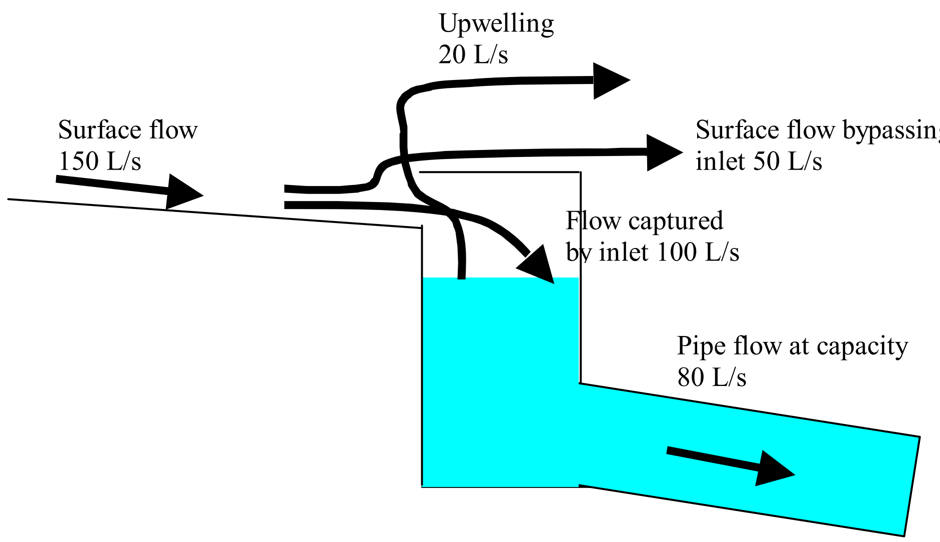

Figure 10. Schematic illustrating pit upwelling and bypass.

The concept is best illustrated by an example. Consider the on-grade pit inlet example shown in Figure 10. A surface inflow of 150 L/s approaches a pit inlet which can only capture a maximum of 100 L/s -100 L/s enters the pit and 50 L/s bypasses the pit. Although 100 L/s has entered the inlet, the pipe capacity is 80 L/s. As a result, 20 L/s of flow that entered the pit cannot enter the pipe and must be returned back to the surface - this is called upwelling. The total overflow is 70 L/s - 20 L/s due to upwelling and 50 L/s due to bypass.

4.3 Sag Pit Inlet

A sag node receives surface flow from its subcatchment as well as from upstream overflows. The surface flow drains into a local topographic depression where water naturally ponds.
A sag pit may be located in the depression allowing surface water to enter a subsurface pipe. The inlet capacity of the sag pit is determined by the depth of ponded water. When the ponded depth exceeds a maximum value, the ponded water can escape along the surface to a downstream node.
Figure 11 illustrates a sag pit inlet draining a road pavement. The depth of ponding has increased to a point that the ponded water overtops the road crown to escape to another node.
Define V as the volume of water ponding at the sag pit inlet, V_{max} as the ponded volume at which surface flow commences to escape to another node, and C the flow captured by the pit. WUFS allows two formats for specifying sag-pit inlet capacity:

When V_{max} is small the ponded volume may rapidly approach V_{max}. In such circumstance the sag pit operates close its maximum capture flow of Q_{max}. Any flow in excess of Q_{max} escapes along the surface to a downstream node. As a result, the ponded volume does not exceed V_{max}.

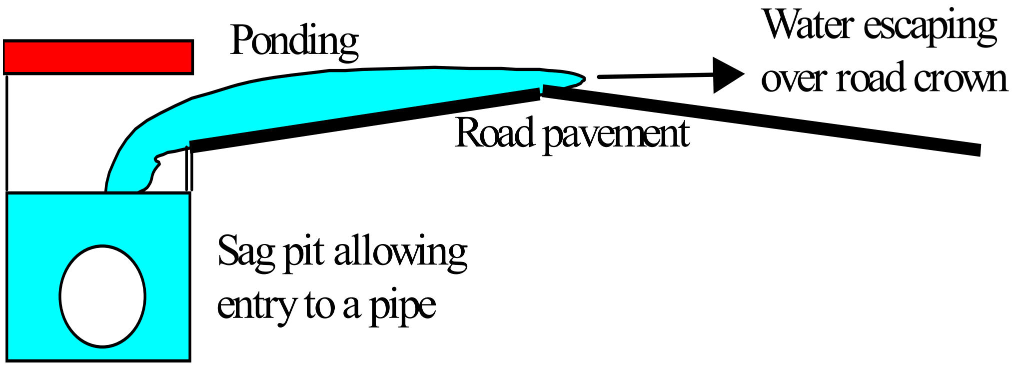

Figure 11. Cross section view of a sag pit illustrating ponding control and overflow.

$$C = \begin{cases} CAP1 * V^{CAP2} \text{ if } V < V_{max} \\ CAP1 * V_{max}{}^{CAP2} \text{ otherwise} \end{cases} \quad (18)$$

This is the same equation as used by ILSAX. It should be used in situations where the ponded volume is significant. In such cases the sag pit behaves like a detention basin attenuating and delaying the peak flow.

Evaluation of the constants CAP1 and CAP2 can be involved. In general three steps are required:

i) Obtain the relationship between ponded depth d and ponded volume V. This will be a function of the topography near the sag pit.

ii) Obtain the capacity Q - depth d relationship taking into the hydraulic controls acting on the flow into the inlet.

iii) Prepare a graph of capacity versus V on log paper and draw the straight line of best fit to estimate the parameters CAP1 and.CAP2.

Like an on-grade pit, a sag pit may experience blockage. Eqn. (17) is used to describe the blockage.

4.4 Sag Pit Inlet Examples

Consider the following example which illustrates application of eqn. (18). The sag pit in Figure 12 has a letter-box inlet which has an opening 1m long and 0.12m high. As shown in Figure, this opening lies in a flat-bottomed, steep-sided depression with a surface area of approximately $4m^2$. Runoff from the sub-catchment enters this depression which is drained by the pit inlet. Once the depth in the depression exceeds 0.17m, overflow commences.

For ponded depths d < 1.4 × 0.12 = 0.17m discharge into inlet is controlled by weir equation

$$Q = 1.66 \times 1 \times d^{3/2} \ m^3/s \quad (19)$$

From geometry of sag it follows that

Ponded volume $V = 4\,d\,m^3$ (20)

Eliminating d gives

$$Q = 1.66\left(\frac{V}{4}\right)^{3/2} = 0.21\,V^{1.5} \quad (21)$$

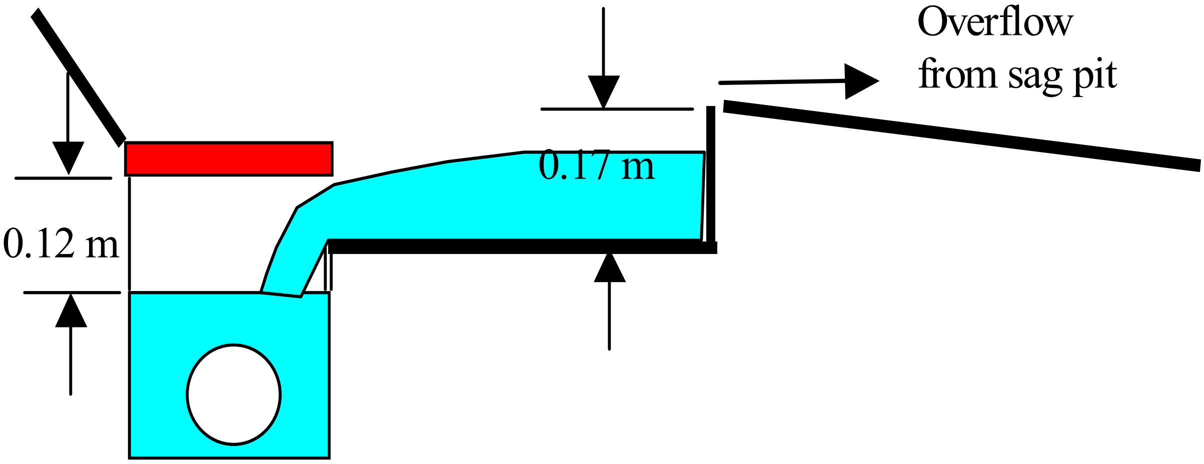

Figure 12. Cross section of letter-box sag inlet

for $V < 0.17 \times 4 = 0.68 m^3$. When V exceeds 0.68 m^3 the sag pit overflows.
Note that in this simplified example the ponded depth d was eliminated explicitly. In more complex situations a graph of V versus d will be required.
Consider another example involving the sag pit at a T-intersection as shown in Figure 13. The ponded volume is approximately by a pyramid

$$V = \frac{1}{3} d \, (\text{surface area}) = \frac{1}{3} d \left(\frac{1}{2} * 2w * w \right) \qquad (22)$$

Noting that $d/w = 3/100$, we get

$$V = \frac{1000}{27} d^3 \qquad (23)$$

For a kerb height of 0.15m and assuming the road crown at its lowest point has the same RL as the kerb top, overflow across the road will commence when the ponded volume exceeds $1.25 m^3$.
Assume a kerb inlet with linked length L. If weir flow acts as a control then discharge into pit is

$$Q = 1.66 \ L \ d^{3/2} = 1.66 \ L \left(\frac{27}{10000} V \right)^{1/2} \qquad (24)$$

$$= 0.0863 L \, V^{1/2} \qquad \left(m^3 / s \right)$$

Figure 13. Sag pit arrangement of T intersection

Note that during heavy rainfall the maximum ponded volume of 1.25 m^3 is rapidly reached. For example, a 1-ha impervious area will discharge a maximum of 0.14 ^{3}/s in response to 50 mm/hr rainfall. At such a rate it would take 9 seconds to fill a volume of 1.25 m^3. Thereafter, the pit operates at its maximum capacity of $0.0863\sqrt{1.25}\,L$.

5. WUFS Synthesis

Figure 14 summarises the sequence of operations performed by WUFS. Flows approach node B along the surface from its subcatchment and upstream surface overflow links (eg from node A). The combined surface flow attempts to enter the pit inlet at node B. The flow that enters the pit combines with flow in upstream pipes and then attempts to enter the pipe link downstream of node B. Any flow that exceeds the capacity of the pipe upwells to the surface to move down the surface overflow link.

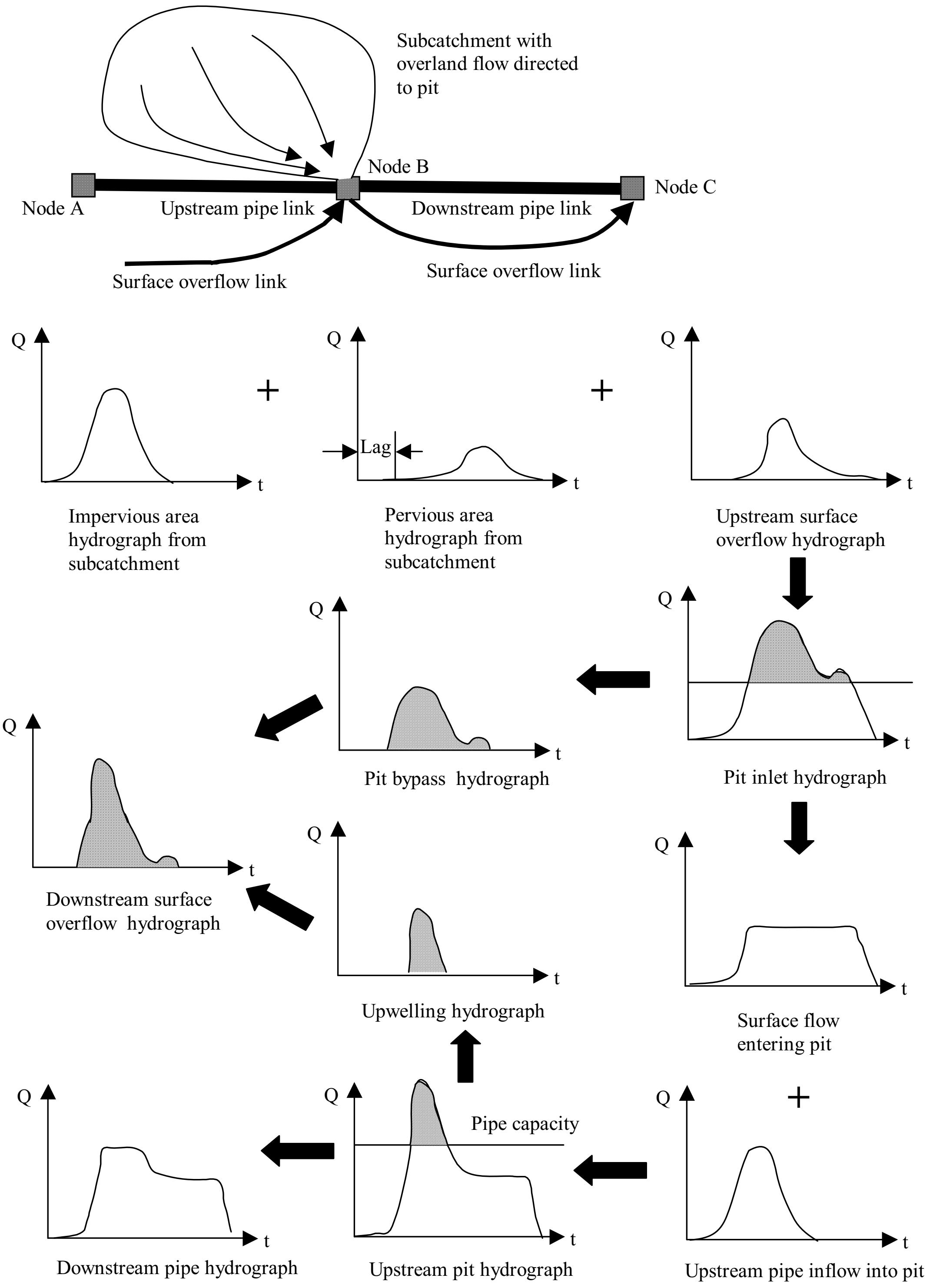

Figure 14. Schematic of WUFS simulation logic.

6. Using WUFS in Design of Urban Stormwater Systems

The following list outlines the steps to be followed in designing an urban stormwater system.

a) Preliminary Work

Determine design objectives and constraints. This includes defining the average recurrence interval (ARI) for design storms.

Decide on location of subcatchment outlets which often coincide with pit inlets. The catchment outlets define the nodes in WUFS. Each node (other than an outfall node) must have one pipe and one surface overflow link leaving the node. Any number of pipe and surface overflow links can enter a node. Connect the nodes with pipe and surface overflow links taking into account the natural drainage features of the catchment.

Gather subcatchment data which includes impervious and pervious areas, - overflow lengths and slopes, depression storage, soil type and so on.

Select an antecedent moisture condition (AMC) to reflect catchment wetness prior to the design storm. Unless specific guidance is provided, err on the conservative side by using a wet AMC.

Once all the preliminary work has been completed the stormwater network can be entered into WUFS.

b) Design of Minor System

During the minor storm (which typically has a small ARI, say 2 to 10 years) the drainage system should be sized so that stormwater is conveyed without significant nuisance or inconvenience to the community. Excessive ponding of water and significant inundation of property and roads is typically constrained. For example, on non-arterial roads the maximum flow width may be set at 2.5 m. Likewise, upwelling from the pipe system is usually avoided.

To satisfy these constraints, it is necessary to interactively size the traditional stormwater conveyance elements including pipe links and pit inlets as well as water sensitive hydraulic structures such as infiltration trenches, water tanks, and landscape depression storage enhancement schemes.. WUFS should be run in either design or upgrade mode.

In design mode WUFS sizes all pipes assuming the hydraulic grade line lies along the pipe obvert and pit losses are negligible. The objective of the design is to select the smallest commercially available pipe diameter which avoids upwelling. In contrast, upgrade mode will only resize an existing pipe if upwelling occurs; pipes which do not produce upwelling are left as is.

The easiest way to size pit inlet structures is to set their capacity to infinity, simulate the minor storms, note the maximum surface flow approaching each pit and size accordingly.

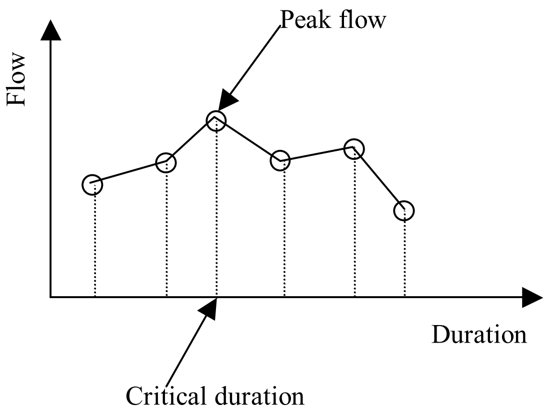

Figure 15. Critical duration concept.

A range of storm durations must always be simulated to identify the critical duration at a particular location. This is essential because different storms can produce the maximum or peak flow at different locations within the catchment. WUFS provides a convenient summary of peak flows in the report file. Figure 15 illustrates the critical duration concept. It is important to simulate sufficient storms to unequivocally identify the critical duration.

c) Design of Major System

During the major storm (which typically has a large ARI, say up to 100 years) the drainage system should be sized so that stormwater is conveyed without significant threat to life or property. Typically convenience systems based on pipes and water sensitive systems surcharge. Surface flow routes must be provided to safely convey this surcharge.

To ensure the designated surface overflow routes safely convey discharges, WUFS must be run in evaluation mode which simulates the system as specified - no resizing of pipes is done in evaluation mode. This ensures that reasonable estimates of surface overflow are obtained.

A range of storm durations should be simulated. This is because different storms produce the maximum or critical flow at different locations within the catchment. The surface overflow route should be designed using hydraulic principles to safely convey the critical discharge.

Appendix B: Stormwater runoff results for 100 year ARI

WUFS Report File (Program version 1.30 ; Build date: 13/09/2003)
Created on 29/05/2007 at 18:32 by Dr. Peter Coombes

Note: Use of this version of WUFS is restricted to educational applications only.
Commercial use is not authorized.

Units: Unless specified otherwise, time is in minutes,
discharge in m^3/s, length in m and area in hectares

```
!------------------------------------------------------------!
! Catchment name: Fern Bay                                   !
! Run title: Planning Study                                  !
!                                                            !
!------------------------------------------------------------!
```

Rainfall depth multiplier: 1.00

ARR storm location: Fern Bay
Latitude: 32.50
Longitude: 152.00
Zone: 1
Skew: 0.00
ARI: 100 years

ARR standard intensities (mm/hr)

ARI	6-min	1 hour	12 hour	72 hour
2	106.00	35.00	7.00	2.28
50	196.21	65.00	14.00	4.70

Antecedent moisture condition: 2.50

Soil Infiltration rates (mm/hr)

Type	Initial	Saturated	k 1/hr
1	122.9	25.0	2.00
2	98.2	13.0	2.00
3	55.9	6.0	2.00
4	24.1	3.0	2.00
5	300.0	50.0	2.00

Global Data
Computation time interval (min): 0.25
Default run mode: Design pipe to avoid upwelling
Pipe defaults: Minimum diameter (mm): 100.0
Minimum slope: 0.005
Design or upgrade mode constraint: Diameters CANNOT decrease in downstream direction

```
!------------------------------------------------------------!
! Link summary for catchment: Fern Bay                       !
!------------------------------------------------------------!
```

Node	Type	Name	To node	Status	Diameter (mm)	Length (m)	Slope	Rough (mm)	Loss	Detail Mode
1	X	Main outfall								

2	S B	5	Off	-----	----	----	----	----	Default	Low
3	S A	8	Off	-----	----	----	----	----	Default	Low
4	S RoadB	5	Off	-----	----	----	----	----	Default	Low
5	S Junction	6	Off	-----	----	----	----	----	Default	Low
6	S Junction	9	Off	-----	----	----	----	----	Default	Low
7	S RoadA	8	Off	-----	----	----	----	----	Default	Low
8	S Junction	6	Off	-----	----	----	----	----	Default	Low
9	D BasinAB	1	Off	-----	----	----	----	----	Default	Low
10	S C	12	Off	-----	----	----	----	----	Default	Low
11	S RoadC	12	Off	-----	----	----	----	----	Default	Low
12	S Junction	13	Off	-----	----	----	----	----	Default	Low
13	S Junction	14	Off	-----	----	----	----	----	Default	Low
14	D BasinC	15	Off	-----	----	----	----	----	Default	Low
15	X Main outfall									
16	S Park	12	Off	-----	----	----	----	----	Default	Low
17	S D	21	Off	-----	----	----	----	----	Default	Low
18	S Cafe	21	Off	-----	----	----	----	----	Default	Low
19	S Integrated Housing	21	Off	-----	----	----	----	----	Default	Low
20	S Roads	21	Off	-----	----	----	----	----	Default	Low
21	S Junction	22	Off	-----	----	----	----	----	Default	Low
22	S Junction	23	Off	-----	----	----	----	----	Default	Low
23	D BasinD	24	Off	-----	----	----	----	----	Default	Low
24	X Main outfall									
25	S E	27	Off	-----	----	----	----	----	Default	Low
26	S Roads	27	Off	-----	----	----	----	----	Default	Low
27	S Junction	28	Off	-----	----	----	----	----	Default	Low
28	S Junction	33	Off	-----	----	----	----	----	Default	Low
29	S F	31	Off	-----	----	----	----	----	Default	Low
30	S Roads	31	Off	-----	----	----	----	----	Default	Low
31	S Junction	32	Off	-----	----	----	----	----	Default	Low
32	S Junction	33	Off	-----	----	----	----	----	Default	Low
33	D BasinF	34	Off	-----	----	----	----	----	Default	Low
34	X Main outfall									
35	S G	37	Off	-----	----	----	----	----	Default	Low
36	S Roads	37	Off	-----	----	----	----	----	Default	Low
37	S Junction	38	Off	-----	----	----	----	----	Default	Low
38	S Junction	39	Off	-----	----	----	----	----	Default	Low
39	S Junction	44	Off	-----	----	----	----	----	Default	Low
40	S Junction	39	Off	-----	----	----	----	----	Default	Low
41	S H	40	Off	-----	----	----	----	----	Default	Low
42	S Roads	40	Off	-----	----	----	----	----	Default	Low
43	X Main outfall									
44	D BasinH	43	Off	-----	----	----	----	----	Default	Low
45	S Junction	44	Off	-----	----	----	----	----	Default	Low
46	S Junction	45	Off	-----	----	----	----	----	Default	Low
47	S Integrated Housing	46	Off	-----	----	----	----	----	Default	Low
48	S Roads	46	Off	-----	----	----	----	----	Default	Low
49	S I	46	Off	-----	----	----	----	----	Default	Low
50	S Junction	44	Off	-----	----	----	----	----	Default	Low
51	S Junction	50	Off	-----	----	----	----	----	Default	Low
52	S Integrated Housing	51	Off	-----	----	----	----	----	Default	Low
53	S J	51	Off	-----	----	----	----	----	Default	Low
54	S Roads	51	Off	-----	----	----	----	----	Default	Low
55	S K	56	Off	-----	----	----	----	----	Default	Low
56	S Junction	57	Off	-----	----	----	----	----	Default	Low
57	S Junction	62	Off	-----	----	----	----	----	Default	Low
58	S Roads	56	Off	-----	----	----	----	----	Default	Low
59	S L	61	Off	-----	----	----	----	----	Default	Low
60	S Roads	61	Off	-----	----	----	----	----	Default	Low
61	S Junction	62	Off	-----	----	----	----	----	Default	Low
62	S Junction	67	Off	-----	----	----	----	----	Default	Low
63	S M	65	Off	-----	----	----	----	----	Default	Low

64	S Roads	65	Off	-----	----	----	----	----	Default	Low
65	S Junction	66	Off	-----	----	----	----	----	Default	Low
66	S Junction	67	Off	-----	----	----	----	----	Default	Low
67	D BasinM	68	Off	-----	----	----	----	----	Default	Low
68	X Main outfall									
69	S N	71	Off	-----	----	----	----	----	Default	Low
70	S Roads	71	Off	-----	----	----	----	----	Default	Low
71	S Junction	72	Off	-----	----	----	----	----	Default	Low
72	S Junction	67	Off	-----	----	----	----	----	Default	Low
73	S O	76	Off	-----	----	----	----	----	Default	Low
74	S Integrated Housing	76	Off	-----	----	----	----	----	Default	Low
75	S Roads	76	Off	-----	----	----	----	----	Default	Low
76	S Junction	77	Off	-----	----	----	----	----	Default	Low
77	S Junction	33	Off	-----	----	----	----	----	Default	Low
78	S Park	37	Off	-----	----	----	----	----	Default	Low
79	S Junction	83	Off	-----	----	----	----	----	Default	Low
80	S Roads	79	Off	-----	----	----	----	----	Default	Low
81	S Integrated Housing	79	Off	-----	----	----	----	----	Default	Low
82	S O	79	Off	-----	----	----	----	----	Default	Low
83	S Junction	84	Off	-----	----	----	----	----	Default	Low
84	S Junction	44	Off	-----	----	----	----	----	Default	Low

Node type code: G=On-grade inlet; S=Sag inlet; D=Detention basin; J=Junction; X=Outfall

Node Name	Type	<----Enabled----> Capacity	Blockage Blockage	<------------Inlet captures-------------> %
2 B	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
3 A	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
4 RoadB	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
5 Junction	Sag	Yes	Zero	0.0 Up to 0.840 m^3/s
6 Junction	Sag	Yes	Zero	0.0 Up to 0.030 m^3/s
7 RoadA	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
8 Junction	Sag	Yes	Zero	0.0 Up to 0.840 m^3/s
10 C	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
11 RoadC	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
12 Junction	Sag	Yes	Zero	0.0 Up to 1.470 m^3/s
13 Junction	Sag	Yes	Zero	0.0 Up to 0.030 m^3/s
16 Park	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
17 D	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
18 Cafe	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
19 Integrated Housing	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
20 Roads	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
21 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
22 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
25 E	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
26 Roads	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
27 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
28 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
29 F	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
30 Roads	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
31 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
32 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
35 G	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
36 Roads	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
37 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
38 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
39 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
40 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
41 H	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
42 Roads	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s
45 Junction	Sag	Yes	Zero	0.0 Up to 0.000 m^3/s

```
 46 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 47 Integrated Housing  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 48 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 49 I                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 50 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 51 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 52 Integrated Housing  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 53 J                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 54 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 55 K                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 56 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 57 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 58 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 59 L                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 60 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 61 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 62 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 63 M                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 64 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 65 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 66 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 69 N                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 70 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 71 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 72 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 73 O                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 74 Integrated Housing  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 75 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 76 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 77 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 78 Park               Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 79 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 80 Roads              Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 81 Integrated Housing  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 82 O                  Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 83 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s
 84 Junction           Sag        Yes    Zero     0.0 Up to    0.000 m^3/s

<--Node--> <--------------------------Overflow link data---------------------------------->
 From  To  Cost   Retention <----------------Concentrated flow options------------------>
           $      option Travel time <------------------Trapezoidal channel------------------->
                         min  Bot width <----Sideslope---> Length  Slope     n Leakage
                                m      Left   Right      m               mm/hr
---------------------------------------------------------------------------------------------------
   2   5    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
   3   8    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
   4   5    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
   5   6    0.  Leaky swale    0.0    -----   ------  ------   ----  ----- -----   ----
   6   9    0.  Leaky swale    0.0    -----   ------  ------   ----  ----- -----   ----
   7   8    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
   8   6    0.  Leaky swale    0.0    -----   ------  ------   ----  ----- -----   ----
   9   1    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  10  12    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  11  12    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  12  13    0.  Leaky swale    0.0    -----   ------  ------   ----  ----- -----   ----
  13  14    0.  Leaky swale    0.0    -----   ------  ------   ----  ----- -----   ----
  14  15    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  16  12    0.       None      2.0    -----   ------  ------   ----  ----- -----   ----
  17  21    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  18  21    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  19  21    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
  20  21    0.       None      0.0    -----   ------  ------   ----  ----- -----   ----
```

21	22	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
22	23	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
23	24	0.	None	0.0	-----	------	------	----	-----	-----	----
25	27	0.	None	0.0	-----	------	------	----	-----	-----	----
26	27	0.	None	0.0	-----	------	------	----	-----	-----	----
27	28	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
28	33	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
29	31	0.	None	0.0	-----	------	------	----	-----	-----	----
30	31	0.	None	0.0	-----	------	------	----	-----	-----	----
31	32	0.	Leaky swale	----	1.000	0.0300	0.0300	450.00	0.0100	0.200	0.00
32	33	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
33	34	0.	None	0.0	-----	------	------	----	-----	-----	----
35	37	0.	None	0.0	-----	------	------	----	-----	-----	----
36	37	0.	None	0.0	-----	------	------	----	-----	-----	----
37	38	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
38	39	0.	Leaky swale	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
39	44	0.	Leaky swale	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
40	39	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
41	40	0.	None	0.0	-----	------	------	----	-----	-----	----
42	40	0.	None	0.0	-----	------	------	----	-----	-----	----
44	43	0.	None	0.0	-----	------	------	----	-----	-----	----
45	44	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
46	45	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
47	46	0.	None	0.0	-----	------	------	----	-----	-----	----
48	46	0.	None	0.0	-----	------	------	----	-----	-----	----
49	46	0.	None	0.0	-----	------	------	----	-----	-----	----
50	44	0.	None	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
51	50	0.	Leaky swale	----	3.000	0.0300	0.0300	900.00	0.0100	0.200	0.00
52	51	0.	None	0.0	-----	------	------	----	-----	-----	----
53	51	0.	None	0.0	-----	------	------	----	-----	-----	----
54	51	0.	None	0.0	-----	------	------	----	-----	-----	----
55	56	0.	None	0.0	-----	------	------	----	-----	-----	----
56	57	0.	Leaky swale	----	1.000	0.0300	0.0300	480.00	0.0100	0.200	0.00
57	62	0.	Leaky swale	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
58	56	0.	None	0.0	-----	------	------	----	-----	-----	----
59	61	0.	None	0.0	-----	------	------	----	-----	-----	----
60	61	0.	None	0.0	-----	------	------	----	-----	-----	----
61	62	0.	Leaky swale	----	1.000	0.0300	0.0300	460.00	0.0100	0.200	0.00
62	67	0.	Leaky swale	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
63	65	0.	None	0.0	-----	------	------	----	-----	-----	----
64	65	0.	None	0.0	-----	------	------	----	-----	-----	----
65	66	0.	Leaky swale	----	1.000	0.0300	0.0300	400.00	0.0100	0.200	0.00
66	67	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
67	68	0.	None	0.0	-----	------	------	----	-----	-----	----
69	71	0.	None	0.0	-----	------	------	----	-----	-----	----
70	71	0.	None	0.0	-----	------	------	----	-----	-----	----
71	72	0.	Leaky swale	----	370.000	0.0300	0.0300	1.00	0.0100	0.200	0.00
72	67	0.	Leaky swale	----	3.000	0.0300	0.0300	200.00	0.0100	0.200	0.00
73	76	0.	None	0.0	-----	------	------	----	-----	-----	----
74	76	0.	None	0.0	-----	------	------	----	-----	-----	----
75	76	0.	None	0.0	-----	------	------	----	-----	-----	----
76	77	0.	Leaky swale	----	1.000	0.0100	0.0300	350.00	0.0100	0.200	0.00
77	33	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
78	37	0.	None	0.0	-----	------	------	----	-----	-----	----
79	83	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
80	79	0.	None	0.0	-----	------	------	----	-----	-----	----
81	79	0.	None	0.0	-----	------	------	----	-----	-----	----
82	79	0.	None	0.0	-----	------	------	----	-----	-----	----
83	84	0.	Leaky swale	0.0	-----	------	------	----	-----	-----	----
84	44	0.	None	0.0	-----	------	------	----	-----	-----	----

Node <----------------------Overflow link retention data------------------------->

```
 From   To
---------------------------------------------------------------------------------------
    5    6 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =  580.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
    6    9 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =   20.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0100,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.100 m^3/s
           Trench: Width  20.000, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
    8    6 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =  600.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   12   13 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length = 1510.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   13   14 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =   20.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0100,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.100 m^3/s
           Trench: Width  20.000, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   21   22 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length = 1300.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   22   23 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =   20.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0100,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.100 m^3/s
           Trench: Width  20.000, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   27   28 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length = 1870.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   28   33 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =   20.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0100,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.100 m^3/s
           Trench: Width  20.000, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   31   32 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =  450.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   32   33 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =   20.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0100,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.100 m^3/s
           Trench: Width  20.000, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
   37   38 Link inflow enters  1 cascading leaky triangular swales:
           Swale: Length =  920.00 m, Longitudinal slope  0.0100, Side slope m (mV:1H)  0.0300,
                  Manning n   0.070, Leakage rate   100.0 mm/hr, Pit capture   0.030 m^3/s
           Trench: Width   0.450, Depth   0.600
                  Discharge slot: Diameter   0.100 m, and invert offset   0.000 m
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38 39 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 5.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
39 44 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 5.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
40 39 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 600.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
45 44 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
46 45 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 960.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
51 50 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 900.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
56 57 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 500.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
57 62 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 5.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
61 62 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 460.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
62 67 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 5.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
65 66 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 400.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
66 67 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
71 72 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 370.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,

Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
72 67 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 20.000, Depth 5.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
76 77 Link inflow enters 1 cascading leaky triangular swales:
Swale: Length = 350.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0300,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.030 m^3/s
Trench: Width 0.450, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
77 33 Link inflow enters 10 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 1.000, Depth 1.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
79 83 Link inflow enters 10 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 1.000, Depth 0.600
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m
83 84 Link inflow enters 10 cascading leaky triangular swales:
Swale: Length = 20.00 m, Longitudinal slope 0.0100, Side slope m (mV:1H) 0.0100,
Manning n 0.070, Leakage rate 100.0 mm/hr, Pit capture 0.100 m^3/s
Trench: Width 1.000, Depth 1.000
Discharge slot: Diameter 0.100 m, and invert offset 0.000 m

Catchment Summary

Node	Type	Impervious subareas: Number of sub areas	Sub area ha	Total area ha	Tc min	DepSto mm	Tank Storage: Collect %	Leakage m^3/hr	Overflows to	Area m^2	Height m	Air-space ht m	Diam mm	%full
2	S	28	0.032	0.904	2.00	1.0	30.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
3	S	28	0.040	1.120	2.00	1.0	30.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
4	S	1	0.406	0.406	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
5	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
6	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
7	S	1	0.420	0.420	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
8	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
10	S	49	0.070	3.430	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
11	S	1	1.867	1.867	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
12	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
13	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
16	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
17	S	87	0.031	2.654	2.00	1.0	30.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
18	S	1	0.150	0.150	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
19	S	1	0.864	0.864	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
20	S	1	1.650	1.650	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
21	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
22	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
25	S	88	0.028	2.438	2.00	1.0	30.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
26	S	1	1.309	1.309	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
27	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
28	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
29	S	52	0.039	2.007	2.00	1.0	25.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
30	S	1	0.630	0.630	3.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
31	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
32	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
35	S	54	0.034	1.831	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0

36	S	1	0.644	0.644	3.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
37	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
38	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
39	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
40	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
41	S	44	0.039	1.703	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
42	S	1	0.420	0.420	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
45	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
46	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
47	S	1	0.820	0.820	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
48	S	1	1.652	1.652	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
49	S	48	0.043	2.050	2.00	1.0	25.0	0.00	outlet	1.50	2.000	0.500	100	0.0
50	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
51	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
52	S	1	0.820	0.820	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
53	S	78	0.048	3.760	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
54	S	1	1.302	1.302	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
55	S	47	0.046	2.157	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
56	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
57	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
58	S	1	0.672	0.672	4.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
59	S	57	0.047	2.702	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
60	S	1	0.651	0.651	4.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
61	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
62	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
63	S	58	0.041	2.372	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
64	S	1	0.567	0.567	3.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
65	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
66	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
69	S	56	0.041	2.296	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
70	S	1	0.546	0.546	3.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
71	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
72	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
73	S	29	0.042	1.224	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
74	S	1	0.610	0.610	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
75	S	1	0.345	0.345	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
76	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
77	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
78	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
79	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
80	S	1	0.345	0.345	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
81	S	1	0.610	0.610	5.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
82	S	29	0.042	1.224	2.00	1.0	20.0	0.00	perv. tank	1.50	2.000	0.090	90	50.0
83	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0
84	S	1	0.000	0.000	2.00	1.0	0.0	0.00	outlet	5.00	2.000	0.500	100	0.0

Total 51.171

Node Type <---Pervious subareas--->
Number Sub Total <-----------Overland flow----------> Soil <----------------Retention Storage------------->
of sub area area Tc Mann Length Slope Conc DepSto type Type Volume outletLeak soilLeak
areas ha ha min n m flow mm m^3 m^3/hr m^3/hr
time Area Height (m) Diam (mm) Cd
min m^2 Wall ht Wall diam

2	S	28	0.010	0.280	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
3	S	28	0.022	0.619	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
4	S	1	0.464	0.464	----	0.070	4.0	0.030	5.00	5.0	1	None			
5	S	1	0.000	0.000	----	0.070	0.0	0.050	0.00	5.0	2	None			
6	S	1	0.000	0.000	----	0.070	0.0	0.050	0.00	5.0	2	None			
7	S	1	0.480	0.480	----	0.070	4.0	0.030	5.00	5.0	1	None			

8	S	1	0.000	0.000	----	0.070	0.0	0.050	0.00	5.0	2	None			
10	S	49	0.030	1.470	----	0.070	20.0	0.010	0.00	5.0	2	None			
11	S	1	2.130	2.130	----	0.070	4.0	0.030	10.00	5.0	2	None			
12	S	1	0.000	0.000	----	0.070	0.0	0.050	0.00	5.0	2	None			
13	S	1	0.000	0.000	----	0.070	0.0	0.050	0.00	5.0	2	None			
16	S	1	4.340	4.340	----	0.070	50.0	0.010	0.00	5.0	1	None			
17	S	87	0.013	1.140	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
18	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
19	S	1	0.096	0.096	----	0.070	50.0	0.010	0.00	5.0	2	None			
20	S	1	1.835	1.835	----	0.070	4.0	0.030	5.00	5.0	1	None			
21	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
22	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
25	S	88	0.012	1.038	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
26	S	1	1.496	1.496	----	0.070	4.0	0.030	5.00	5.0	2	None			
27	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
28	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
29	S	52	0.016	0.858	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
30	S	1	0.720	0.720	----	0.070	4.0	0.030	3.00	5.0	1	None			
31	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
32	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
35	S	54	0.014	0.783	----	0.070	20.0	0.010	0.00	5.0	2	None			
36	S	1	0.736	0.736	----	0.070	4.0	0.030	3.00	5.0	1	None			
37	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
38	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
39	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
40	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
41	S	44	0.017	0.730	----	0.070	20.0	0.010	0.00	5.0	2	None			
42	S	1	0.480	0.480	----	0.070	4.0	0.030	2.00	5.0	1	None			
45	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
46	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
47	S	1	0.090	0.090	----	0.070	50.0	0.010	0.00	5.0	2	None			
48	S	1	1.888	1.888	----	0.070	5.0	0.030	4.00	5.0	1	None			
49	S	48	0.018	0.878	----	0.070	20.0	0.010	0.00	5.0	2	None			
50	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
51	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
52	S	1	0.090	0.090	----	0.070	20.0	0.010	0.00	5.0	2	None			
53	S	78	0.021	1.607	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
54	S	1	1.488	1.488	----	0.070	4.0	0.030	5.00	5.0	1	None			
55	S	47	0.020	0.926	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
56	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
57	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
58	S	1	0.768	0.768	----	0.070	4.0	0.030	4.00	5.0	1	None			
59	S	57	0.020	1.157	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
60	S	1	0.744	0.744	----	0.070	4.0	0.030	4.00	5.0	1	None			
61	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
62	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
63	S	58	0.018	1.015	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
64	S	1	0.648	0.648	----	0.070	4.0	0.030	3.00	5.0	1	None			
65	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
66	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
69	S	56	0.018	0.986	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
70	S	1	0.176	0.176	----	0.070	4.0	0.030	3.00	5.0	1	None			
71	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
72	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
73	S	29	0.018	0.525	----	0.070	20.0	0.010	0.00	5.0	2	Leaky storage	10.0	0.00	1.00
74	S	1	0.045	0.045	----	0.070	50.0	0.010	0.00	5.0	2	None			
75	S	1	0.395	0.395	----	0.070	4.0	0.030	5.00	5.0	1	None			
76	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
77	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
78	S	1	1.650	1.650	----	0.070	30.0	0.010	0.00	5.0	2	None			
79	S	1	0.000	0.000	----	0.200	0.0	0.050	0.00	5.0	2	None			
80	S	1	0.395	0.395	----	0.070	4.0	0.030	5.00	5.0	1	None			

```
 81   S      1  0.045  0.045 ---- 0.070   50.0 0.010  0.00    5.0    2         None
 82   S     29  0.018  0.525 ---- 0.070   20.0 0.010  0.00    5.0    2 Leaky storage    10.0       0.00      1.00
 83   S      1  0.000  0.000 ---- 0.200    0.0 0.050  0.00    5.0    2         None
 84   S      1  0.000  0.000 ---- 0.200    0.0 0.050  0.00    5.0    2         None
---------------------------------------------------------------------------------------------------------------------
            Total    35.736
                     -------

-------------------------------------------------------------------------------
Detention basin node: BasinAB at node   9 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 1700.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0   850.0  1500.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600

-------------------------------------------------------------------------------
Detention basin node: BasinC at node  14 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 4000.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0  2000.0  2400.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600

-------------------------------------------------------------------------------
Detention basin node: BasinD at node  23 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 2600.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0  1300.0  2000.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600

-------------------------------------------------------------------------------
Detention basin node: BasinF at node  33 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 2000.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0   600.0  1200.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600

-------------------------------------------------------------------------------
Detention basin node: BasinH at node  44 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 4167.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0  2000.0  2500.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600

-------------------------------------------------------------------------------
Detention basin node: BasinM at node  67 with initial storage (m^3/s)   0.000
                  Leakage rate (mm/hr)  429.98 from basin area (m^2) 1400.00
                  Effective area over which rainfall instantly enter basin (m^2)      0.00
Storage (m^3)          :     0.0   700.0  1800.0
Pipe discharge (m^3/s) :   0.000   0.001   0.001
Ovflw discharge (m^3/s):   0.000   0.000   1.000
Water height (m)       :   0.000   0.500   0.600
```

!-------------------------!
! Simulated Storm Summary !
!-------------------------!

ARR storm number 1: ARI (yrs) 100; Duration (mins) 10.0; Average intensity (mm/hr) 177.21

ARR storm number 2: ARI (yrs) 100; Duration (mins) 20.0; Average intensity (mm/hr) 129.24

ARR storm number 3: ARI (yrs) 100; Duration (mins) 30.0; Average intensity (mm/hr) 105.13

ARR storm number 4: ARI (yrs) 100; Duration (mins) 45.0; Average intensity (mm/hr) 84.38

ARR storm number 5: ARI (yrs) 100; Duration (mins) 60.0; Average intensity (mm/hr) 71.72

ARR storm number 6: ARI (yrs) 100; Duration (mins) 90.0; Average intensity (mm/hr) 56.28

ARR storm number 7: ARI (yrs) 100; Duration (mins) 120.0; Average intensity (mm/hr) 47.22

ARR storm number 8: ARI (yrs) 100; Duration (mins) 180.0; Average intensity (mm/hr) 36.76

ARR storm number 9: ARI (yrs) 100; Duration (mins) 270.0; Average intensity (mm/hr) 28.59

ARR storm number 10: ARI (yrs) 100; Duration (mins) 360.0; Average intensity (mm/hr) 23.92

!-------------------!
! Peak Flow Summary !
!-------------------!

Node	Name	Type	<To node>		<------Surface---->			<-----------Pipe--------->				<-Overflow->	
			Pipe	Oflw	Peak flow m^3/s	Crit dur min	Upwell peak m^3/s	Peak flow m^3/s	Crit dur min	Cap m^3/s	Diam mm	Peak flow m^3/s	Crit dur min
1	Main outfall	X											
2	B	S	5	5	0.276	20.0	0.000	0.000	0.0	0.000	----	0.276	20.0
3	A	S	8	8	0.341	20.0	0.000	0.000	0.0	0.000	----	0.341	20.0
4	RoadB	S	5	5	0.325	20.0	0.000	0.000	0.0	0.000	----	0.325	20.0
5	Junction	S	6	6	0.578	20.0	0.578	0.000	0.0	0.000	----	0.578	20.0
6	Junction	S	9	9	0.421	120.0	0.030	0.000	0.0	0.000	----	0.421	120.0
7	RoadA	S	8	8	0.336	20.0	0.000	0.000	0.0	0.000	----	0.336	20.0

8	Junction	S	6	6	0.651	20.0	0.651	0.000	0.0	0.000	----	0.651	20.0
9	BasinAB	D	1	1	0.359	120.0	0.000	0.000	0.0	0.000	----	0.000	120.0
10	C	S	12	12	1.295	60.0	0.000	0.000	0.0	0.000	----	1.295	60.0
11	RoadC	S	12	12	1.305	20.0	0.000	0.000	0.0	0.000	----	1.305	20.0
12	Junction	S	13	13	3.101	20.0	1.470	0.000	0.0	0.000	----	3.101	20.0
13	Junction	S	14	14	0.782	120.0	0.030	0.000	0.0	0.000	----	0.782	120.0
14	BasinC	D	15	15	0.719	120.0	0.000	0.000	0.0	0.000	----	0.000	120.0
15	Main outfall	X											
16	Park	S	12	12	0.761	20.0	0.000	0.000	0.0	0.000	----	0.761	20.0
17	D	S	21	21	0.458	60.0	0.000	0.000	0.0	0.000	----	0.458	60.0
18	Cafe	S	21	21	0.086	20.0	0.000	0.000	0.0	0.000	----	0.086	20.0
19	Integrated Housing	S	21	21	0.509	20.0	0.000	0.000	0.0	0.000	----	0.509	20.0
20	Roads	S	21	21	1.306	20.0	0.000	0.000	0.0	0.000	----	1.306	20.0
21	Junction	S	22	22	2.002	20.0	0.000	0.000	0.0	0.000	----	2.002	20.0
22	Junction	S	23	23	0.524	120.0	0.000	0.000	0.0	0.000	----	0.524	120.0
23	BasinD	D	24	24	0.462	120.0	0.000	0.000	0.0	0.000	----	0.000	120.0
24	Main outfall	X											
25	E	S	27	27	0.418	60.0	0.000	0.000	0.0	0.000	----	0.418	60.0
26	Roads	S	27	27	1.171	20.0	0.000	0.000	0.0	0.000	----	1.171	20.0
27	Junction	S	28	28	1.472	90.0	0.000	0.000	0.0	0.000	----	1.472	90.0
28	Junction	S	33	33	0.260	120.0	0.000	0.000	0.0	0.000	----	0.260	120.0
29	F	S	31	31	0.483	60.0	0.000	0.000	0.0	0.000	----	0.483	60.0
30	Roads	S	31	31	0.569	90.0	0.000	0.000	0.0	0.000	----	0.569	90.0
31	Junction	S	32	32	1.027	90.0	0.000	0.000	0.0	0.000	----	1.027	90.0
32	Junction	S	33	33	0.139	120.0	0.000	0.000	0.0	0.000	----	0.139	120.0
33	BasinF	D	34	34	0.317	120.0	0.000	0.000	0.0	0.000	----	0.000	120.0
34	Main outfall	X											
35	G	S	37	37	0.662	60.0	0.000	0.000	0.0	0.000	----	0.662	60.0
36	Roads	S	37	37	0.582	90.0	0.000	0.000	0.0	0.000	----	0.582	90.0
37	Junction	S	38	38	1.631	90.0	0.000	0.000	0.0	0.000	----	1.631	90.0
38	Junction	S	39	39	0.463	120.0	0.000	0.000	0.0	0.000	----	0.463	120.0
39	Junction	S	44	44	0.581	120.0	0.000	0.000	0.0	0.000	----	0.581	120.0
40	Junction	S	39	39	1.011	90.0	0.000	0.000	0.0	0.000	----	1.011	90.0
41	H	S	40	40	0.667	60.0	0.000	0.000	0.0	0.000	----	0.667	60.0
42	Roads	S	40	40	0.396	90.0	0.000	0.000	0.0	0.000	----	0.396	90.0
43	Main outfall	X											
44	BasinH	D	43	43	0.935	120.0	0.001	0.000	0.0	0.000	----	0.001	120.0
45	Junction	S	44	44	0.715	120.0	0.000	0.000	0.0	0.000	----	0.715	120.0
46	Junction	S	45	45	2.369	90.0	0.000	0.000	0.0	0.000	----	2.369	90.0
47	Integrated Housing	S	46	46	0.483	20.0	0.000	0.000	0.0	0.000	----	0.483	20.0
48	Roads	S	46	46	1.359	20.0	0.000	0.000	0.0	0.000	----	1.359	20.0
49	I	S	46	46	0.705	60.0	0.000	0.000	0.0	0.000	----	0.705	60.0
50	Junction	S	44	44	0.159	120.0	0.000	0.000	0.0	0.000	----	0.159	120.0
51	Junction	S	50	50	2.000	90.0	0.000	0.000	0.0	0.000	----	2.000	90.0
52	Integrated Housing	S	51	51	0.491	20.0	0.000	0.000	0.0	0.000	----	0.491	20.0
53	J	S	51	51	0.790	60.0	0.000	0.000	0.0	0.000	----	0.790	60.0
54	Roads	S	51	51	1.042	20.0	0.000	0.000	0.0	0.000	----	1.042	20.0
55	K	S	56	56	0.575	60.0	0.000	0.000	0.0	0.000	----	0.575	60.0
56	Junction	S	57	57	1.119	90.0	0.000	0.000	0.0	0.000	----	1.119	90.0
57	Junction	S	62	62	0.149	120.0	0.000	0.000	0.0	0.000	----	0.149	120.0
58	Roads	S	56	56	0.547	90.0	0.000	0.000	0.0	0.000	----	0.547	90.0
59	L	S	61	61	0.665	60.0	0.000	0.000	0.0	0.000	----	0.665	60.0
60	Roads	S	61	61	0.530	90.0	0.000	0.000	0.0	0.000	----	0.530	90.0
61	Junction	S	62	62	1.167	90.0	0.000	0.000	0.0	0.000	----	1.167	90.0
62	Junction	S	67	67	0.211	120.0	0.000	0.000	0.0	0.000	----	0.211	120.0
63	M	S	65	65	0.580	60.0	0.000	0.000	0.0	0.000	----	0.580	60.0
64	Roads	S	65	65	0.512	90.0	0.000	0.000	0.0	0.000	----	0.512	90.0
65	Junction	S	66	66	1.041	90.0	0.000	0.000	0.0	0.000	----	1.041	90.0
66	Junction	S	67	67	0.199	120.0	0.000	0.000	0.0	0.000	----	0.199	120.0
67	BasinM	D	68	68	0.383	120.0	0.001	0.000	0.0	0.000	----	0.001	120.0
68	Main outfall	X											
69	N	S	71	71	0.570	60.0	0.000	0.000	0.0	0.000	----	0.570	60.0

70 Roads	S	71	71	0.352	90.0	0.000	0.000	0.0	0.000	----	0.352	90.0
71 Junction	S	72	72	0.875	90.0	0.000	0.000	0.0	0.000	----	0.875	90.0
72 Junction	S	67	67	0.529	60.0	0.000	0.000	0.0	0.000	----	0.529	60.0
73 O	S	76	76	0.419	20.0	0.000	0.000	0.0	0.000	----	0.419	20.0
74 Integrated Housing	S	76	76	0.356	20.0	0.000	0.000	0.0	0.000	----	0.356	20.0
75 Roads	S	76	76	0.277	20.0	0.000	0.000	0.0	0.000	----	0.277	20.0
76 Junction	S	77	77	0.943	20.0	0.000	0.000	0.0	0.000	----	0.943	20.0
77 Junction	S	33	33	0.124	120.0	0.000	0.000	0.0	0.000	----	0.124	120.0
78 Park	S	37	37	0.489	120.0	0.000	0.000	0.0	0.000	----	0.489	120.0
79 Junction	S	83	83	0.943	20.0	0.000	0.000	0.0	0.000	----	0.943	20.0
80 Roads	S	79	79	0.277	20.0	0.000	0.000	0.0	0.000	----	0.277	20.0
81 Integrated Housing	S	79	79	0.356	20.0	0.000	0.000	0.0	0.000	----	0.356	20.0
82 O	S	79	79	0.419	20.0	0.000	0.000	0.0	0.000	----	0.419	20.0
83 Junction	S	84	84	0.113	20.0	0.000	0.000	0.0	0.000	----	0.113	20.0
84 Junction	S	44	44	0.045	10.0	0.000	0.000	0.0	0.000	----	0.045	10.0

Note: Surface = Flow arriving at node inlet from impervious and pervious subcatchments and from upstream overflows
Pipe = Flow leaving node in pipe
Overflow = Flow leaving node along a surface route