

Hydrological and nutrient modelling of the Wilson Inlet catchment

Appendices (A–E)

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Appendix A: Hydrological calibration

A.1 Hydrological model testing

A.1.1 Testing different hydrological models

We tested the following hydrological models in this project (Table A.1):

- GR4J (Perrin et al. 2003)
- LASCAM (Large Scale Catchment Model, Viney et al. 2000)

Models were tested in the Cuppup Creek catchment at flow gauge 603013. Models were calibrated using the Nash-Sutcliffe Efficiency (NSE) daily with bias penalty from 1/1/2005 to the 28/4/2017. The models were validated from 1985 to 2004. The LASCAM model performed significantly better for the calibration period but was slightly worse in the validation period (see Table A.1). Ultimately, we opted to use LASCAM due to its ability to model land-use changes over time and produce a better calibration.

Table A.1: Calibration results of the hydrological models tested

Period	Statistic	603013: LASCAM	603013: GR4J
	Objective function usef for calibration	NSE daily bias	NSE daily bias
	NSE Daily	0.86	0.79
	NSE Daily & Bias Penalty	0.86	0.77
Calibration period (2005–2017)	NSE Log Daily & Bias Penalty	0.39	0.48
	NSE Monthly	0.96	0.93
	NSE Annual	0.95	0.84
	Volume Bias (%)	-2.74	10.55
	NSE Daily	0.81	0.81
	NSE Daily & Bias Penalty	0.80	0.81
Validation period (1975–2004)	NSE Log Daily & Bias Penalty	0.52	0.55
	NSE Monthly	0.92	0.90
	NSE Annual	0.67	0.82
	Volume Bias (%)	-8.67	-2.47

A.1.2 Testing the effect of plantation leaf area index responses to clearing

We tested the effect of three different plantation leaf area index (LAI) responses during the initial stages of the hydrological model development: a fixed annual LAI, a two-year LAI response to planting/harvesting and a five-year LAI response to planting/harvesting. All three tests had their LAI scaled according to the monthly factors given in Table A.2, were optimised using NSE log daily bias (1/1/2005 to 31/12/2016) and had no stream routing.

All three models had good calibration results with most statistics being similar in all three tests (Table A.3). However, the two-year plantation LAI response gave a better annual NSE score and had a closer matching cumulative flow plot and daily flow plots (Figure A.1).

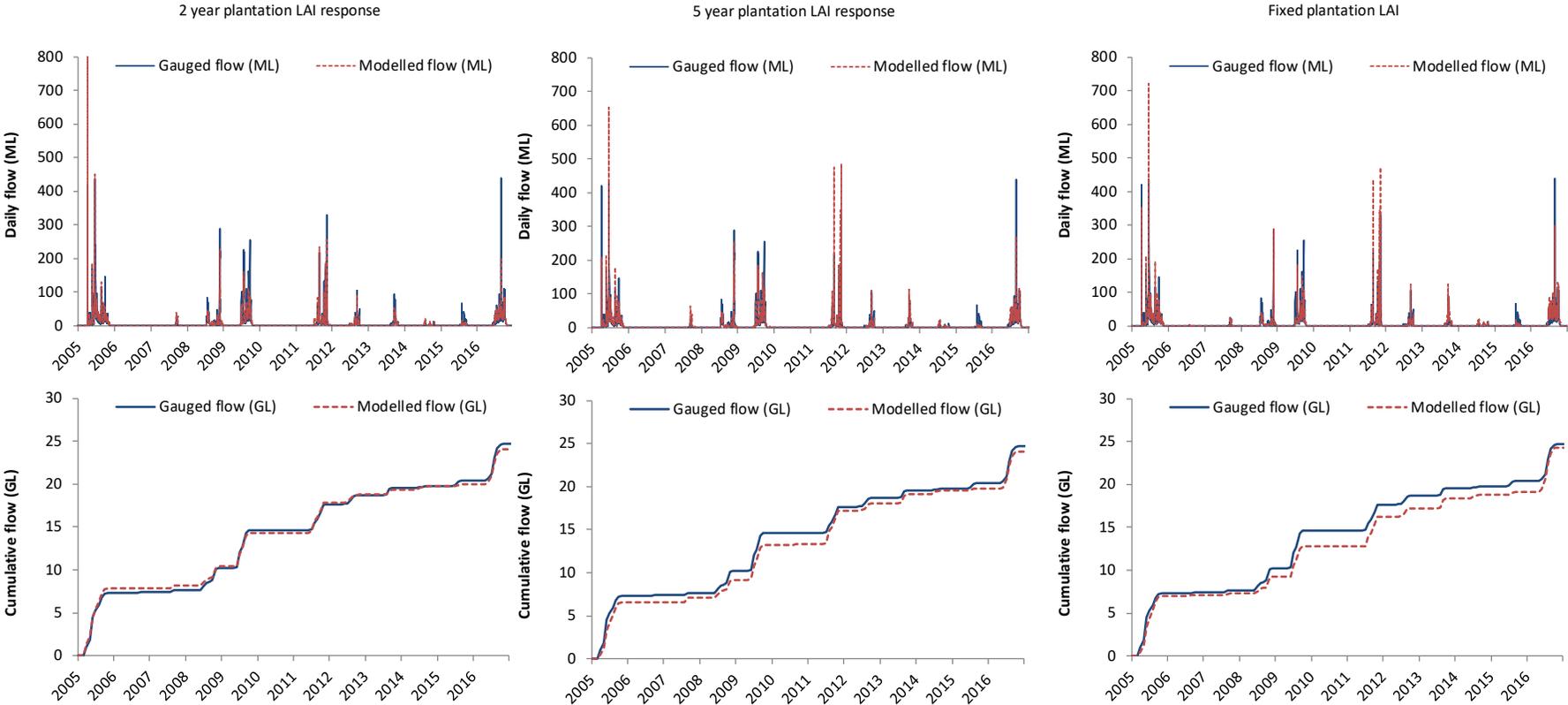
Table A.2: Monthly LAI scaling factor used for all land uses

Month	LAI factor
Jan	0.90
Feb	0.89
Mar	0.90
Apr	0.90
May	0.85
Jun	0.92
Jul	1.12
Aug	1.21
Sep	1.27
Oct	1.20
Nov	0.96
Dec	0.88

Table A.3: Model calibration statistics for three different plantation LAI responses to clearing

Period	Statistic	603190: 2- year LAI response	603190: 5- year LAI response	603190 fixed LAI
	Objective function use for calibration	NSE log daily bias	NSE log daily bias	NSE log daily bias
Calibration period (2005–201 8)	NSE Daily	0.47	0.68	0.67
	NSE Daily & Bias Penalty	0.47	0.68	0.67
	NSE Log Daily & Bias Penalty	0.84	0.84	0.87
	NSE Monthly	0.94	0.92	0.92
	NSE Annual	0.98	0.96	0.95
	Volume Bias (%)	-2.5	-2.3	-1.4
Validation period (1975- 2004)	NSE Daily	0.51	0.42	0.28
	NSE Daily & Bias Penalty	0.19	0.06	-0.74
	NSE Log Daily & Bias Penalty	0.11	0.20	-0.94
	NSE Monthly	0.69	0.69	0.38
	NSE Annual	0.38	0.30	-0.54
	Volume Bias (%)	-39.6	-41.8	-69.8

Figure A.1: Hydrographs and cumulative flow from three different plantation LAI responses to clearing



A.2 Hydrology parameters and functions

A.2.1 LASCAM parameters

Table A.4: Calibrated hydrology parameters by parameter set

Parameter	Parameter set ID												
	602009	603003	603004	603005	603007	603013	603020	603021	603022	603023	603190	Quickup	
alphag*	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
betac*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
betag*	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
betass*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
amn (mm)	54	161	29	31	50	47	54	28	14	63	4	10	
amx (mm)	197	502	314	364	364	403	419	255	205	242	153	828	
bm_x (mm)	1677	1461	783	1898	1750	1439	2285	502	2496	2428	1081	1576	
fm_x (mm)	776	322	368	448	206	218	412	865	585	629	212	400	
fs0	196	24	79	101	80	82	89	35	5	69	25	127	
dfs	71	164	136	148	46	67	43	81	95	76	32	105	
td	570	586	729	363	82	256	256	1488	364	209	1167	1259	
alphaa	1.24	3.06	3.06	2.67	2.54	1.25	1.34	10.00	1.84	1.14	4.89	1.54	
alphab	7.12	1.29	6.81	4.22	7.26	8.58	4.74	9.79	9.18	0.26	2.60	5.24	
alphac	2.58	3.24	0.00	0.12	0.00	0.01	9.81	0.00	1.89	5.61	5.74	3.88	
alphaf	4.08	0.18	3.32	6.82	4.06	9.94	3.29	2.98	4.38	5.17	8.74	0.85	
alphass	10.99	1.56	4.68	10.83	5.16	10.89	10.98	1.30	10.37	10.96	0.10	8.24	
betaa	58	3513	9914	5698	1062	342	452	1536	512	64	9999	5871	
betab	0.65	8.54	9.86	5.56	6.16	9.85	0.17	9.99	4.99	9.96	9.84	8.33	
betaf	6.84	8.92	2.06	3.55	0.15	4.31	5.91	1.00	9.99	3.01	5.11	8.76	
gammaa	1.83	5.38	3.19	2.31	9.98	4.90	1.79	7.52	9.98	0.76	4.54	2.46	
gammab	0.18	0.17	0.60	0.83	0.75	0.87	0.62	0.30	0.31	0.11	0.76	0.40	
gammaf	0.50	0.69	0.37	0.51	0.70	0.47	0.43	0.65	0.66	0.13	0.28	0.27	
deltab	2.49	3.95	3.32	2.51	0.14	0.45	2.32	0.52	2.13	2.38	4.21	2.39	
deltaf	1.00	0.89	1.00	1.00	0.98	1.00	1.00	0.30	0.30	0.42	0.95	0.71	
dmu1	1.64	1.02	0.73	0.93	0.47	0.57	1.16	1.15	1.98	1.26	0.71	1.64	
dmu2 (mm)	1250	707	2446	1933	807	631	1695	506	1353	1050	2333	1504	
dmu3	0.87	0.66	0.90	0.57	1.01	1.91	0.73	0.98	1.99	1.25	1.94	0.70	

* Parameter is fixed. All other parameters are calibrated

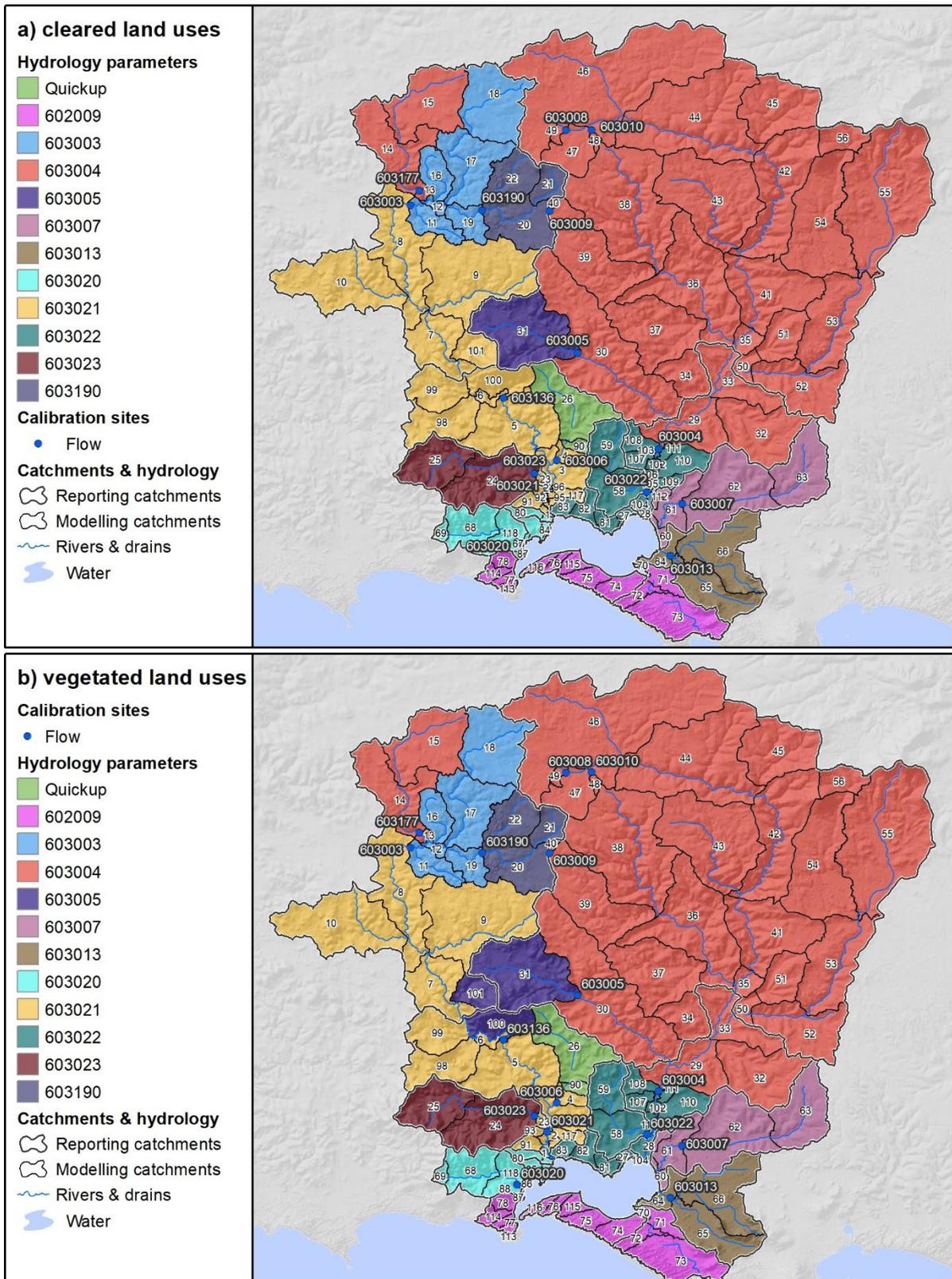


Figure A.2: Hydrology parameter sets for cleared and vegetated land uses

Table A.5: Hydrology parameter sets by modelling catchment and average annual rainfall (anrain parameter)

Cat ID	Reporting catchment	Parameter set ID			Cat ID	Reporting catchment	Parameter set ID		
		anrain (mm)	Cleared FU	Vegetated FU			anrain (mm)	Cleared FU	Vegetated FU
1	Lower Denmark River	1000	603021	603021	60	Sleeman River	900	603007	603007
2	Lower Denmark River	1000	603021	603021	61	Sleeman River	900	603007	603007
3	Lower Denmark River	900	603021	603021	62	Sleeman River	900	603007	603007
4	Lower Denmark River	900	603021	603021	63	Sleeman River	900	603007	603007
5	Lower Denmark River	1000	603021	603021	64	Cuppup Creek	900	603013	603013
6	Lower Denmark River	1000	603021	603021	65	Cuppup Creek	900	603013	603013
7	Upper Denmark River	900	603021	603021	66	Cuppup Creek	900	603013	603013
8	Upper Denmark River	900	603021	603021	67	Little River	1000	603020	603020
9	Upper Denmark River	800	603021	603021	68	Little River	1000	603020	603020
10	Upper Denmark River	900	603021	603021	69	Little River	1000	603020	603020
11	Upper Denmark River	800	603003	603003	70	Lake Saide	900	602009	602009
12	Upper Denmark River	800	603003	603003	71	Lake Saide	900	602009	602009
13	Upper Denmark River	800	603004	603004	72	Lake Saide	900	602009	602009
14	Upper Denmark River	700	603004	603004	73	Lake Saide	900	602009	602009
15	Upper Denmark River	700	603004	603004	74	Nullaki	1000	602009	602009
16	Upper Denmark River	700	603003	603003	75	Nullaki	1000	602009	602009
17	Upper Denmark River	800	603003	603003	76	Nullaki	1000	602009	602009
18	Upper Denmark River	700	603003	603003	77	Ocean Beach Road	1100	602009	602009
19	Upper Denmark River	800	603003	603003	78	Ocean Beach Road	1100	602009	602009
20	Upper Denmark River	800	603190	603190	79	Koorabup Creek	1000	603020	603020
21	Upper Denmark River	800	603190	603190	80	Koorabup Creek	1000	603020	603020
22	Upper Denmark River	800	603190	603190	81	Foreshore	900	603022	603022
23	Scotsdale Brook	1000	603021	603021	82	Foreshore	900	603022	603022
24	Scotsdale Brook	1100	603023	603023	83	Foreshore	900	603022	603022
25	Scotsdale Brook	1100	603023	603023	84	Foreshore	1000	603020	603020
26	Lower Denmark River	900	Quickup	Quickup	85	Foreshore	1000	603020	603020
27	Foreshore	900	603022	603022	86	Foreshore	1000	603020	603020
28	Lower Hay River	900	603022	603022	87	Foreshore	1100	603020	603020
29	Lower Hay River	900	603004	603004	88	Foreshore	1100	603020	603020
30	Upper Hay River	900	603004	603004	90	Lower Denmark River	900	Quickup	Quickup
31	Upper Hay River	800	603005	603005	91	Lower Denmark River	1000	603021	603021
32	Lower Hay River	800	603004	603004	92	Lower Denmark River	1000	603021	603021
33	Lower Hay River	800	603004	603004	93	Lower Denmark River	1000	603021	603021
34	Upper Hay River	800	603004	603004	94	Lower Denmark River	1000	603021	603021
35	Upper Hay River	800	603004	603004	95	Lower Denmark River	1000	603021	603021
36	Upper Hay River	700	603004	603004	96	Lower Denmark River	1000	603021	603021
37	Upper Hay River	800	603004	603004	97	Lower Denmark River	1000	603021	603021
38	Upper Hay River	700	603004	603004	98	Lower Denmark River	1000	603021	603021
39	Upper Hay River	700	603004	603004	99	Lower Denmark River	1000	603021	603021
40	Upper Hay River	800	603004	603004	100	Lower Denmark River	1000	603021	603005
41	Upper Hay River	700	603004	603004	101	Upper Denmark River	900	603021	603005
42	Upper Hay River	700	603004	603004	102	Lower Hay River	900	603022	603022
43	Upper Hay River	700	603004	603004	103	Lower Hay River	900	603022	603022
44	Upper Hay River	600	603004	603004	104	Lower Hay River	900	603022	603022
45	Upper Hay River	600	603004	603004	105	Sunny Glen Creek	900	603022	603022
46	Upper Hay River	700	603004	603004	106	Lower Hay River	900	603022	603022
47	Upper Hay River	700	603004	603004	107	Lower Hay River	900	603022	603022
48	Upper Hay River	700	603004	603004	108	Lower Hay River	900	603022	603022
49	Upper Hay River	700	603004	603004	109	Lower Hay River	900	603022	603022
50	Upper Hay River	800	603004	603004	110	Lower Hay River	900	603022	603022
51	Upper Hay River	700	603004	603004	111	Lower Hay River	900	603022	603022
52	Upper Hay River	700	603004	603004	112	Sleeman River	900	603007	603007
53	Upper Hay River	700	603004	603004	113	Ocean Beach Road	1100	602009	602009
54	Upper Hay River	700	603004	603004	114	Ocean Beach Road	1100	602009	602009
55	Upper Hay River	700	603004	603004	115	Nullaki	1000	602009	602009
56	Upper Hay River	700	603004	603004	116	Nullaki	1000	602009	602009
58	Sunny Glen Creek	900	603022	603022	117	Lower Denmark River	900	603021	603021
59	Sunny Glen Creek	900	603022	603022	118	Little River	1000	603020	603020

A.2.2 Storage node parameters (dams and lakes)

Table A.6: Storage node parameters

Model component	Parameter	Lake Saide	Nenamup Inlet	Wentworth Road dam	Mount Hallowell Stud dam	Denmark Dam	Quickup Dam	Carter Dam
Storage details	Full Supply Level (m)	-0.2	0.1	3	3	8.2	45	35.39
	Full Supply Volume (ML)	27.2	277.9	0.0	13.9	444.0	0.0	0.0
	Initial Storage Level	-0.8	-0.8	0	0	0	37	33
	Initial Storage Volume	0	0	0	0	0	0	0
	Dead Storage Level (m)	-0.2	-0.2	3	3	0	37	35.39
	Dead Storage Volume (ML)	27.2	59.4	0.0	13.9	0.0	0.0	0.0
Climate details	Climate Data-Rainfall file	Cat ID 73 Rainfall	Cat ID 72 Rainfall	Cat ID 69 Rainfall	Cat ID 68 Rainfall	Cat ID 05 Rainfall	Cat ID 26 Rainfall	Cat ID 26 Rainfall
	Climate Data-Evaporation file	Cat ID 73 Evap	Cat ID 72 Evap	Cat ID 69 Evap	Cat ID 68 Evap	Cat ID 05 Evap	Cat ID 26 Evap	Cat ID 26 Evap

A.2.3 Functions

Table A.7: Functions used for the Nenamup Inlet and Lake Saide minimum flow requirement nodes

<p>Flow from Lake Saide to Nenamup Inlet via the Wolves Pump Road flood management structure:</p> <p><i>Used by the “LakeSaideToNenamup” minimum flow requirement node.</i></p> <p>\$LakeSaideToNenamupDischarge = if(\$LakeSaideStorageVol=0,0,if(\$LakeSaideLevel<=\$NenamupInletLevel,0,if(\$LakeSaideFlow>400,400,\$LakeSaideFlow)))</p>
<p>Discharge from Nenamup Inlet to the Wilson Inlet via the Eden Road flood gates:</p> <p><i>Used by the “EdenRoadGates” minimum flow requirement node.</i></p> <p>\$NenamupRelease = if(\$InletOpening=0,0,if(\$NenamupInletLevel<=\$NenamupLevelCTF,0,if(\$NenamupInletFlow>400,400,\$NenamupInletFlow)))</p>
\$LakeSaideFlow = \$HeadDiff * 300
\$HeadDiff = \$LakeSaideLevel-\$NenamupInletLevel
\$LakeSaideStorageVol = Lake Saide modelled storage volume (ML)
\$LakeSaideLevel = Lake Saide modelled storage level (m)
\$NenamupInletLevel = Nenamup Inlet modelled storage level (m)
\$NenamupInletFlow = \$NenamupInletLevel*444.44-44.444
\$InletOpening = daily timeseries file when the Wilson Inlet bar was open (value of 1) or closed (0).
\$NenamupLevelCTF = 0.1
\$NenamupInletStorageVol = Nenamup Inlet modelled storage level (ML)

Table A.8: Functions used for water supply dams

<p>The Albany–Denmark water supply pipeline:</p> <p><i>Used by the “AlbanyWaterSupplyPipeline” inflow node.</i></p> <p>\$AlbanyWaterSupply = If(\$Now.Year<1990,0,if(\$QuickupStorageVolume>\$QuickupDamVolThreshold,0,\$DailyTownWaterDemand))</p>
<p>Pumpback from Denmark to Quickup Dam:</p> <p><i>Used by the “DenmarkMeasuredPumpback” water user node.</i></p> <p>\$Pumpback = if(\$Now.Year<2020,\$MeasuredDenmarkPumpback,If(\$QuickupStorageVolume<\$QuickupDamVolThreshold,0,if(\$QuickupDamLevel>44.5,0,if(\$DenmarkDamLevel<8.20,0,if(\$DenmarkDamInflow=0,0,if(\$DenmarkDamInflow<20,\$DenmarkDamInflow*0.2,4))))))</p>
<p>Quickup Dam water abstraction for town water supply:</p> <p><i>Used by the “QuickupWaterSupply” water user node.</i></p> <p>\$QuickupWaterSupply = if(\$Now.Year<2020,\$QuickupWaterSupplyTimeSeries,if(\$QuickupStorageVolume<\$QuickupDamVolThreshold,0,\$QuickupWaterSupplyTimeSeries))</p>
<p>Water abstraction from Denmark Dam for direct town water supply:</p> <p><i>Used by the “DenmarkWaterSupply” water user node</i></p> <p>\$DenmarkDamWaterSupply = timeseries of measured or estimated water abstraction for direct town water supply.</p>
<p>Quickup Dam volume threshold that engages the Albany–Denmark water supply:</p> <p>\$QuickupDamVolThreshold = 400</p>
<p>Modelled variable for determining the pumpback volume from Denmark Dam to Quickup Dam</p> <p>\$DenmarkDamInflow = modelled downstream flow at 613136 on the previous day</p>
<p>\$DailyTownWaterDemand = timeseries of measured or estimated town water demand (ML)</p>
<p>\$DenmarkDamLevel = modelled storage level in Denmark Dam</p>
<p>\$MeasuredDenmarkPumpback = timeseries of measured pumpback from Denmark to Quickup dam (ML)</p>
<p>\$QuickupDamLevel = modelled storage level in Quickup Dam</p>
<p>\$QuickupStorageVolume = modelled storage volume in Quickup Dam</p>

A.3 Model performance

A.3.1 Overall performance of the catchment model

The overall performance of the catchment model is represented here by summing all end-of-catchment measured and monitored flows. Days without measured flow are excluded from the sum of modelled flow data.

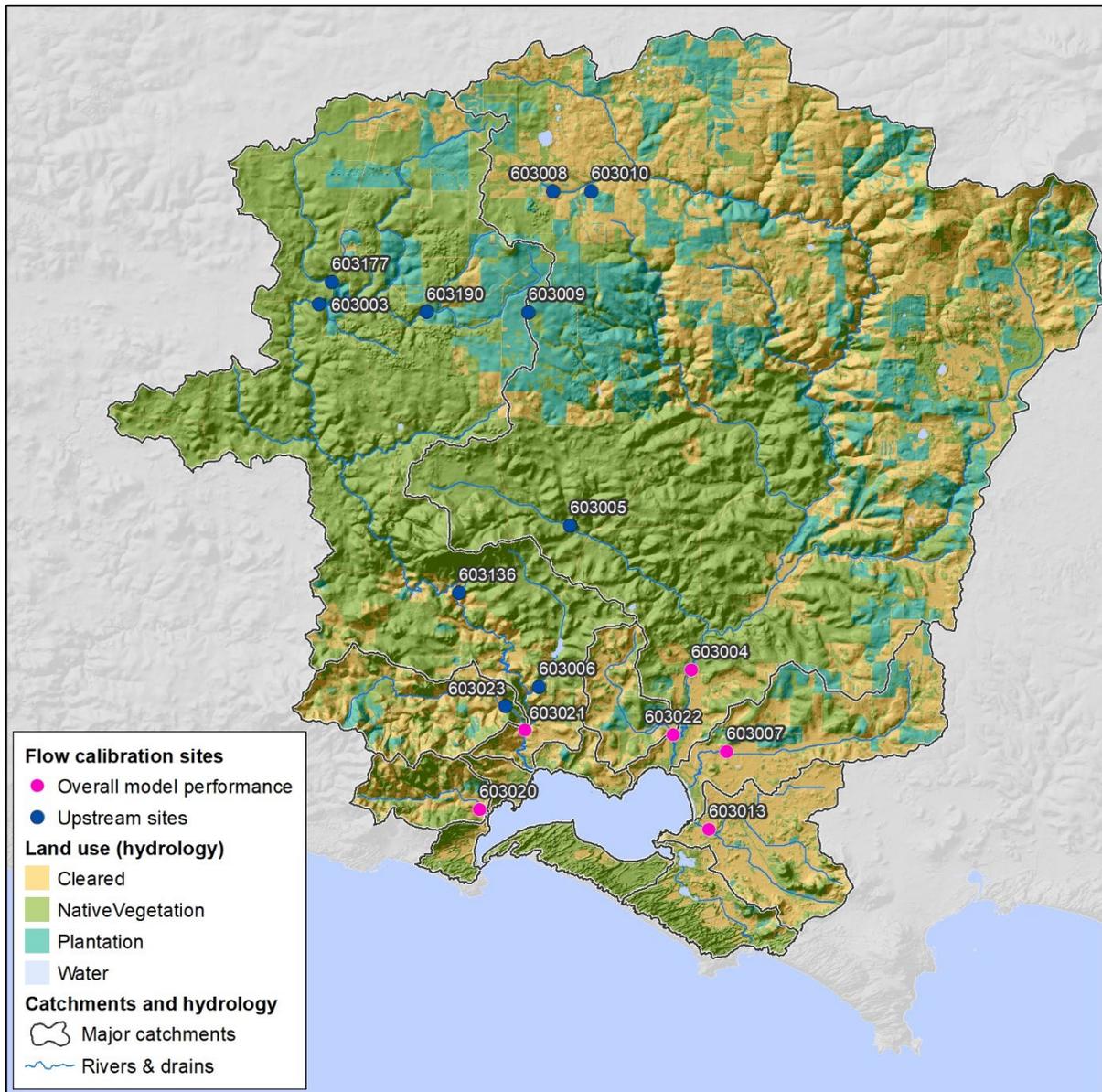


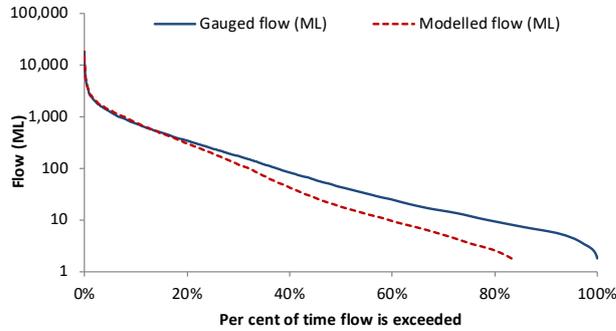
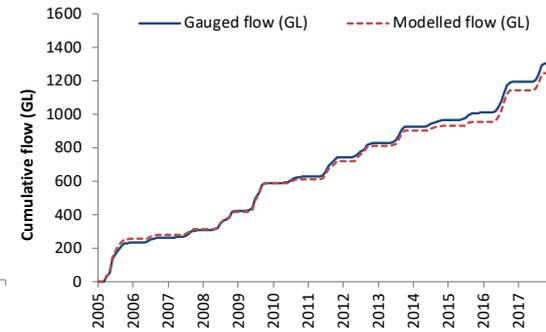
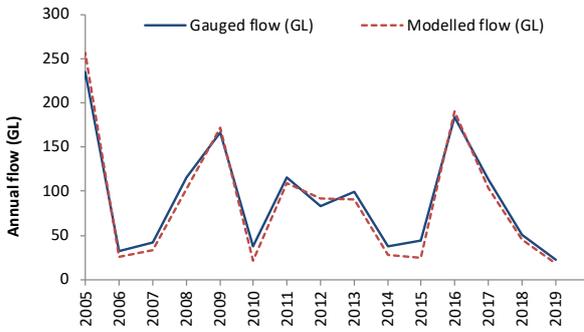
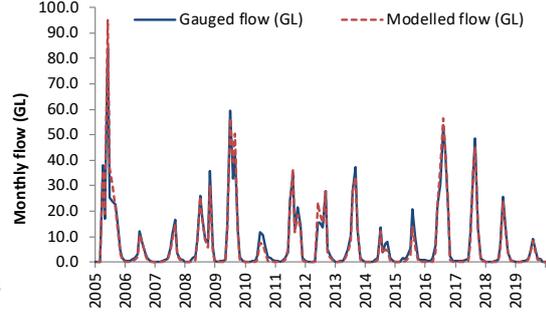
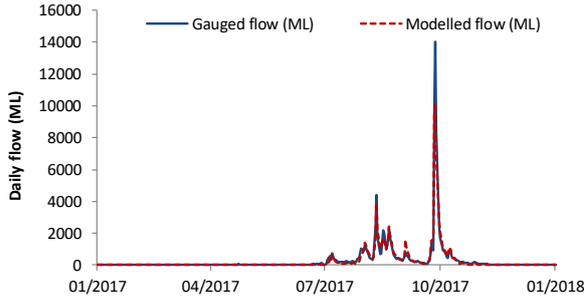
Figure A.3: Flow measurement sites used to summarise the overall performance of the hydrological model

Overall model performance (sum of end-of-catchment flow sites)

Statistic	Calibration 1/01/2005 to 31/12/2018	Validation 2/01/1984 to 31/12/2004
NSE daily bias	0.94	0.60
NSE log daily bias	0.83	0.55
NSE daily	0.94	0.84
NSE monthly	0.97	0.88
NSE annual	0.97	0.73
Mass balance error	-5%	-35%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	1	0	0	0
Percentile:				
5th	5	0	0	0
10th	6	1	0	0
20th	9	2	0	0
50th	42	18	9	0
75th	235	189	118	37
Max	17 673	15 209	20 444	16 349



A.3.2 Model performance: Little River

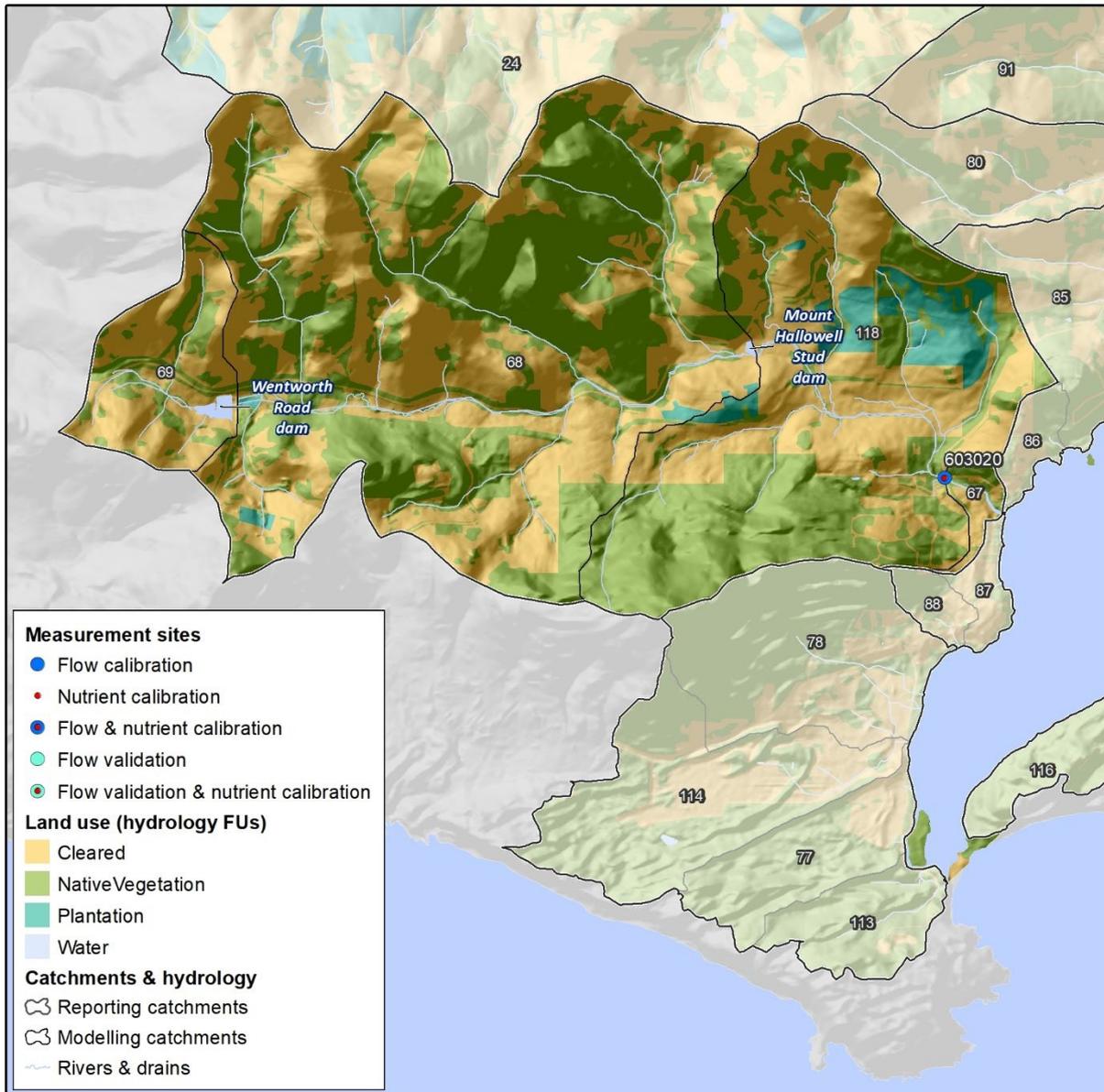


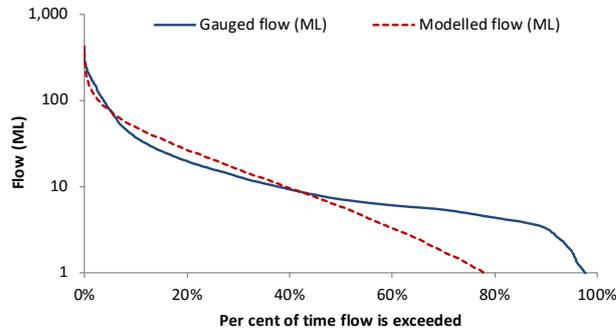
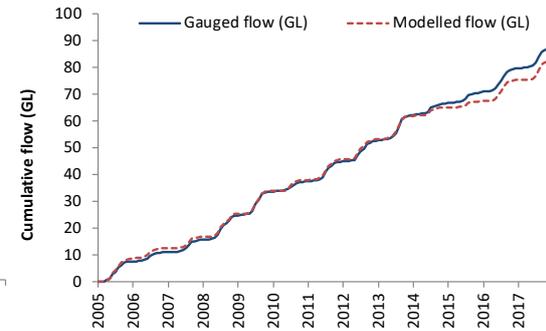
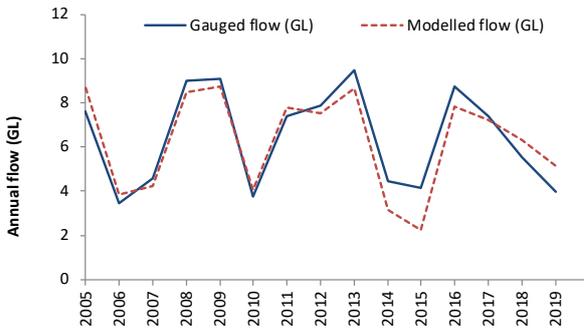
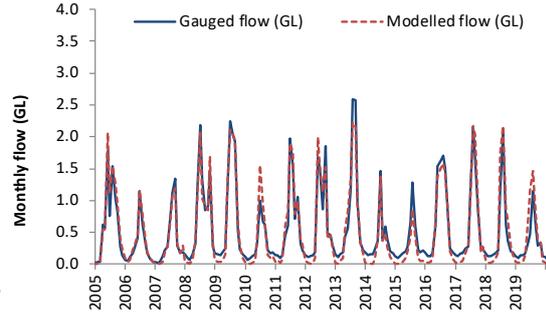
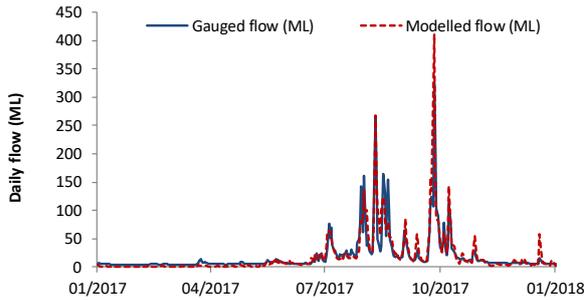
Figure A.4: Little River model domain

Little River - Ocean Beach Road - 603020

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	10/5/1997 to 31/12/2004
NSE daily bias	0.80	0.67
NSE log daily bias	0.65	0.78
NSE daily	0.80	0.75
NSE monthly	0.94	0.84
NSE annual	0.87	-0.16
Mass balance error	-4%	-22%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	2	0	0	0
10th	3	0	1	0
20th	4	1	1	1
50th	7	6	7	7
75th	16	20	25	23
Max	324	411	304	252

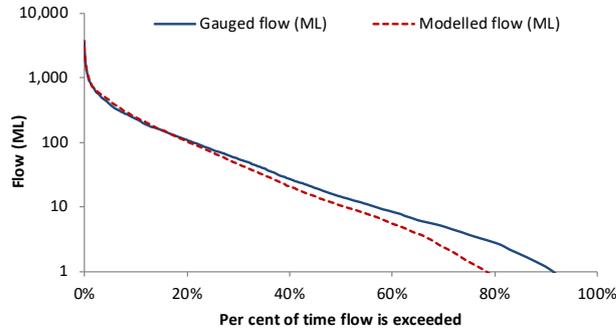
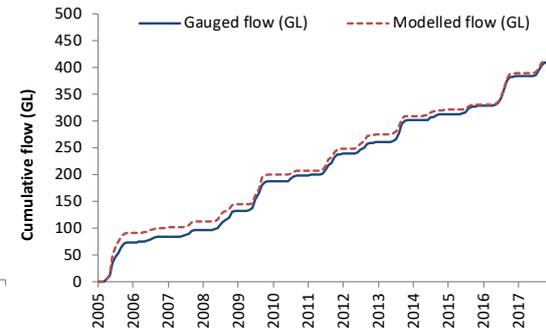
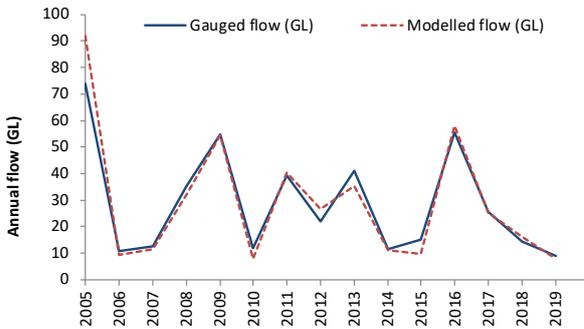
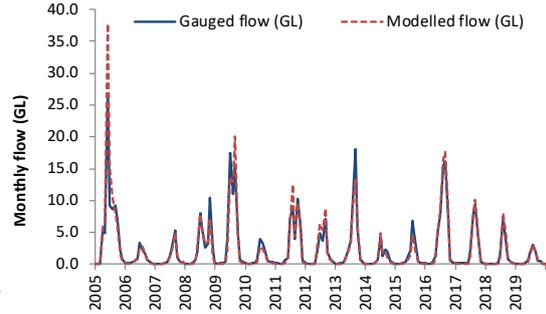
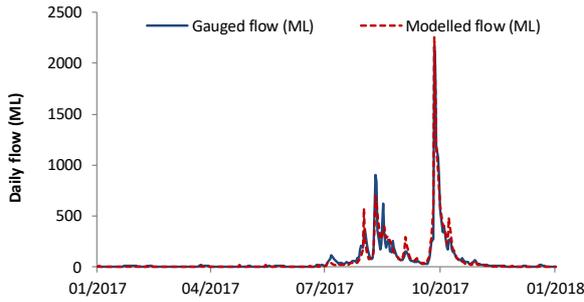


Denmark River - Denmark Ag College - 603021

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	17/5/1997 to 31/12/2004
NSE daily bias	0.86	0.48
NSE log daily bias	0.81	0.49
NSE daily	0.86	0.75
NSE monthly	0.89	0.78
NSE annual	0.92	-0.08
Mass balance error	2%	-36%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	1	0	2	0
20th	3	1	4	1
50th	14	10	21	11
75th	76	69	112	69
Max	2 870	3 660	3 340	1 953

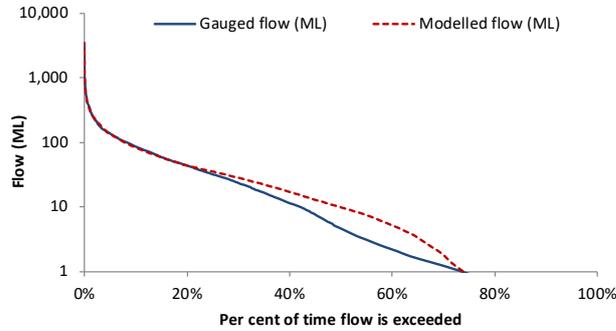
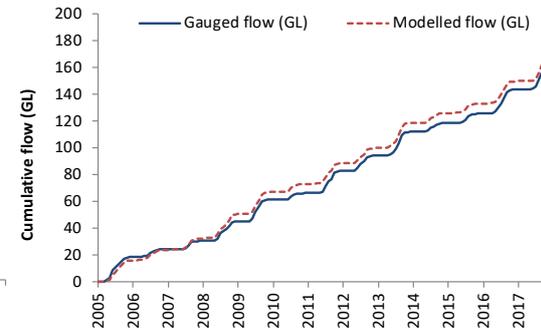
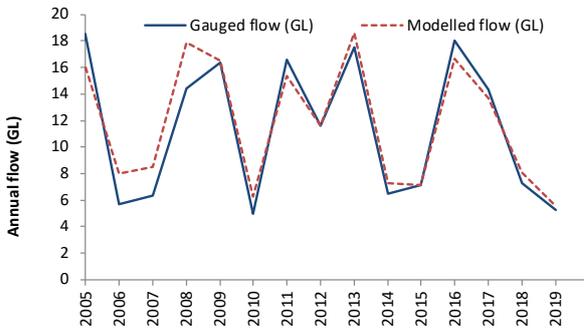
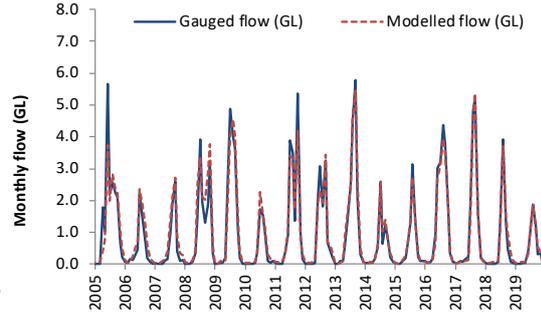
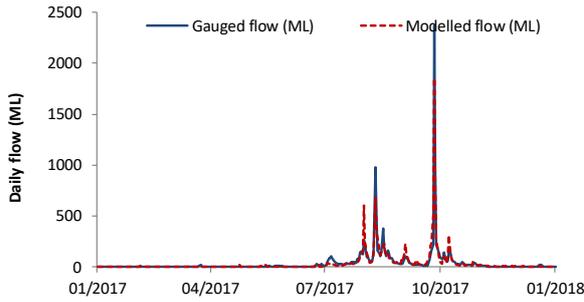


Scotsdale Brook - Pipehead - 603023

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	26/4/1997 to 31/12/2004
NSE daily bias	0.83	0.70
NSE log daily bias	0.67	0.68
NSE daily	0.83	0.72
NSE monthly	0.95	0.91
NSE annual	0.91	0.48
Mass balance error	4%	-12%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	1	0	1	1
50th	5	10	7	10
75th	32	36	45	38
Max	3 480	2 236	2 477	889

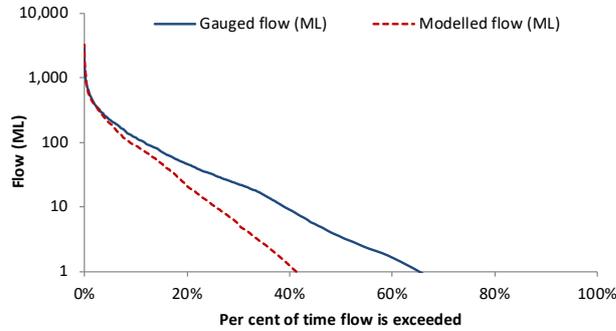
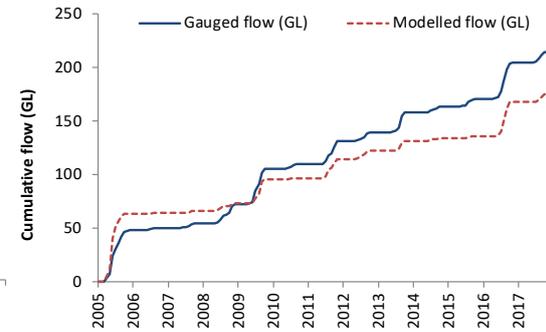
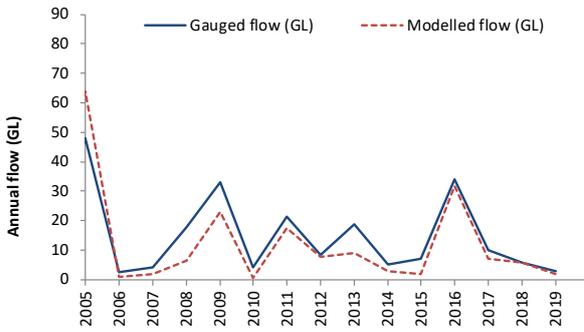
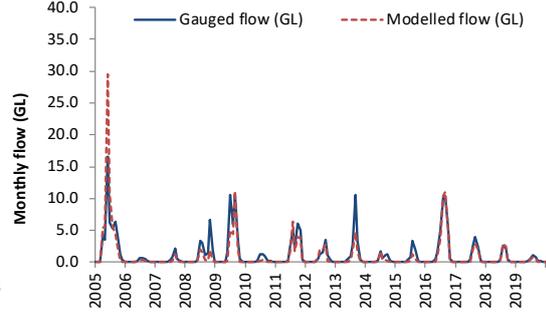
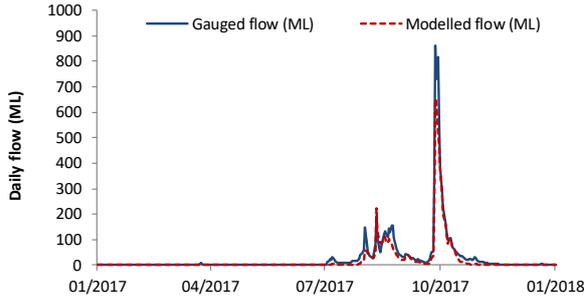


Denmark River - Mt Lindesay - 603136

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	1/1/1975 to 31/12/2004
NSE daily bias	0.61	-0.08
NSE log daily bias	0.66	-0.30
NSE daily	0.66	0.57
NSE monthly	0.71	0.65
NSE annual	0.82	0.16
Mass balance error	-18%	-56%

Objective function used for calibration: NSE log daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	1	0
50th	3	0	8	0
75th	32	11	67	13
Max	1 840	3 194	4 061	7 162

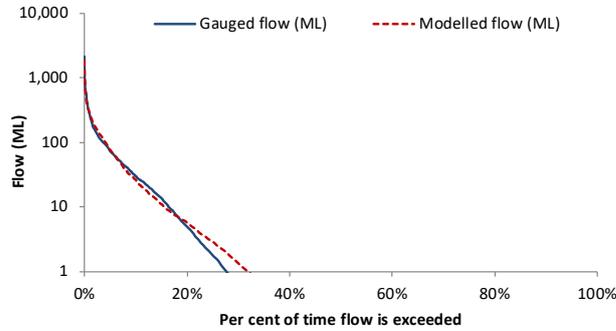
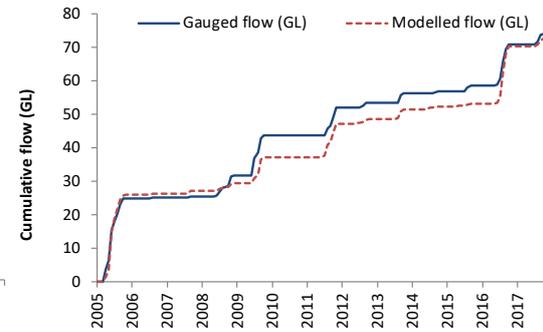
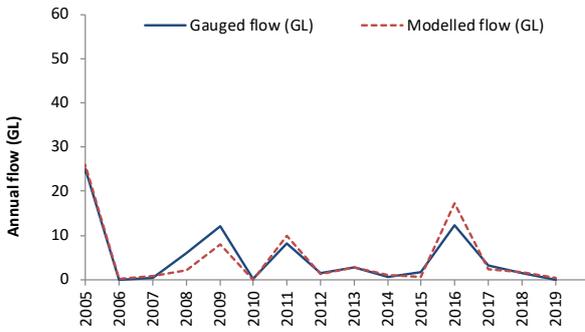
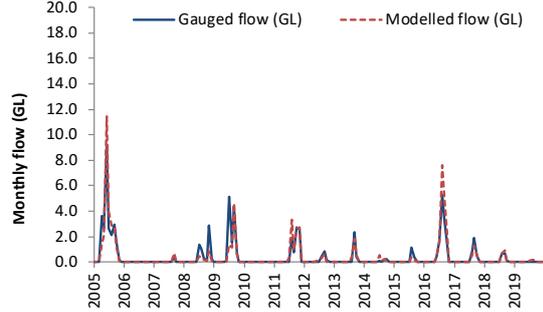
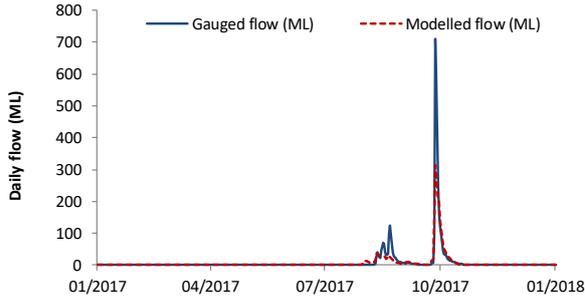


Denmark River - Kompup - 603003

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	1/1/1975 to 31/12/2004
NSE daily bias	0.72	0.15
NSE log daily bias	0.75	0.36
NSE daily	0.72	0.64
NSE monthly	0.82	0.75
NSE annual	0.94	0.56
Mass balance error	-1%	-48%

Objective function used for calibration: NSE log daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	0	0	1	0
75th	2	3	17	5
Max	2 094	1 862	4 807	5 184

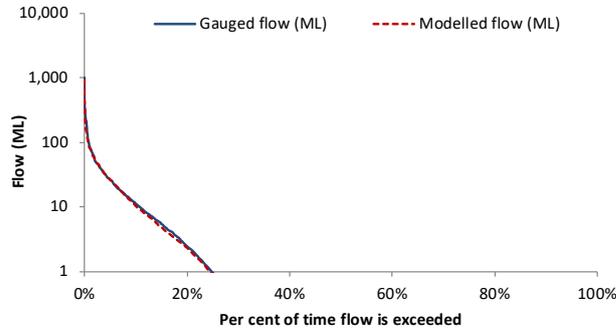
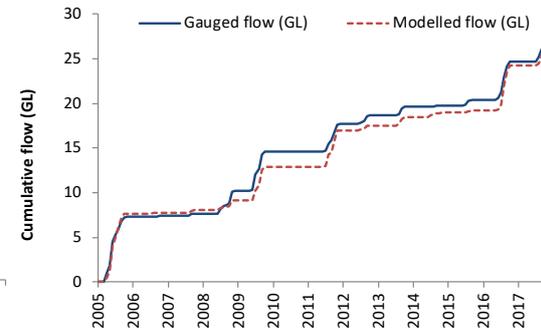
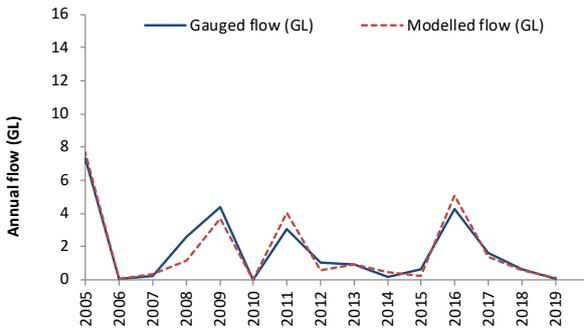
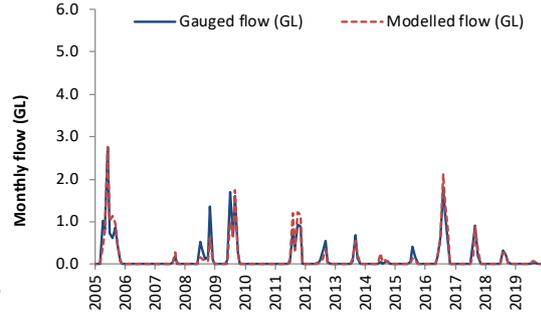
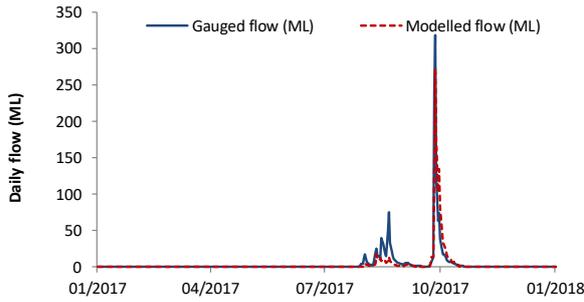


Yates Flat Creek - Woodanup - 603190

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	1/1/1975 to 31/12/2004
NSE daily bias	0.52	-0.25
NSE log daily bias	0.92	-0.11
NSE daily	0.52	0.20
NSE monthly	0.90	0.69
NSE annual	0.96	0.38
Mass balance error	-3%	-46%

Objective function used for calibration: NSE log daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	0	0	0	0
75th	1	1	6	2
Max	438	1 002	1 487	3 743

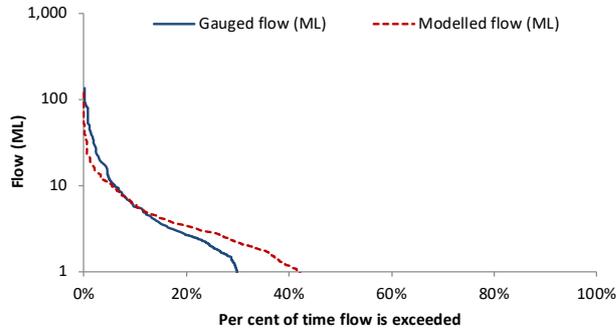
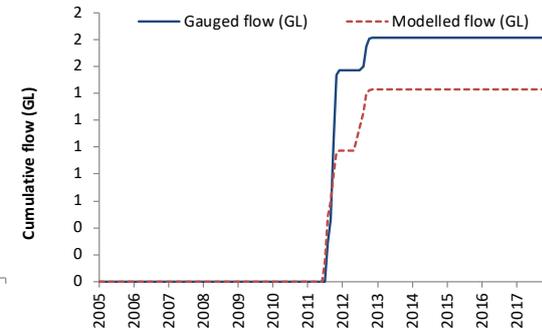
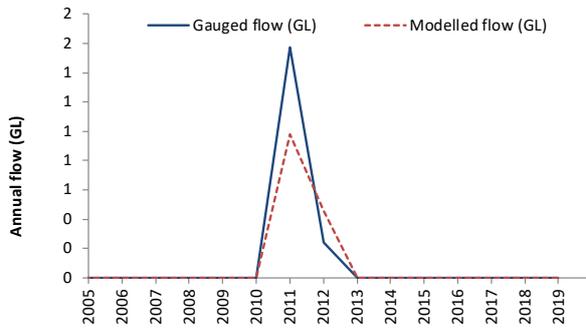
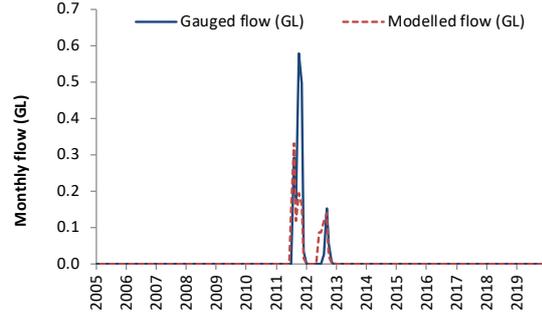
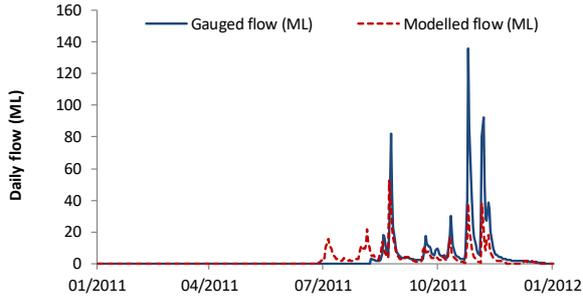


Perillup Brook - Perillup Brook - 603177

Statistic	Calibration	Validation
	Not calibrated	25/6/2011 to 19/3/2013
NSE daily bias	-	0.37
NSE log daily bias	-	0.04
NSE daily	-	0.44
NSE monthly	-	0.45
NSE annual	-	0.55
Mass balance error	-	-21%

Objective function used for calibration: Not calibrated

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	-	-	0	0
Percentile:				
5th	-	-	0	0
10th	-	-	0	0
20th	-	-	0	0
50th	-	-	0	0
75th	-	-	2	3
Max	-	-	136	52



A.3.4 Model performance: Hay River and Sunny Glen Creek

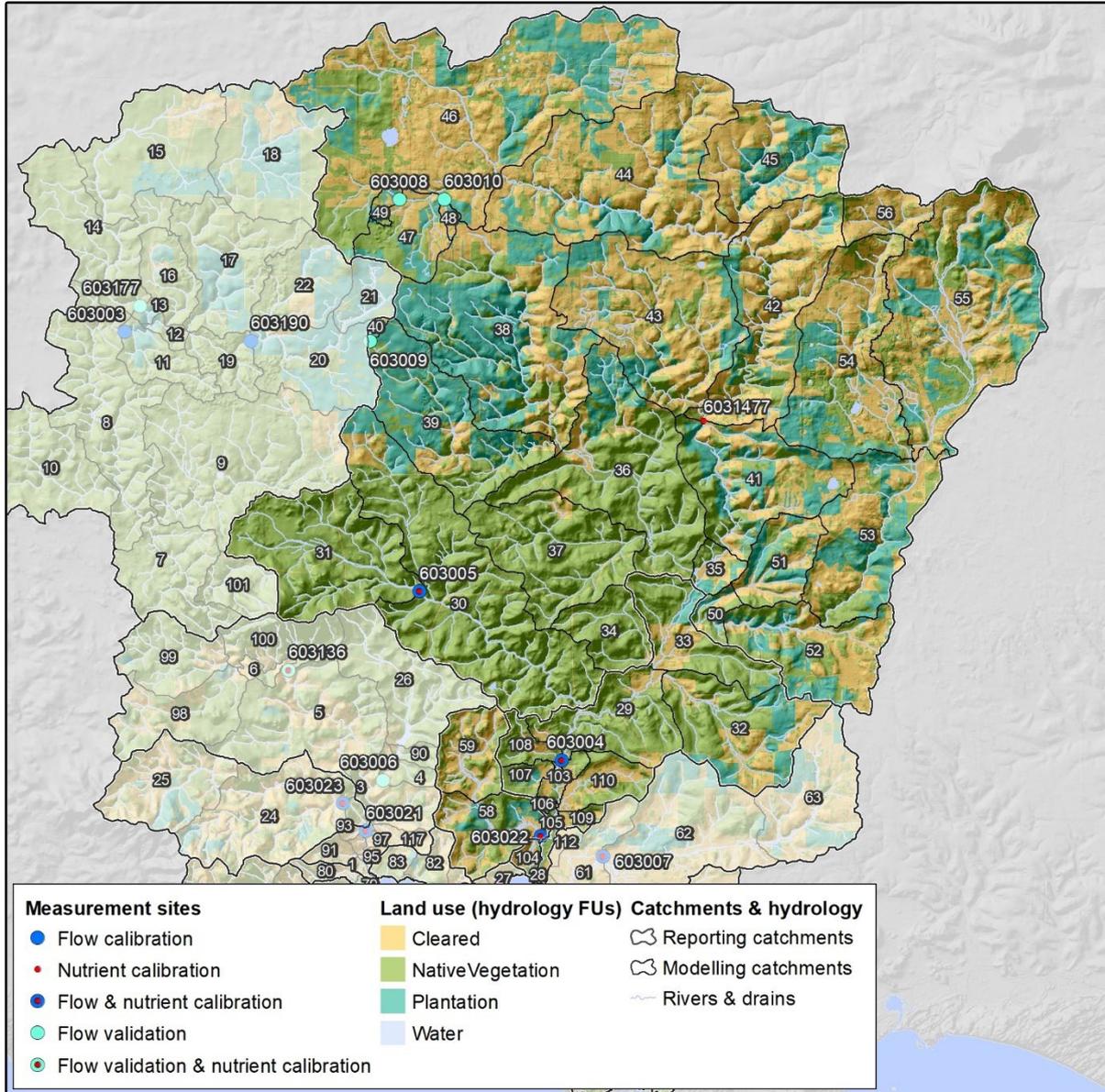


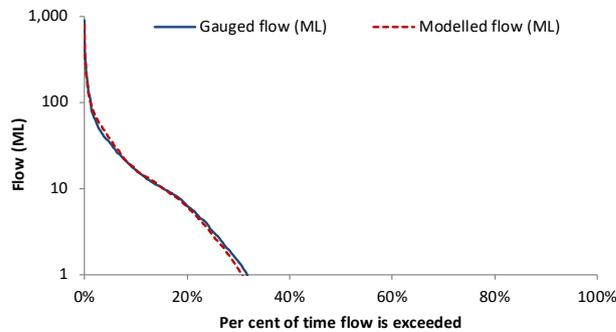
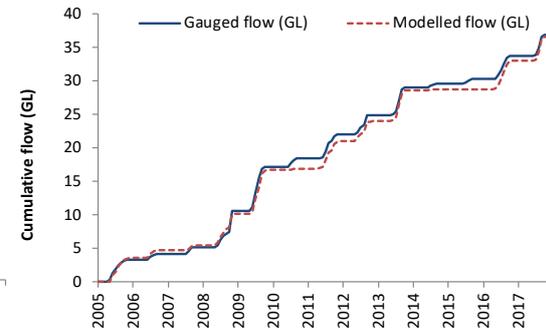
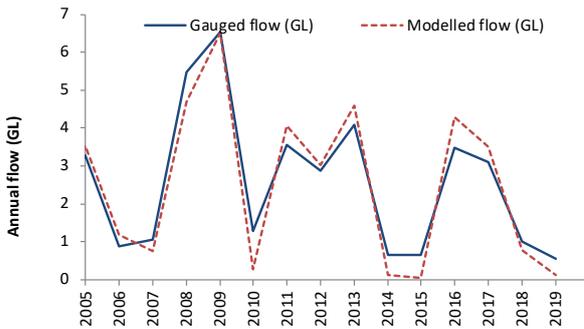
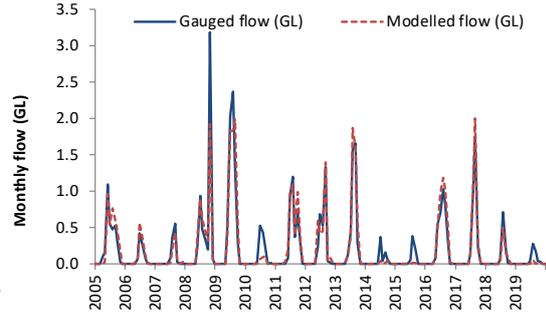
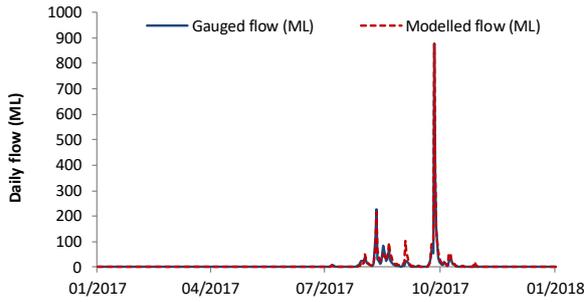
Figure A.6: Hay River and Sunny Glen Creek model domain

Sunny Glen Creek - Girrawheen - 603022

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	17/5/1997 to 31/12/2004
NSE daily bias	0.81	0.44
NSE log daily bias	0.81	0.68
NSE daily	0.81	0.60
NSE monthly	0.89	0.72
NSE annual	0.92	-0.04
Mass balance error	-1%	-29%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	0	0	0	0
75th	3	3	10	3
Max	897	878	628	434

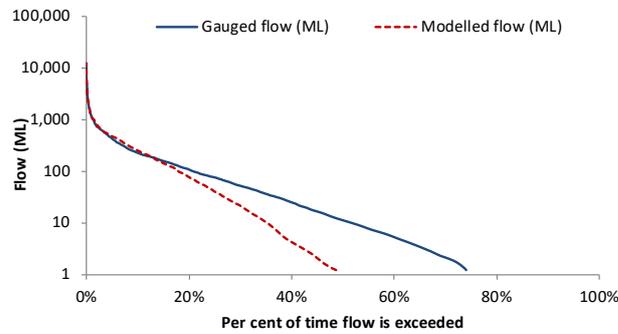
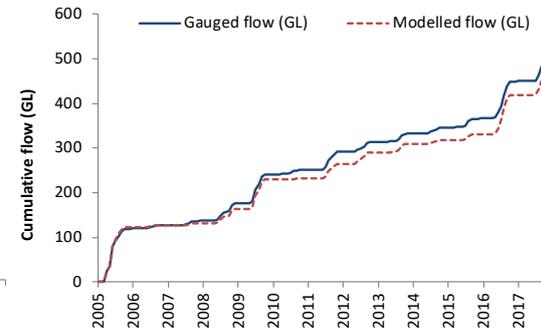
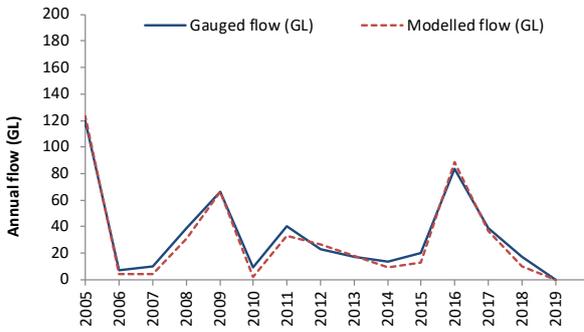
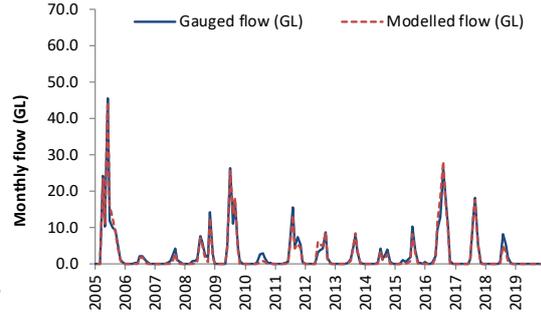
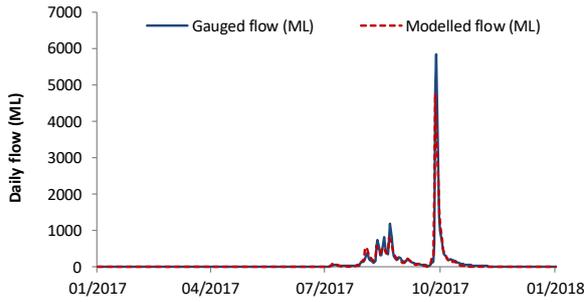


Hay River - Sunny Glen - 603004

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	2/01/1984 to 31/12/2004
NSE daily bias	0.90	0.37
NSE log daily bias	0.70	0.00
NSE daily	0.91	0.77
NSE monthly	0.97	0.80
NSE annual	0.98	0.41
Mass balance error	-8%	-44%

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	1	0
50th	11	1	24	1
75th	77	41	140	55
Max	12 377	10 357	13 190	12 112

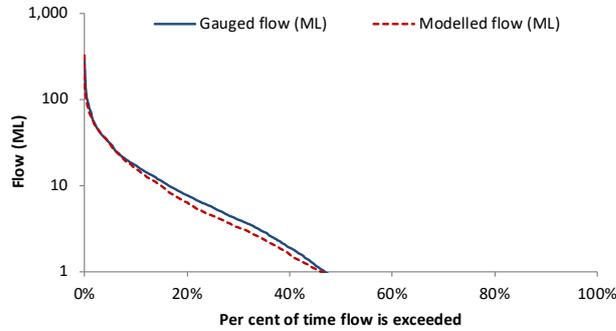
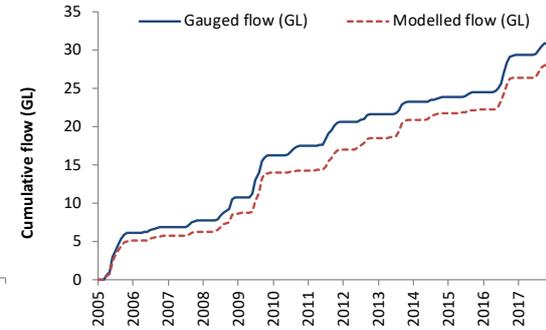
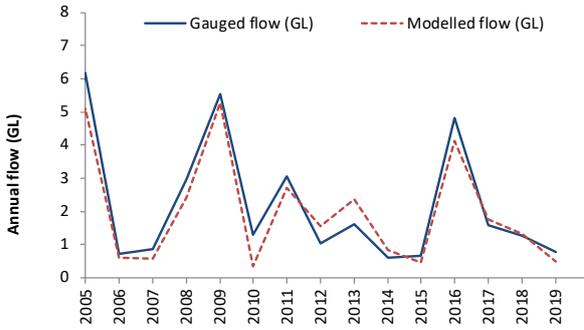
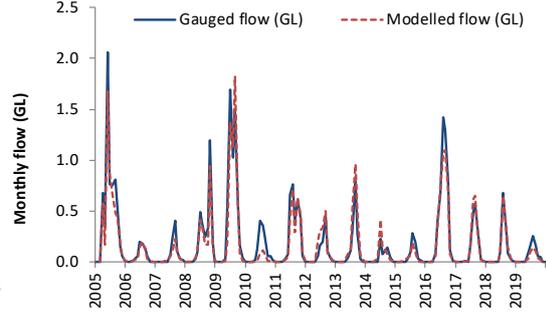
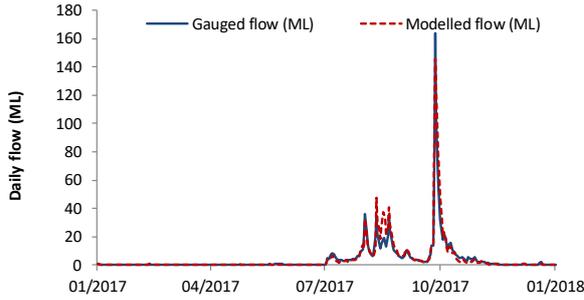


Michell River - Beigpiegup - 603005

Statistic	Calibration	Validation
	1/01/2005 to 31/12/2018	2/01/1986 to 31/12/2004
NSE daily bias	0.83	-0.45
NSE log daily bias	0.69	-0.10
NSE daily	0.84	0.41
NSE monthly	0.92	0.36
NSE annual	0.93	-1.07
Mass balance error	-9%	-64%

Objective function used for calibration: NSE log daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	1	1	2	1
75th	6	4	10	3
Max	303	319	609	375

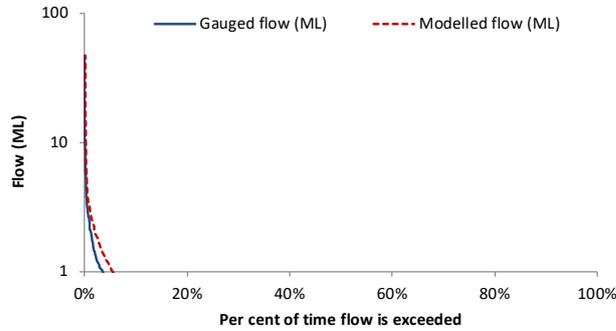
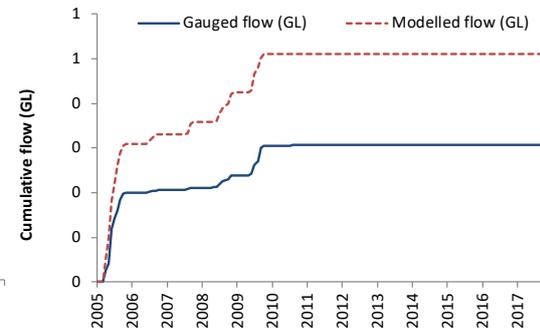
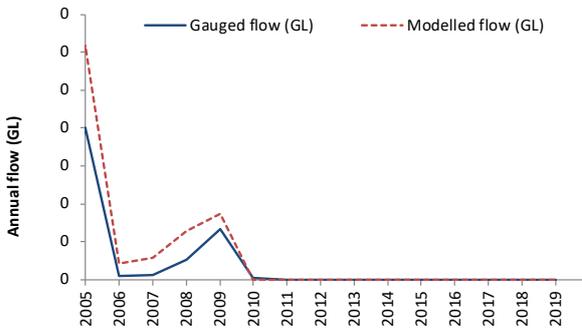
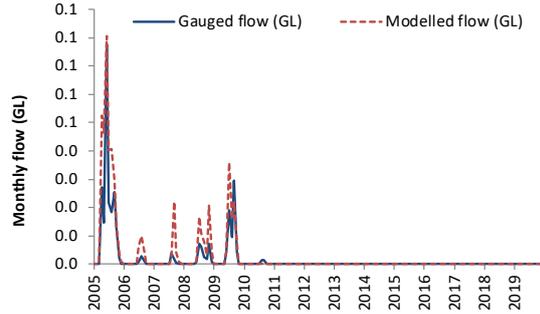
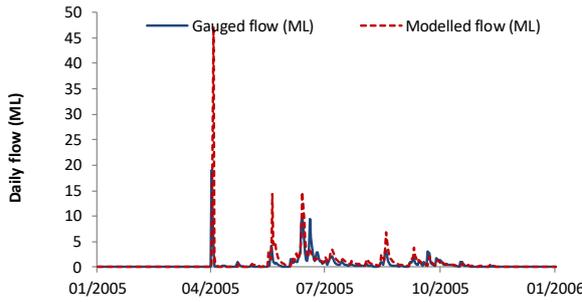


Upper Hay Tributary - Pardelup Prison Farm - 603008

Statistic	Calibration	Validation
	Not calibrated	1/09/1988 to 2/03/2011
NSE daily bias	-2.69	0.36
NSE log daily bias	-0.24	0.61
NSE daily	-1.78	0.37
NSE monthly	0.58	0.74
NSE annual	0.51	0.63
Mass balance error	66%	8%

Objective function used for calibration: Not calibrated

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	0	0	0	0
75th	0	0	0	0
Max	19	47	25	12



603009 and 603010 (Upper Hay)

No flow measurement in the calibration period.

A.3.5 Model performance: Sleeman River, Cuppup Creek and Lake Saide

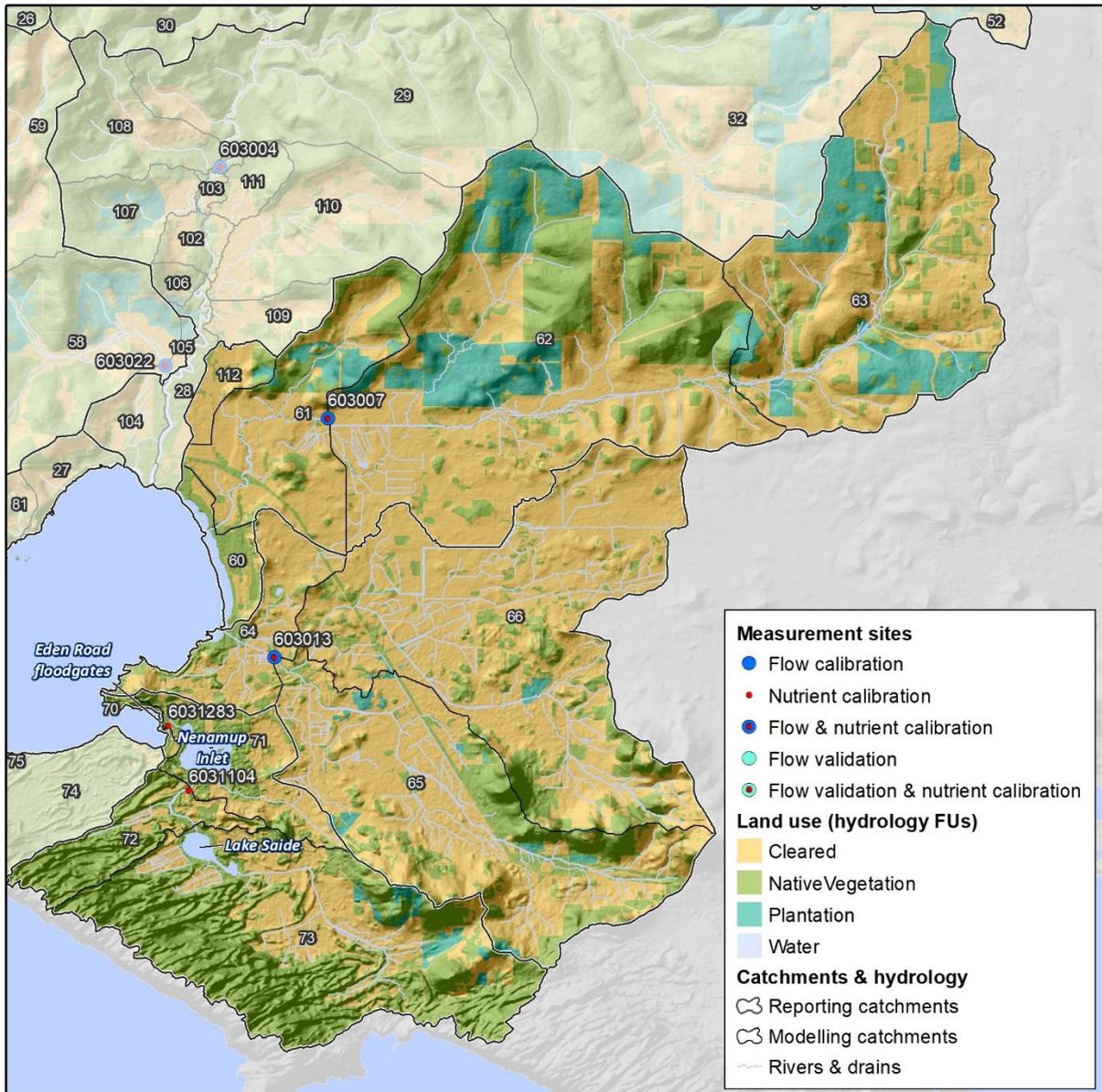


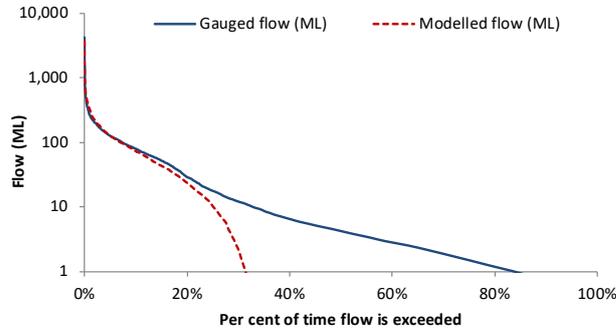
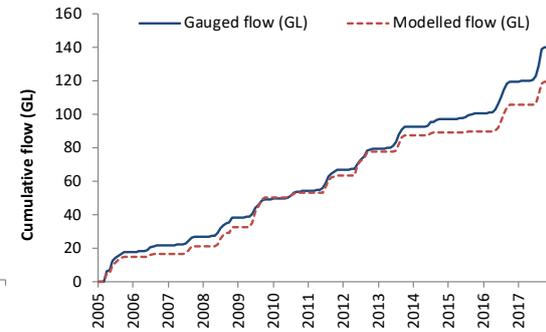
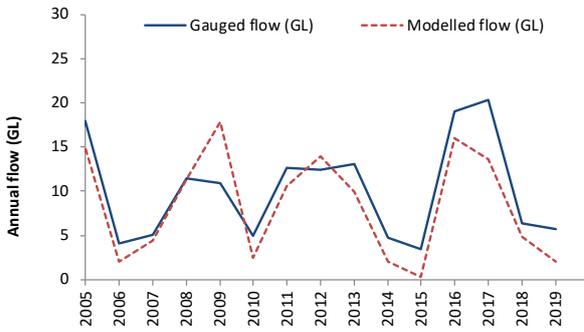
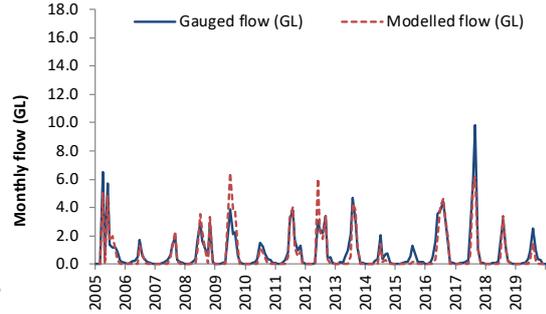
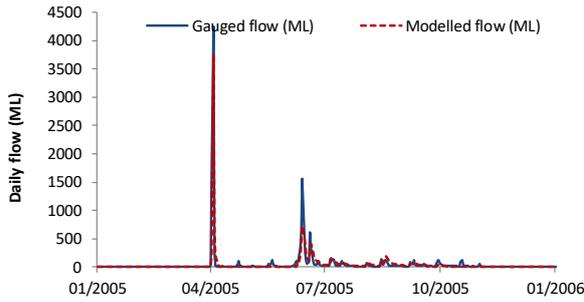
Figure A.7: Sleeman River, Cuppup Creek and Lake Saide model domain

Sleeman River - Sleeman Rd Bridge - 603007

Statistic	Calibration		Validation	
	1/01/2005 to 31/12/2018		14/4/1985 to 31/12/2004	
NSE daily bias	0.68	0.57		
NSE log daily bias	-0.10	-0.14		
NSE daily	0.71	0.57		
NSE monthly	0.82	0.81		
NSE annual	0.65	0.58		
Mass balance error	-15%	-5%		

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	1	0
10th	1	0	1	0
20th	1	0	2	0
50th	4	0	5	0
75th	18	10	20	20
Max	4 255	3 765	8 214	4 237

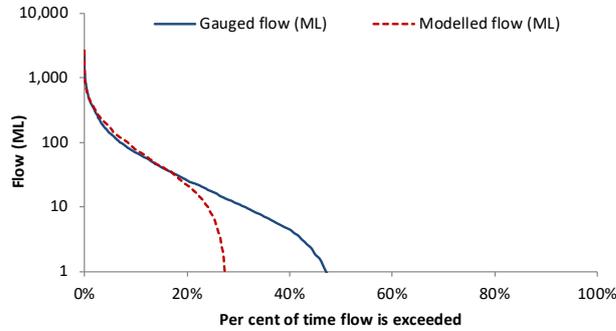
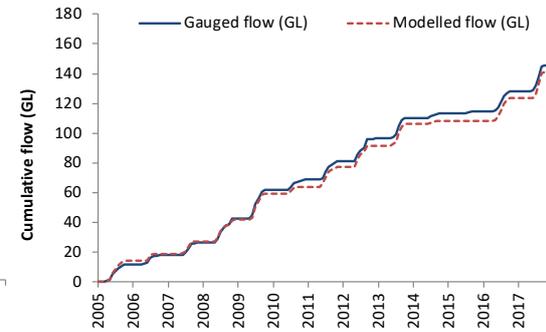
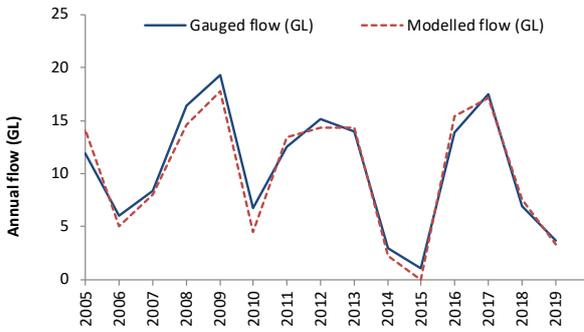
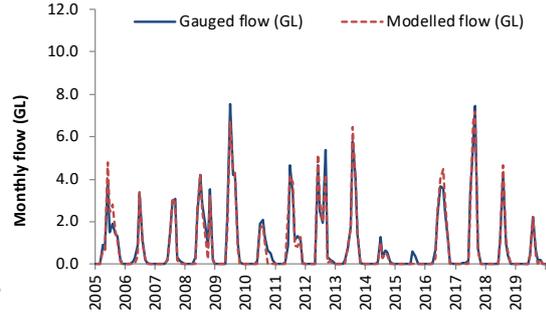
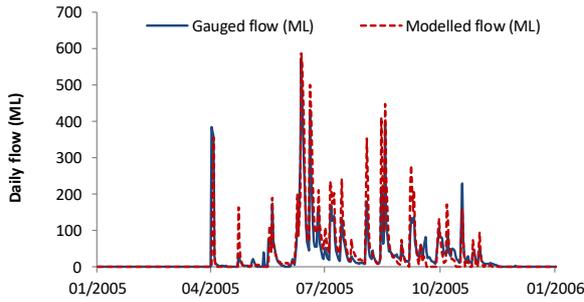


Cuppup River - Eden Rd - 603013

Statistic	Calibration		Validation	
	1/01/2005 to 31/12/2018		15/6/1989 to 31/12/2004	
NSE daily bias	0.86	0.80		
NSE log daily bias	0.39	0.52		
NSE daily	0.86	0.81		
NSE monthly	0.96	0.92		
NSE annual	0.95	0.67		
Mass balance error	-3%	-9%		

Objective function used for calibration: NSE daily bias

Daily flow statistic	Calibration		Validation	
	Gauged (ML)	Modelled (ML)	Gauged (ML)	Modelled (ML)
Min	0	0	0	0
Percentile:				
5th	0	0	0	0
10th	0	0	0	0
20th	0	0	0	0
50th	0	0	0	0
75th	17	7	19	16
Max	2 643	2 303	2 258	2 920



Appendix B: Nutrient calibration

B.1 Nutrient model parameters and daily data

B.1.1 Nutrient generation model parameters



Figure B.1: Nutrient model parameter sets

Table B.1: Nitrogen model parameters by parameter set (1 of 2)

Modelling land use	Cuppup			Denmark Ag College			Lake Saide			Little River			Lower Hay			Mitchell River		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Bare soil & other (high PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Bare soil & other (low PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Beef (high PRI)	0.237	0.001	1.843	0.771	0.206	0.567	2.172	0.07	1.693	0.714	0.394	0.572	0.234	0.25	0.931	10.04	0.213	1.761
Beef (low PRI)	0.237	0.001	1.843	0.771	0.206	0.567	2.172	0.07	1.693	0.714	0.394	0.572	0.234	0.25	0.931	10.04	0.213	1.761
Cropping (high PRI)	0.108	0.001	0.84	0.352	0.206	0.259	0.992	0.07	0.773	0.326	0.394	0.261	0.107	0.25	0.426	4.585	0.213	0.804
Cropping (low PRI)	0.108	0.001	0.84	0.352	0.206	0.259	0.992	0.07	0.773	0.326	0.394	0.261	0.107	0.25	0.426	4.585	0.213	0.804
Dairy (high PRI)	0.366	0.001	2.846	1.189	0.206	0.875	3.351	0.07	2.612	1.102	0.394	0.882	0.361	0.25	1.437	15.49	0.213	2.717
Dairy (low PRI)	0.366	0.001	2.846	1.189	0.206	0.875	3.351	0.07	2.612	1.102	0.394	0.882	0.361	0.25	1.437	15.49	0.213	2.717
Feedlots & stockyards (high PRI)	1.776	0.001	13.81	5.776	0.206	4.249	16.28	0.07	12.69	5.352	0.394	4.286	1.751	0.25	6.969	75.22	0.213	13.2
Feedlots & stockyards (low PRI)	1.776	0.001	13.81	5.776	0.206	4.249	16.28	0.07	12.69	5.352	0.394	4.286	1.751	0.25	6.969	75.22	0.213	13.2
Horses (high PRI)	0.189	0.001	1.47	0.615	0.206	0.452	1.734	0.07	1.352	0.57	0.394	0.456	0.187	0.25	0.744	8.011	0.213	1.405
Horses (low PRI)	0.189	0.001	1.47	0.615	0.206	0.452	1.734	0.07	1.352	0.57	0.394	0.456	0.187	0.25	0.744	8.011	0.213	1.405
Horticulture (high PRI)	1.729	0.001	13.45	5.623	0.206	4.136	15.85	0.07	12.36	5.21	0.394	4.172	1.705	0.25	6.786	73.23	0.213	12.85
Horticulture (low PRI)	1.729	0.001	13.45	5.623	0.206	4.136	15.85	0.07	12.36	5.21	0.394	4.172	1.705	0.25	6.786	73.23	0.213	12.85
Lifestyle block (high PRI)	0.148	0.001	1.151	0.481	0.206	0.354	1.356	0.07	1.057	0.446	0.394	0.357	0.146	0.25	0.581	6.266	0.213	1.099
Lifestyle block (low PRI)	0.148	0.001	1.151	0.481	0.206	0.354	1.356	0.07	1.057	0.446	0.394	0.357	0.146	0.25	0.581	6.266	0.213	1.099
Native vegetation (high PRI)	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099
Native vegetation (low PRI)	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099
Orchard (high PRI)	0.025	0.001	0.194	0.082	0.206	0.06	0.232	0.07	0.181	0.076	0.394	0.061	0.025	0.25	0.1	1.07	0.213	0.188
Orchard (low PRI)	0.025	0.001	0.194	0.082	0.206	0.06	0.232	0.07	0.181	0.076	0.394	0.061	0.025	0.25	0.1	1.07	0.213	0.188
Piggeries & abattoirs (high PRI)	0.851	0.001	6.618	2.767	0.206	2.035	7.797	0.07	6.079	2.564	0.394	2.053	0.839	0.25	3.339	36.03	0.213	6.321
Piggeries & abattoirs (low PRI)	0.851	0.001	6.618	2.767	0.206	2.035	7.797	0.07	6.079	2.564	0.394	2.053	0.839	0.25	3.339	36.03	0.213	6.321
Plantation (high PRI)	0.063	0.001	0.49	0.931	0.206	0.685	2.862	0.07	2.231	0.308	0.394	0.247	0.318	0.25	1.266	0	0.213	0
Plantation (low PRI)	0.063	0.001	0.49	0.931	0.206	0.685	2.862	0.07	2.231	0.308	0.394	0.247	0.318	0.25	1.266	0	0.213	0
Point source (high PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Point source (low PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Potatoes (high PRI)	0.138	0.001	1.073	0.448	0.206	0.33	1.262	0.07	0.984	0.415	0.394	0.332	0.136	0.25	0.541	5.833	0.213	1.023
Potatoes (low PRI)	0.138	0.001	1.073	0.448	0.206	0.33	1.262	0.07	0.984	0.415	0.394	0.332	0.136	0.25	0.541	5.833	0.213	1.023
Recreation (high PRI)	0.193	0.001	1.501	0.627	0.206	0.461	1.766	0.07	1.377	0.581	0.394	0.465	0.19	0.25	0.756	8.161	0.213	1.432
Recreation (low PRI)	0.193	0.001	1.501	0.627	0.206	0.461	1.766	0.07	1.377	0.581	0.394	0.465	0.19	0.25	0.756	8.161	0.213	1.432
Roads & industrial (high PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Roads & industrial (low PRI)	0.014	0.001	0.109	0.046	0.206	0.034	0.129	0.07	0.101	0.042	0.394	0.034	0.014	0.25	0.056	0.596	0.213	0.105
Rural living (bush block) (high PRI)	0.054	0.001	0.42	0.967	0.206	0.711	1.749	0.07	1.364	0.23	0.394	0.184	0.13	0.25	0.517	10.21	0.213	1.79
Rural living (bush block) (low PRI)	0.054	0.001	0.42	0.967	0.206	0.711	1.749	0.07	1.364	0.23	0.394	0.184	0.13	0.25	0.517	10.21	0.213	1.79
Urban (high PRI)	0.243	0.001	1.89	0.789	0.206	0.58	2.225	0.07	1.735	0.731	0.394	0.585	0.239	0.25	0.951	10.28	0.213	1.803
Urban (low PRI)	0.243	0.001	1.89	0.789	0.206	0.58	2.225	0.07	1.735	0.731	0.394	0.585	0.239	0.25	0.951	10.28	0.213	1.803
Viticulture (high PRI)	0.142	0.001	1.104	0.461	0.206	0.339	1.298	0.07	1.012	0.427	0.394	0.342	0.14	0.25	0.557	5.998	0.213	1.052
Viticulture (low PRI)	0.142	0.001	1.104	0.461	0.206	0.339	1.298	0.07	1.012	0.427	0.394	0.342	0.14	0.25	0.557	5.998	0.213	1.052
Wastewater irrigation (high PRI)	0.109	0.001	0.848	1.617	0.206	1.189	4.97	0.07	3.875	0.536	0.394	0.429	0.552	0.25	2.197	0	0.213	0
Wastewater irrigation (low PRI)	0.109	0.001	0.848	1.617	0.206	1.189	4.97	0.07	3.875	0.536	0.394	0.429	0.552	0.25	2.197	0	0.213	0

Table B.2: Nitrogen model parameters by parameter set (2 of 2)

Modelling land use	Mt Lindesay			Scotsdale Brook			Sleeman			Sunny Glen Creek			Upper Hay		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Bare soil & other (high PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Bare soil & other (low PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Beef (high PRI)	0.559	0.447	1.225	0.544	0.431	0.478	1.418	0.119	0.858	0.637	0.07	1.693	0.488	0.25	0.971
Beef (low PRI)	0.559	0.447	1.225	0.544	0.431	0.478	1.418	0.119	0.858	0.637	0.07	1.693	0.488	0.25	0.971
Cropping (high PRI)	0.255	0.447	0.559	0.248	0.431	0.218	0.648	0.119	0.392	0.291	0.07	0.773	0.223	0.25	0.444
Cropping (low PRI)	0.255	0.447	0.559	0.248	0.431	0.218	0.648	0.119	0.392	0.291	0.07	0.773	0.223	0.25	0.444
Dairy (high PRI)	0.862	0.447	1.89	0.839	0.431	0.737	2.188	0.119	1.324	0.983	0.07	2.613	0.753	0.25	1.499
Dairy (low PRI)	0.862	0.447	1.89	0.839	0.431	0.737	2.188	0.119	1.324	0.983	0.07	2.613	0.753	0.25	1.499
Feedlots & stockyards (high PRI)	4.186	0.447	9.176	4.076	0.431	3.582	10.63	0.119	6.429	4.775	0.07	12.69	3.658	0.25	7.28
Feedlots & stockyards (low PRI)	4.186	0.447	9.176	4.076	0.431	3.582	10.63	0.119	6.429	4.775	0.07	12.69	3.658	0.25	7.28
Horses (high PRI)	0.446	0.447	0.978	0.434	0.431	0.381	1.132	0.119	0.685	0.509	0.07	1.353	0.39	0.25	0.776
Horses (low PRI)	0.446	0.447	0.978	0.434	0.431	0.381	1.132	0.119	0.685	0.509	0.07	1.353	0.39	0.25	0.776
Horticulture (high PRI)	4.076	0.447	8.935	3.968	0.431	3.487	10.35	0.119	6.26	4.649	0.07	12.36	3.561	0.25	7.087
Horticulture (low PRI)	4.076	0.447	8.935	3.968	0.431	3.487	10.35	0.119	6.26	4.649	0.07	12.36	3.561	0.25	7.087
Lifestyle block (high PRI)	0.349	0.447	0.765	0.34	0.431	0.299	0.885	0.119	0.536	0.398	0.07	1.058	0.305	0.25	0.607
Lifestyle block (low PRI)	0.349	0.447	0.765	0.34	0.431	0.299	0.885	0.119	0.536	0.398	0.07	1.058	0.305	0.25	0.607
Native vegetation (high PRI)	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099
Native vegetation (low PRI)	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099	0.567	0.213	0.099
Orchard (high PRI)	0.06	0.447	0.132	0.058	0.431	0.051	0.151	0.119	0.091	0.068	0.07	0.181	0.052	0.25	0.103
Orchard (low PRI)	0.06	0.447	0.132	0.058	0.431	0.051	0.151	0.119	0.091	0.068	0.07	0.181	0.052	0.25	0.103
Piggeries & abattoirs (high PRI)	2.005	0.447	4.395	1.952	0.431	1.716	5.09	0.119	3.08	2.287	0.07	6.078	1.752	0.25	3.487
Piggeries & abattoirs (low PRI)	2.005	0.447	4.395	1.952	0.431	1.716	5.09	0.119	3.08	2.287	0.07	6.078	1.752	0.25	3.487
Plantation (high PRI)	0.446	0.447	0.978	0.664	0.431	0.584	0.3	0.119	0.182	0.839	0.07	2.23	1.261	0.25	2.509
Plantation (low PRI)	0.446	0.447	0.978	0.664	0.431	0.584	0.3	0.119	0.182	0.839	0.07	2.23	1.261	0.25	2.509
Point source (high PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Point source (low PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Potatoes (high PRI)	0.325	0.447	0.712	0.316	0.431	0.278	0.824	0.119	0.499	0.37	0.07	0.983	0.284	0.25	0.565
Potatoes (low PRI)	0.325	0.447	0.712	0.316	0.431	0.278	0.824	0.119	0.499	0.37	0.07	0.983	0.284	0.25	0.565
Recreation (high PRI)	0.454	0.447	0.995	0.442	0.431	0.388	1.153	0.119	0.698	0.518	0.07	1.377	0.397	0.25	0.79
Recreation (low PRI)	0.454	0.447	0.995	0.442	0.431	0.388	1.153	0.119	0.698	0.518	0.07	1.377	0.397	0.25	0.79
Roads & industrial (high PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Roads & industrial (low PRI)	0.033	0.447	0.072	0.032	0.431	0.028	0.084	0.119	0.051	0.038	0.07	0.101	0.029	0.25	0.058
Rural living (bush block) (high PRI)	0.484	0.447	1.061	0.757	0.431	0.665	0.255	0.119	0.154	0.513	0.07	1.363	3.478	0.25	6.921
Rural living (bush block) (low PRI)	0.484	0.447	1.061	0.757	0.431	0.665	0.255	0.119	0.154	0.513	0.07	1.363	3.478	0.25	6.921
Urban (high PRI)	0.572	0.447	1.254	0.557	0.431	0.49	1.452	0.119	0.879	0.653	0.07	1.736	0.5	0.25	0.995
Urban (low PRI)	0.572	0.447	1.254	0.557	0.431	0.49	1.452	0.119	0.879	0.653	0.07	1.736	0.5	0.25	0.995
Viticulture (high PRI)	0.334	0.447	0.732	0.325	0.431	0.286	0.847	0.119	0.513	0.381	0.07	1.013	0.292	0.25	0.581
Viticulture (low PRI)	0.334	0.447	0.732	0.325	0.431	0.286	0.847	0.119	0.513	0.381	0.07	1.013	0.292	0.25	0.581
Wastewater irrigation (high PRI)	0.774	0.447	1.697	1.154	0.431	1.014	0.521	0.119	0.315	1.458	0.07	3.875	2.191	0.25	4.36
Wastewater irrigation (low PRI)	0.774	0.447	1.697	1.154	0.431	1.014	0.521	0.119	0.315	1.458	0.07	3.875	2.191	0.25	4.36

Table B.3: Phosphorus model parameters by parameter set (1 of 2)

Modelling land use	Cuppup			Denmark Ag College			Lake Saide			Little River			Lower Hay			Mitchell River		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Bare soil & other (high PRI)	0.004	0.100	-	0.000	0.300	0.000	0.001	0.100	-	0.002	0.450	-	0.000	0.392	0.000	0.006	0.140	0.001
Bare soil & other (low PRI)	0.032	0.100	-	0.002	0.300	0.001	0.007	0.100	-	0.013	0.450	-	0.001	0.392	0.000	0.045	0.140	0.009
Beef (high PRI)	0.250	0.100	-	0.017	0.300	0.005	0.053	0.100	-	0.103	0.450	-	0.008	0.392	0.003	0.352	0.140	0.074
Beef (low PRI)	1.996	0.100	-	0.138	0.300	0.041	0.427	0.100	-	0.824	0.450	-	0.066	0.392	0.022	2.817	0.140	0.591
Cropping (high PRI)	0.088	0.100	-	0.006	0.300	0.002	0.019	0.100	-	0.037	0.450	-	0.003	0.392	0.001	0.125	0.140	0.026
Cropping (low PRI)	0.707	0.100	-	0.049	0.300	0.015	0.151	0.100	-	0.292	0.450	-	0.023	0.392	0.008	0.997	0.140	0.209
Dairy (high PRI)	0.444	0.100	-	0.031	0.300	0.009	0.095	0.100	-	0.183	0.450	-	0.015	0.392	0.005	0.626	0.140	0.131
Dairy (low PRI)	3.550	0.100	-	0.246	0.300	0.074	0.759	0.100	-	1.466	0.450	-	0.118	0.392	0.039	5.011	0.140	1.050
Feedlots & stockyards (high PRI)	1.002	0.100	-	0.069	0.300	0.021	0.214	0.100	-	0.414	0.450	-	0.033	0.392	0.011	1.415	0.140	0.297
Feedlots & stockyards (low PRI)	8.018	0.100	-	0.555	0.300	0.167	1.714	0.100	-	3.312	0.450	-	0.266	0.392	0.088	11.318	0.140	2.373
Horses (high PRI)	0.291	0.100	-	0.020	0.300	0.006	0.062	0.100	-	0.120	0.450	-	0.010	0.392	0.003	0.411	0.140	0.086
Horses (low PRI)	2.331	0.100	-	0.161	0.300	0.048	0.498	0.100	-	0.963	0.450	-	0.077	0.392	0.025	3.291	0.140	0.690
Horticulture (high PRI)	3.113	0.100	-	0.216	0.300	0.065	0.665	0.100	-	1.286	0.450	-	0.103	0.392	0.034	4.394	0.140	0.921
Horticulture (low PRI)	24.903	0.100	-	1.724	0.300	0.517	5.322	0.100	-	10.286	0.450	-	0.825	0.392	0.272	35.150	0.140	7.369
Lifestyle block (high PRI)	0.053	0.100	-	0.004	0.300	0.001	0.011	0.100	-	0.022	0.450	-	0.002	0.392	0.001	0.075	0.140	0.016
Lifestyle block (low PRI)	0.424	0.100	-	0.029	0.300	0.009	0.091	0.100	-	0.175	0.450	-	0.014	0.392	0.005	0.598	0.140	0.125
Native vegetation (high PRI)	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001
Native vegetation (low PRI)	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005
Orchard (high PRI)	0.137	0.100	-	0.010	0.300	0.003	0.029	0.100	-	0.057	0.450	-	0.005	0.392	0.001	0.193	0.140	0.041
Orchard (low PRI)	1.095	0.100	-	0.076	0.300	0.023	0.234	0.100	-	0.452	0.450	-	0.036	0.392	0.012	1.546	0.140	0.324
Piggeries & abattoirs (high PRI)	1.488	0.100	-	0.103	0.300	0.031	0.318	0.100	-	0.615	0.450	-	0.049	0.392	0.016	2.100	0.140	0.440
Piggeries & abattoirs (low PRI)	11.904	0.100	-	0.824	0.300	0.247	2.544	0.100	-	4.917	0.450	-	0.394	0.392	0.130	16.802	0.140	3.522
Plantation (high PRI)	0.301	0.100	-	0.095	0.300	0.029	0.320	0.100	-	0.203	0.450	-	0.051	0.392	0.017	0.000	0.140	-
Plantation (low PRI)	2.411	0.100	-	0.760	0.300	0.228	2.558	0.100	-	1.621	0.450	-	0.409	0.392	0.135	0.000	0.140	-
Point source (high PRI)	0.004	0.100	-	0.000	0.300	0.000	0.001	0.100	-	0.002	0.450	-	0.000	0.392	0.000	0.006	0.140	0.001
Point source (low PRI)	0.032	0.100	-	0.002	0.300	0.001	0.007	0.100	-	0.013	0.450	-	0.001	0.392	0.000	0.045	0.140	0.009
Potatoes (high PRI)	2.565	0.100	-	0.178	0.300	0.053	0.548	0.100	-	1.060	0.450	-	0.085	0.392	0.028	3.621	0.140	0.759
Potatoes (low PRI)	20.523	0.100	-	1.421	0.300	0.426	4.386	0.100	-	8.477	0.450	-	0.680	0.392	0.224	28.967	0.140	6.073
Recreation (high PRI)	0.044	0.100	-	0.003	0.300	0.001	0.009	0.100	-	0.018	0.450	-	0.001	0.392	0.000	0.062	0.140	0.013
Recreation (low PRI)	0.350	0.100	-	0.024	0.300	0.007	0.075	0.100	-	0.144	0.450	-	0.012	0.392	0.004	0.494	0.140	0.103
Roads & industrial (high PRI)	0.004	0.100	-	0.000	0.300	0.000	0.001	0.100	-	0.002	0.450	-	0.000	0.392	0.000	0.006	0.140	0.001
Roads & industrial (low PRI)	0.032	0.100	-	0.002	0.300	0.001	0.007	0.100	-	0.013	0.450	-	0.001	0.392	0.000	0.045	0.140	0.009
Rural living (bush block) (high PRI)	0.009	0.100	-	0.003	0.300	0.001	0.007	0.100	-	0.005	0.450	-	0.001	0.392	0.000	0.054	0.140	0.011
Rural living (bush block) (low PRI)	0.069	0.100	-	0.026	0.300	0.008	0.052	0.100	-	0.040	0.450	-	0.006	0.392	0.002	0.434	0.140	0.091
Urban (high PRI)	0.353	0.100	-	0.024	0.300	0.007	0.075	0.100	-	0.146	0.450	-	0.012	0.392	0.004	0.498	0.140	0.104
Urban (low PRI)	2.823	0.100	-	0.196	0.300	0.059	0.603	0.100	-	1.166	0.450	-	0.094	0.392	0.031	3.985	0.140	0.835
Viticulture (high PRI)	0.298	0.100	-	0.021	0.300	0.006	0.064	0.100	-	0.123	0.450	-	0.010	0.392	0.003	0.421	0.140	0.088
Viticulture (low PRI)	2.384	0.100	-	0.165	0.300	0.050	0.510	0.100	-	0.985	0.450	-	0.079	0.392	0.026	3.365	0.140	0.706
Wastewater irrigation (high PRI)	0.182	0.100	-	0.058	0.300	0.017	0.193	0.100	-	0.123	0.450	-	0.031	0.392	0.010	0.000	0.140	-
Wastewater irrigation (low PRI)	1.458	0.100	-	0.460	0.300	0.138	1.547	0.100	-	0.980	0.450	-	0.248	0.392	0.082	0.000	0.140	-

Table B.4: Phosphorus model parameters by parameter set (2 of 2)

Modelling land use	Mt Lindesay			Scotsdale Brook			Sleeman			Sunny Glen Creek			Upper Hay		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Bare soil & other (high PRI)	0.000	0.050	-	0.001	0.200	-	0.001	0.260	0.000	0.001	0.100	-	0.000	0.300	0.000
Bare soil & other (low PRI)	0.003	0.050	-	0.006	0.200	-	0.005	0.260	0.002	0.006	0.100	-	0.002	0.300	0.001
Beef (high PRI)	0.021	0.050	-	0.044	0.200	-	0.039	0.260	0.017	0.048	0.100	-	0.013	0.300	0.004
Beef (low PRI)	0.167	0.050	-	0.353	0.200	-	0.314	0.260	0.135	0.386	0.100	-	0.104	0.300	0.034
Cropping (high PRI)	0.007	0.050	-	0.016	0.200	-	0.014	0.260	0.006	0.017	0.100	-	0.005	0.300	0.001
Cropping (low PRI)	0.059	0.050	-	0.125	0.200	-	0.111	0.260	0.048	0.137	0.100	-	0.037	0.300	0.012
Dairy (high PRI)	0.037	0.050	-	0.078	0.200	-	0.070	0.260	0.030	0.086	0.100	-	0.023	0.300	0.007
Dairy (low PRI)	0.298	0.050	-	0.627	0.200	-	0.559	0.260	0.241	0.687	0.100	-	0.184	0.300	0.060
Feedlots & stockyards (high PRI)	0.084	0.050	-	0.177	0.200	-	0.158	0.260	0.068	0.194	0.100	-	0.052	0.300	0.017
Feedlots & stockyards (low PRI)	0.672	0.050	-	1.416	0.200	-	1.262	0.260	0.544	1.552	0.100	-	0.416	0.300	0.136
Horses (high PRI)	0.024	0.050	-	0.052	0.200	-	0.046	0.260	0.020	0.056	0.100	-	0.015	0.300	0.005
Horses (low PRI)	0.195	0.050	-	0.412	0.200	-	0.367	0.260	0.158	0.451	0.100	-	0.121	0.300	0.039
Horticulture (high PRI)	0.261	0.050	-	0.550	0.200	-	0.490	0.260	0.211	0.602	0.100	-	0.162	0.300	0.053
Horticulture (low PRI)	2.087	0.050	-	4.398	0.200	-	3.920	0.260	1.690	4.820	0.100	-	1.293	0.300	0.421
Lifestyle block (high PRI)	0.004	0.050	-	0.009	0.200	-	0.008	0.260	0.004	0.010	0.100	-	0.003	0.300	0.001
Lifestyle block (low PRI)	0.036	0.050	-	0.075	0.200	-	0.067	0.260	0.029	0.082	0.100	-	0.022	0.300	0.007
Native vegetation (high PRI)	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001	0.003	0.140	0.001
Native vegetation (low PRI)	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005	0.024	0.140	0.005
Orchard (high PRI)	0.012	0.050	-	0.024	0.200	-	0.022	0.260	0.009	0.027	0.100	-	0.007	0.300	0.002
Orchard (low PRI)	0.092	0.050	-	0.193	0.200	-	0.172	0.260	0.074	0.212	0.100	-	0.057	0.300	0.019
Piggeries & abattoirs (high PRI)	0.125	0.050	-	0.263	0.200	-	0.234	0.260	0.101	0.288	0.100	-	0.077	0.300	0.025
Piggeries & abattoirs (low PRI)	0.998	0.050	-	2.103	0.200	-	1.874	0.260	0.808	2.304	0.100	-	0.618	0.300	0.201
Plantation (high PRI)	0.076	0.050	-	0.245	0.200	-	0.038	0.260	0.016	0.290	0.100	-	0.152	0.300	0.050
Plantation (low PRI)	0.608	0.050	-	1.959	0.200	-	0.303	0.260	0.130	2.316	0.100	-	1.219	0.300	0.397
Point source (high PRI)	0.000	0.050	-	0.001	0.200	-	0.001	0.260	0.000	0.001	0.100	-	0.000	0.300	0.000
Point source (low PRI)	0.003	0.050	-	0.006	0.200	-	0.005	0.260	0.002	0.006	0.100	-	0.002	0.300	0.001
Potatoes (high PRI)	0.215	0.050	-	0.453	0.200	-	0.404	0.260	0.174	0.497	0.100	-	0.133	0.300	0.043
Potatoes (low PRI)	1.720	0.050	-	3.625	0.200	-	3.231	0.260	1.393	3.972	0.100	-	1.065	0.300	0.347
Recreation (high PRI)	0.004	0.050	-	0.008	0.200	-	0.007	0.260	0.003	0.009	0.100	-	0.002	0.300	0.001
Recreation (low PRI)	0.029	0.050	-	0.062	0.200	-	0.055	0.260	0.024	0.068	0.100	-	0.018	0.300	0.006
Roads & industrial (high PRI)	0.000	0.050	-	0.001	0.200	-	0.001	0.260	0.000	0.001	0.100	-	0.000	0.300	0.000
Roads & industrial (low PRI)	0.003	0.050	-	0.006	0.200	-	0.005	0.260	0.002	0.006	0.100	-	0.002	0.300	0.001
Rural living (bush block) (high PRI)	0.003	0.050	-	0.009	0.200	-	0.001	0.260	0.000	0.006	0.100	-	0.014	0.300	0.005
Rural living (bush block) (low PRI)	0.022	0.050	-	0.074	0.200	-	0.009	0.260	0.004	0.047	0.100	-	0.112	0.300	0.036
Urban (high PRI)	0.030	0.050	-	0.062	0.200	-	0.056	0.260	0.024	0.068	0.100	-	0.018	0.300	0.006
Urban (low PRI)	0.237	0.050	-	0.499	0.200	-	0.444	0.260	0.192	0.546	0.100	-	0.147	0.300	0.048
Viticulture (high PRI)	0.025	0.050	-	0.053	0.200	-	0.047	0.260	0.020	0.058	0.100	-	0.016	0.300	0.005
Viticulture (low PRI)	0.200	0.050	-	0.421	0.200	-	0.375	0.260	0.162	0.461	0.100	-	0.124	0.300	0.040
Wastewater irrigation (high PRI)	0.046	0.050	-	0.148	0.200	-	0.023	0.260	0.010	0.175	0.100	-	0.092	0.300	0.030
Wastewater irrigation (low PRI)	0.368	0.050	-	1.185	0.200	-	0.183	0.260	0.079	1.401	0.100	-	0.737	0.300	0.240

Table B.5: Nutrient model parameter sets by modelling catchment

Cat ID	Reporting	Nutrient parameter set ID	Cat ID	Reporting	Nutrient parameter set ID
1	Lower Denmark River	Denmark Ag College	60	Sleeman River	Sleeman
2	Lower Denmark River	Denmark Ag College	61	Sleeman River	Sleeman
3	Lower Denmark River	Denmark Ag College	62	Sleeman River	Sleeman
4	Lower Denmark River	Denmark Ag College	63	Sleeman River	Sleeman
5	Lower Denmark River	Denmark Ag College	64	Cuppup Creek	Cuppup
6	Lower Denmark River	Denmark Ag College	65	Cuppup Creek	Cuppup
7	Upper Denmark River	Mt Lindesay	66	Cuppup Creek	Cuppup
8	Upper Denmark River	Mt Lindesay	67	Little River	Little River
9	Upper Denmark River	Mt Lindesay	68	Little River	Little River
10	Upper Denmark River	Mt Lindesay	69	Little River	Little River
11	Upper Denmark River	Mt Lindesay	70	Lake Saide	Lake Saide
12	Upper Denmark River	Mt Lindesay	71	Lake Saide	Lake Saide
13	Upper Denmark River	Mt Lindesay	72	Lake Saide	Lake Saide
14	Upper Denmark River	Mt Lindesay	73	Lake Saide	Lake Saide
15	Upper Denmark River	Mt Lindesay	74	Nullaki	Sunny Glen Creek
16	Upper Denmark River	Mt Lindesay	75	Nullaki	Sunny Glen Creek
17	Upper Denmark River	Mt Lindesay	76	Nullaki	Sunny Glen Creek
18	Upper Denmark River	Mt Lindesay	77	Ocean Beach Road	Sunny Glen Creek
19	Upper Denmark River	Mt Lindesay	78	Ocean Beach Road	Sunny Glen Creek
20	Upper Denmark River	Mt Lindesay	79	Koorabup Creek	Denmark Ag College
21	Upper Denmark River	Mt Lindesay	80	Koorabup Creek	Denmark Ag College
22	Upper Denmark River	Mt Lindesay	81	Foreshore	Denmark Ag College
23	Scotsdale Brook	Scotsdale Brook	82	Foreshore	Denmark Ag College
24	Scotsdale Brook	Scotsdale Brook	83	Foreshore	Denmark Ag College
25	Scotsdale Brook	Scotsdale Brook	84	Foreshore	Denmark Ag College
26	Lower Denmark River	Denmark Ag College	85	Foreshore	Denmark Ag College
27	Foreshore	Lower Hay	86	Foreshore	Denmark Ag College
28	Lower Hay River	Lower Hay	87	Foreshore	Denmark Ag College
29	Lower Hay River	Lower Hay	88	Foreshore	Denmark Ag College
30	Upper Hay River	Lower Hay	90	Lower Denmark River	Denmark Ag College
31	Upper Hay River	Mitchell River	91	Lower Denmark River	Denmark Ag College
32	Lower Hay River	Lower Hay	92	Lower Denmark River	Denmark Ag College
33	Lower Hay River	Lower Hay	93	Lower Denmark River	Denmark Ag College
34	Upper Hay River	Lower Hay	94	Lower Denmark River	Denmark Ag College
35	Upper Hay River	Lower Hay	95	Lower Denmark River	Denmark Ag College
36	Upper Hay River	Lower Hay	96	Lower Denmark River	Denmark Ag College
37	Upper Hay River	Lower Hay	97	Lower Denmark River	Denmark Ag College
38	Upper Hay River	Lower Hay	98	Lower Denmark River	Denmark Ag College
39	Upper Hay River	Lower Hay	99	Lower Denmark River	Denmark Ag College
40	Upper Hay River	Lower Hay	100	Lower Denmark River	Mt Lindesay
41	Upper Hay River	Lower Hay	101	Upper Denmark River	Mitchell River
42	Upper Hay River	Upper Hay	102	Lower Hay River	Sunny Glen Creek
43	Upper Hay River	Upper Hay	103	Lower Hay River	Sunny Glen Creek
44	Upper Hay River	Upper Hay	104	Lower Hay River	Sunny Glen Creek
45	Upper Hay River	Upper Hay	105	Sunny Glen Creek	Sunny Glen Creek
46	Upper Hay River	Upper Hay	106	Lower Hay River	Sunny Glen Creek
47	Upper Hay River	Upper Hay	107	Lower Hay River	Sunny Glen Creek
48	Upper Hay River	Upper Hay	108	Lower Hay River	Sunny Glen Creek
49	Upper Hay River	Upper Hay	109	Lower Hay River	Sunny Glen Creek
50	Upper Hay River	Lower Hay	110	Lower Hay River	Sunny Glen Creek
51	Upper Hay River	Lower Hay	111	Lower Hay River	Sunny Glen Creek
52	Upper Hay River	Lower Hay	112	Sleeman River	Sleeman
53	Upper Hay River	Lower Hay	113	Ocean Beach Road	Sunny Glen Creek
54	Upper Hay River	Upper Hay	114	Ocean Beach Road	Sunny Glen Creek
55	Upper Hay River	Upper Hay	115	Nullaki	Sunny Glen Creek
56	Upper Hay River	Upper Hay	116	Nullaki	Sunny Glen Creek
58	Sunny Glen Creek	Sunny Glen Creek	117	Lower Denmark River	Denmark Ag College
59	Sunny Glen Creek	Sunny Glen Creek	118	Little River	Little River

Calibrated land-use nutrient export rates

Table B.6: Range in average annual nutrient exports (2010–19) for the various land uses

Land use	Nitrogen	Phosphorus
	kg/ha/yr	kg/ha/yr
Septic tanks*	0.42 – 3.64	0.033 – 0.189
Beef & other grazing	0.46 – 6.14	0.009 – 0.872
Cropping	0.19 – 0.19	0.003 – 0.003
Dairy	1.37 – 6.50	0.020 – 0.871
Horses	0.44 – 2.75	0.014 – 0.387
Horticulture	3.05 – 43	0.075 – 12.7
Intensive animal use	2.69 – 15	0.050 – 0.507
Lifestyle block	0.32 – 3.79	0.003 – 0.164
Native vegetation	0.03 – 0.58	<0.001 – 0.012
Other landuses	0.03 – 0.51	<0.001 – 0.025
Plantation	0.04 – 1.58	0.003 – 0.485
Roads & industrial	0.08 – 0.43	0.001 – 0.014
Urban	0.48 – 6.11	0.007 – 0.957
Viticulture & orchards	0.11 – 1.81	0.005 – 0.371

* kg/septic tank/yr

B.1.2 Riparian filtering model parameters

Table B.7: Riparian filtering model parameters

Cat ID	Riparian P removal H= High L = Low	Total riparian length (km)	Vegetated (%)	Existing fencing or fencing not required (%)	Base case: N removal (%)	Base case: P removal (%)	Max fencing scenario: N removal (%)	Max fencing scenario: P removal (%)	Max fencing & revegetation scenario: N removal (%)	Max fencing & revegetation scenario: P removal (%)
1	H	2.2	97	64	29	29	30	30	30	30
2	H	0.5	100	100	30	30	30	30	30	30
3	H	18.6	78	22	23	23	30	30	30	30
4	H	4.6	96	0	29	29	30	30	30	30
5	H	46.8	77	16	23	23	30	30	30	30
6	H	3.9	100	53	30	30	30	30	30	30
7	H	37.7	99	24	30	30	30	30	30	30
8	H	83.3	99	19	30	30	30	30	30	30
9	H	92.9	93	0	28	28	30	30	30	30
10	H	60.8	99	0	30	30	30	30	30	30
11	H	15.9	92	3	28	28	30	30	30	30
12	H	4.2	99	44	30	30	30	30	30	30
13	H	1.7	73	0	22	22	30	30	30	30
14	H	43.8	99	0	30	30	30	30	30	30
15	H	31.0	82	0	25	25	30	30	30	30
16	H	13.7	73	0	22	22	30	30	30	30
17	H	37.0	88	24	26	26	30	30	30	30
18	H	32.6	61	16	18	18	30	30	30	30
19	H	12.7	97	0	29	29	30	30	30	30
20	H	23.6	62	0	19	19	30	30	30	30
21	H	12.0	46	0	14	14	29	29	30	30
22	H	18.8	72	0	22	22	30	30	30	30
23	H	1.8	99	98	30	30	30	30	30	30
24	H	59.3	70	58	21	21	27	27	30	30
25	H	41.0	70	69	21	21	26	26	30	30
26	H	40.4	98	0	29	29	30	30	30	30
27	L	0.7	19	0	6	1	21	6	30	6
28	L	6.6	99	62	30	5	30	7	30	7
29	L	33.7	89	29	27	4	30	8	30	8
30	H	111.8	97	0	29	29	30	30	30	30
31	H	65.5	99	0	30	30	30	30	30	30
32	L	40.4	64	0	19	3	30	8	30	8
33	L	27.9	84	16	25	4	30	8	30	8
34	H	15.2	96	0	29	29	30	30	30	30
35	H	8.7	66	38	20	20	29	29	30	30
36	H	65.8	87	0	26	26	30	30	30	30
37	H	43.0	96	0	29	29	30	30	30	30
38	H	98.0	71	0	21	21	30	30	30	30
39	H	54.1	80	0	24	24	30	30	30	30
40	H	1.3	67	0	20	20	30	30	30	30
41	H	39.7	63	18	19	19	30	30	30	30
42	H	69.2	76	5	23	23	30	30	30	30
43	H	71.0	60	0	18	18	30	30	30	30
44	H	71.4	73	12	22	22	30	30	30	30
45	H	31.2	69	0	21	21	30	30	30	30
46	H	91.3	61	1	18	18	30	30	30	30
47	H	17.9	48	13	15	15	28	28	30	30
48	H	0.6	0	0	0	0	15	15	30	30
49	H	1.1	19	0	6	6	21	21	30	30
50	L	6.4	71	0	21	4	30	9	30	9
51	H	16.8	59	0	18	18	30	30	30	30
52	H	19.2	55	0	17	17	30	30	30	30
53	H	22.1	80	0	24	24	30	30	30	30
54	H	53.2	57	0	17	17	30	30	30	30
55	H	86.4	48	0	14	14	29	29	30	30
56	H	11.1	46	0	14	14	29	29	30	30

Cat ID	Riparian P removal H= High L = Low	Total riparian length (km)	Vegetated (%)	Existing fencing or fencing not required (%)	Base case: N removal (%)	Base case: P removal (%)	Max fencing scenario: N removal (%)	Max fencing scenario: P removal (%)	Max fencing & revegetation scenario: N removal (%)	Max fencing & revegetation scenario: P removal (%)
58	L	24.5	46	0	14	2	29	7	30	7
59	L	22.1	42	0	13	2	28	7	30	7
60	L	0.0	100	100	30	5	30	5	30	5
61	L	17.7	50	31	15	3	25	6	30	6
62	L	70.2	35	7	11	2	24	6	30	6
63	L	39.2	49	33	15	2	25	6	30	6
64	L	14.1	18	6	5	1	20	6	30	6
65	L	61.5	20	7	6	1	20	6	30	6
66	L	87.6	8	21	3	1	15	5	30	5
67	H	0.7	88	0	26	26	30	30	30	30
68	H	31.7	81	0	24	24	30	30	30	30
69	H	3.9	60	0	18	18	30	30	30	30
70	L	0.2	94	0	28	5	30	10	30	10
71	L	4.8	53	0	16	3	30	8	30	8
72	L	4.6	67	0	20	3	30	8	30	8
73	L	26.5	41	0	12	2	27	7	30	7
74	L	0.0	0	0	0	0	15	5	30	5
75	L	1.7	22	0	7	1	22	6	30	6
76	L	1.4	0	0	15	5	30	10	30	10
77	L	0.2	73	0	22	5	30	10	30	10
78	L	3.1	49	0	15	2	30	7	30	7
79	H	1.1	75	0	22	22	30	30	30	30
80	H	5.8	62	0	19	19	30	30	30	30
81	L	4.4	27	0	8	1	23	6	30	6
82	L	4.9	85	0	26	4	30	9	30	9
83	H	2.6	70	0	21	21	30	30	30	30
84	H	0.6	91	0	27	27	30	30	30	30
85	H	4.0	72	0	22	22	30	30	30	30
86	H	0.2	100	0	30	30	30	30	30	30
87	H	0.2	95	0	29	29	30	30	30	30
88	H	0.4	31	0	15	15	30	30	30	30
90	H	3.0	93	0	28	28	30	30	30	30
91	H	2.8	71	4	21	21	30	30	30	30
92	H	2.4	83	61	25	25	30	30	30	30
93	H	1.2	38	24	11	11	23	23	30	30
94	H	0.1	100	100	30	30	30	30	30	30
95	H	0.8	63	0	19	19	30	30	30	30
96	H	0.7	98	11	29	29	30	30	30	30
97	H	0.1	100	66	30	30	30	30	30	30
98	H	21.2	68	1	20	20	30	30	30	30
99	H	33.2	88	3	26	26	30	30	30	30
100	H	27.9	97	16	29	29	30	30	30	30
101	H	17.7	100	0	30	30	30	30	30	30
102	L	2.9	86	50	26	4	30	7	30	7
103	L	1.4	100	91	30	5	30	5	30	5
104	L	5.9	34	5	10	2	24	6	30	6
105	L	0.4	89	0	27	4	30	9	30	9
106	L	0.3	70	78	21	4	24	5	30	5
107	L	3.9	34	0	10	2	25	7	30	7
108	L	6.8	80	0	24	4	30	9	30	9
109	L	0.4	2	0	0	0	15	5	30	5
110	L	11.7	42	0	13	2	28	7	30	7
111	L	1.1	11	0	3	1	18	6	30	6
112	L	0.1	0	0	0	0	15	5	30	5
113	L	2.0	93	0	28	5	30	10	30	10
114	L	2.0	24	0	7	1	22	6	30	6
115	L	0.0	0	0	0	0	15	5	30	5
116	L	0.0	0	0	0	0	15	5	30	5
117	H	4.0	36	0	11	11	26	26	30	30
118	H	19.0	63	0	19	19	30	30	30	30
Total		2535.1	71	9	20	16	28	21	30	22

B.1.3 Storage node parameters

Table B.8: Storage node nutrient model parameters

Model component	Parameter	Lake Saide	Nenamup Inlet	Wentworth Road dam	Mount Hollowell Stud dam	Denmark Dam	Quickup Dam	Carter Dam
Constituent model	TN storage decay model (s)	6,048,000	12,960,000	Nil	Nil	Nil	Nil	Nil
	TP storage decay model (s)	864,000	5,184,000	Nil	Nil	Nil	Nil	Nil

B.2 Daily modelled and measured nutrient concentrations

B.2.1 Little River, Ocean Beach Rd (AWRC ref. 603020)

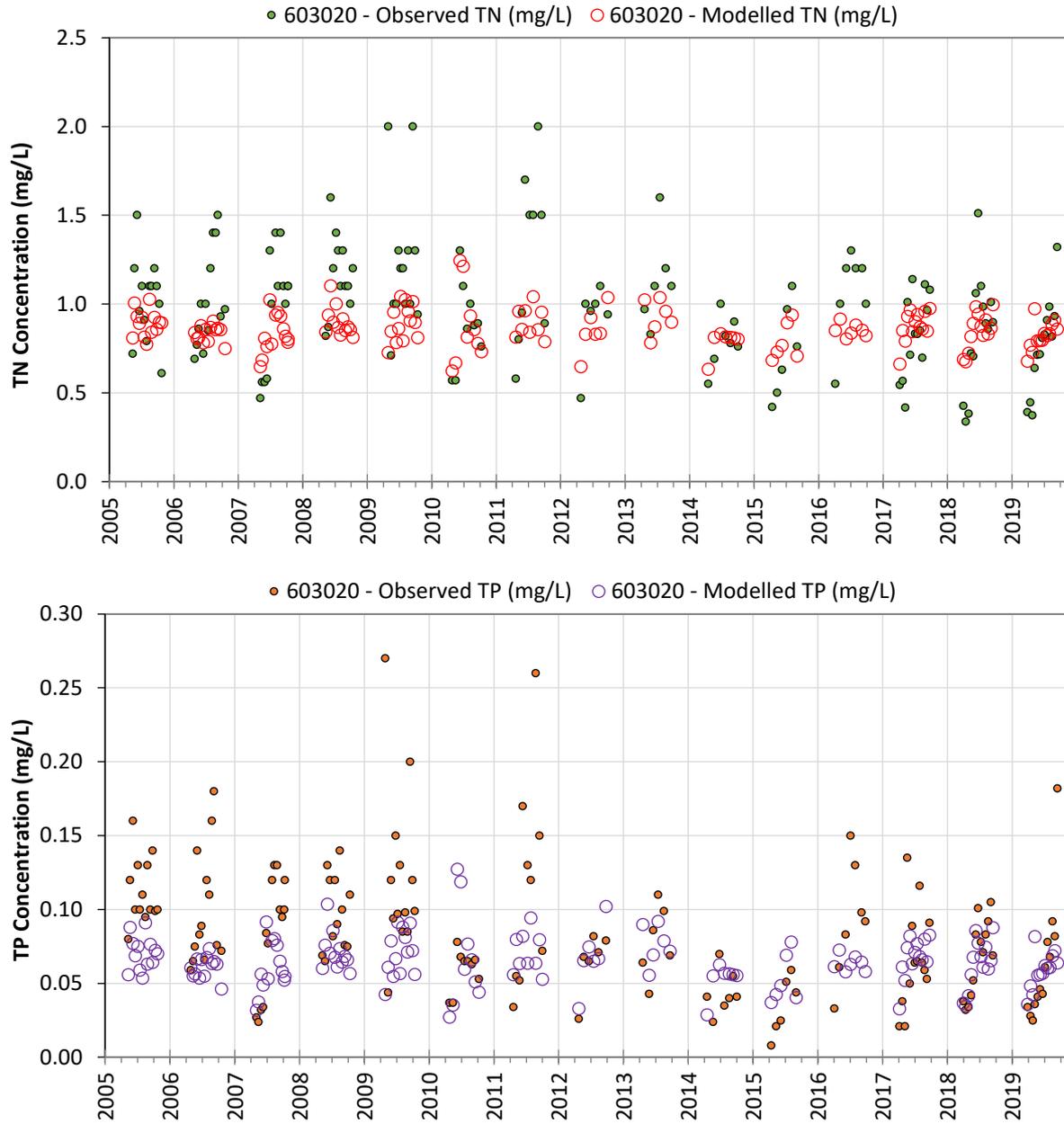


Figure B.2: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Ocean Beach Rd (Little River, AWRC ref. 603020)

B.2.2 Denmark River, Denmark Ag College (AWRC ref. 603021)

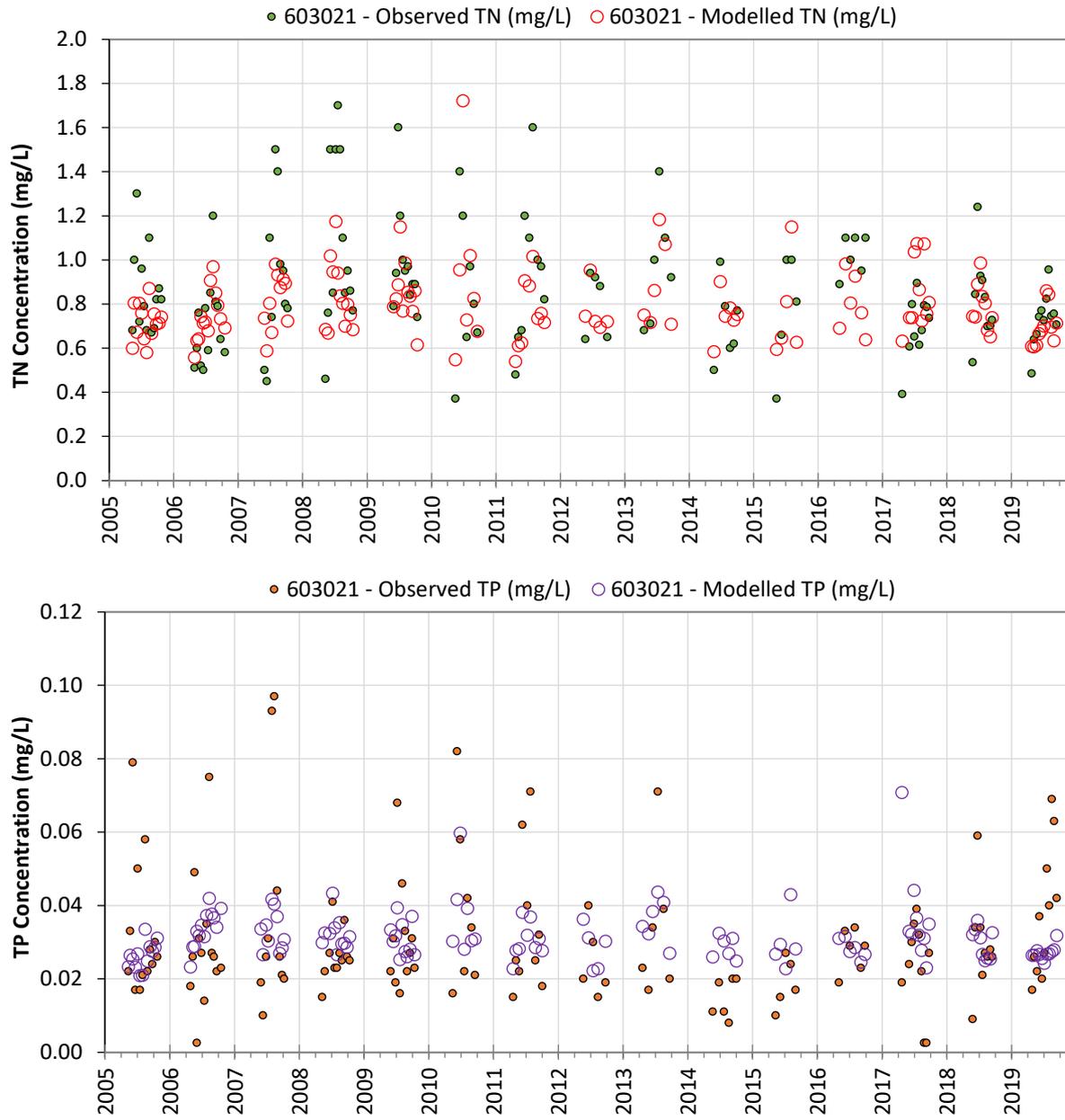


Figure B.3: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Denmark Ag College (Denmark River, AWRC ref. 603021)

B.2.3 Scotsdale Brook, Pipehead (AWRC ref. 603023)

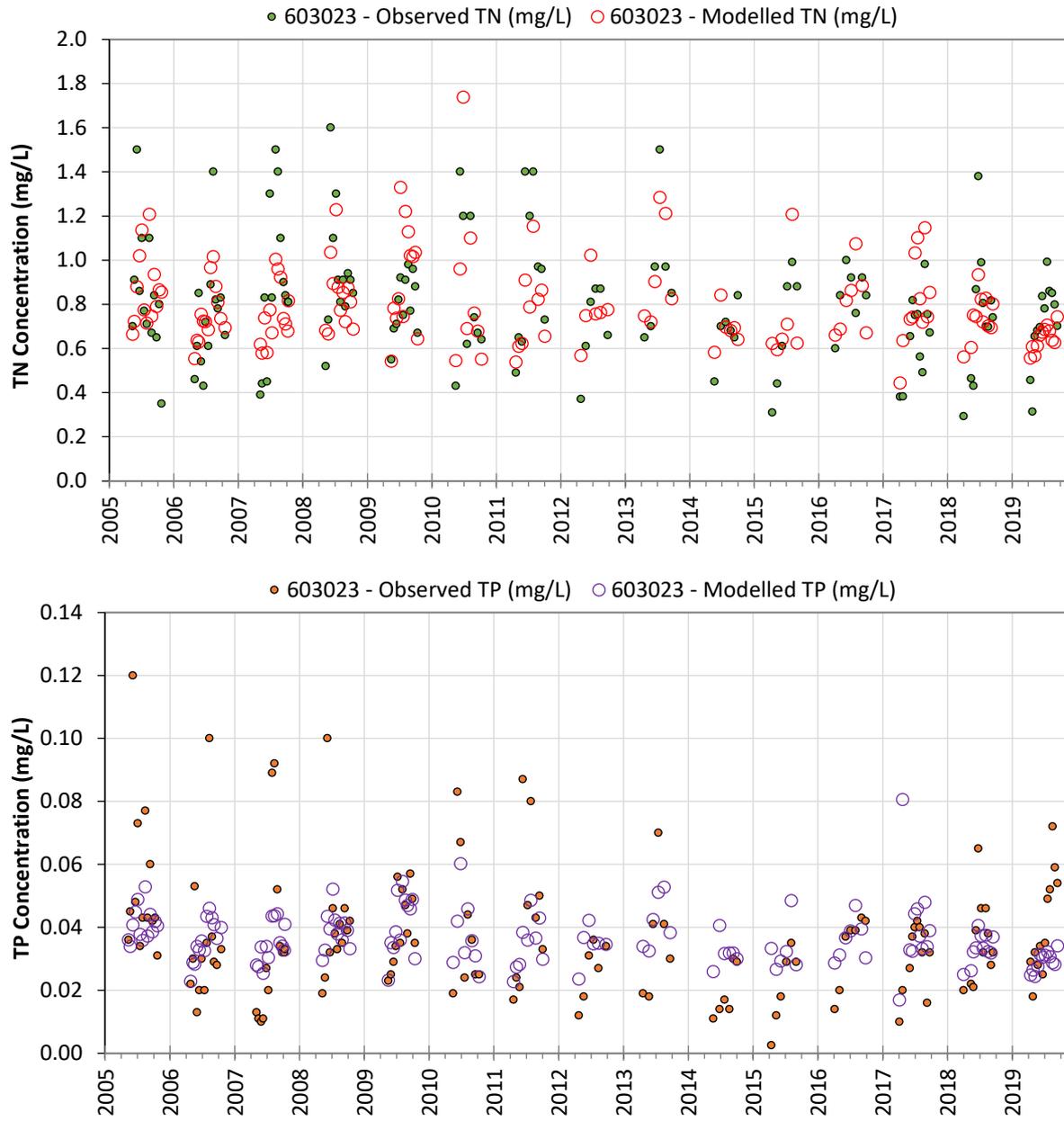


Figure B.4: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Pipehead (Scotsdale, AWRC ref. 603023)

B.2.4 Denmark River, Mt Lindesay (AWRC ref. 603136)

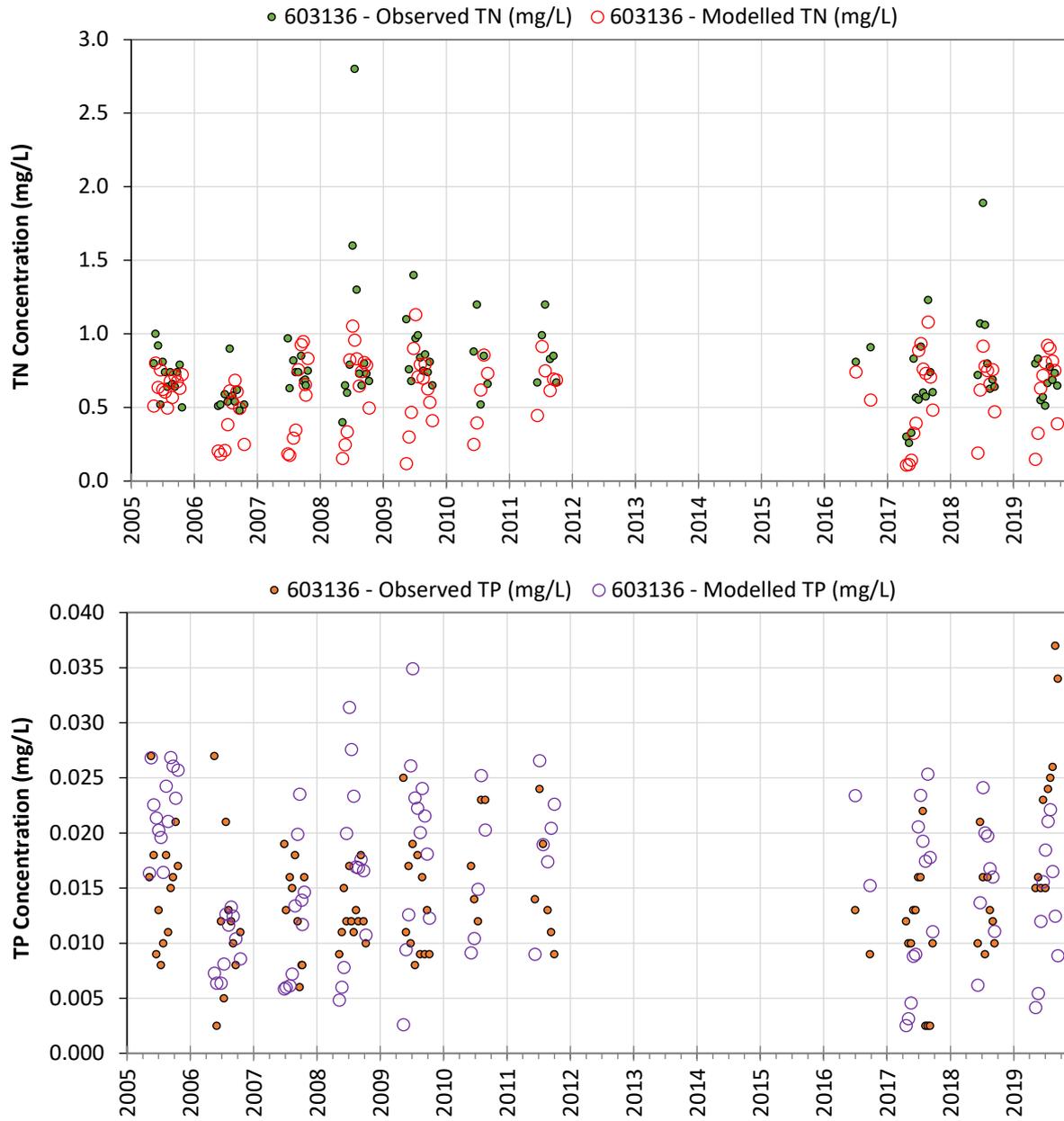


Figure B.5: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Mt Lindesay (Denmark River, AWRC ref. 603136)

B.2.5 Sunny Glen Creek, Girrawheen (AWRC ref. 603022)

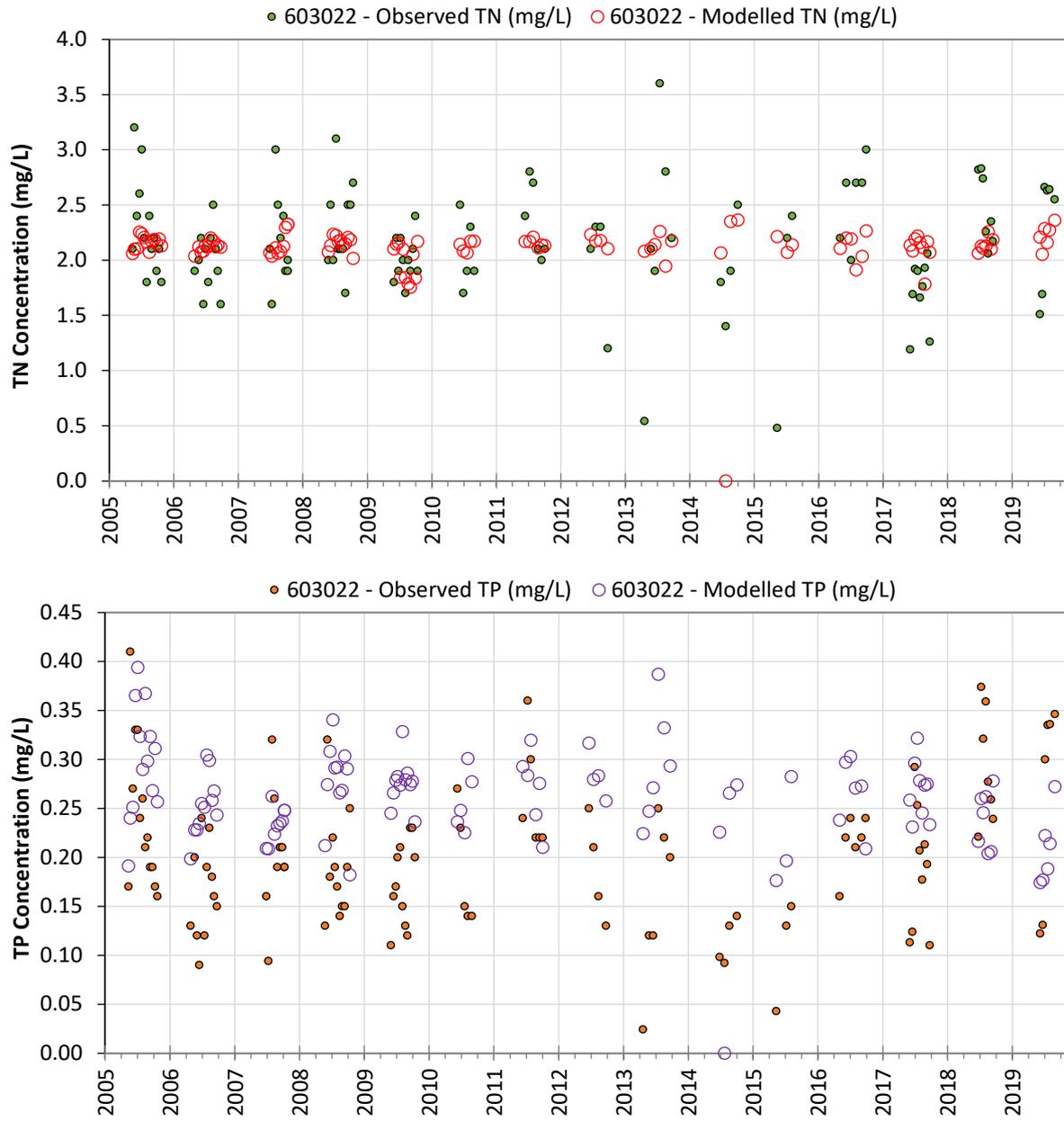


Figure B.6: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Girrawheen (Sunny Glen Creek, AWRC ref. 603022)

B.2.6 Hay River, Sunny Glen (AWRC ref. 603004)

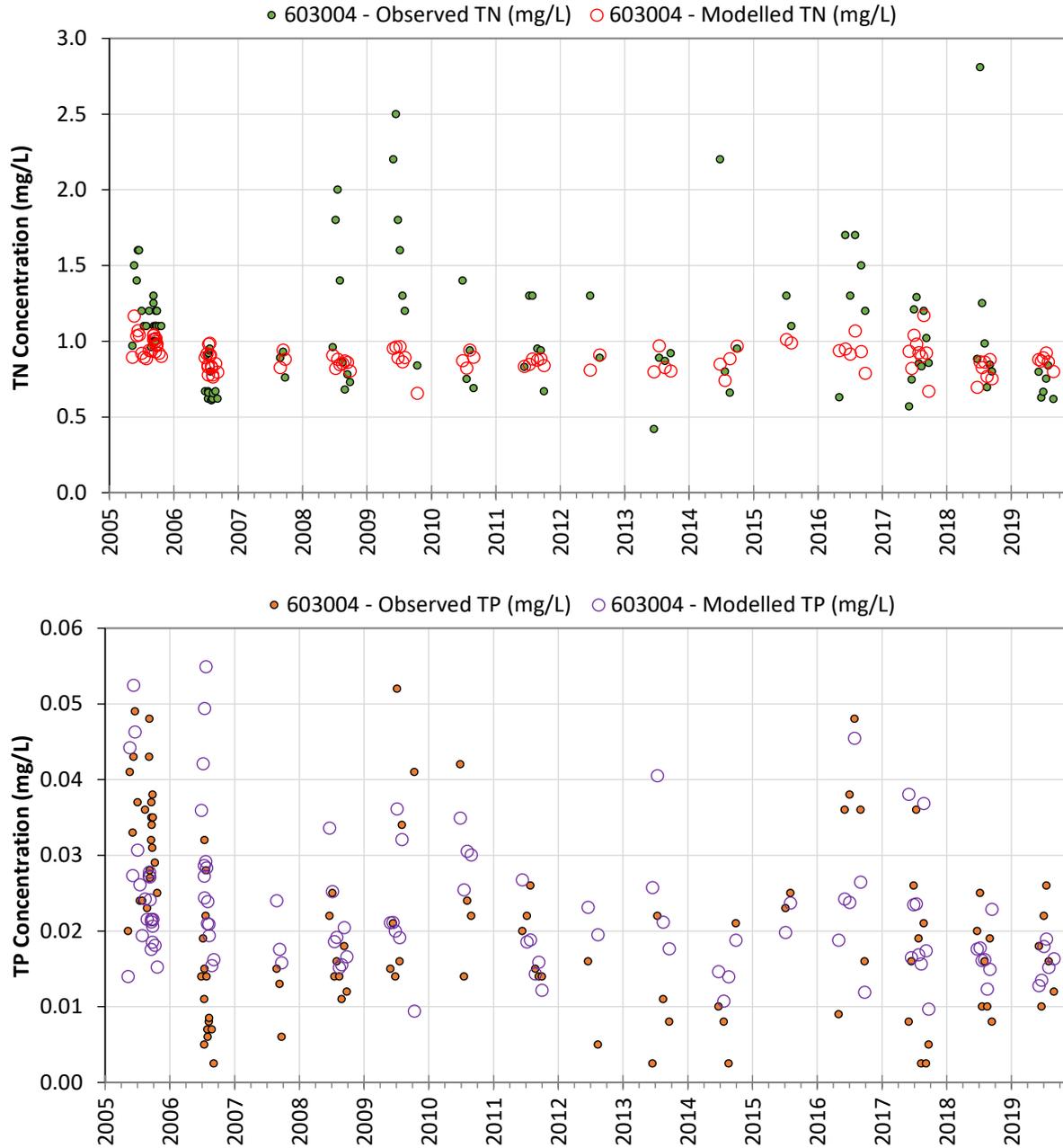


Figure B.7: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Sunny Glen (Hay River, AWRC ref. 603004)

B.2.7 Mitchell River, Beigpiegup (AWRC ref. 603005)

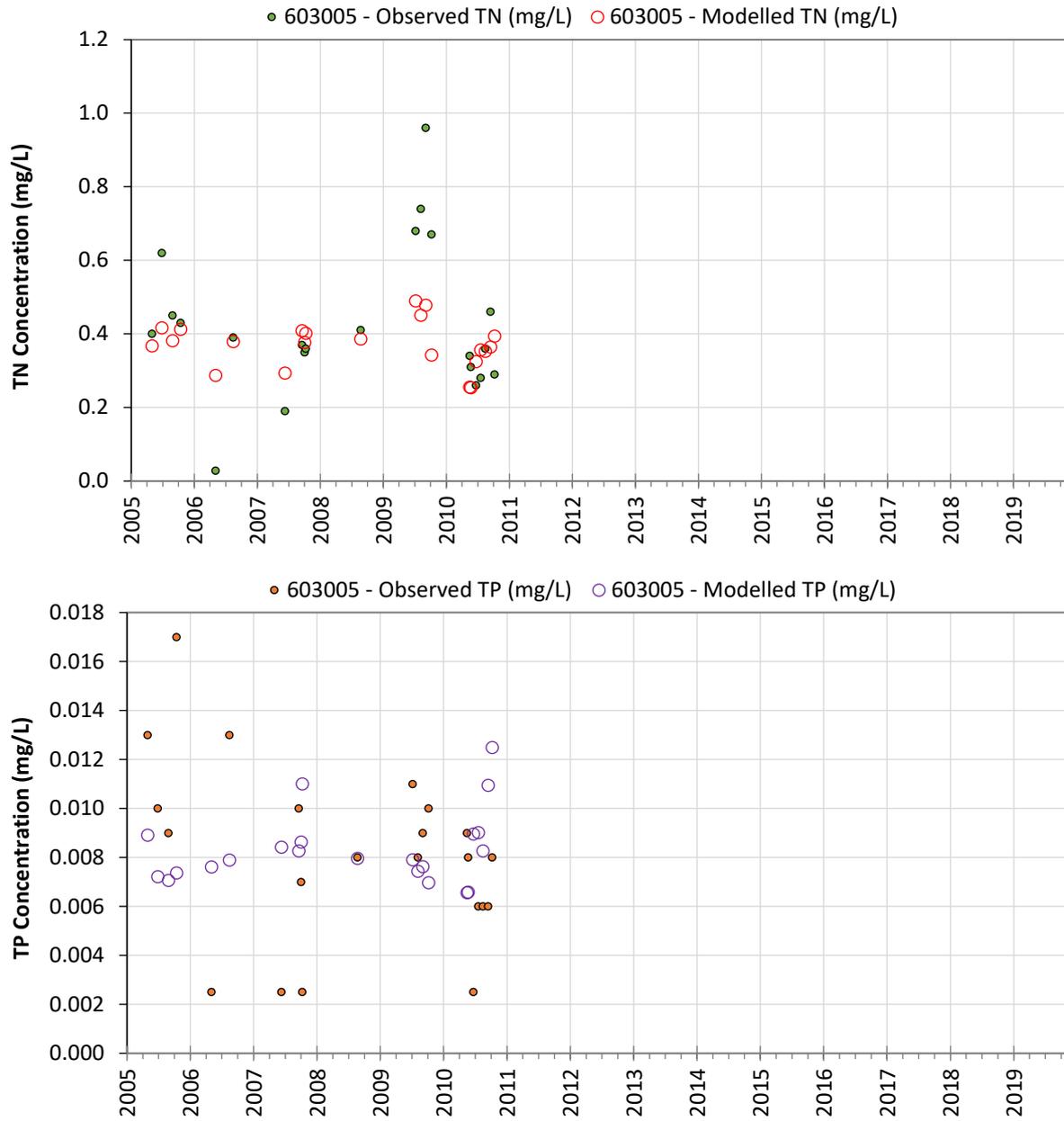


Figure B.8: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Beigpiegup (Mitchell River, AWRC ref. 603005)

B.2.8 Hay River, EVh01 (AWRC ref. 6031477)

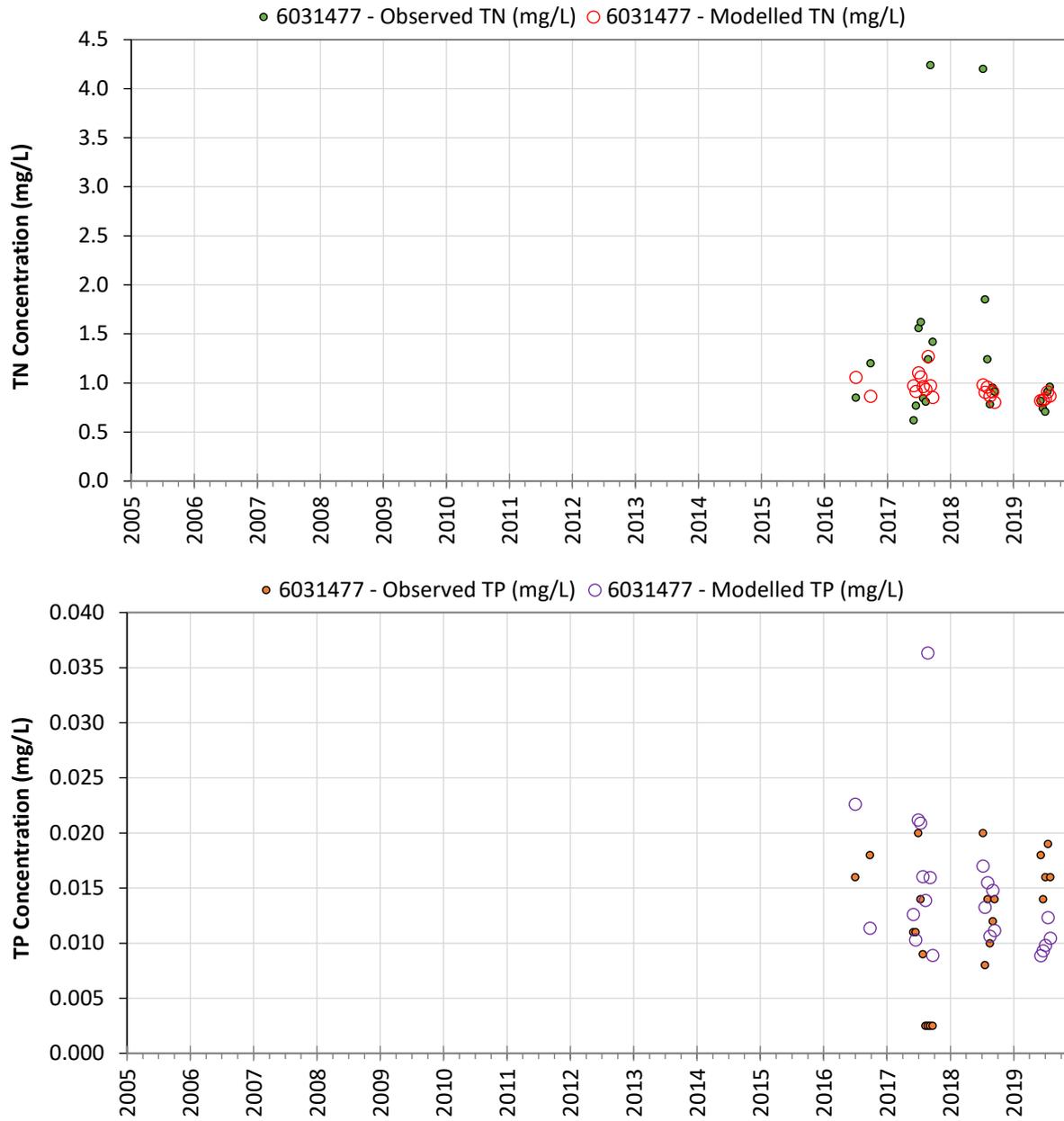


Figure B.9: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at EVhay01 (Hay River, AWRC ref. 6031477)

B.2.9 Sleeman River, Sleeman Rd Bridge (AWRC ref. 603007)

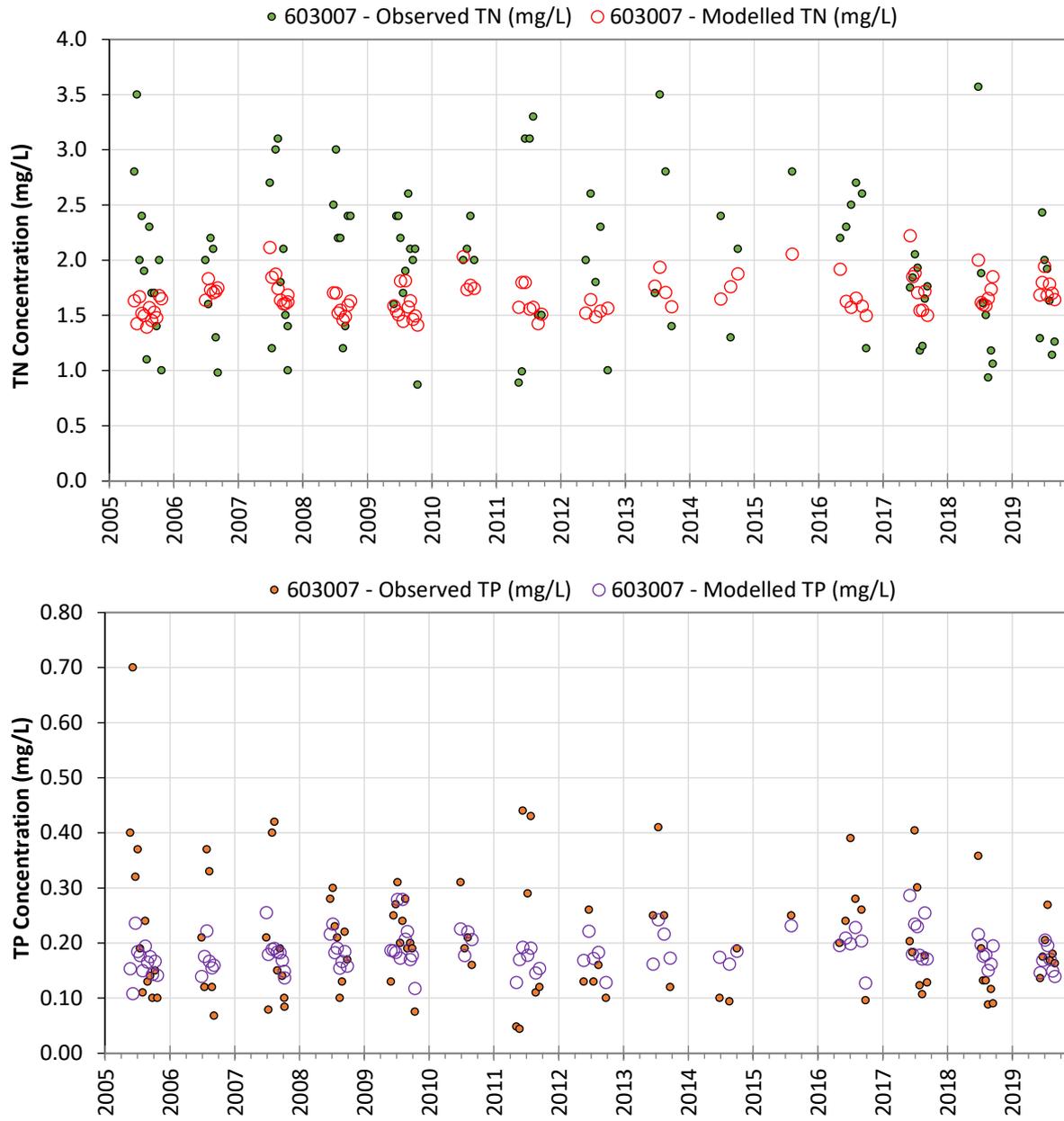


Figure B.10: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Sleeman Rd Bridge (Sleeman River, AWRC ref. 603007)

B.2.10 Cuppup River, Eden Rd (AWRC ref. 603013)

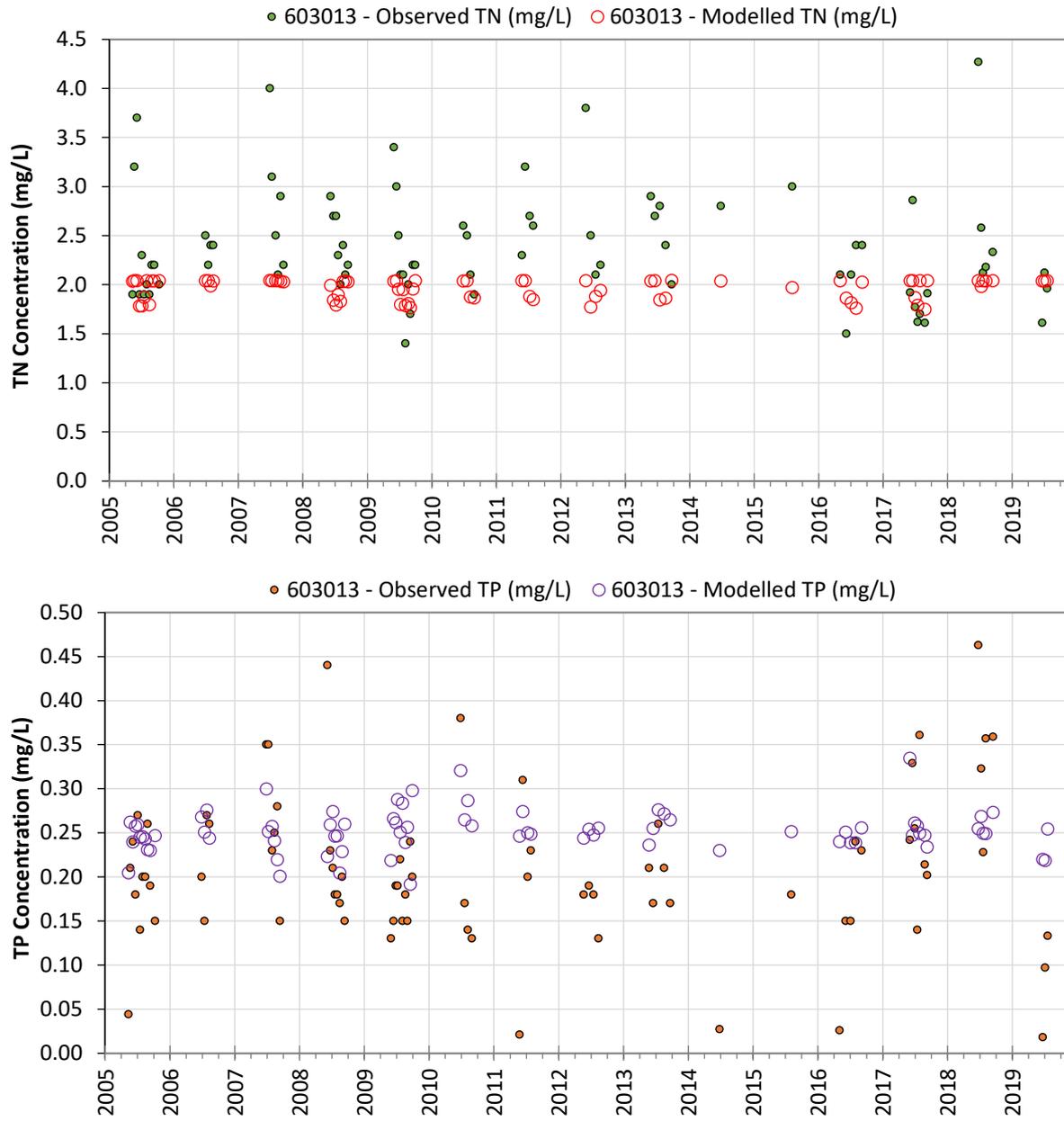


Figure B.11: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Eden Rd (Cuppup River, AWRC ref. 603013)

B.2.11 Lake Saide Drain, Bridge 127-Wolves (AWRC ref. 6031104)

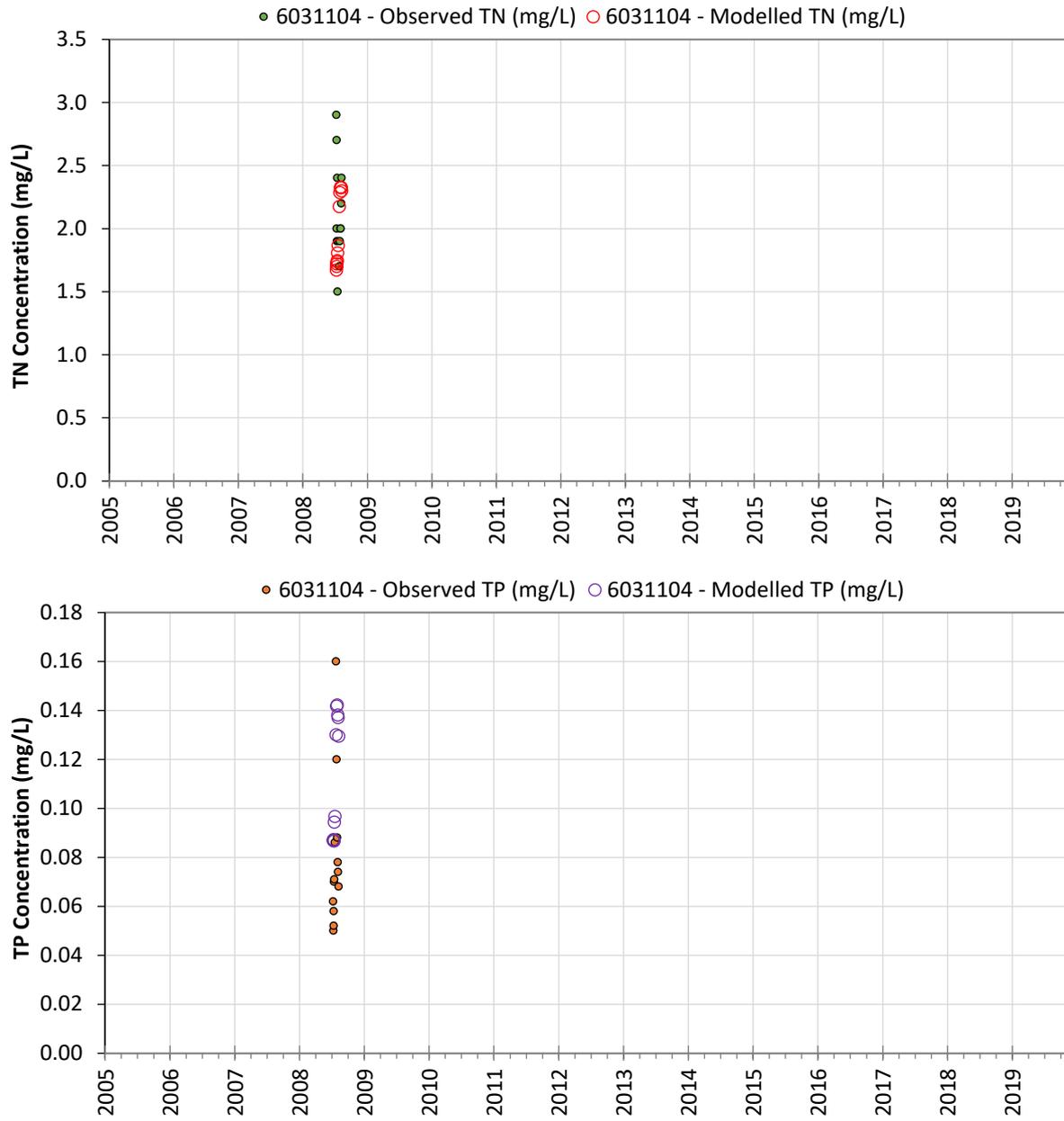


Figure B.12: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Bridge 127-Wolves (Lake Saide Drain, AWRC ref. 6031104)

B.2.12 Nenamup Inlet Drain (AWRC ref. 6031283)

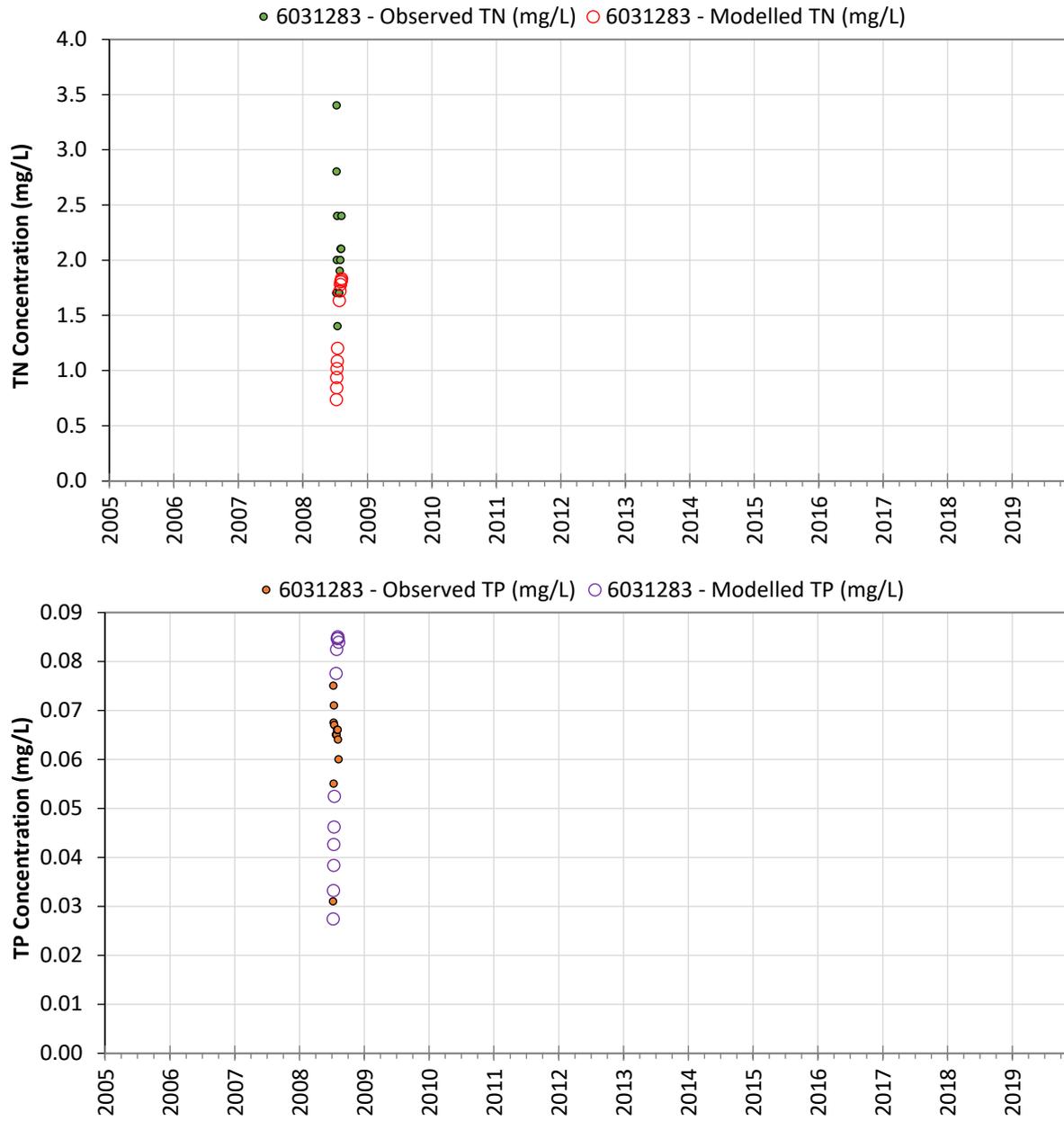


Figure B.13: Measured and modelled winter total nitrogen (TN, top graph) and total phosphorus (TP, bottom graph) at Nenamup Inlet Drain (AWRC ref. 6031283)

Appendix C: Point sources and septic tanks

C.1 Point sources

We identified 24 nutrient point sources in the Wilson Inlet catchment (see Table C.1 and Figure C.1). Of these, we included 20 in the model. Intensive animal industries (piggeries, feedlots, stockyards) were modelled using the diffuse model described in Section 3.1 of the main report. The following sections of this appendix detail our modelling approach for wastewater treatment plants (WWTP), beverage-making sites and dairy sheds. We identified four point sources but did not include them in the model, as follows:

- **Two landfill sites (Mount Barker and Denmark):** these were not included due to the difficulty in estimating their nutrient contributions to surface water. Groundwater contaminant transport modelling would likely be required to adequately quantify these emissions, which was outside of the scope of this project.
- **Treated wastewater from the Pardelup Prison farm:** this was not included because we could not find detailed publicly available information about the treatment and management of wastewater, other than a [report](#) saying that grey water is treated and used for onsite irrigation. Although we did not explicitly model this reuse, we mapped the land uses within the prison farm, such as the areas used for horticulture. In the model, these land uses assume nutrient input and surplus rates as given in the main report.
- **A septage disposal site:** this was not included in the model because the site was constructed in about 2020 and therefore not in the model's basecase period.

Table C.1: Point sources identified in the Wilson Inlet catchment

#	Type	Facility name	Licence	Included in model	Reporting catchment	Cat ID
1	Dairy shed	Dairy shed #1	-	Yes	Sunny Glen	59
2	Dairy shed	Dairy shed #2	-	Yes	Lower Denmark	117
3	Dairy shed	Dairy shed #3	-	Yes	Scotsdale	24
4	Dairy shed	Dairy shed #4	-	Yes	Upper Denmark	9
5	Dairy shed	Dairy shed #5	-	Yes	Lower Hay	33
6	Dairy shed	Dairy shed #6	-	Yes	Lower Hay	32
7	Dairy shed	Dairy shed #7	-	Yes	Sleeman	63
8	Dairy shed	Dairy shed #8	-	Yes	Sleeman	61
9	Feedlots & stockyards	Small feedlot	-	Yes	Upper Hay	42
10	Feedlots & stockyards	Great Southern Regional Cattle Saleyards	L7407/1998/9	Yes	Upper Hay	55
11	Feedlots & stockyards	Stockyard	-	Yes	Foreshore	83
12	Feedlots & stockyards	Small feedlot	-	Yes	Lower Denmark	117
13	Piggery	Piggery #1	-	Yes	Upper Hay	45
14	Piggery	Piggery #2	-	Yes	Upper Hay	36
15	Wastewater irrigation	West Cape Howe Wines	L7730/2001/8	Yes	Upper Hay	44
16	Wastewater irrigation	Forest Hill Wines	L8042/2004/4	Yes	Little River	118
17	Wastewater irrigation	Howard Park	L80434/2005/4	Yes	Scotsdale	23
18	Wastewater irrigation	Willoughby Estate	L8081/2006/3	Yes	Lower Denmark	117
19	WWTP	Denmark WWTP	L6315/1991/11	Yes	Koorabup	79
20	WWTP	Mount Barker WWTP	L6314/1991/12	Yes	Upper Hay	42
21	Landfill	Mount Barker Landfill	L7026/1997/14	No	Upper Hay	55
22	Landfill	Waste Transfer Station (Denmark)	L6862/1997/11	No	Foreshore	82
23	Septage pond	Liquid waste facility (Pile Rd)	L9022/2016/2	No	Upper Hay	47
24	Wastewater	Pardelup Prison Farm	-	No	Upper Hay	47

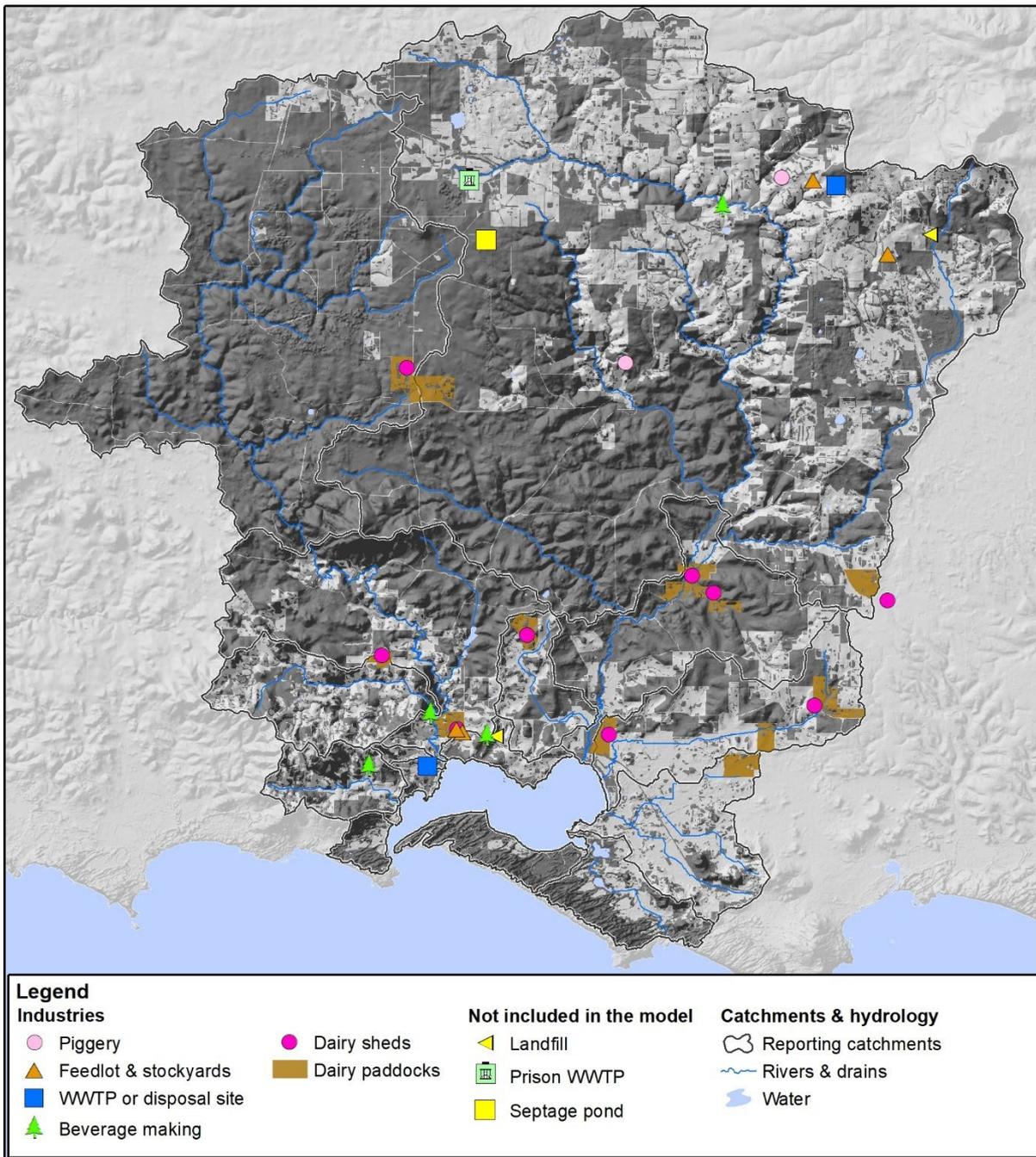


Figure C.1: All identified point sources and dairy sheds

Dairy sheds

Dairy sheds can be a significant source of nutrients and were included in our model using inflow nodes. Inflow nodes require a pre-computed timeseries of water discharge and nutrient concentrations. We did this by estimating the timeseries of nutrient loss from dairy sheds based on published literature, assumptions and model calibration. This approach was similar to that of the Peel-Harvey catchment modelling (Hennig et al. 2021). For each dairy shed, we calculated the mass of nitrogen and phosphorus produced in dairy shed effluent based on the approximate number of cattle for each farm (numbers provided by Western

Dairy). We then calculated the nutrient mass available for loss to surface water by multiplying the nutrient load in dairy shed effluent by the nutrient loss factor (see Table C.2). All eight dairy sheds used the same nutrient loss factors (0.14 for nitrogen and 0.05 for phosphorus). We derived the nutrient loss factors through calibration. The loss factor for nitrogen was similar to the Peel-Harvey catchment's factor. However, the phosphorus loss factor was about 60% lower than that of the Peel-Harvey. This indicates greater soil phosphorus retention on the dairy farms in the Wilson Inlet.

We assume that the mass of daily nutrient loss is a proportion of daily functional unit flow of the model timestep to average annual functional unit flow (1975–2019). This assumption avoids large spikes in nutrient concentration downstream when catchment flows cease or are very low.

Table C.2: Dairy shed assumptions

Parameter	Units	Value (Wilson Inlet)	Value (Peel-Harvey)
Wash-down volume per cow per day	kL/cow/day	0.06	0.06
Number of milking days per year	# days	365	365
Effluent TN concentration	mg/L	200	200
Effluent TP concentration	mg/L	40	40
Mass of nitrogen in dairy effluent	kg/cow/yr	4.38	4.38
Mass of phosphorus in dairy effluent	kg/cow/yr	0.88	0.876
Nitrogen loss factor	Factor	0.14	0.15
Phosphorus loss factor	Factor	0.05	0.13
Nitrogen load available for loss to surface water	kg/cow/yr	0.61	0.66
Phosphorus load available for loss to surface water	kg/cow/yr	0.04	0.11

Denmark WWTP

The Denmark WWTP infiltrates treated wastewater adjacent to an unnamed stream in the Koorabup reporting catchment. This discharge site is less than 1 km from Wilson Inlet. Measured nutrient concentrations in this stream suggest that treated wastewater enters this unnamed stream and is mobilised to Wilson Inlet.

We assume there is no attenuation of nutrients between the infiltration of treated wastewater and its mobilisation to Wilson Inlet, other than dilution from catchment sources of flow. We took the volume of treated wastewater discharge and the concentrations of nutrients from monthly estimates in the Water Corporation's annual environmental reports (AER). We incorporated this data in the model at a daily timestep using the periods below (all months are inclusive):

- January 1960 to June 2010 uses data from the 2009–10 AER
- July 2010 to June 2012 uses data from the 2010–11 and 2011–12 AER
- July 2012 to June 2014 uses data from the 2011–12 AER
- July 2014 to June 2015 uses data from the 2014–15 AER
- July 2015 to June 2018 uses data from the 2017–18 AER

- July 2018 to June 2019 uses data from the 2018–19 AER
- July 2019 and onwards uses data from the 2019–20 AER

Figure C.2 shows the assumed daily timeseries of discharge from the Denmark WWTP as well as annual nutrient loads to the Wilson Inlet.

Mount Barker WWTP disposal site (woodlot irrigation)

The Mount Barker WWTP is located north-east of the town and is in the Kalgan River catchment, which drains to the Oyster Harbour estuary. However, treated wastewater is pumped to an irrigation site in the Upper Hay catchment (Oorangatup Creek, modelling catchment 42). The land use of this irrigation site has changed over the years. Initially the site was used for dryland pasture grazing until it was converted to a vineyard in 2000. This vineyard began using treated wastewater for irrigation at some point before early 2013 when the Water Corporation took ownership. Today, most of the 126 ha site is used as woodlot for treated wastewater irrigation.

We used the Water Corporation's 2014–15 and 2015–16 AER to parameterise the amount of irrigation and nutrient inputs of the disposal site in the catchment model. The assumed daily irrigation depth differs by month (see Figure C.3). We simulated irrigation in the catchment model by combining the depth of treated wastewater irrigation with the rainfall data for modelling catchment 42. Nutrient inputs to the woodlot from treated wastewater irrigation were 22 kg/ha/yr for nitrogen and 5 kg/ha/yr for phosphorus. We also created a leaf area index (LAI) timeseries to account for the land-use changes from grazing to vineyards to woodlots since 2000, which was based on aerial photography (see Figure C.4). We assumed harvesting of the woodlot every 10 years.

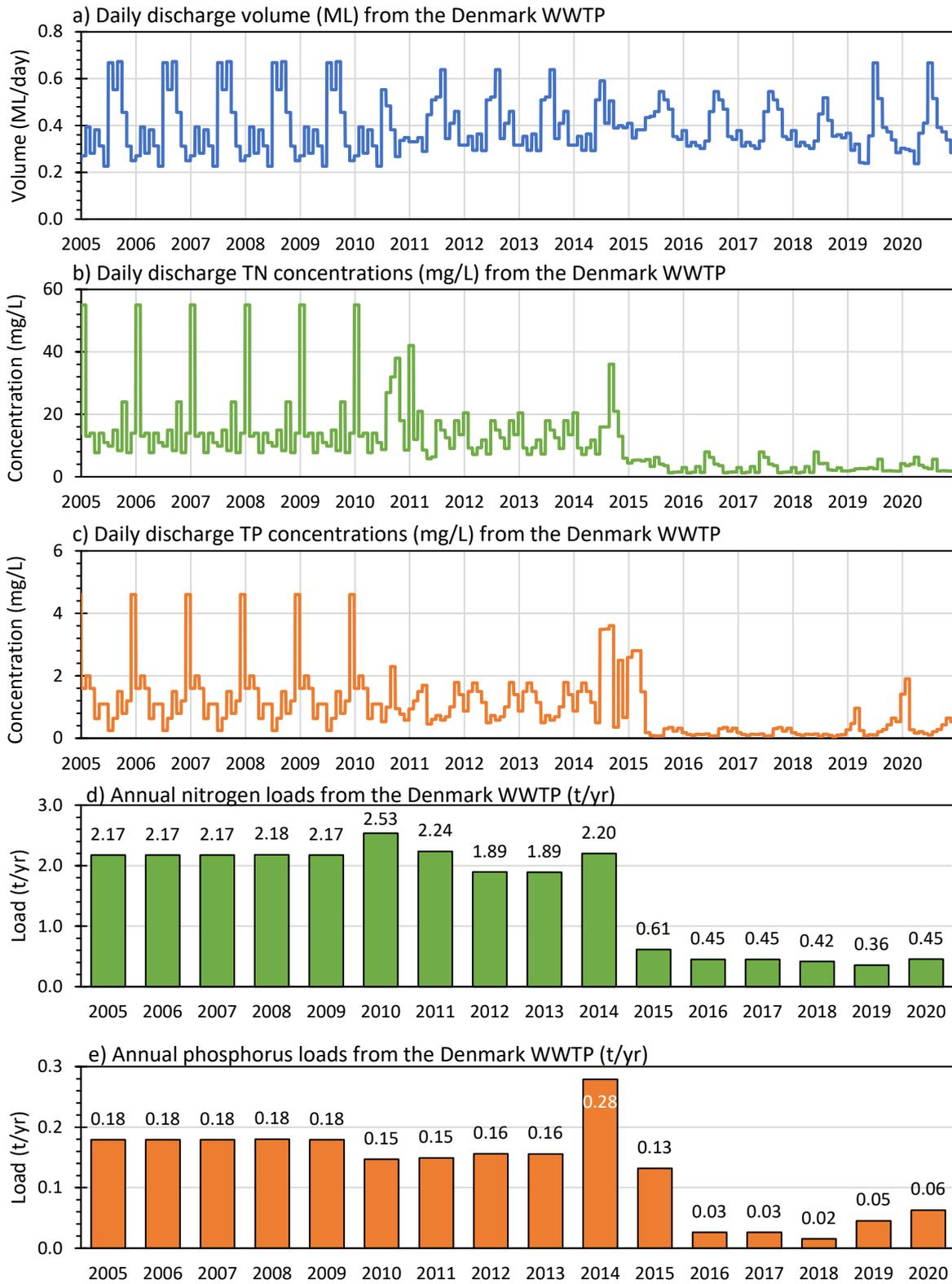


Figure C.2: Assumed daily discharge and nutrient concentrations, and annual nutrient loads from the Denmark WWTP

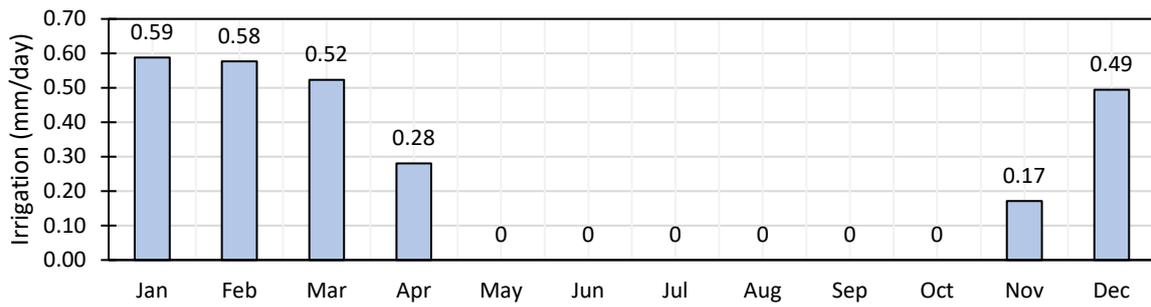


Figure C.3: Assumed monthly woodlot irrigation based on data from the Water Corporation’s 2014–15 and 2015–16 annual environmental reports

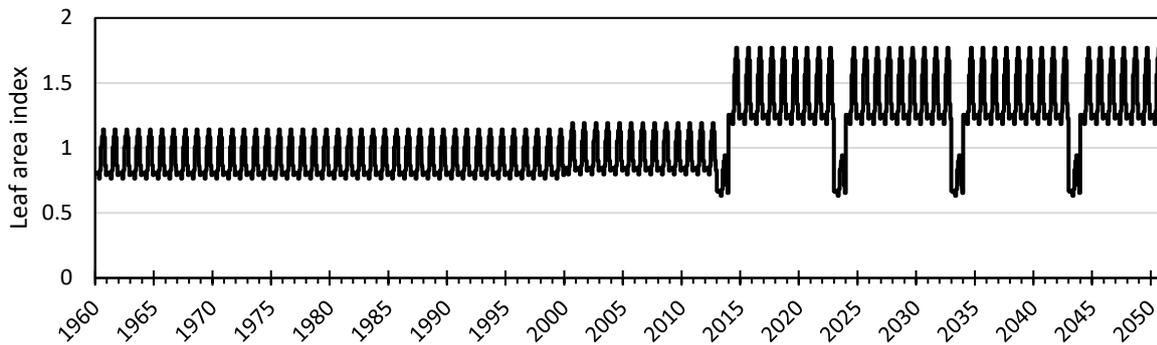


Figure C.4: Assumed leaf area index of the Mount Barker disposal site

Wastewater irrigation (beverage making)

Three sites irrigate woodlots with treated wastewater from alcoholic beverage making (see Table C.3). A fourth site irrigates its vineyards with treated wastewater, which typically is carefully managed to avoid unpleasant flavours when overfertilised. Hence, we opted to model this site in the same way as other vineyards. For the sites listed in Table C.3, we estimated the irrigation and nutrient application using the criteria given in their environmental licences – the results were mostly similar to those for the Mount Barker WWTP disposal site. Thus, we opted to model the three sites using the same approach, nutrient application and irrigation rates as the Mount Barker disposal site.

Table C.3: Estimated annual nutrient loading and irrigation of sites that irrigate woodlots with treated wastewater

Site (env licence)	Cat ID	Climate ID	Treated wastewater irrigation			Max licensed concentrations		Max estimated emissions to land		Licensed maximum loading to land	
			Volume (KL/yr)	Area (ha)	Irrigation (mm/yr)	TN (mg/L)	TP (mg/L)	N load (kg/ha/yr)	P load (kg/ha/yr)	N load (kg/ha/yr)	P load (kg/ha/yr)
Howard Park wines (L8042/2004/4)	23 Scotsdale Brook	23	0.70	2.1	34	30	7.5	10	2.5	480	120
Wiloughby Estate (L8081/2006/3)	117 Little River	3	1.05	1.4	74	30	7.5	22	5.6	480	120
Forest Hill Winery (L8042/2004/4)	118 Lower Denmark	68	0.90	1.4	64	30	7.5	19	4.8	480	120
Assumed in catchment model			-	-	79	27	6.2	22	5.0	-	-

C.2 Septic tanks

We identified unsewered lots using the Water Corporation’s 2016 sewerage connection spatial layer. As there is no known mapping of alternative treatment units, we assumed that all unsewered properties dispose of onsite wastewater using septic tanks. We assumed septic tanks discharge 56.6 kL/person/yr (Loh & Coghlan 2003), which results in the discharge of 5.5 kg/person/yr of nitrogen and 1.1 kg/person/yr of phosphorus (Whelan et al. 1981). We assumed each septic tank serviced a dwelling with 2.2 people (Denmark suburb ABS 2016). When mapping septic tanks, we assigned one to each unsewered accommodation unit, caravan bay or camping site. Therefore, each mapped septic tank – regardless of its use (residential, industrial, accommodation) – is assumed to discharge 124.5 kL/dwelling/yr of effluent, 12.1 kg/dwelling/yr of nitrogen, and 2.4 kg/dwelling/yr of phosphorus to land.

We calibrated the proportion of nutrients mobilised to surface water from land discharge to groundwater concentrations in modelling catchments 84 to 88. About 27% of the septic tanks in the Wilson Inlet catchment are in these catchments.

We used groundwater measurements from six bores adjacent to Wilson Inlet for calibration (Figure C.5). Of these bores, five also had an upgradient bore that we considered during the calibration process. In addition, catchment 87 had two calibration bores and two upstream bores.

The objective of this calibration was to achieve a good fit with measured data, particularly high nutrient concentration measurements, which could indicate the presence of septic tank effluent. We used the calibration that produced the best overall match to all observed data in the catchment model. See Table C.4 for the export rates.

Table C.4: Septic tank nutrient export categories and calibrated nitrogen and phosphorus exports

Export category	N export	P export	# septics	% of septics
Heavy soils	40%	0.5%	265	17%
Moderate soils	14%	4%	965	61%
Sandy soils	40%	20%	348	22%
Not included in the model			714	45%
Total (included in the model)	24%	7%	1578	100%
Total	17%	5%	2292	

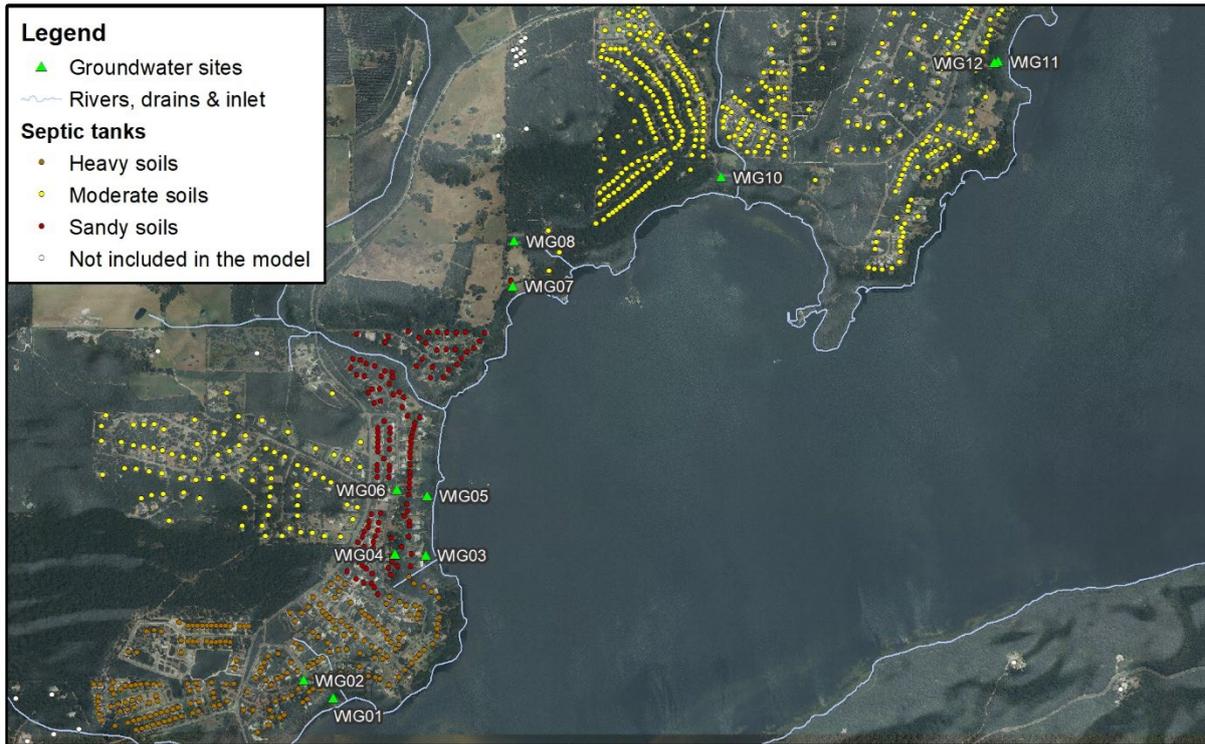


Figure C.5: Map of groundwater sites used to calibrate septic tank nutrient exports

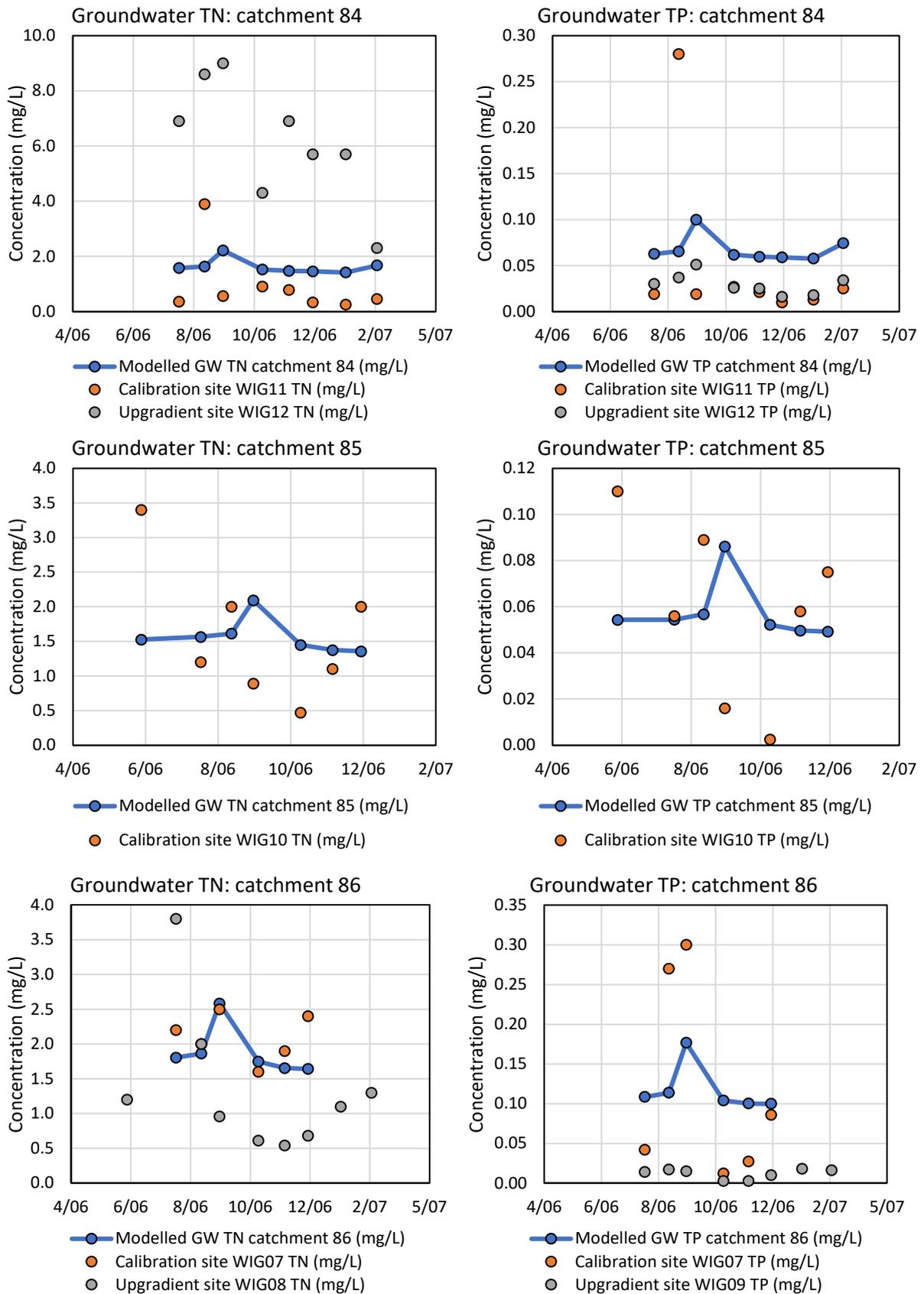


Figure C.6: Groundwater nutrient calibration for modelling catchments 84–86

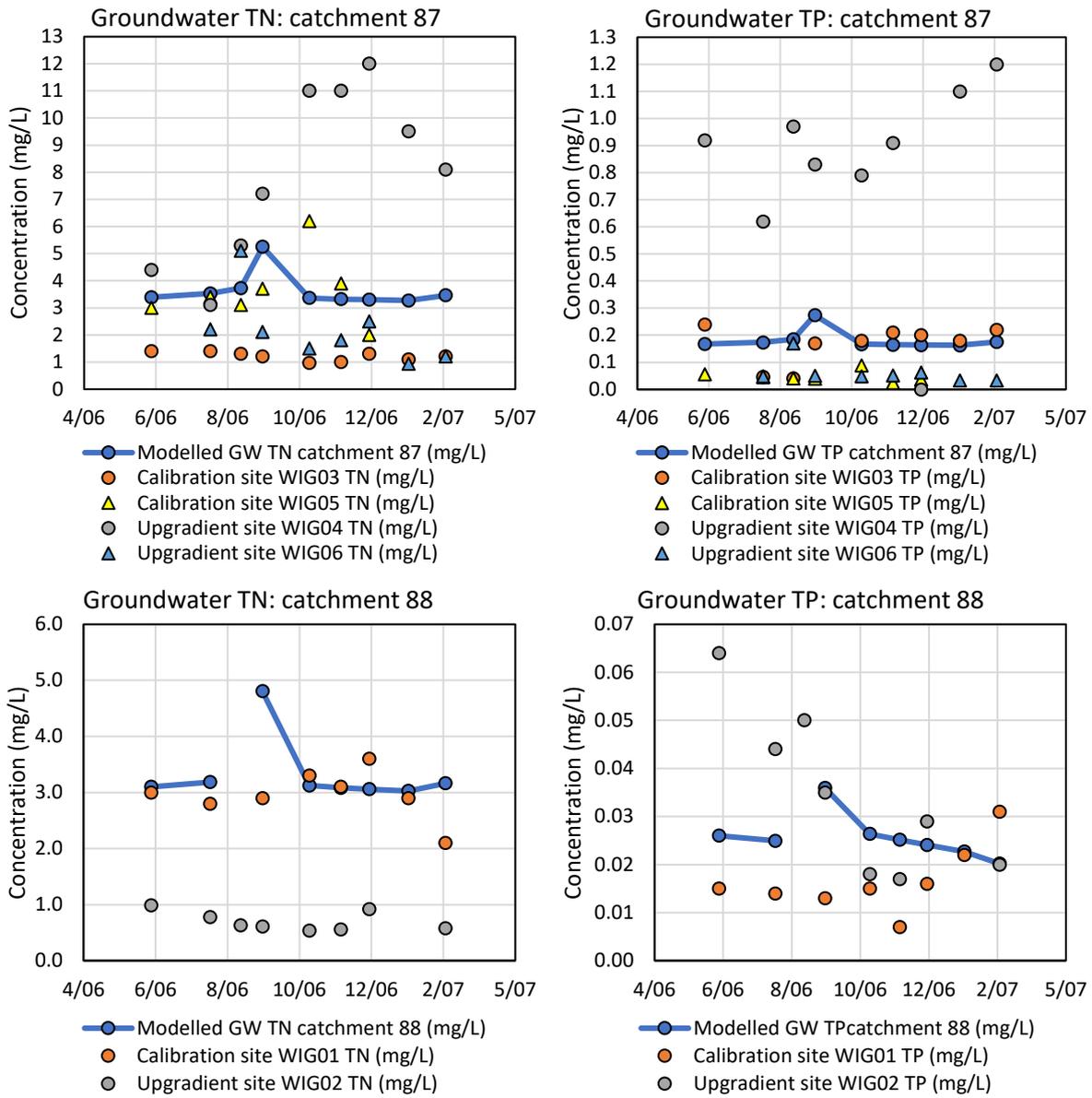


Figure C.7: Groundwater nutrient calibration for modelling catchments 87–88

Appendix D: Source separation

D.1 Ocean Beach Road

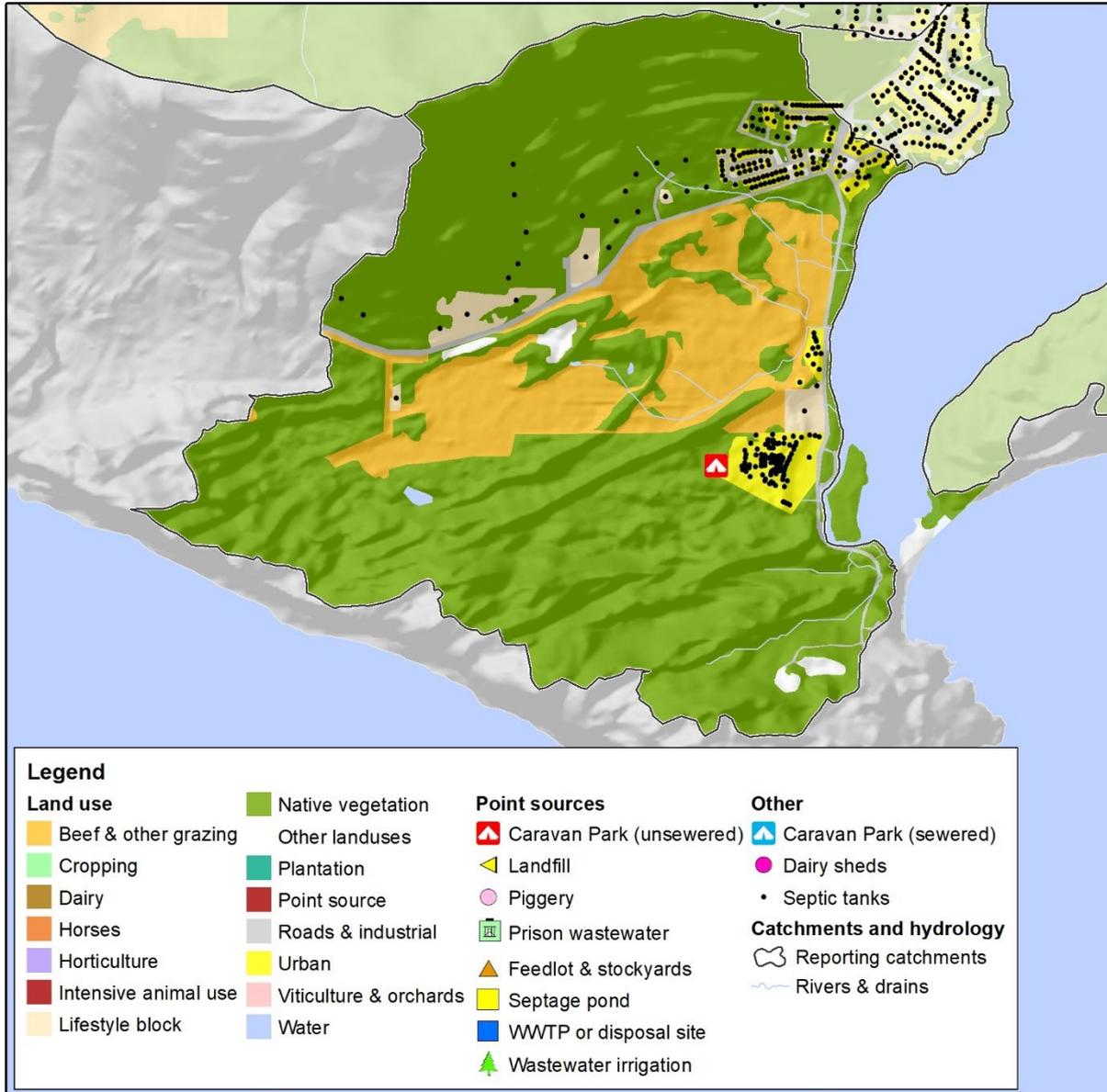
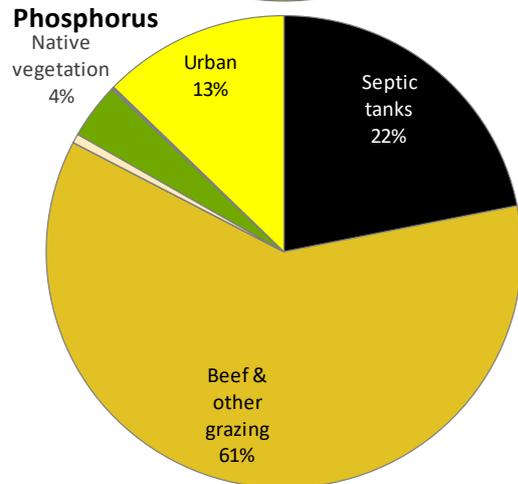
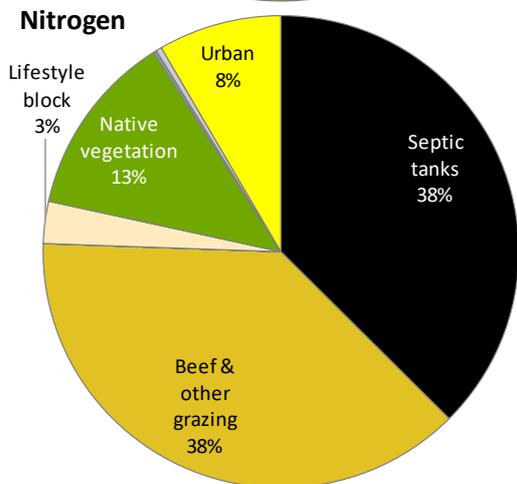
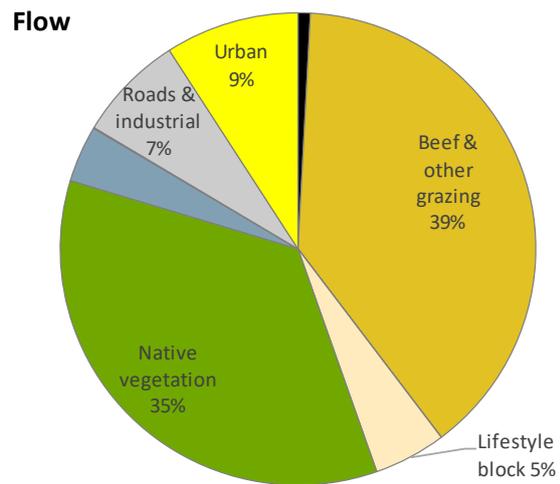
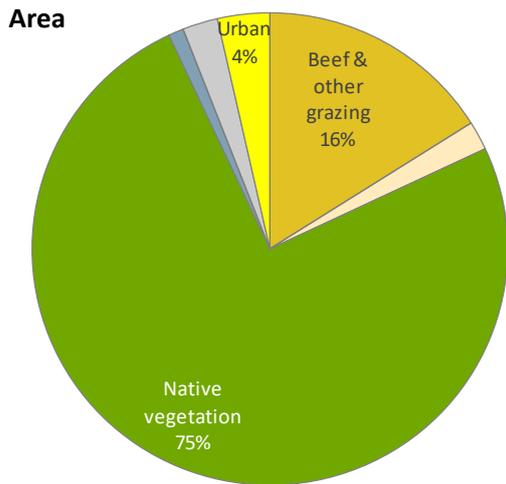


Figure D.1: Land uses of the Ocean Beach Road reporting catchment

Ocean Beach Road source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		266	-	10	1%	968	37%	50	22%
Beef & other grazing		160	16%	464	39%	982	38%	140	61%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		0	0%	0	0%	0	0%	0	0%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		0	0%	0	0%	0	0%	0	0%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		20	2%	59	5%	74	3%	1	1%
Native vegetation		748	75%	418	35%	325	13%	9	4%
Other landuses		10	1%	46	4%	5	0%	0	0%
Plantation		0	0%	0	0%	0	0%	0	0%
Point source		0	0%	1	0%	0	0%	0	0%
Roads & industrial		24	2%	87	7%	10	0%	0	0%
Urban		35	4%	108	9%	217	8%	29	13%
Viticulture & orchards		0	0%	0	0%	0	0%	0	0%
Total: Generated by catchment		997	100%	1 192	100%	2 581	100%	230	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		997	100%	1 192	100%	2 581	100%	230	100%



D.2 Little River

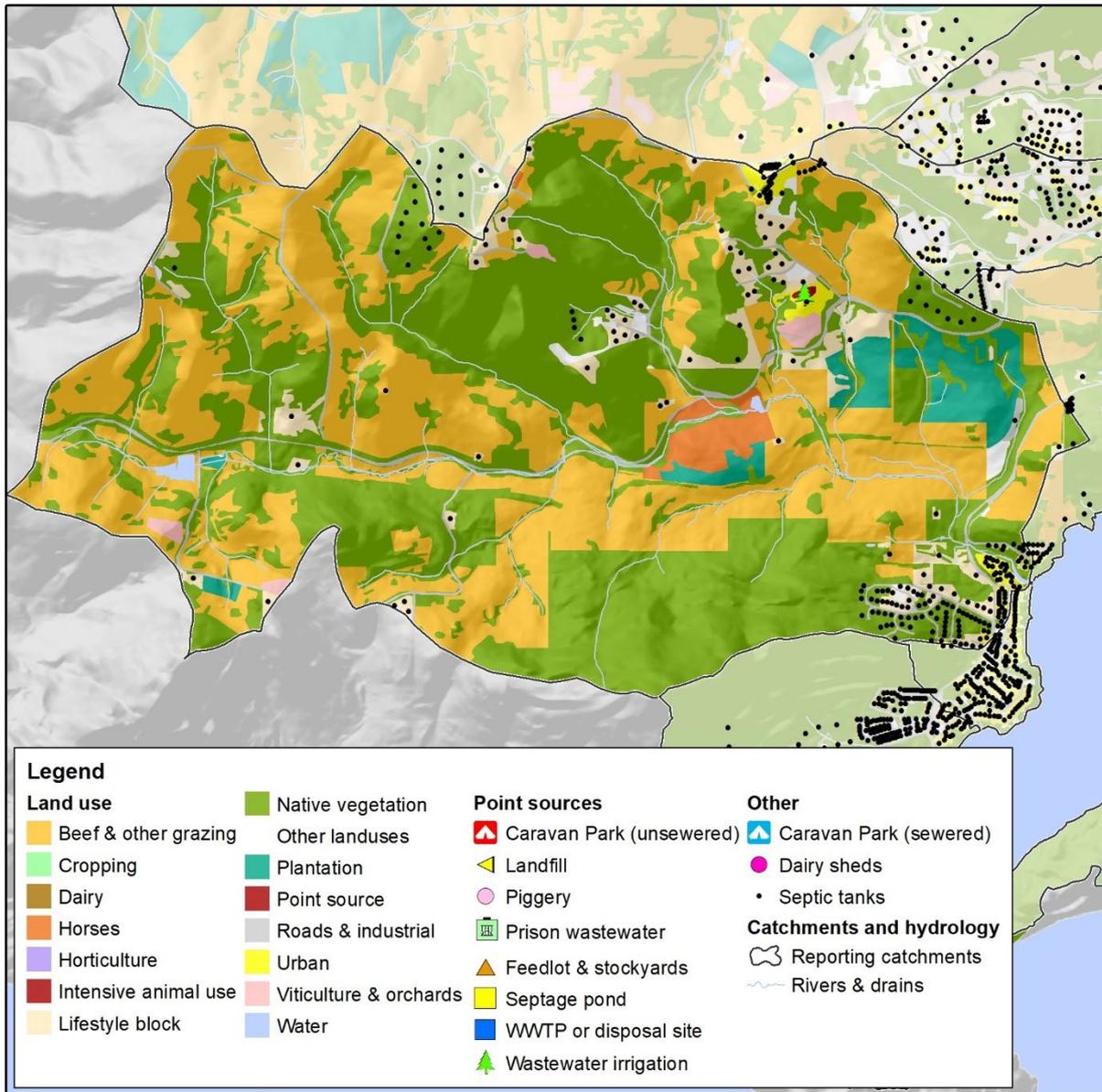
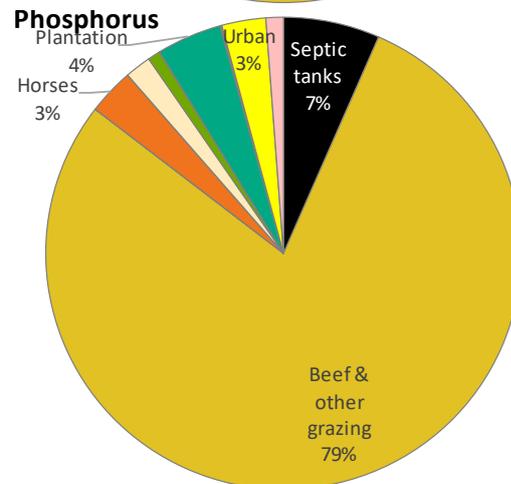
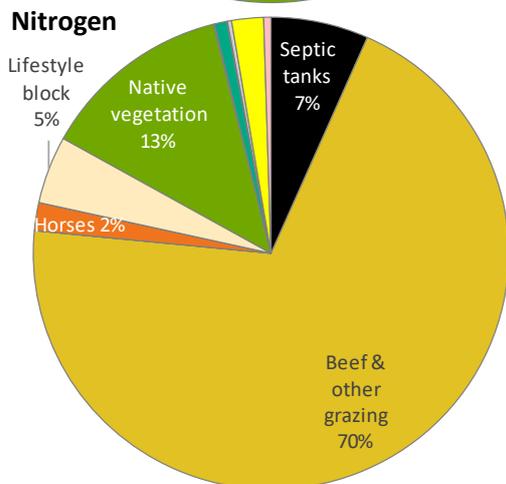
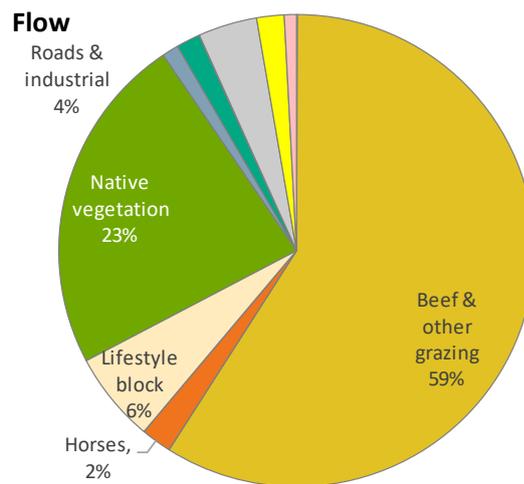
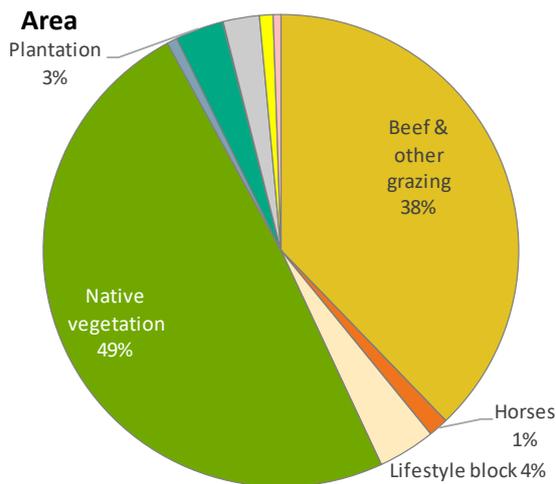


Figure D.2: Land uses of the Little River reporting catchment

Little River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		251	-	4	0%	411	7%	34	7%
Beef & other grazing		1 209	38%	3 591	59%	4 325	70%	415	79%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		0	0%	0	0%	0	0%	0	0%
Horses		43	1%	127	2%	119	2%	17	3%
Horticulture		0	0%	0	0%	0	0%	0	0%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		125	4%	377	6%	287	5%	9	2%
Native vegetation		1 567	49%	1 416	23%	806	13%	4	1%
Other landuses		22	1%	69	1%	5	0%	0	0%
Plantation		105	3%	99	2%	53	1%	23	4%
Point source		1	0%	2	0%	2	0%	0	0%
Roads & industrial		79	2%	244	4%	17	0%	0	0%
Urban		30	1%	114	2%	134	2%	16	3%
Viticulture & orchards		17	1%	50	1%	30	0%	6	1%
Total: Generated by catchment		3 198	100%	6 092	100%	6 188	100%	526	100%
Removal (-) or gain (+)		-		3	0%	0	0%	0	0%
Total: Leaving catchment		3 198	100%	6 096	100%	6 188	100%	526	100%



D.3 Koorabup Creek

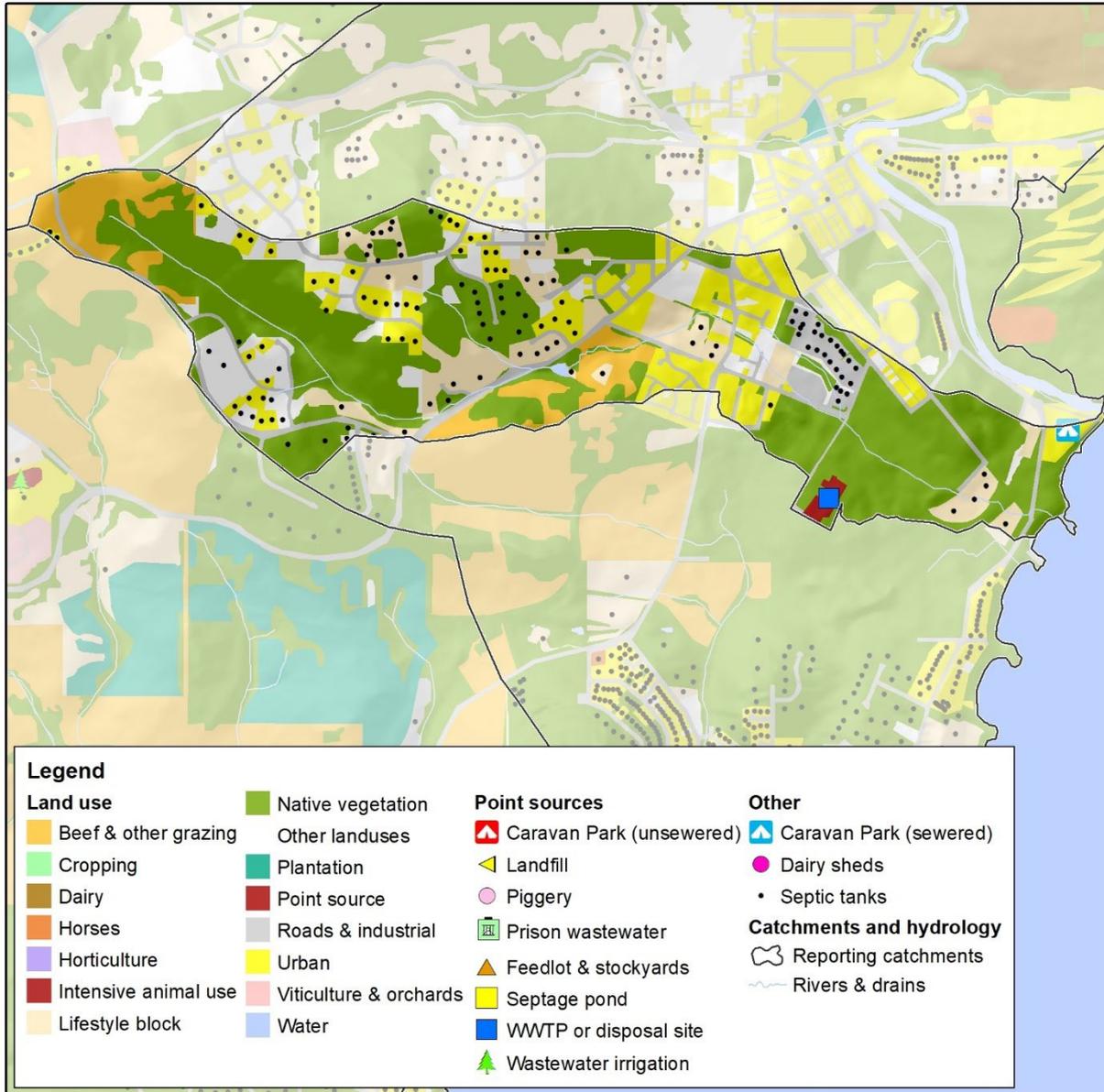
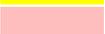
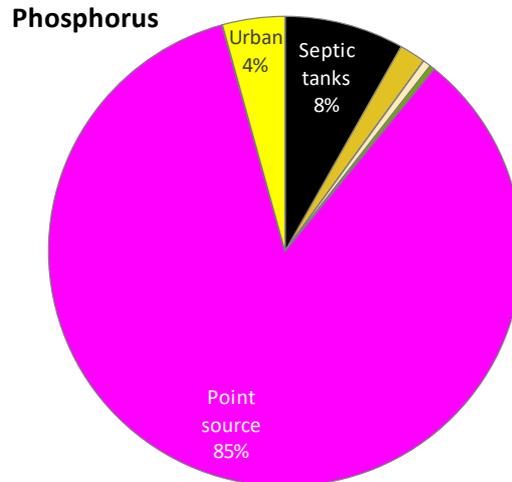
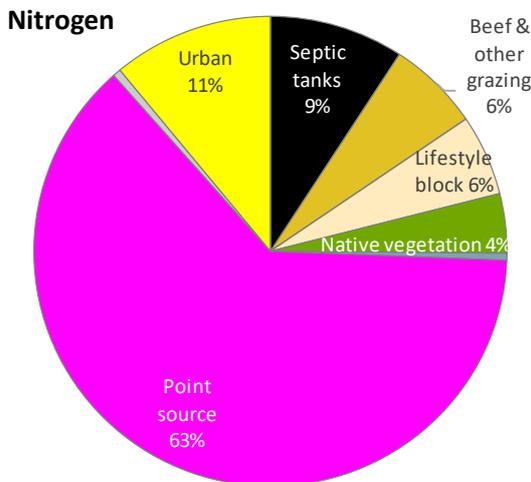
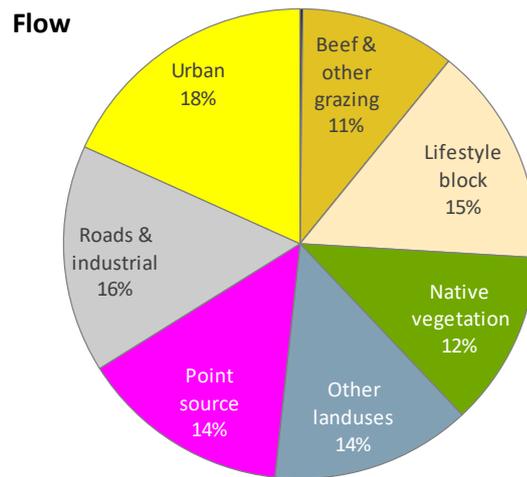
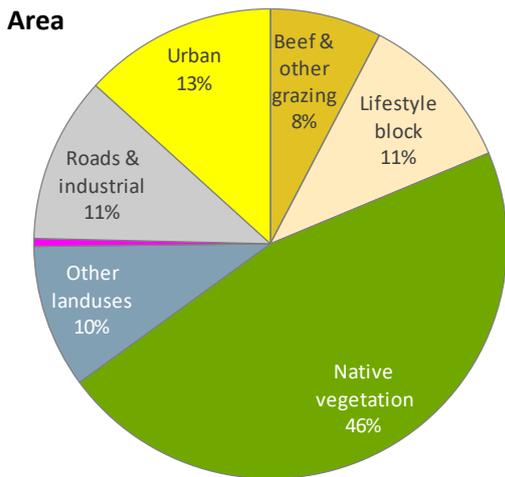


Figure D.3: Land uses of the Koorabup Creek reporting catchment

Koorabup Creek source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		136	-	2	0%	191	9%	11	8%
Beef & other grazing		29	8%	111	11%	131	6%	2	2%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		0	0%	0	0%	0	0%	0	0%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		0	0%	0	0%	0	0%	0	0%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		41	11%	157	15%	115	6%	1	1%
Native vegetation		173	46%	125	12%	85	4%	0	0%
Other landuses		37	10%	142	14%	10	0%	0	0%
Plantation		0	0%	0	0%	0	0%	0	0%
Point source		2	1%	149	14%	1 305	63%	113	85%
Roads & industrial		43	11%	163	16%	11	1%	0	0%
Urban		49	13%	189	18%	228	11%	6	4%
Viticulture & orchards		0	0%	0	0%	0	0%	0	0%
Total: Generated by catchment		374	100%	1 039	100%	2 077	100%	133	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		374	100%	1 039	100%	2 077	100%	133	100%



D.4 Lower Denmark

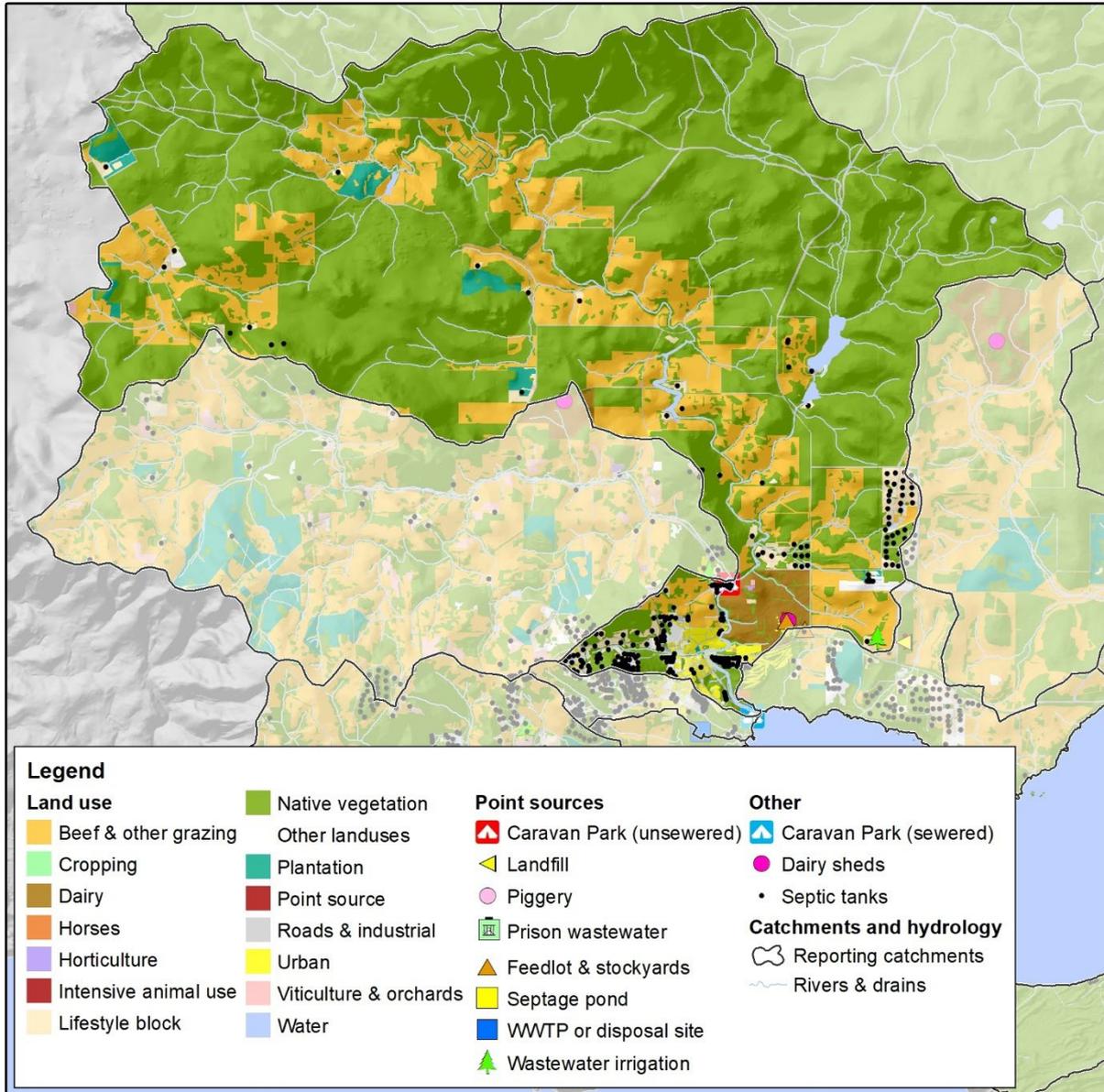
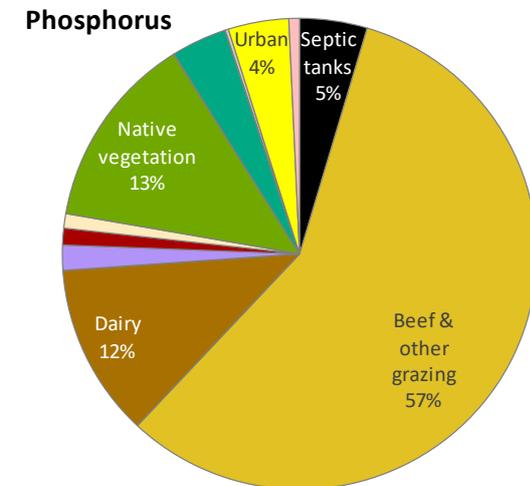
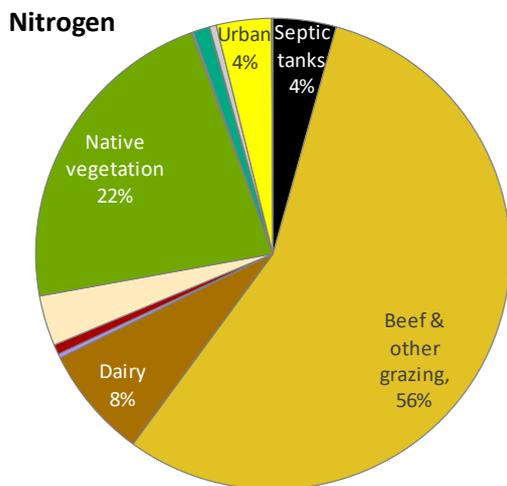
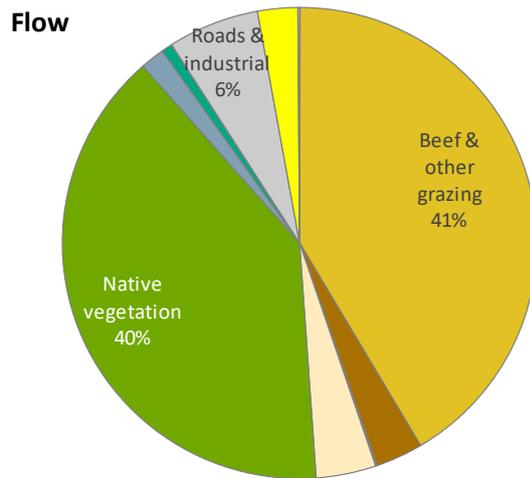
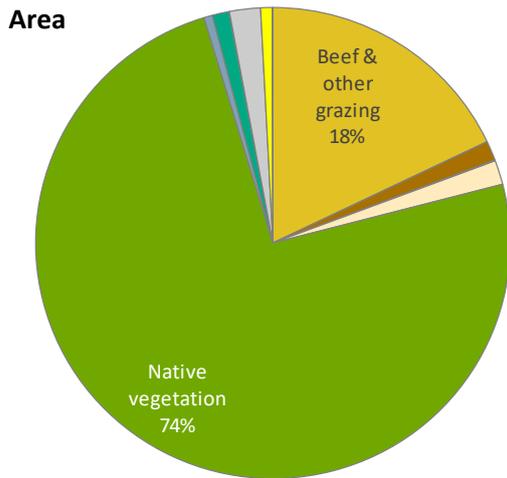


Figure D.4: Land uses of the Lower Denmark reporting catchment

Lower Denmark River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		293	-	3	0%	335	4%	10	5%
Beef & other grazing		2 869	18%	3 726	41%	4 340	56%	120	57%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		217	1%	291	3%	597	8%	25	12%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		2	0%	3	0%	21	0%	4	2%
Intensive animal use		5	0%	5	0%	52	1%	2	1%
Lifestyle block		266	2%	367	4%	269	3%	2	1%
Native vegetation		11 893	74%	3 564	40%	1 736	22%	28	13%
Other landuses		93	1%	148	2%	11	0%	0	0%
Plantation		186	1%	68	1%	87	1%	8	4%
Point source		1	0%	0	0%	1	0%	0	0%
Roads & industrial		338	2%	559	6%	36	0%	0	0%
Urban		126	1%	246	3%	292	4%	9	4%
Viticulture & orchards		8	0%	10	0%	7	0%	2	1%
Total: Generated by catchment		16 002	100%	8 992	100%	7 785	100%	209	100%
Removal (-) or gain (+)		-		- 601	-7%	- 294	-4%	- 9	-4%
Total: Leaving catchment		16 002	100%	8 391	93%	7 491	96%	200	96%



D.5 Upper Denmark

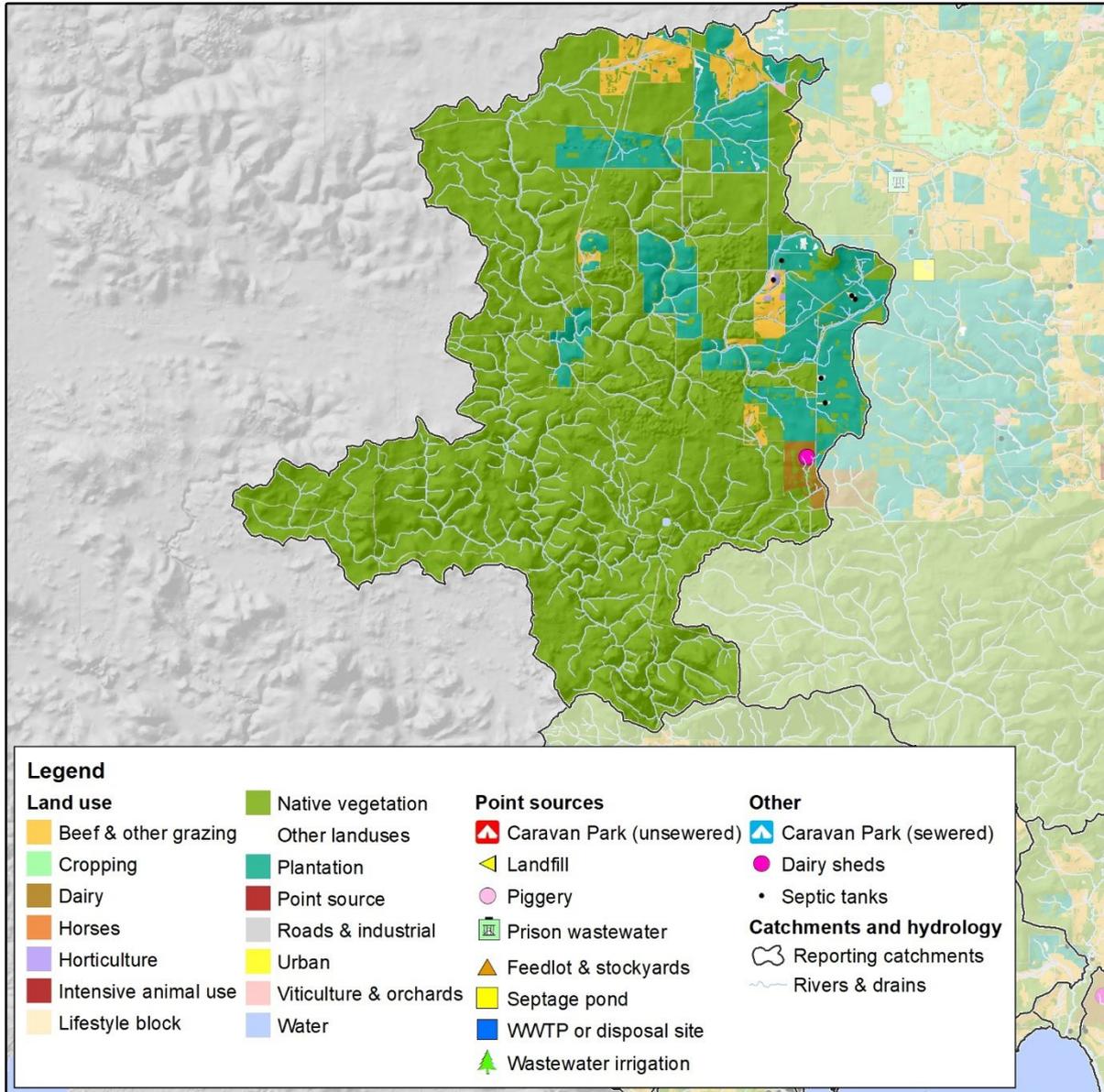
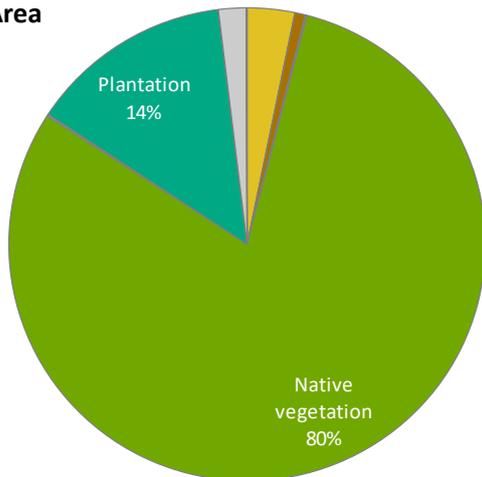


Figure D.5: Land uses of the Upper Denmark reporting catchment

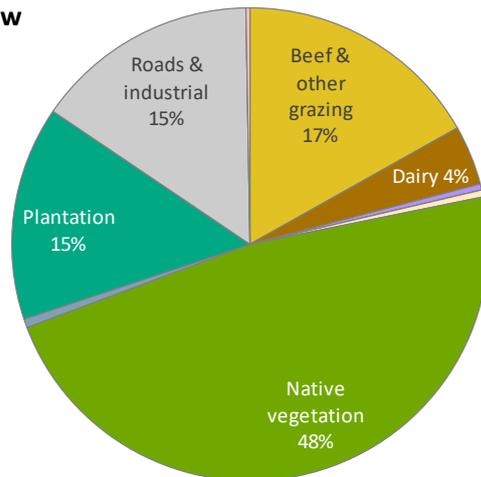
Upper Denmark River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		6	-	0	0%	0	0%	0	0%
Beef & other grazing		1 432	3%	900	17%	1 383	30%	15	11%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		314	1%	218	4%	674	15%	32	23%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		24	0%	22	0%	271	6%	5	3%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		26	0%	25	0%	28	1%	0	0%
Native vegetation		35 564	80%	2 541	48%	1 235	27%	22	15%
Other landuses		53	0%	32	1%	3	0%	0	0%
Plantation		6 131	14%	783	15%	958	21%	66	47%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		829	2%	814	15%	82	2%	1	1%
Urban		0	0%	0	0%	0	0%	0	0%
Viticulture & orchards		27	0%	15	0%	3	0%	0	0%
Total: Generated by catchment		44 399	100%	5 350	100%	4 639	100%	141	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		44 399	100%	5 350	100%	4 639	100%	141	100%

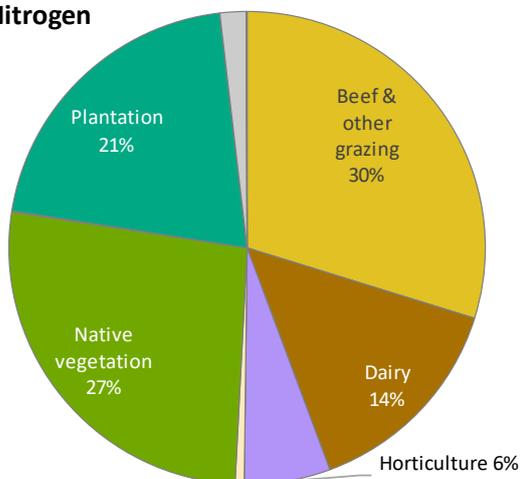
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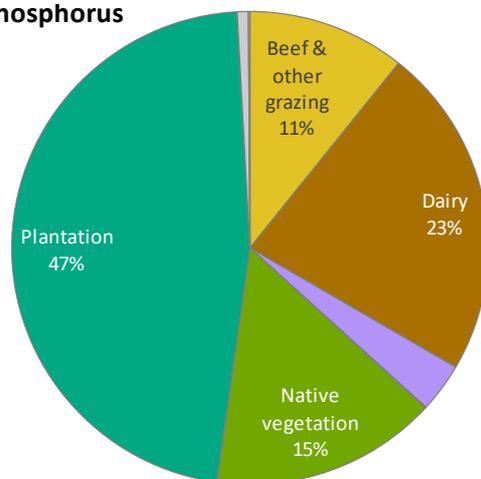
Flow



Nitrogen



Phosphorus



D.6 Scotsdale Brook

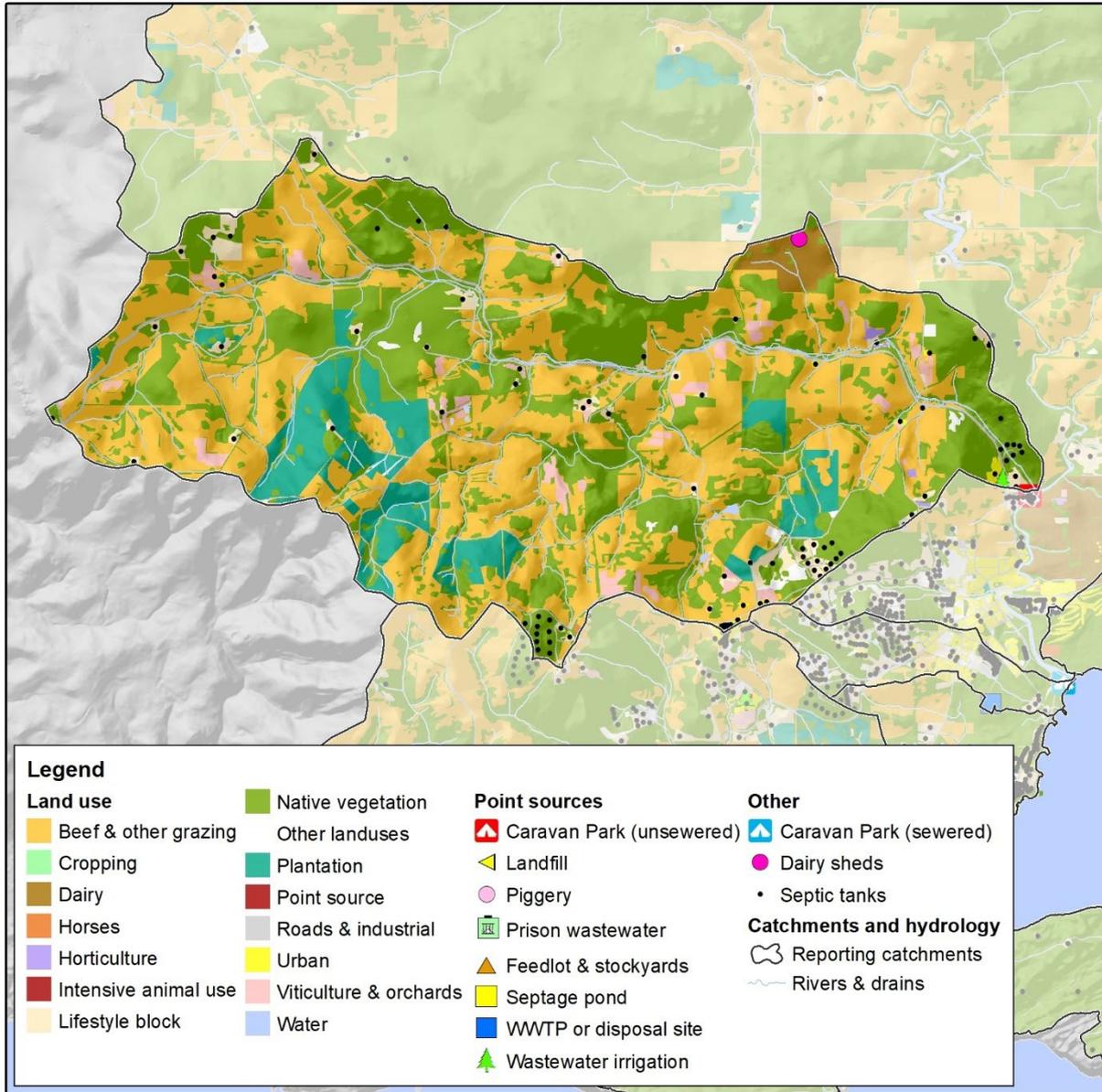
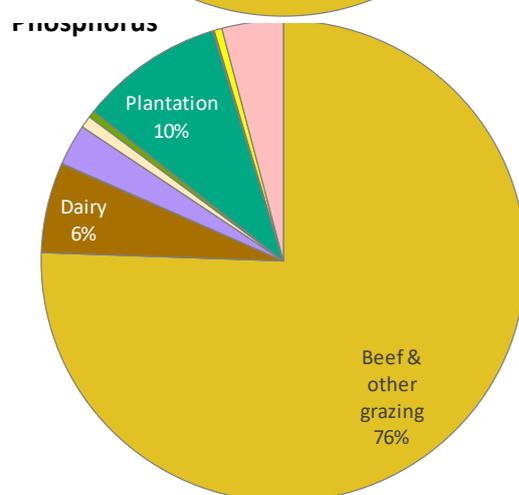
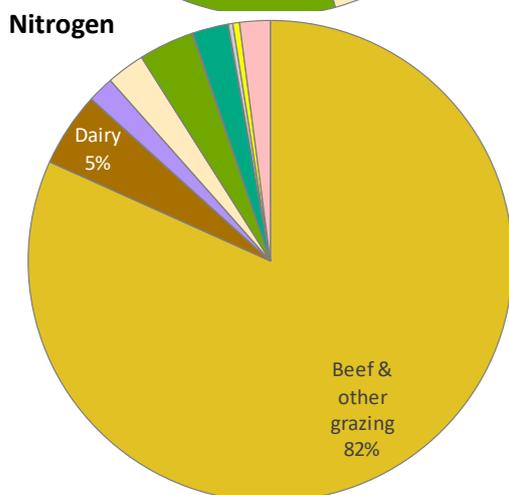
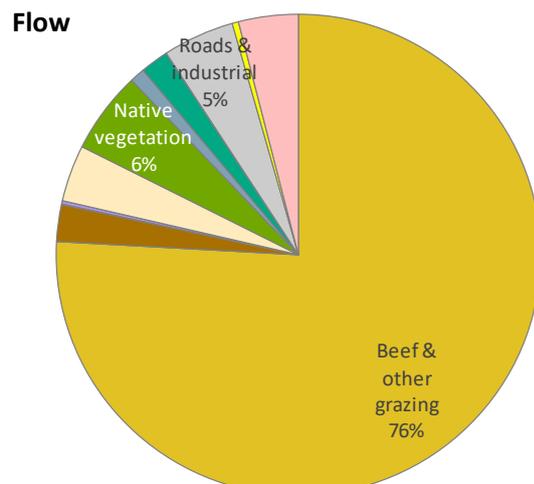
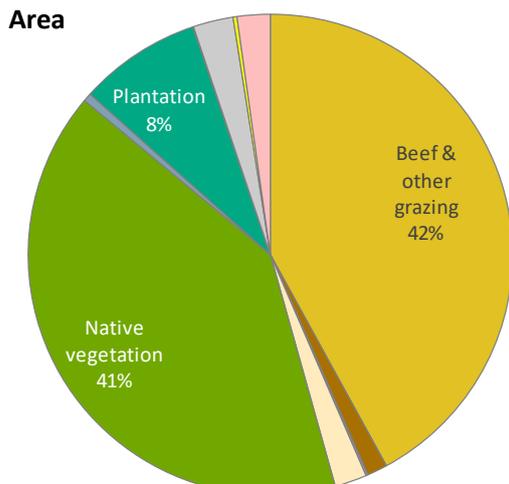


Figure D.6: Land uses of the Scotsdale Brook reporting catchment

Scotsdale Brook source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		100	-	0	0%	0	0%	0	0%
Beef & other grazing		2 786	42%	8 442	76%	9 526	82%	369	76%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		89	1%	276	2%	579	5%	30	6%
Horses		1	0%	4	0%	3	0%	0	0%
Horticulture		8	0%	25	0%	204	2%	14	3%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		142	2%	423	4%	297	3%	4	1%
Native vegetation		2 677	40%	613	6%	430	4%	2	0%
Other landuses		37	1%	111	1%	7	0%	0	0%
Plantation		543	8%	210	2%	277	2%	47	10%
Point source		2	0%	1	0%	2	0%	0	0%
Roads & industrial		177	3%	532	5%	35	0%	0	0%
Urban		17	0%	47	0%	52	0%	3	1%
Viticulture & orchards		146	2%	443	4%	237	2%	20	4%
Total: Generated by catchment		6 626	100%	11 126	100%	11 651	100%	488	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		6 626	100%	11 126	100%	11 651	100%	488	100%



D.7 Foreshore

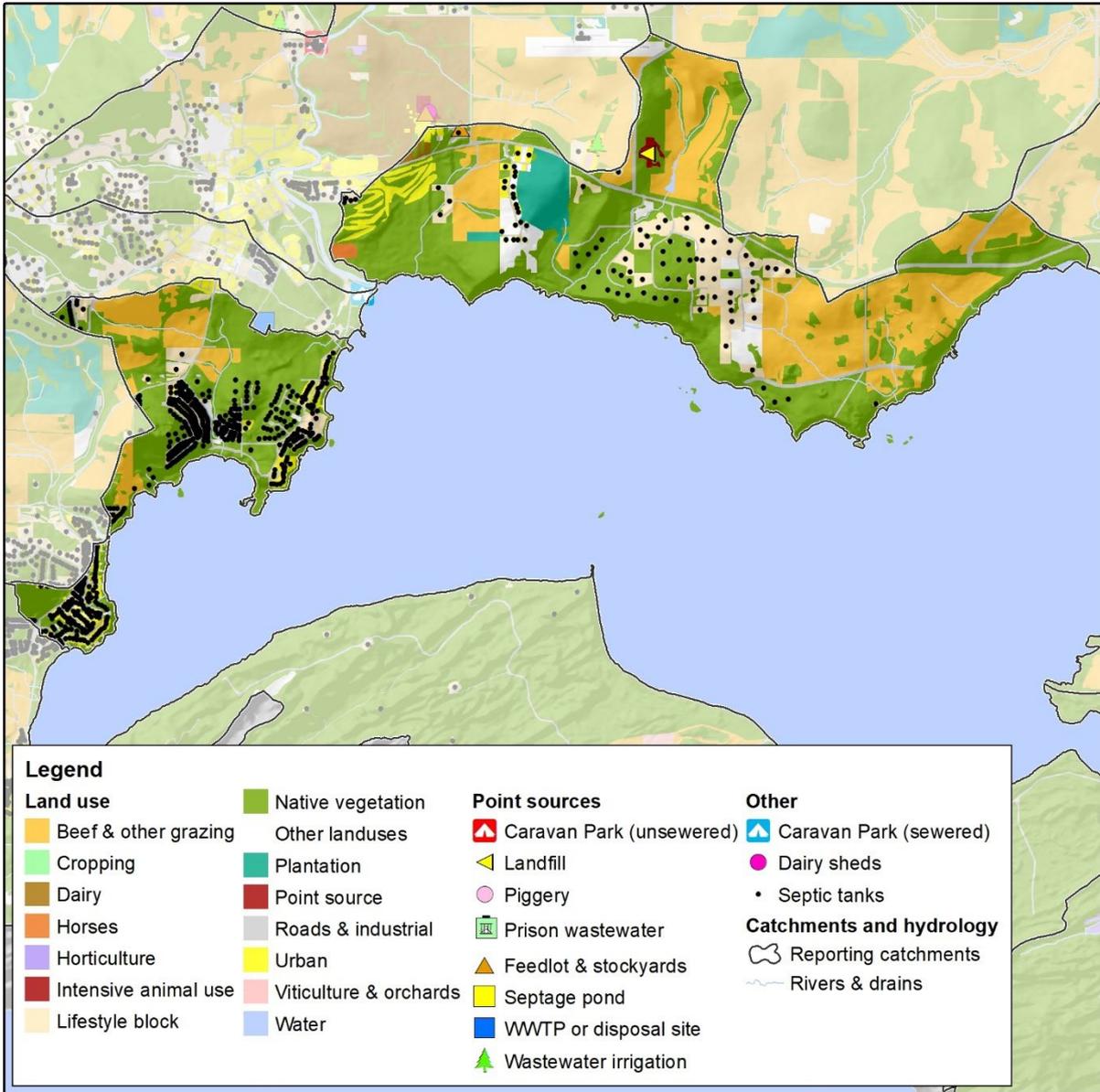
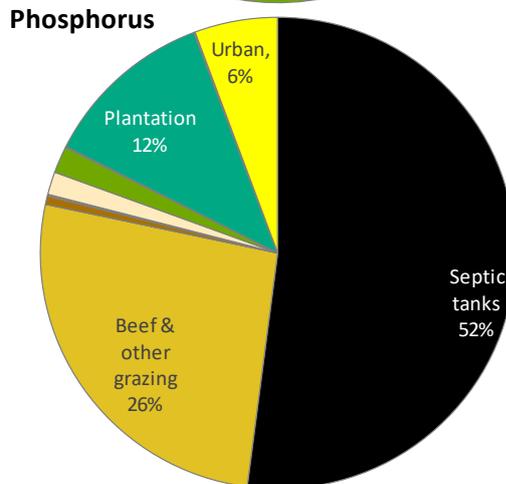
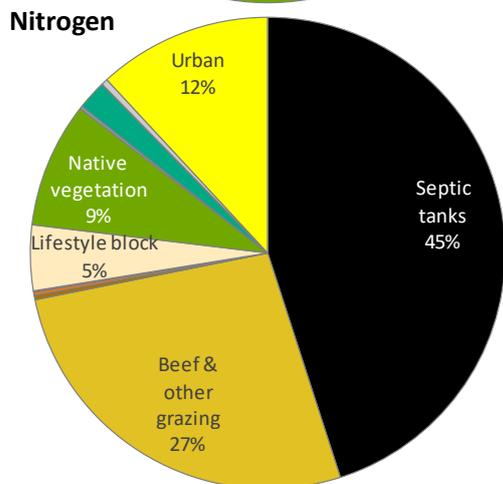
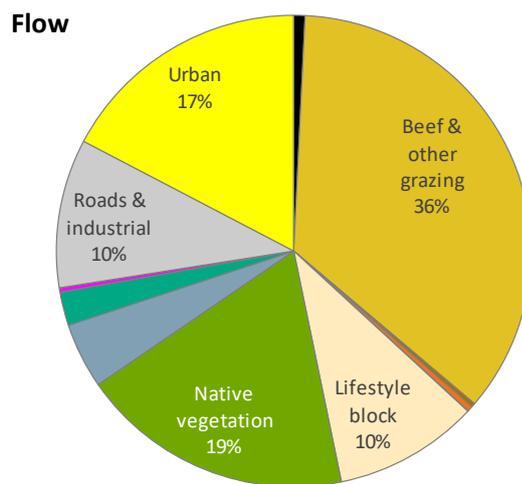
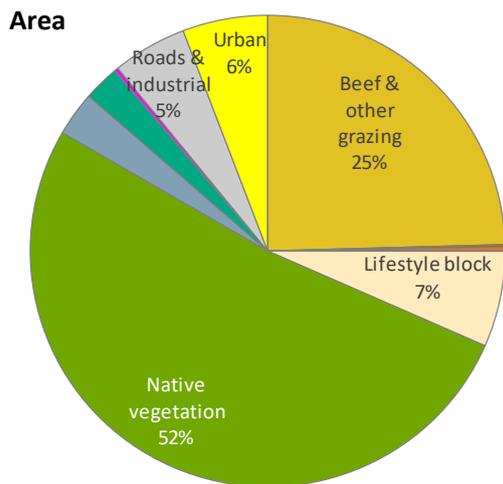


Figure D.7: Land uses of the Foreshore reporting catchment

Foreshore source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		688	-	18	1%	1 747	45%	105	52%
Beef & other grazing		490	25%	831	35%	1 038	27%	53	26%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		4	0%	6	0%	11	0%	1	1%
Horses		5	0%	9	0%	9	0%	0	0%
Horticulture		0	0%	0	0%	0	0%	0	0%
Intensive animal use		0	0%	0	0%	3	0%	0	0%
Lifestyle block		131	7%	232	10%	174	4%	3	2%
Native vegetation		1 034	52%	437	19%	333	9%	4	2%
Other landuses		61	3%	105	4%	8	0%	0	0%
Plantation		49	2%	54	2%	77	2%	24	12%
Point source		5	0%	7	0%	0	0%	0	0%
Roads & industrial		102	5%	239	10%	17	0%	0	0%
Urban		116	6%	405	17%	460	12%	11	6%
Viticulture & orchards		0	0%	0	0%	0	0%	0	0%
Total: Generated by catchment		1 996	100%	2 344	100%	3 878	100%	202	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		1 996	100%	2 344	100%	3 878	100%	202	100%



D.8 Sunny Glen Creek

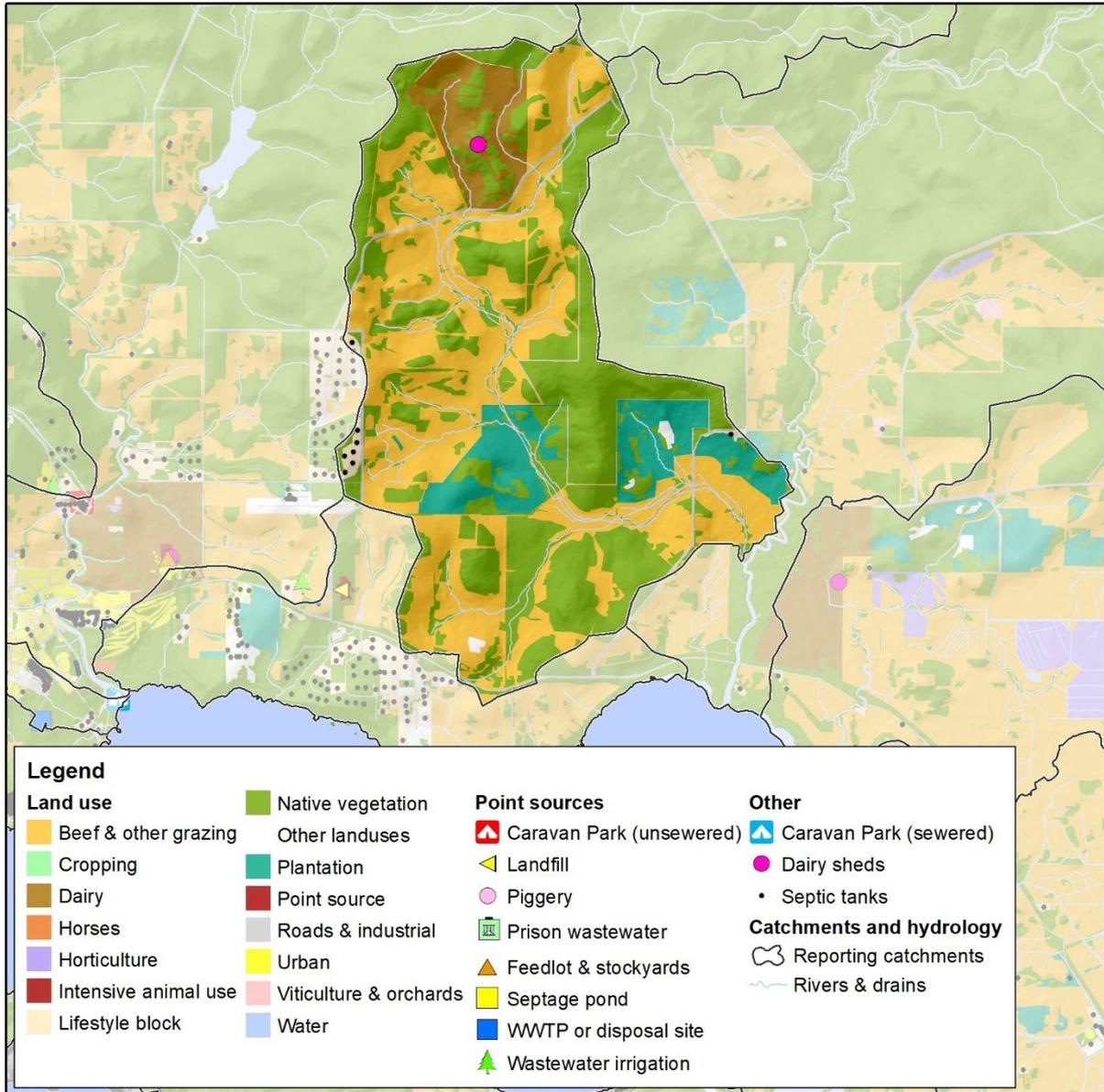
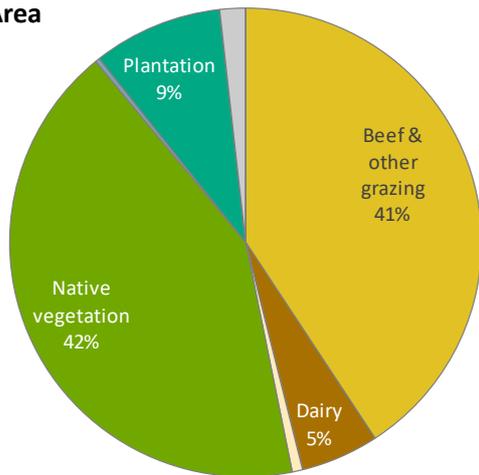


Figure D.8: Land uses of the Sunny Glen Creek reporting catchment

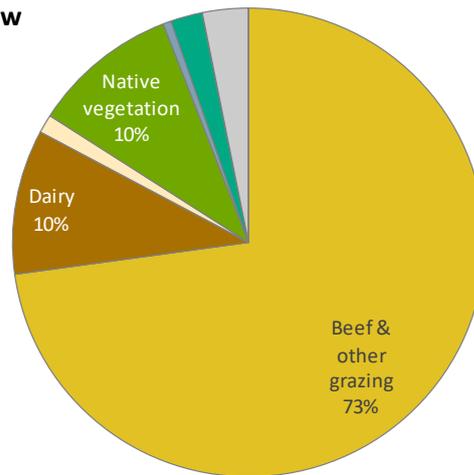
Sunny Glen Creek source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		8	-	0	0%	0	0%	0	0%
Beef & other grazing		1 457	41%	1 536	73%	3 156	72%	477	69%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		192	5%	211	10%	900	21%	142	21%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		0	0%	0	0%	0	0%	0	0%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		25	1%	27	1%	34	1%	0	0%
Native vegetation		1 509	42%	211	10%	155	4%	4	1%
Other landuses		11	0%	12	1%	1	0%	0	0%
Plantation		318	9%	46	2%	124	3%	64	9%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		63	2%	66	3%	8	0%	0	0%
Urban		0	0%	0	0%	0	0%	0	0%
Viticulture & orchards		0	0%	0	0%	0	0%	0	0%
Total: Generated by catchment		3 575	100%	2 109	100%	4 379	100%	687	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		3 575	100%	2 109	100%	4 379	100%	687	100%

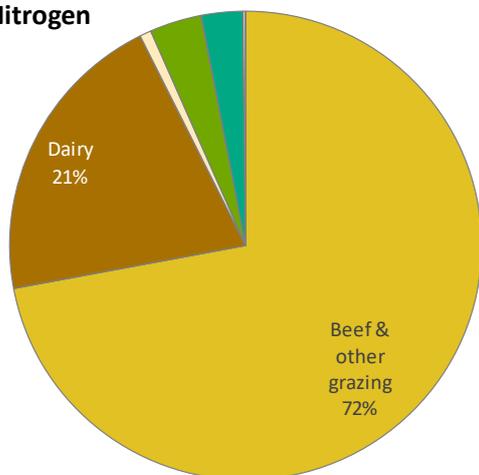
Area



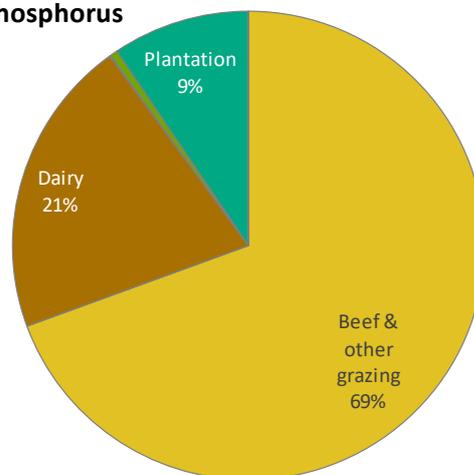
Flow



Nitrogen



Phosphorus



D.9 Lower Hay River

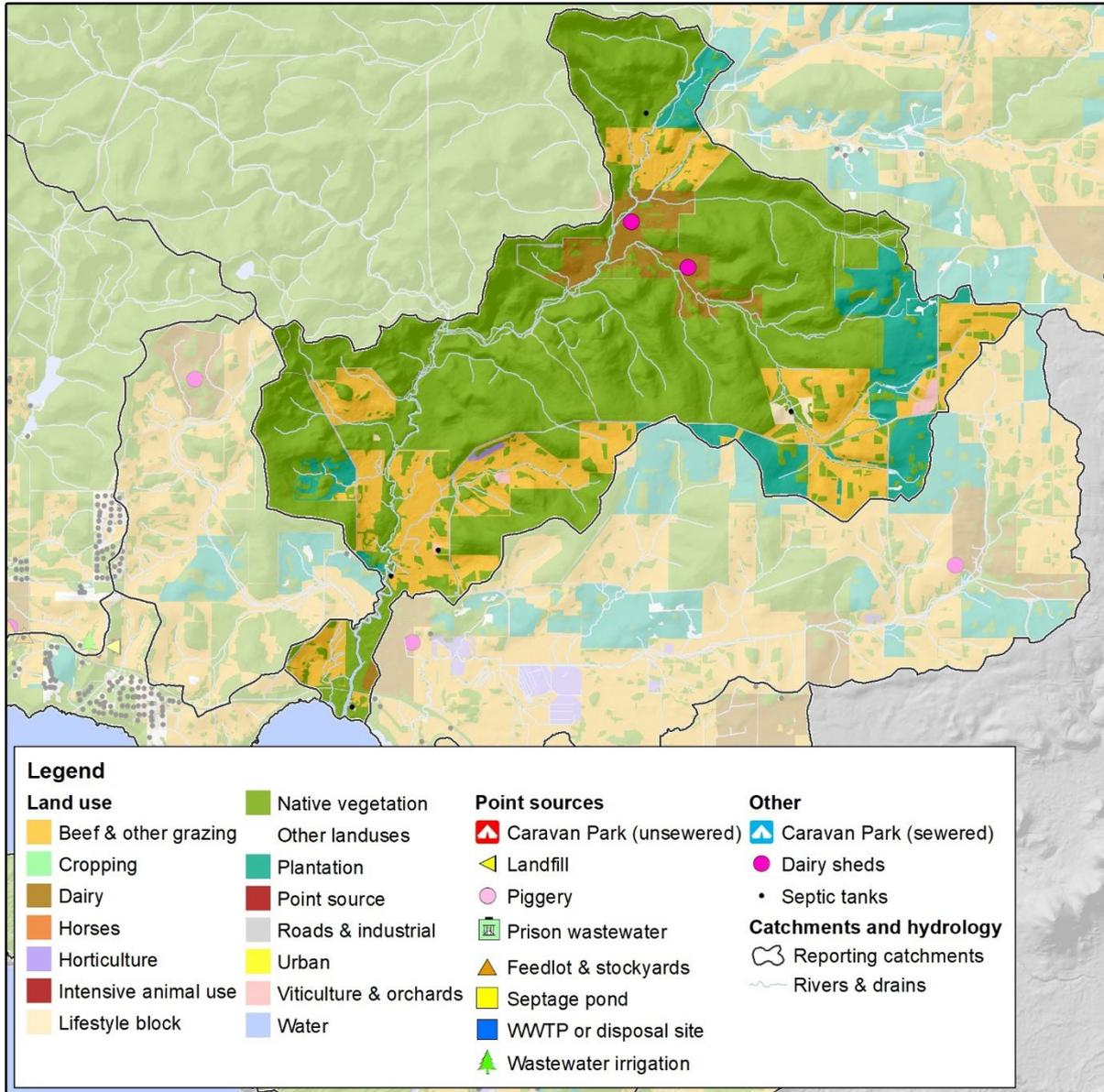
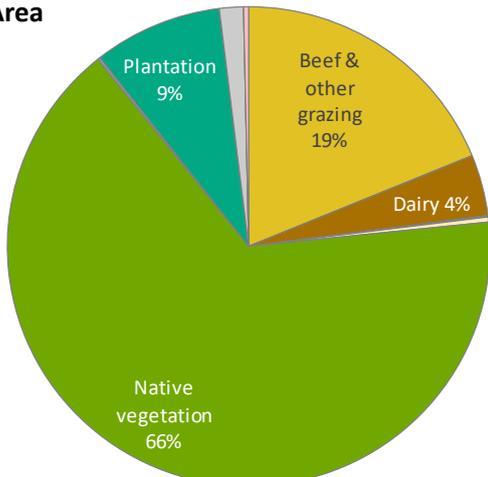


Figure D.9: Land uses of the Lower Hay River reporting catchment

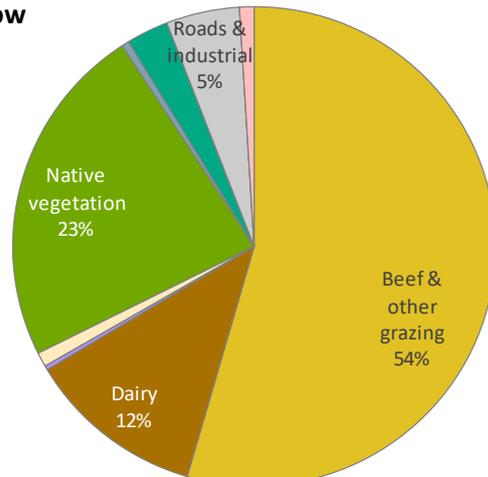
Lower Hay River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		5	-	0	0%	0	0%	0	0%
Beef & other grazing		2 290	19%	2 341	54%	3 486	65%	374	67%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		501	4%	512	12%	914	17%	79	14%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		11	0%	12	0%	183	3%	63	11%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		41	0%	42	1%	28	1%	1	0%
Native vegetation		8 012	66%	995	23%	544	10%	15	3%
Other landuses		22	0%	21	0%	1	0%	0	0%
Plantation		1 048	9%	121	3%	176	3%	25	4%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		196	2%	211	5%	16	0%	0	0%
Urban		0	0%	0	0%	0	0%	0	0%
Viticulture & orchards		41	0%	42	1%	33	1%	6	1%
Total: Generated by catchment		12 162	100%	4 298	100%	5 382	100%	563	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		12 162	100%	4 298	100%	5 382	100%	563	100%

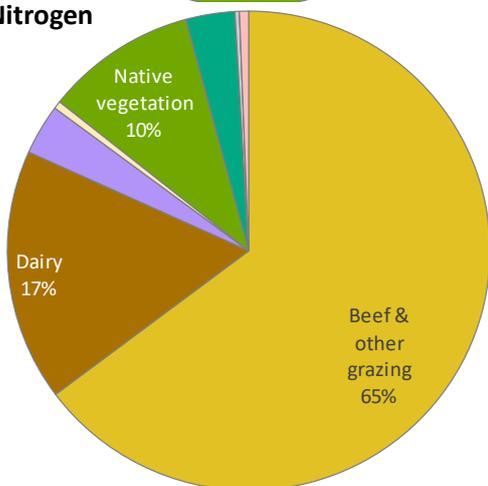
Area



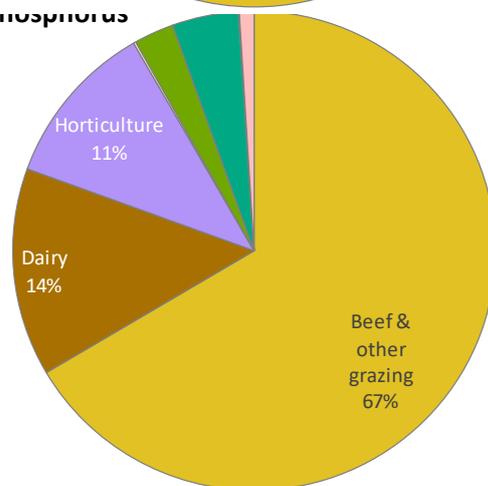
Flow



Nitrogen



Phosphorus



D.10 Upper Hay River

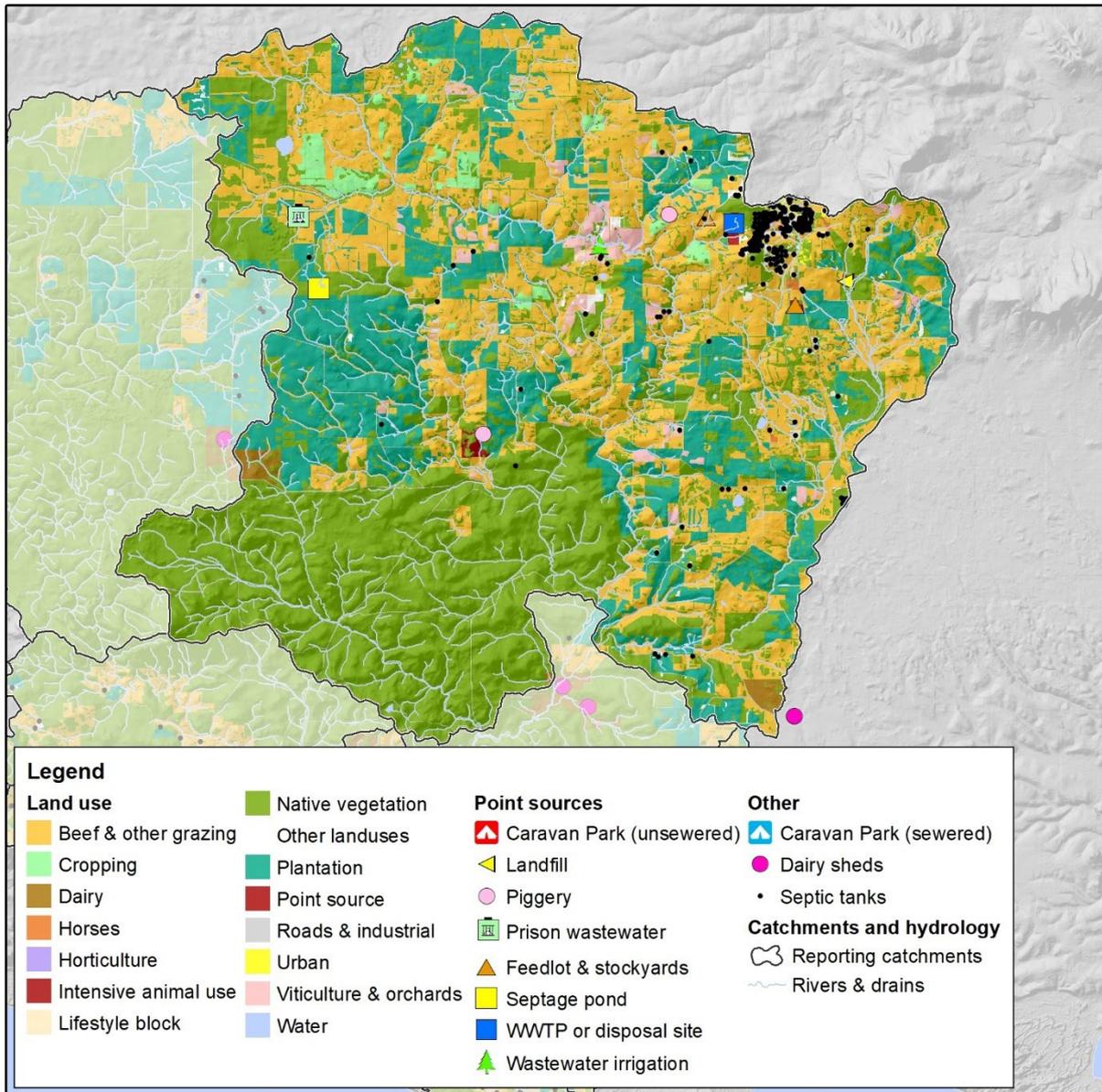
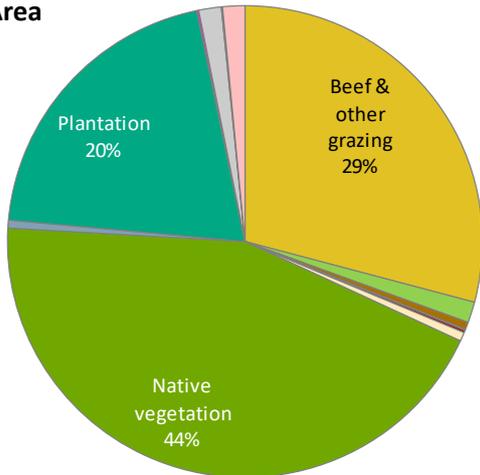


Figure D.10: Land uses of the Upper Hay River reporting catchment

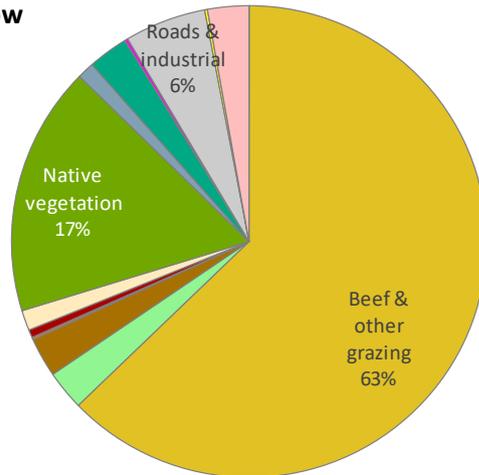
Upper Hay River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		327	-	4	0%	378	2%	22	5%
Beef & other grazing		32 698	29%	13 378	63%	14 973	73%	293	62%
Cropping		1 601	1%	578	3%	310	2%	4	1%
Dairy		568	1%	573	3%	776	4%	11	2%
Horses		71	0%	31	0%	31	0%	1	0%
Horticulture		10	0%	4	0%	35	0%	1	0%
Intensive animal use		181	0%	116	1%	486	2%	9	2%
Lifestyle block		687	1%	295	1%	222	1%	2	0%
Native vegetation		49 342	44%	3 643	17%	1 573	8%	21	4%
Other landuses		609	1%	247	1%	17	0%	0	0%
Plantation		22 763	20%	585	3%	945	5%	78	17%
Point source		145	0%	45	0%	180	1%	11	2%
Roads & industrial		1 717	2%	1 182	6%	203	1%	5	1%
Urban		97	0%	41	0%	47	0%	1	0%
Viticulture & orchards		1 693	2%	598	3%	385	2%	14	3%
Total: Generated by catchment		112 181	100%	21 318	100%	20 561	100%	472	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		112 181	100%	21 318	100%	20 561	100%	472	100%

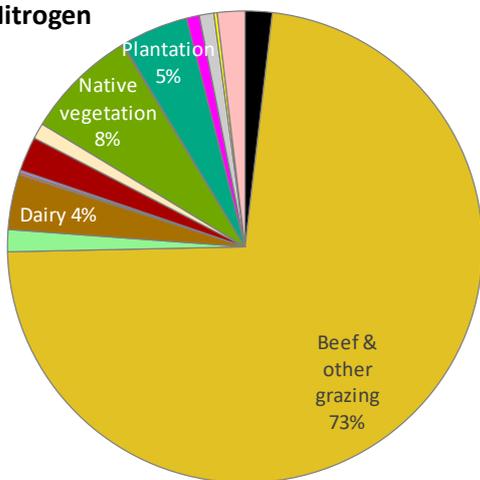
Area



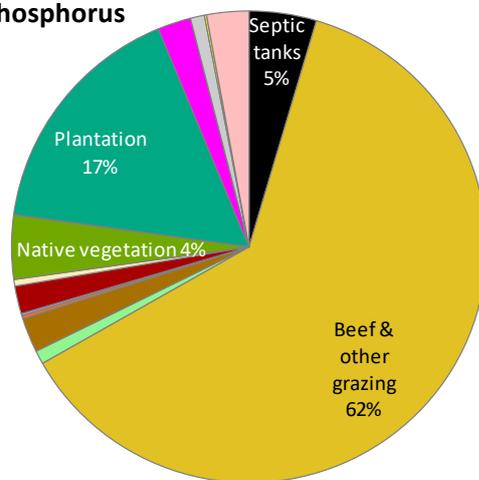
Flow



Nitrogen



Phosphorus



D.11 Sleeman River

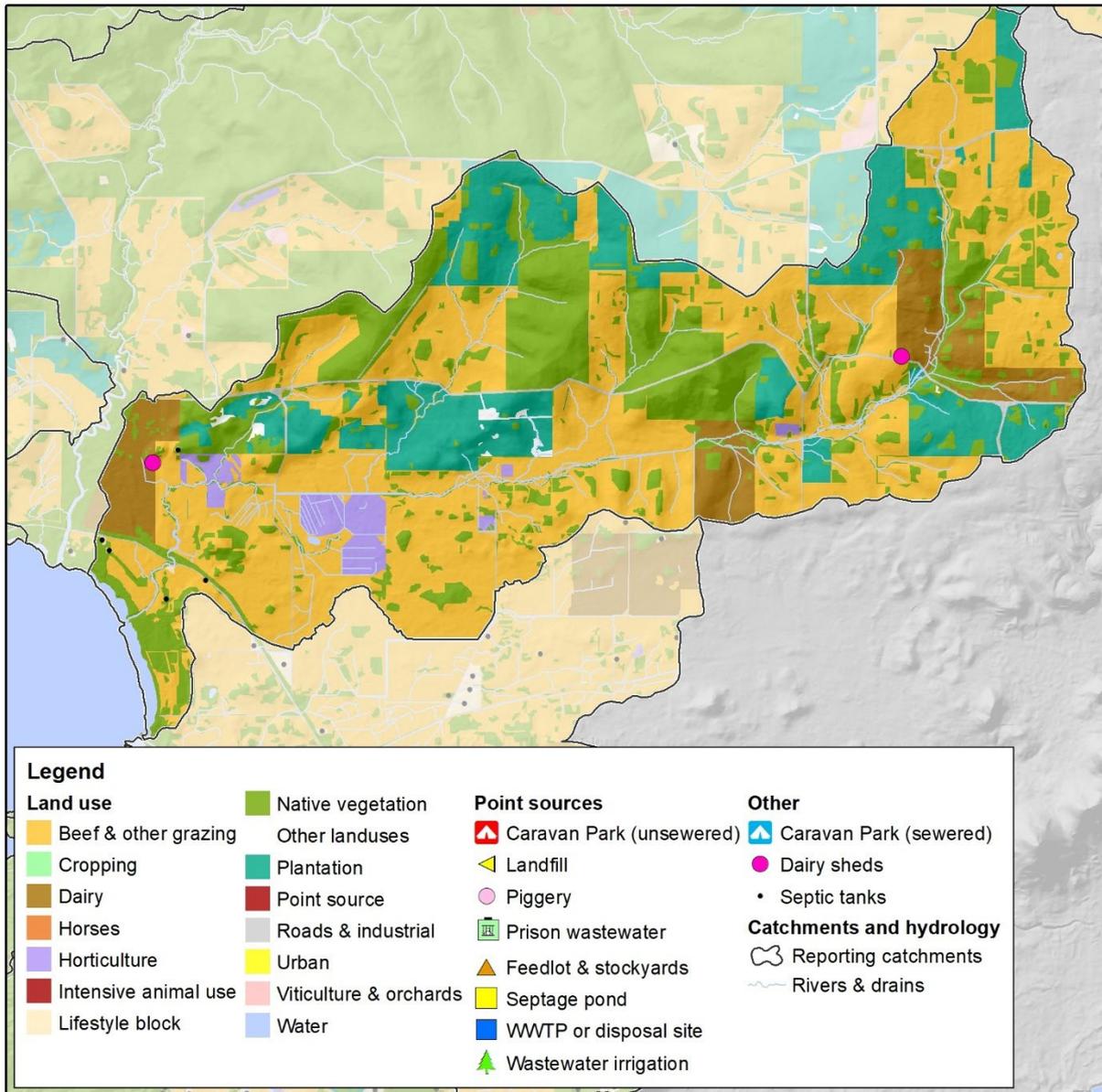
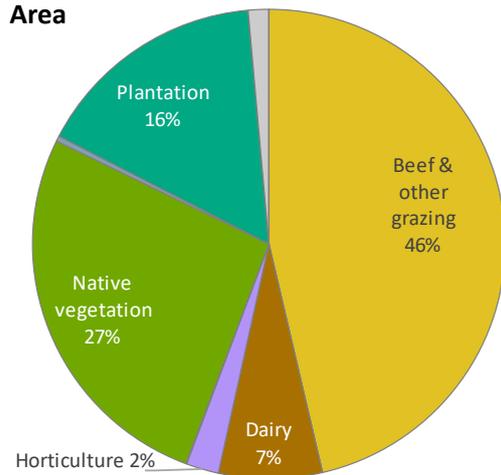


Figure D.11: Land uses of the Sleeman River reporting catchment

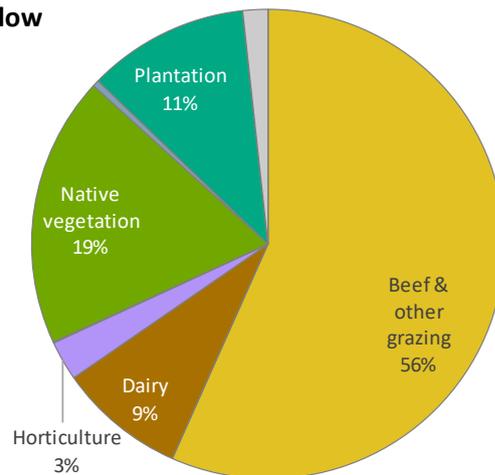
Sleeman River source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		5	-	0	0%	0	0%	0	0%
Beef & other grazing		4 374	46%	5 231	57%	11 049	68%	1 110	53%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		668	7%	804	9%	2 928	18%	436	21%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		211	2%	252	3%	644	4%	303	14%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		5	0%	6	0%	7	0%	0	0%
Native vegetation		2 501	27%	1 722	19%	1 128	7%	28	1%
Other landuses		35	0%	42	0%	5	0%	0	0%
Plantation		1 509	16%	1 021	11%	451	3%	220	10%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		132	1%	158	2%	20	0%	1	0%
Urban		0	0%	0	0%	0	0%	0	0%
Viticulture & orchards		0	0%	0	0%	0	0%	0	0%
Total: Generated by catchment		9 435	100%	9 236	100%	16 232	100%	2 097	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		9 435	100%	9 236	100%	16 232	100%	2 097	100%

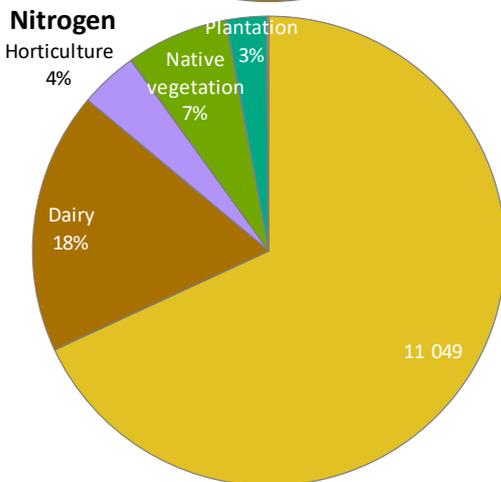
Area



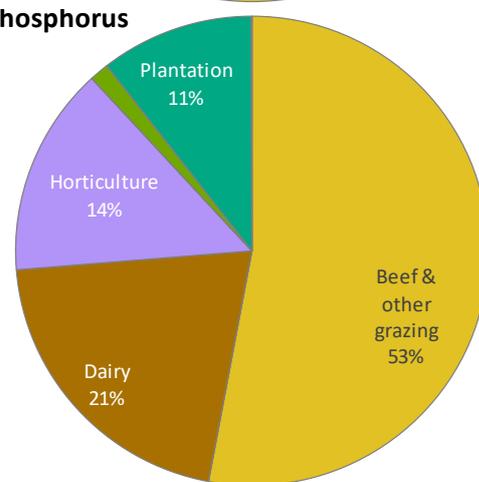
Flow



Nitrogen



Phosphorus



D.12 Cuppup Creek

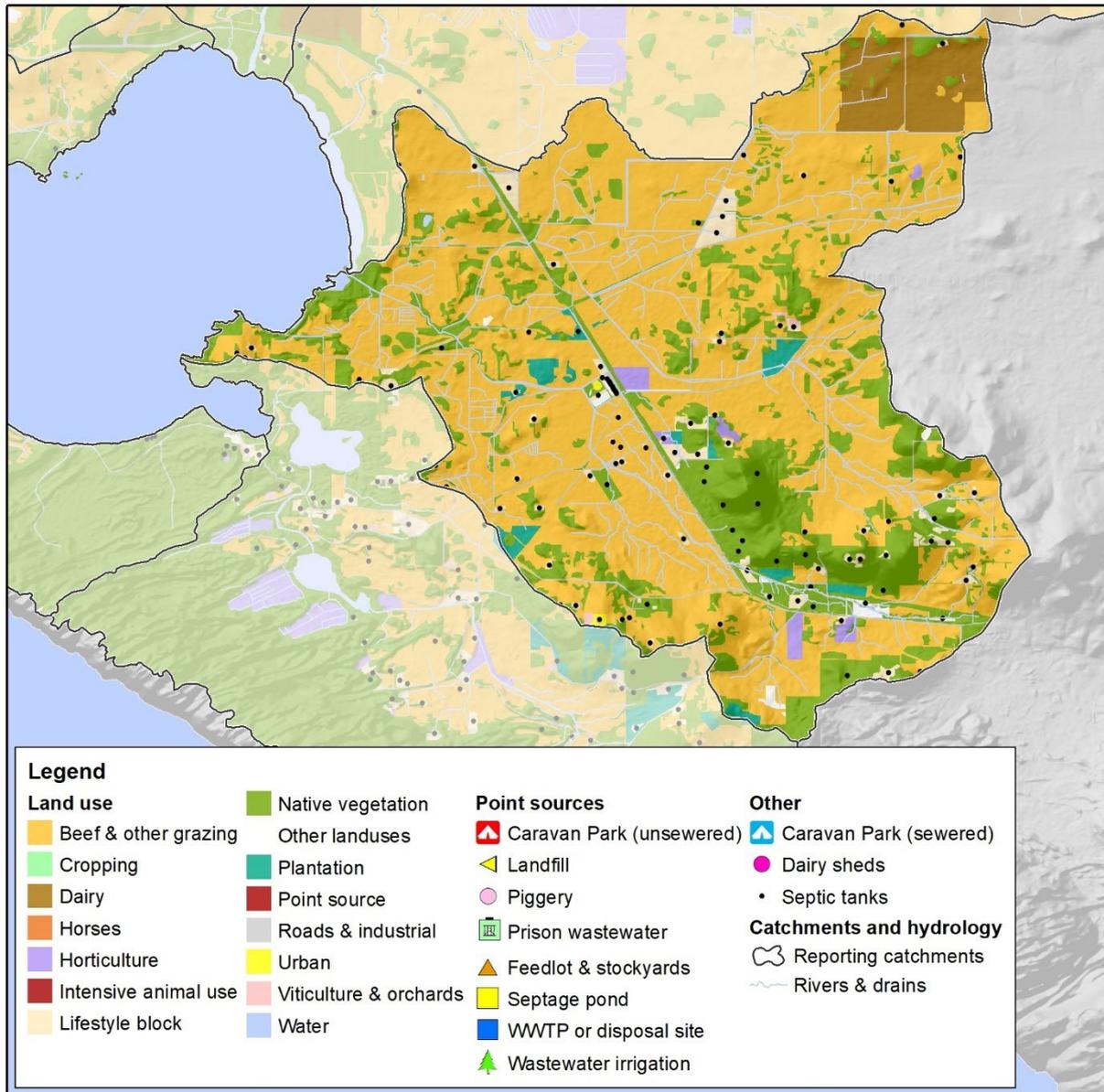
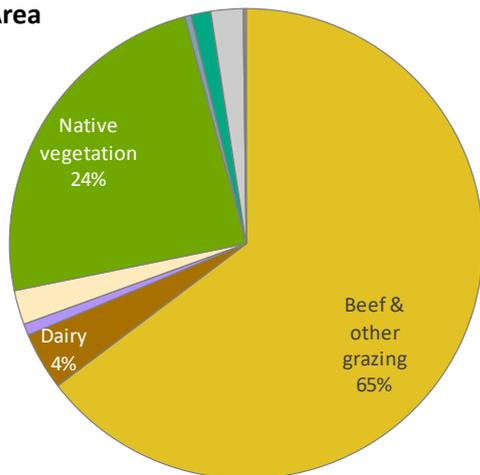


Figure D.12: Land uses of the Cuppup Creek reporting catchment

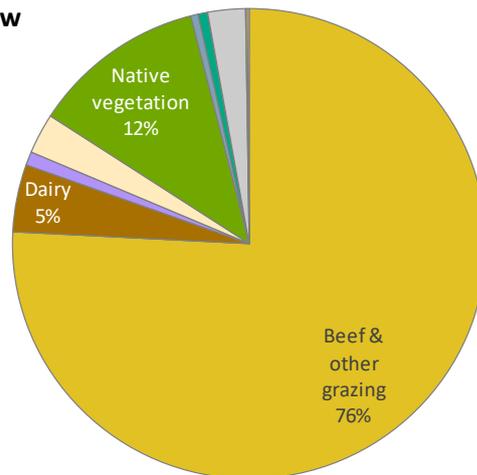
Cuppup Creek source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		109	-	0	0%	0	0%	0	0%
Beef & other grazing		4 461	65%	7 735	76%	15 389	81%	2 201	78%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		274	4%	473	5%	1 472	8%	239	9%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		54	1%	95	1%	790	4%	310	11%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		162	2%	282	3%	349	2%	17	1%
Native vegetation		1 658	24%	1 213	12%	958	5%	7	0%
Other landuses		30	0%	52	1%	6	0%	0	0%
Plantation		94	1%	66	1%	35	0%	23	1%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		151	2%	262	3%	31	0%	1	0%
Urban		7	0%	12	0%	23	0%	4	0%
Viticulture & orchards		7	0%	13	0%	3	0%	2	0%
Total: Generated by catchment		6 899	100%	10 204	100%	19 056	100%	2 804	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		6 899	100%	10 204	100%	19 056	100%	2 804	100%

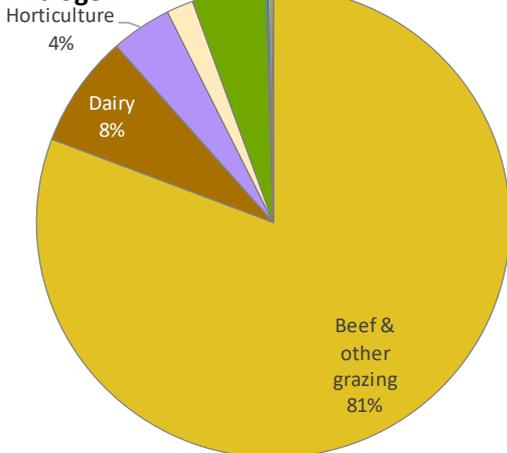
Area



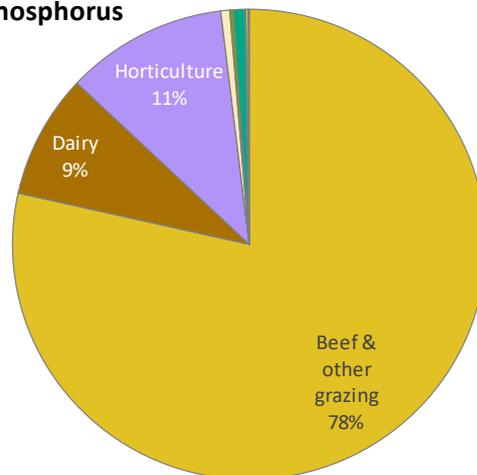
Flow



Nitrogen



Phosphorus



D.13 Lake Saide

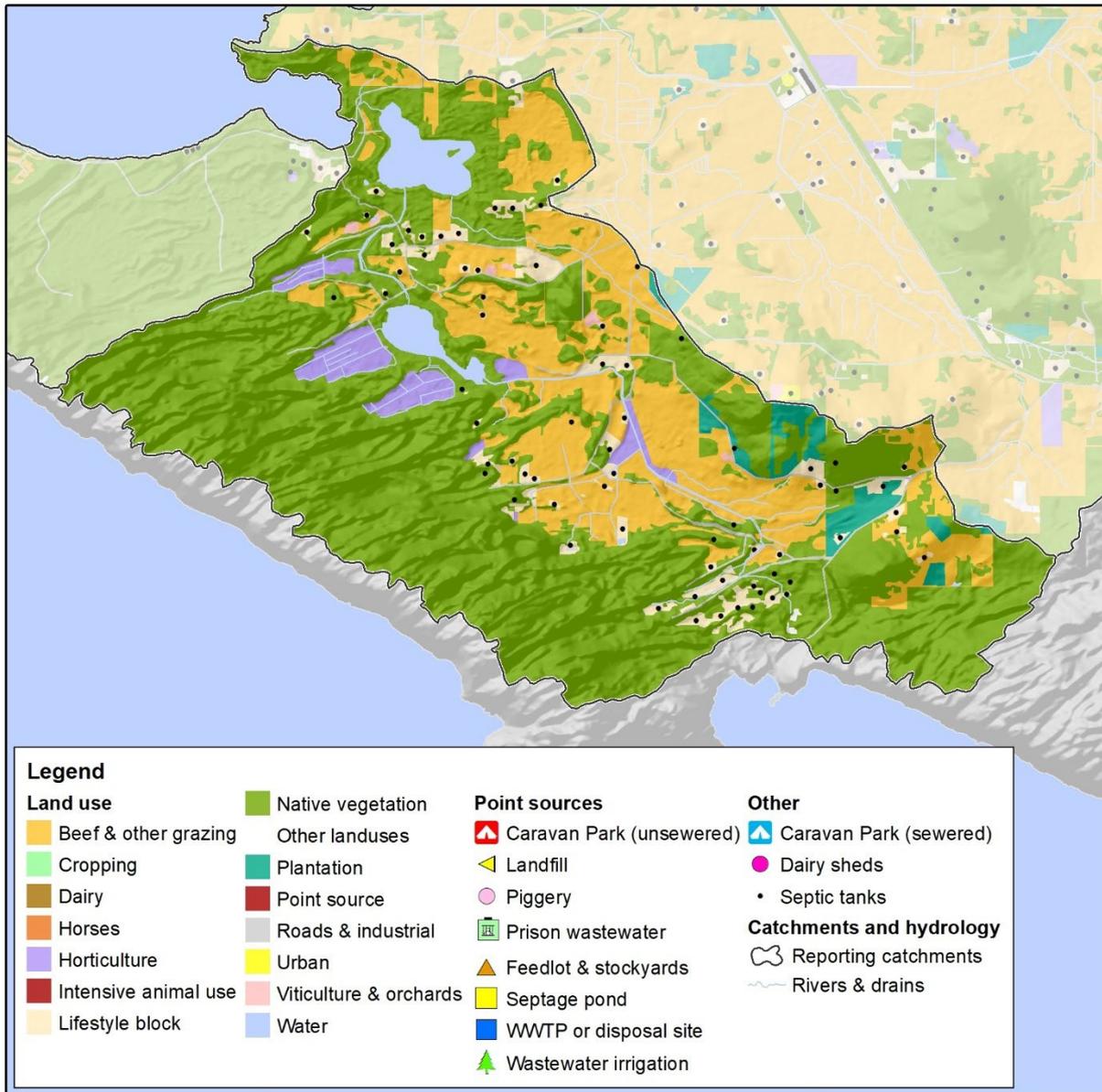
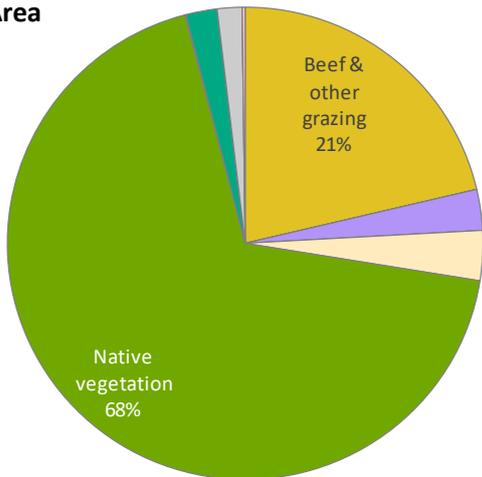


Figure D.13: Land uses of the Lake Saide reporting catchment

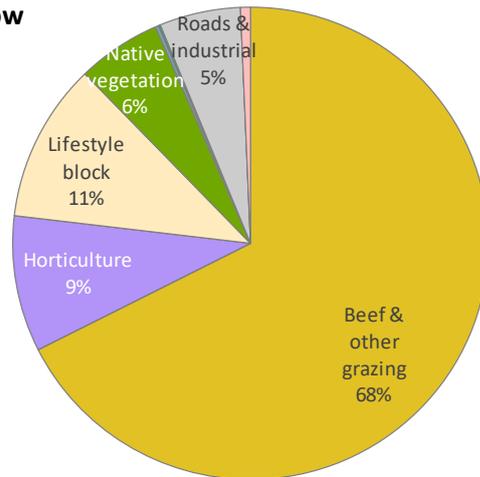
Lake Saide source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		71	-	0	0%	0	0%	0	0%
Beef & other grazing		841	21%	1 098	68%	3 731	81%	112	44%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		0	0%	0	0%	0	0%	0	0%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		110	3%	151	9%	392	9%	131	51%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		135	3%	177	11%	374	8%	7	3%
Native vegetation		2 696	68%	93	6%	69	2%	2	1%
Other landuses		3	0%	4	0%	1	0%	0	0%
Plantation		84	2%	2	0%	10	0%	1	0%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		66	2%	90	6%	18	0%	0	0%
Urban		0	0%	0	0%	0	0%	0	0%
Viticulture & orchards		8	0%	11	1%	4	0%	1	0%
Total: Generated by catchment		3 943	100%	1 626	100%	4 598	100%	254	100%
Removal (-) or gain (+)		-	-	- 73	-4%	-1 692	-37%	- 161	-63%
Total: Leaving catchment		3 943	100%	1 553	96%	2 906	63%	94	37%

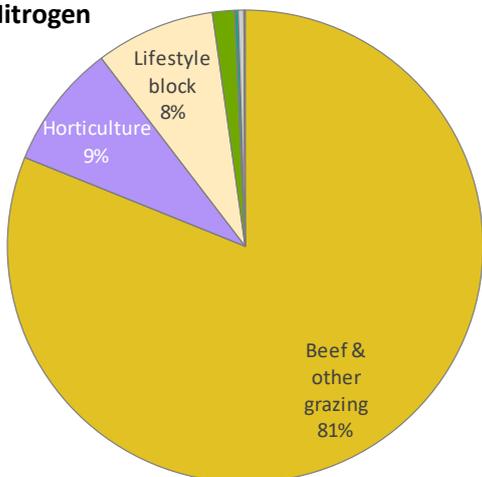
Area



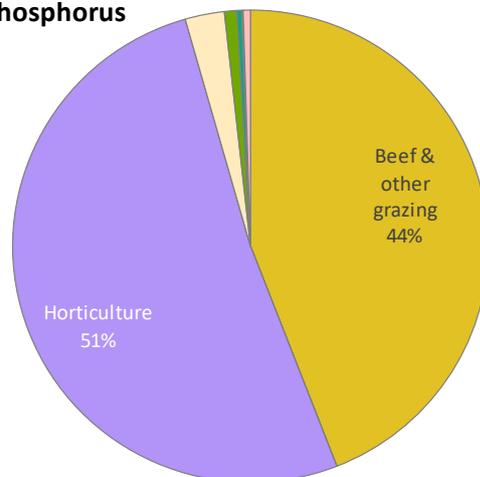
Flow



Nitrogen



Phosphorus



D.14 Nullaki

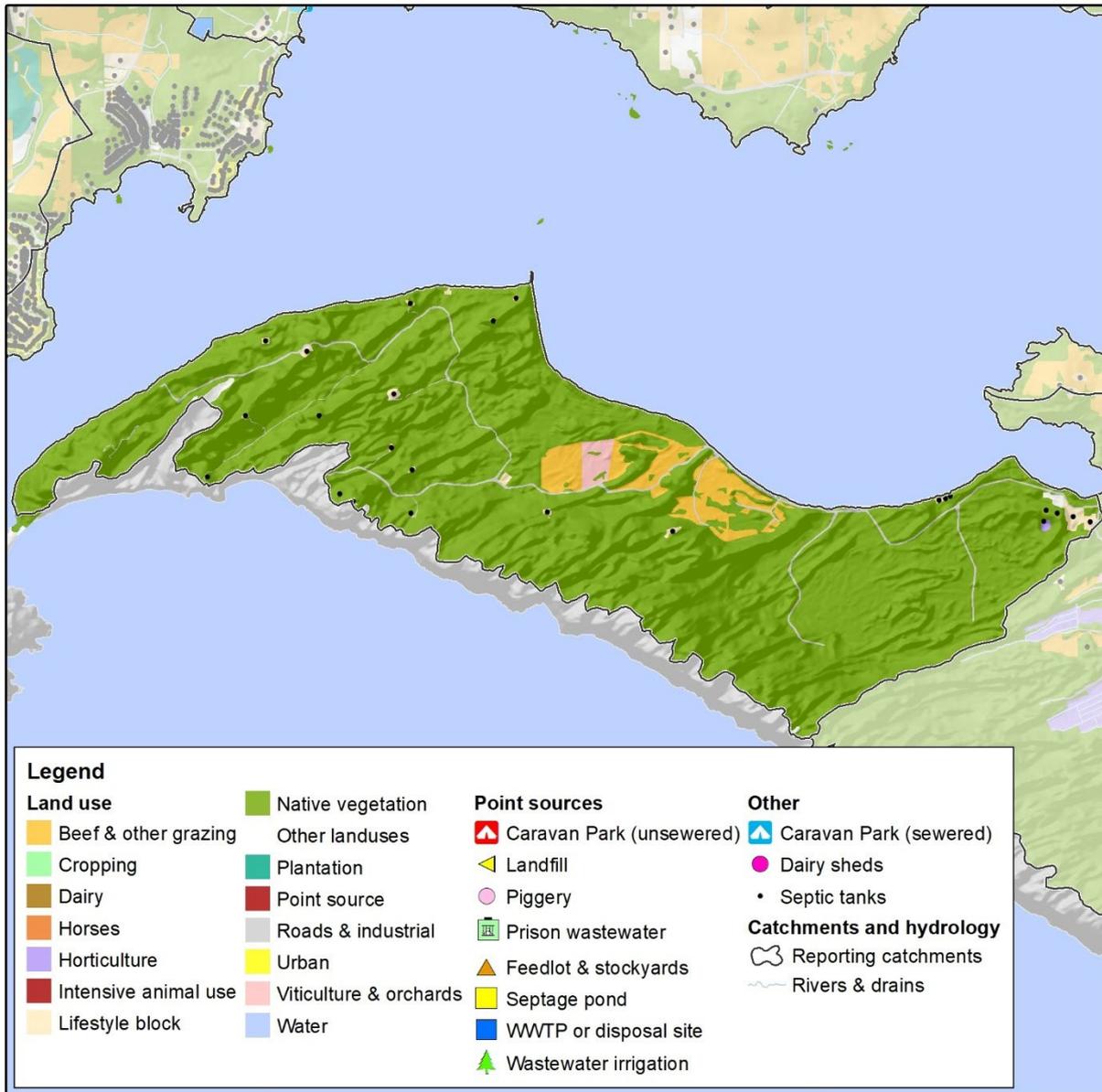
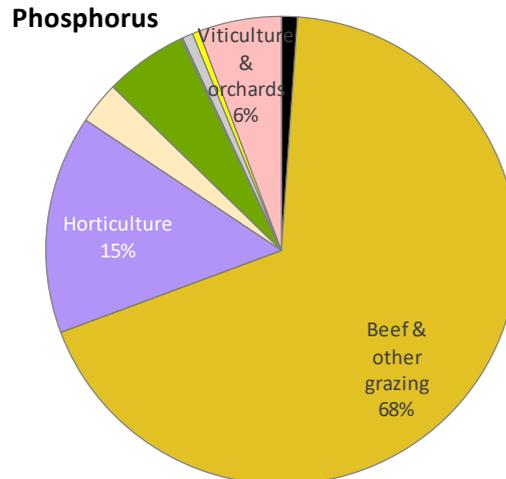
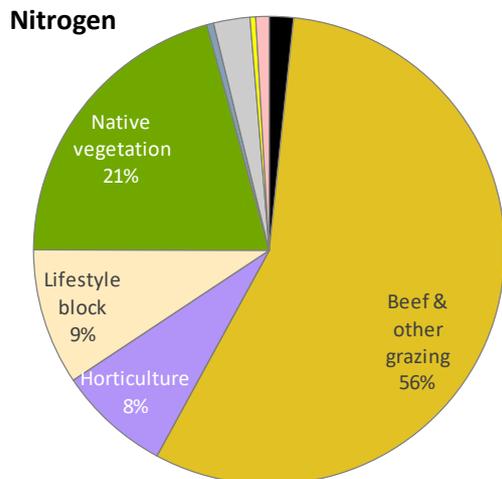
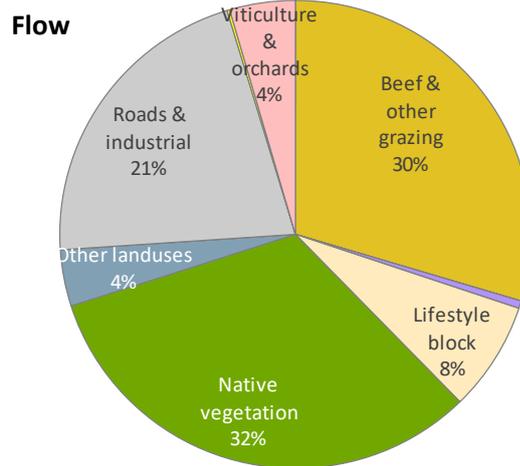
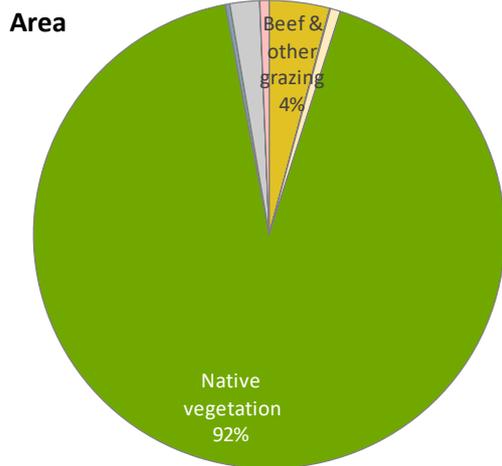


Figure D.14: Land uses of the Nullaki reporting catchment

Nullaki source separation

Landuse name	Colour	Area		Flow		Nitrogen		Phosphorus	
		(ha)	(%)	(ML/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Septic tanks		24	-	0	0%	10	2%	1	1%
Beef & other grazing		97	4%	155	30%	341	56%	63	68%
Cropping		0	0%	0	0%	0	0%	0	0%
Dairy		0	0%	0	0%	0	0%	0	0%
Horses		0	0%	0	0%	0	0%	0	0%
Horticulture		1	0%	3	1%	47	8%	14	15%
Intensive animal use		0	0%	0	0%	0	0%	0	0%
Lifestyle block		16	1%	40	8%	57	9%	3	3%
Native vegetation		2 160	92%	170	32%	126	21%	5	6%
Other landuses		7	0%	20	4%	3	0%	0	0%
Plantation		0	0%	0	0%	0	0%	0	0%
Point source		0	0%	0	0%	0	0%	0	0%
Roads & industrial		47	2%	112	21%	15	2%	1	1%
Urban		0	0%	1	0%	2	0%	0	0%
Viticulture & orchards		15	1%	24	5%	6	1%	5	6%
Total: Generated by catchment		2 345	100%	524	100%	607	100%	92	100%
Removal (-) or gain (+)		-		0	0%	0	0%	0	0%
Total: Leaving catchment		2 345	100%	524	100%	607	100%	92	100%



Appendix E: Management scenario supporting information

E.1 Overseer modelling

We used the Overseer Sci (version 6.4.0) lot-scale model to estimate the reduction in phosphorus loss from beef and dairy farms for two fertiliser management scenarios. We developed four Overseer models for different grazing land uses and phosphorus retention index (PRI) categories: beef low PRI, beef high PRI, dairy low PRI and dairy high PRI. The models were parameterised for the following scenarios:

- **Current management (basecase).** Highly soluble phosphorus fertilisers are applied at ‘typical’ rates and soil phosphorus content is based on average soil measurements from the Wilson Inlet catchment.
- **Best-practice fertiliser management using traditional fertilisers.** Farms utilise excess soil phosphorus until concentrations are optimal for growing profitable pastures. Soluble phosphorus fertilisers are then applied to maintain optimum soil phosphorus concentrations.
- **Best-practice fertiliser management using low-water-soluble phosphorus fertilisers.** We modelled the same scenario described above but used low-water-soluble phosphorus fertilisers rather than highly soluble phosphorus fertilisers.

We attempted to run the four beef and dairy models for each scenario above using soil parameters derived from the area-weighted average soil measurements of each of the 14 reporting catchments. Where there was insufficient data, we used the area-weighted average soil measurements for the entire Wilson Inlet catchment. In total there were 38 soil parameter sets for the four Overseer models per scenario.

E.1.1 Whole-farm nutrient mapping dataset

The DPIRD whole-farm nutrient mapping dataset contains the soil test results of farms that were part of programs from 2009 to 2020 to improve fertiliser use and agricultural productivity in sensitive estuary catchments, which includes the Wilson Inlet. This dataset includes soil testing through the State Government-funded Regional Estuaries Initiative (REI) from 2016 to 2020. We used this dataset to parameterise the soil parameters of the Overseer models. We also used it to obtain the area of farmland that was part of government-funded fertiliser extension programs – required for a scenario in Section 7.3.2 in the main report.

E.1.2 Overseer model setup for the basecase farm models (current management)

Beef farm models

In Overseer we modelled the farm area of beef farms as 120 ha, stocked with Angus cattle (0.86 head/ha). We populated livestock using the Overseer breeding stock tool using a breeding stock of 40. Pastures consisting of a mix of clover and ryegrass with medium levels

of clover were used as the sole source of feed. No feed was exported from the farm and there was no irrigation. Livestock had access to waterways in the basecase and management scenarios.

We based nutrient inputs (e.g. feed, fertiliser) on local farm-gate nutrient budget survey data (Ovens et al. 2008; Weaver et al. 2008). Phosphorus inputs of 13 kg P/ha/yr were from single superphosphate fertiliser. Nitrogen inputs totalled 45 kg N/ha/yr and were from clover fixation (43 kg N/ha/yr) and atmospheric deposition (2 kg N/ha/yr). The modelled farm-gate nutrient budget was similar to local surveys for phosphorus (see Table E.1). However, for nitrogen, the model tended to have lower inputs (less fixation) and outputs than local surveys.

Dairy farm models

Dairy farm models had a total farm area of 165 ha and were stocked with 230 Friesian milking cows (1.4 head per hectare). These areas were based on average dairy farm areas and milking herd numbers for the Peel-Harvey catchment. This 165 ha farm consisted of a 163 ha non-dairy effluent block (traditionally fertilised and used for pasture production) and a 2 ha effluent block. We used the default Overseer milk production values with a lactation length of 335 days per year. Livestock had access to waterways in the basecase and management scenarios.

We assumed dairy effluent was managed according to best practice (i.e. use of a holding pond with regular spray irrigation and annual solid spreading onto the effluent block). Hence paddocks received liquid and solid effluent in Overseer. (Note that Overseer cannot estimate the nutrient loss resulting from poorly constructed or managed dairy effluent systems.)

We based fertiliser inputs and feed on local farm-gate nutrient budget data (Table E.1). We modelled dairy farms to have total nutrient inputs of 147 kg N/ha/yr and 29 kg P/ha/yr, which consisted of:

- **Fertiliser:** 25 kg N/ha/yr and 23 kg P/ha/yr on non-effluent blocks and 8 kg P/ha/yr on effluent blocks.
- **Feed inputs:** Feed inputs to the entire farm (effluent and non-effluent blocks) were 39 kg N/ha/yr and 6 kg P/ha/yr. The feed types assumed were 'oats' (150 tonnes dry matter) and 'silage' (150 tonnes dry matter).
- **Atmospheric inputs:** 2 kg N/ha/yr (Overseer default).
- **Pasture fixation:** 39 kg N/ha/yr on the non-effluent block and 0 kg N/ha/yr on the effluent block.
- **Irrigation:** Inputs of 11 kg N/ha/yr and <1 kg P/ha/yr on all farm areas. The irrigation method used was border dyke irrigation and Overseer default values for inflow concentrations (0.2 mg/L TN and 0.1 mg/L TP).

The modelled dairy farm-gate nutrient budget was generally comparable with local surveys in terms of total inputs and outputs (Table E.1). Again, modelled nitrogen inputs from nitrogen fixation were lower than local surveys. Modelled phosphorus inputs were also higher than local surveys.

Table E.1: Farm-gate nutrient budgets of beef and dairy farms that were modelled in Overseer and from local surveys (Ovens et al. 2008; Weaver et al. 2008)

Farm budget Category		Beef							
		Nitrogen				Phosphorus			
		WA surveys		Overseer		WA surveys		Overseer	
		kg/ha/yr	%	kg/ha/yr	%	kg/ha/yr	%	kg/ha/yr	%
Input	Livestock	0.7	1%	0.0	<1%	0.26	2%	0.00	<1%
	Feed	0.3	<1%	-	-	0.1	1%	-	-
	Fertiliser	1.7	2%	0.0	0%	12.3	96%	13.0	100%
	Pasture	83.6	97%	43.0	96%	-	-	0	<1%
	Other	0.0	<1%	2.0	4%	0.1	1%	0.0	<1%
	Total	86.4		45.0		12.7		13.0	
Output	Livestock & milk	7.5	99%	4.0	100%	1.4	99%	1.0	100%
	Feed	0.1	1%	-	-	0.01	1%	-	-
	Total	7.6		4.0		1.4		1.0	
Surplus Total		78.8		41.0		11.3		12.0	
Farm budget Category		Dairy							
		Nitrogen				Phosphorus			
		WA surveys		Overseer		WA surveys		Overseer	
		kg/ha/yr	%	kg/ha/yr	%	kg/ha/yr	%	kg/ha/yr	%
Input	Livestock	0.1	<1%	-	-	0.04	<1%	-	-
	Feed	54	37%	39	34%	9.1	36%	6.0	21%
	Fertiliser	25	17%	25	22%	15.9	63%	23.0	79%
	Pasture	65	45%	39	34%	-	<1%	0.0	<1%
	Other	0.4	0%	13	11%	0.4	2%	0.0	<1%
	Total	145		116		25.5		29.0	
Output	Livestock & milk	23	100%	31	100%	5.4	100%	5.0	100%
	Feed	0.1	<1%	-	-	0.01	<1%	-	-
	Total	24		31		5.4		5.0	
Surplus Total		122		85		20.1		24.0	

Soil phosphorus parameterisation

We parameterised Overseer using soil testing data (2009–20) that was intersected with our land-use spatial data for the Wilson Inlet catchment. We calculated the reporting catchment area-weighted average soil test values¹ of beef and dairy farms when their measured phosphorus buffering index (PBI) was < 35 or ≥ 35. These PBI ranges indicate low PRI and high PRI soil classes respectively. We used PBI instead of PRI classes because:

- PBI measurements were part of all paddock measurements, whereas PRI was not commonly measured.
- The DPIRD soil testing dataset had measured PBI values which indicated poor sandy soils, yet the soil PRI mapping showed high PRI soils. This issue was most prominent in the Cuppup catchment which has no low PRI soils, indicating the PRI mapping in this area may need to be revised.

Overseer uses Olsen P rather than Colwell P, but the latter is predominantly used in south-west Western Australia. We converted Colwell P to Olsen P using relationships for different PBI classes that were developed by DPIRD (see Table E.2). Table E.3 gives the soil

¹ Colwell P, phosphorus buffering index (PBI) and fertility index values (85% and 95%)

properties that we derived from the DPIRD database (2009–20) and used in the Overseer modelling.

Models of low PRI beef and dairy farms used ‘sandy high P export’ soils and had phosphorus retention (anion storage capacity) values of 1% and 2% respectively. For high PRI beef and dairy models, we used ‘sedimentary’ soils with phosphorus retention values of 20.

Table E.2: The conversion of Colwell P to Olsen P (derived by DPIRD)

PBI class	Equation
<35	$10^{0.882 * \log(\text{Colwell P}) - 0.155}$
35–139	$10^{0.874 * \log(\text{Colwell P}) - 0.23}$
140–279	$10^{0.89 * \log(\text{Colwell P}) - 0.32}$
>280	$10^{0.89 * \log(\text{Colwell P}) - 0.38}$

Table E.3: Assumed soil properties of beef and dairy farms that were derived (area-weighted average) from the DPIRD whole-farm nutrient mapping dataset (2009–20)

Reporting catchment	Phosphorus buffering index (PBI) <35 (indicative of low PRI soils)							Phosphorus buffering index (PBI) ≥35 (indicative of low PRI soils)							
	Area of testing (ha)	PBI (mg/kg)	Current Colwell P (mg/kg)	Target Colwell P (mg/kg)	Fertility index (85% max)	Current Olsen P (mg/kg)	Target Olsen P (mg/kg)	Area of testing (ha)	PBI (mg/kg)	Current Colwell P (mg/kg)	Target Colwell P (mg/kg)	Fertility index (85% max)	Current Olsen P (mg/kg)	Target Olsen P (mg/kg)	
Beef	Ocean Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Little River	156	15	22	11	2.1	11	6	400	184	48	24	2.0	15	8
	Koorabup	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lower Denmark	89	25	22	16	1.4	11	8	753	217	43	24	1.8	14	8
	Upper Denmark	-	-	-	-	-	-	-	29	176	29	23	1.3	10	8
	Scotsdale	16	27	42	16	2.6	19	8	241	191	59	24	2.5	18	8
	Foreshore	40	18	21	14	1.6	10	7	68	102	29	21	1.4	11	8
	Sunny Glen	180	14	22	12	1.9	11	6	140	130	33	21	1.5	13	8
	Lower Hay	97	17	17	12	1.5	9	6	60	118	20	20	1.0	8	8
	Upper Hay	1 805	17	18	13	1.5	9	7	7 258	166	36	23	1.6	12	8
	Sleeman	535	19	20	13	1.5	10	7	643	73	33	19	1.7	13	8
	Cuppup	208	16	24	12	2.0	12	6	797	243	39	25	1.6	12	8
	Lake Saide	34	7	14	9	1.6	7	5	18	191	29	24	1.2	10	8
Nullaki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Wilson Inlet	3 161	17	19	12	1.6	9	6	10 406	170	37	23	1.6	12	8	
Dairy	Ocean Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Little River	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Koorabup	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Lower Denmark	92	25	35	26	1.4	16	12	94	83	38	31	1.2	14	12
	Upper Denmark	2	34	16	27	0.6	8	13	289	230	28	40	0.7	9	13
	Scotsdale	6	21	22	24	0.9	11	12	75	147	51	36	1.4	16	12
	Foreshore	2	20	25	23	1.1	12	11	-	-	-	-	-	-	-
	Sunny Glen	104	15	29	19	1.5	14	9	72	79	48	31	1.5	17	12
	Lower Hay	97	14	17	19	0.9	9	9	324	137	32	36	0.9	12	13
	Upper Hay	30	34	17	28	0.6	9	13	260	169	26	36	0.7	9	12
	Sleeman	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cuppup	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lake Saide	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nullaki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Wilson Inlet	334	19	26	22	1.2	12	11	1 115	161	33	36	0.9	11	12	

E.1.3 Overseer scenario model setup

Best-practice fertiliser management using traditional fertilisers

We assumed that beef and dairy farms run down their available soil phosphorus content to critical values (fertility index of 1) by applying lower (or no) phosphorus fertilisers. This is represented by changing soil Olsen parameters to target concentrations (see Table E.3). Farms used single superphosphate fertilisers to apply phosphorus at ‘maintenance rates’, which were derived from Overseer when sedimentary soils were selected. Phosphorus inputs in this scenario were:

- **Beef: 6 kg P/ha/yr** as single superphosphate.
- **Dairy: 12 kg P/ha/yr** as single superphosphate (feed and irrigation inputs were unchanged in this scenario and amounted to 7 kg P/ha/yr).

Best-practice fertiliser management using slow-release fertilisers

This scenario is identical to the previous scenario except that we used low-water-soluble phosphorus (LWSP) fertilisers in place of single superphosphate. Overseer allows users to input multiple fertiliser sources, including reactive phosphate rock, which has a low solubility and is the only fertiliser type that reduces phosphorus loss in the model. We used an approximate blend of **60% reactive phosphate rock** and **40% highly soluble phosphorus** (as elemental phosphorus) to represent low-water-soluble phosphorus fertilisers. Phosphorus inputs in this scenario were:

- **Beef: 6 kg P/ha/yr** as low-water-soluble phosphorus fertiliser.
- **Dairy: 12 kg P/ha/yr** as low-water-soluble phosphorus fertiliser (feed and irrigation inputs were unchanged in this scenario and amounted to 7 kg P/ha/yr).

E.1.4 Overseer parameter and result summaries

Table E.4: Overseer beef (low PRI) parameterisation and results

Variable	Units	Basecase		Fertiliser management (traditional fertilisers)		Low water soluble phosphorus fertilisers	
Area	ha	120		Same as basecase		Same as basecase	
Number of cows	#	104 (Black angus)		Same as basecase		Same as basecase	
Irrigation method		No irrigation		Same as basecase		Same as basecase	
Animal access to streams?	Yes/no	Yes		Same as basecase		Same as basecase	
Pasture and clover		Ryegrass/white clover		Same as basecase		Same as basecase	
Soils & drainage							
Soil description	-	Sand (high P export)		Same as basecase		Same as basecase	
Soil drainage class and characteristics	-	Moderately well - Drainage always soaks in		Same as basecase		Same as basecase	
Top soil texture	-	Sand		Same as basecase		Same as basecase	
Maximum rooting depth	cm	20		Same as basecase		Same as basecase	
Soil phosphate retention (PR)	%	1		Same as basecase		Same as basecase	
PBI	mg/kg	AWA of 18 (7 to 27 by catchment)		Same as basecase		Same as basecase	
Colwell P	mg/kg	AWA of 19 (14 to 42 by catchment)		AWA of 12 (9 to 16 by catchment)		AWA of 12 (9 to 16 by catchment)	
Fertiliser index (85% productivity)	Fraction	AWA of 1.6 (1.4 to 2.6 by catchment)		1.0		1.0	
Current Olsen P	mg/kg	AWA of 9 (7 to 19 by catchment)		AWA of 6 (5 to 8 by catchment)		AWA of 6 (5 to 8 by catchment)	
Target Olsen P	mg/kg	AWA of 6 (5 to 8 by catchment)		-		-	
Farm nutrient budget (for AWA soil test results)							
		N	P	N	P	N	P
Timing and amount of fertilisation: SSP =single super phosphate, RPR= reactive phosphate rock	Apr (kg/ha/yr)	0	13 (SSP)	0	6 (SSP)	0	1 (SSP) 4 (RPR)
Maintenance rate	kg/ha/yr	NA	12	NA	12	NA	12
Nutrient inputs							
		N	P	N	P	N	P
Fertiliser	kg/ha/yr	0.0	13.0	0.0	6.0	0.0	5.0
Rain/clover fixation	kg/ha/yr	44.0	0.0	44.0	0.0	44.0	0.0
Rainfall	kg/ha/yr	2.0	0.0	2.0	0.0	2.0	0.0
Biological fixation	kg/ha/yr	42.0	0.0	42.0	0.0	42.0	0.0
Nutrients removed							
		N	P	N	P	N	P
Leached from root zone	kg/ha/yr	18.0	0.3	18.0	0.2	18.0	0.2
Leaching - urine patches	kg/ha/yr	7.0	0.0	7.0	0.0	7.0	0.0
Runoff	kg/ha/yr	0.0	0.2	0.0	0.1	0.0	0.1
Direct (animals, drains)	kg/ha/yr	0.0	0.1	0.0	0.0	0.0	0.0
Leaching - other	kg/ha/yr	10.0	0.0	10.0	0.0	10.0	0.0
As product	kg/ha/yr	4.0	1.0	4.0	1.0	4.0	1.0
To atmosphere	kg/ha/yr	23.0	0.0	23.0	0.0	23.0	0.0
Denitrification - background	kg/ha/yr	4.0	0.0	4.0	0.0	4.0	0.0
Volatilisation - urine	kg/ha/yr	11.0	0.0	11.0	0.0	11.0	0.0
Denitrification - urine	kg/ha/yr	8.0	0.0	8.0	0.0	8.0	0.0
Change in plant and soil stores							
		N	P	N	P	N	P
Organic pool	kg/ha/yr	0.0	17.0	0.0	13.0	0.0	13.0
Immobilisation	kg/ha/yr	0.0	17.0	0.0	13.0	0.0	13.0
Inorganic mineral	kg/ha/yr	0.0	-2.0	0.0	-2.0	0.0	-2.0
Adsorption	kg/ha/yr	0.0	1.0	0.0	1.0	0.0	1.0
Slow release	kg/ha/yr	0.0	-3.0	0.0	-3.0	0.0	-3.0
Inorganic soil pool	kg/ha/yr	0.0	-4.0	0.0	-6.0	0.0	-7.0

Note: AWA = area-weighted average

Table E.5: Overseer beef (high PRI) parameterisation and results

Variable	Units	Basecase		Fertiliser management (traditional fertilisers)	
Area	ha	120		Same as basecase	
Number of cows	#	104 (Black angus)		Same as basecase	
Irrigation method		No irrigation		Same as basecase	
Animal access to streams?	Yes/no	Yes		Same as basecase	
Pasture and clover		Ryegrass/white clover		Same as basecase	
Soils & drainage					
Soil description	-	Sedimentary		Same as basecase	
Soil drainage class and characteristics	-	Poor (default with naturally high groundwater)		Same as basecase	
Top soil texture	-	Clay loam (heavy)		Same as basecase	
Maximum rooting depth	cm	20		Same as basecase	
Soil phosphate retention (PR)	%	20		Same as basecase	
PBI		AWA of 170 (73 to 243 by catchment)		Same as basecase	
Colwell P	mg/kg	AWA of 37 (20 to 59 by catchment)		AWA of 23 (19 to 25 by catchment)	
Fertiliser index (85% productivity)	Fraction	AWA of 1.6 (1.0 to 2.5 by catchment)		2	
Current Olsen P	mg/kg	AWA of 12 (8 to 18 by catchment)		AWA of 8 (8 for all catchments)	
Target Olsen P	mg/kg	AWA of 8 (8 for all catchments)		8	
Farm nutrient budget (for AWA soil test results)					
		N	P	N	P
Timing and amount of fertilisation: SSP = single super phosphate, RPR = reactive phosphate rock	Apr (kg/ha/yr)	0	13 (SSP)	0	6 (SSP)
Maintenance rate	kg/ha/yr	NA	9	NA	6
Nutrient inputs					
		N	P	N	P
Fertiliser	Kg/ha/yr	0.0	13.0	0.0	6.0
Rain/clover fixation	Kg/ha/yr	45.0	0.0	45.0	0.0
Rainfall	Kg/ha/yr	2.0	0.0	2.0	0.0
Biological fixation	Kg/ha/yr	43.0	0.0	43.0	0.0
Nutrients removed					
		N	P	N	P
Leached from root zone	Kg/ha/yr	17.0	0.2	17.0	0.1
Leaching - urine patches	Kg/ha/yr	7.0	0.0	7.0	0.0
Runoff	Kg/ha/yr	0.0	0.1	0.0	0.0
Direct (animals, drains)	Kg/ha/yr	0.0	0.1	0.0	0.1
Leaching - other	Kg/ha/yr	10.0	0.0	10.0	0.0
As product	Kg/ha/yr	4.0	1.0	4.0	1.0
To atmosphere	Kg/ha/yr	25.0	0.0	25.0	0.0
Denitrification - background	Kg/ha/yr	4.0	0.0	4.0	0.0
Volatilisation - urine	Kg/ha/yr	11.0	0.0	11.0	0.0
Denitrification - urine	Kg/ha/yr	10.0	0.0	10.0	0.0
Change in plant and soil stores					
		N	P	N	P
Organic pool	Kg/ha/yr	-1.0	8.0	-1.0	6.0
Immobilisation	Kg/ha/yr	-1.0	8.0	-1.0	6.0
Inorganic mineral	Kg/ha/yr	0.0	-1.0	0.0	-1.0
Adsorption	Kg/ha/yr	0.0	2.0	0.0	1.0
Slow release	Kg/ha/yr	0.0	-3.0	0.0	-3.0
Inorganic soil pool	Kg/ha/yr	0.0	5.0	0.0	0.0

Note: AWA = area-weighted average

Table E.6: Overseer dairy (low PRI) parameterisation and results

Variable	Units	Basecase	Fertiliser management (traditional fertilisers)	Low water soluble phosphorus fertilisers
Area	ha	Non-effluent block 163	Same as basecase	Same as basecase
	ha	Effluent block 2		
	ha	Farm total 165		
Number of milking cows and type		230 milking cows (Friesian)	Same as basecase	Same as basecase
Effluent management	-	Holding pond: Irrigation & spreading solids to effluent block in April >24 mm	Same as basecase	Same as basecase
Effluent irrigation (effluent block)	mm/day	Boarder dyke with overseer default nutrient concentrations	Same as basecase	Same as basecase
Irrigation method		Nov–March (65-80 mm/month)	Same as basecase	Same as basecase
Months irrigated and amount		Yes	Same as basecase	Same as basecase
Animal access to streams?	Yes/no	Ryegrass/white clover	Same as basecase	Same as basecase
Pasture and clover				
Soils & drainage				
Soil description	-	Sand (high P export)	Same as basecase	Same as basecase
Soil drainage class and characteristics	-	Moderately well - Drainage always soaks in	Same as basecase	Same as basecase
Top soil texture	-	Sand	Same as basecase	Same as basecase
Maximum rooting depth	cm	20	Same as basecase	Same as basecase
Soil phosphate retention (PR)	%	2	Same as basecase	Same as basecase
PBI	mg/kg	AWA of 19 (14 to 34 by catchment)	Same as basecase	Same as basecase
Colwell P	mg/kg	AWA of 26 (16 to 35 by catchment)	AWA of 22 (19 to 28 by catchment)	AWA of 22 (19 to 28 by catchment)
Fertiliser index (95% productivity)	Fraction	AWA of 1.2 (0.6 to 1.5 by catchment)	1.0	1.0
Current Olsen P	mg/kg	AWA of 12 (8 to 16 by catchment)	AWA of 12 (9 to 13 by catchment)	AWA of 12 (9 to 13 by catchment)
Target Olsen P	mg/kg	AWA of 12 (9 to 13 by catchment)	-	-
Farm nutrient budget (for AWA soil test results)		N P	N P	N P
Timing and amount of fertilisation: Non-effluent block	Apr (kg/ha/yr)	25 15.5 (SSP)	25 6 (SSP)	25 2 (SSP) 3.5 (RPR)
SSP =single super phosphate, RPR= reactive phosphate rock	Sep (kg/ha/yr)	0 8.2 (SSP)	0 6 (SSP)	0 2 (SSP) 3.5 (RPR)
Effluent block	Sep (kg/ha/yr)	0 8.2 (SSP)	0	0 0
Maintenance rate	kg/ha/yr	NA 12	NA 12	NA 12
Nutrient inputs		N P	N P	N P
Fertiliser	Kg/ha/yr	25.0 24.0	25.0 12.0	25.0 11.0
Irrigation	Kg/ha/yr	11.0 0.0	11.0 0.0	11.0 0.0
Supplements	Kg/ha/yr	39.0 6.0	39.0 6.0	39.0 6.0
Imported	Kg/ha/yr	39.0 6.0	39.0 6.0	39.0 6.0
Rain/clover fixation	Kg/ha/yr	41.0 0.0	41.0 0.0	41.0 0.0
Rainfall	Kg/ha/yr	2.0 0.0	2.0 0.0	2.0 0.0
Biological fixation	Kg/ha/yr	39.0 0.0	39.0 0.0	39.0 0.0
Nutrients removed		N P	N P	N P
Leached from root zone	Kg/ha/yr	36.0 4.0	36.0 3.3	36.0 2.9
Leaching - urine patches	Kg/ha/yr	20.0 0.0	20.0 0.0	20.0 0.0
Runoff	Kg/ha/yr	0.0 2.4	0.0 1.8	0.0 1.4
Direct (animals, drains)	Kg/ha/yr	1.0 0.1	1.0 0.1	1.0 0.1
Leaching - other	Kg/ha/yr	8.0 0.2	8.0 0.2	8.0 0.2
Border dyke outwash	Kg/ha/yr	6.0 1.2	6.0 1.2	6.0 1.2
As product	Kg/ha/yr	31.0 5.0	31.0 5.0	31.0 5.0
To atmosphere	Kg/ha/yr	49.0 0.0	49.0 0.0	49.0 0.0
Change in plant and soil stores		N P	N P	N P
Organic pool	Kg/ha/yr	0.0 24.0	0.0 23.0	0.0 23.0
Immobilisation	Kg/ha/yr	0.0 24.0	0.0 23.0	0.0 23.0
Inorganic mineral	Kg/ha/yr	0.0 -3.0	0.0 -3.0	0.0 -3.0
Slow release	Kg/ha/yr	0.0 -3.0	0.0 -3.0	0.0 -3.0
Inorganic soil pool	Kg/ha/yr	0.0 -1.0	0.0 -9.0	0.0 -11.0

Note: AWA = area-weighted average

Table E.7: Overseer dairy (high PRI) parameterisation and results

Variable	Units	Basecase		Fertiliser management (traditional fertilisers)	
Area	ha	Non-effluent block	163	Same as basecase	
	ha	Effluent block	2		
	ha	Farm total	165		
Number of milking cows and type		230 milking cows (Friesian)		Same as basecase	
Effluent management	-	Holding pond: Irrigation & spreading solids to effluent block in April >24 mm		Same as basecase	
Effluent irrigation	mm/day	Boarder dyke with overseer default nutrient concentrations		Same as basecase	
Irrigation method		Nov–March (65-80 mm/month)		Same as basecase	
Months irrigated and amount		Yes		Same as basecase	
Animal access to streams?	Yes/no	Yes		Same as basecase	
Pasture and clover		Ryegrass/white clover		Same as basecase	
Soils & drainage					
Soil description	-	Sedimentary		Same as basecase	
Soil drainage class and characterist	-	Poor - Rainfall mostly runs off		Same as basecase	
Top soil texture	-	Clay loam - Heavy texture		Same as basecase	
Maximum rooting depth	cm	20		Same as basecase	
Soil phosphate retention (PR)	%	20		Same as basecase	
PBI	mg/kg	AWA of 161 (79 to 230 by catchment)		Same as basecase	
Colwell P	mg/kg	AWA of 33 (26 to 51 by catchment)		AWA of 36 (31 to 40 by catchment)	
Fertiliser index (95% productivity)	Fraction	AWA of 0.9 (0.7 to 1.5 by catchment)		1.0	
Current Olsen P	mg/kg	AWA of 11 (9 to 17 by catchment)		AWA of 12 (9 to 13 by catchment)	
Target Olsen P	mg/kg	AWA of 12 (12 to 13 by catchment)		-	
Farm nutrient budget (for AWA soil test results)					
		N	P	N	P
Timing and amount of fertilisation: Non-effluent block	Apr (kg/ha/yr)	25	15.5 (SSP)	25	6 (SSP)
SSP =single super phosphate, RPR= reactive phosphate rock	Sep (kg/ha/yr)	0	8.2 (SSP)	0	6 (SSP)
Effluent block	Sep (kg/ha/yr)	0	8.2 (SSP)	0	0
Maintenance rate	kg/ha/yr	NA	12	NA	12
Nutrient inputs					
		N	P	N	P
Fertiliser	Kg/ha/yr	25.0	23.0	25.0	12.0
Irrigation	Kg/ha/yr	11.0	0.0	11.0	0.0
Supplements	Kg/ha/yr	39.0	6.0	39.0	6.0
Imported	Kg/ha/yr	39.0	6.0	39.0	6.0
Rain/clover fixation	Kg/ha/yr	41.0	0.0	41.0	0.0
Rainfall	Kg/ha/yr	2.0	0.0	2.0	0.0
Biological fixation	Kg/ha/yr	39.0	0.0	39.0	0.0
Nutrients removed					
		N	P	N	P
Leached from root zone	Kg/ha/yr	32.0	2.3	32.0	2.2
Leaching - urine patches	Kg/ha/yr	16.0	0.0	16.0	0.0
Runoff	Kg/ha/yr	0.0	0.7	0.0	0.6
Direct (animals, drains)	Kg/ha/yr	1.0	0.1	1.0	0.1
Leaching - other	Kg/ha/yr	8.0	0.2	8.0	0.2
Border dyke outwash	Kg/ha/yr	6.0	1.2	6.0	1.2
As product	Kg/ha/yr	31.0	5.0	31.0	5.0
To atmosphere	Kg/ha/yr	52.0	0.0	52.0	0.0
Change in plant and soil stores					
		N	P	N	P
Organic pool	Kg/ha/yr	0.0	10.0	0.0	11.0
Immobilisation	Kg/ha/yr	0.0	10.0	0.0	11.0
Inorganic mineral	Kg/ha/yr	0.0	-3.0	0.0	-3.0
Slow release	Kg/ha/yr	0.0	-3.0	0.0	-3.0
Inorganic soil pool	Kg/ha/yr	0.0	15.0	0.0	4.0

Note: AWA = area-weighted average

E.2 Summary of management scenario results

Table E.8: Nitrogen load removal from all individual and combined management scenarios

Reporting catchment	Load reduction target (excess load)			Urban expansion		Maintain 2020 plantation area		Extensive plantation reversion		Riparian fencing		Riparian fencing & revegetation		Dairy effluent management	
	Basecase kg/yr	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)
Ocean Beach	2,581	1,150	-45%	162	6.3%	-	-	-	-	-253	-10%	-318	-12%	-	-
Little River	6,188	-	-	23	0.4%	-	-	93	1.5%	-590	-10%	-590	-10%	-	-
Koorabup	2,077	830	-40%	116	5.6%	-	-	-	-	-79	-3.8%	-79	-3.8%	-	-
Lower Denmark	7,491	-	-	-10	-0.1%	50	0.7%	171	2.3%	-613	-8.2%	-647	-8.6%	-38	-0.5%
Upper Denmark	4,639	2,362	-51%	-	-	-14	-0.3%	2,165	47%	-372	-8.0%	-375	-8.1%	-44	-0.9%
Scotsdale	11,651	-	-	-6	-0.1%	321	2.8%	1,532	13%	-831	-7.1%	-1,299	-11%	-21	-0.2%
Foreshore	3,878	1,065	-27%	821	21%	1	0.0%	10	0.2%	-224	-5.8%	-271	-7.0%	-	-
Sunny Glen	4,379	1,848	-42%	-	-	-	-	612	14%	-705	-16%	-794	-18%	-64	-1.5%
Lower Hay	5,382	224	-4%	-	-	21	0.4%	938	17%	-643	-12%	-780	-14%	-35	-0.7%
Upper Hay	20,561	9,038	-44%	3,541	17%	179	0.9%	10,363	50%	-2,408	-12%	-2,460	-12%	-	-
Sleeman	16,232	5,148	-32%	-	-	-	-	268	1.7%	-2,168	-13%	-3,181	-20%	-57	-0.3%
Cuppup	19,056	6,811	-36%	-	-	4	0.0%	40	0.2%	-2,548	-13%	-5,112	-27%	-	-
Lake Saiide	2,906	1,043	-36%	-	-	15	0.5%	179	6.2%	-447	-15%	-543	-19%	-	-
Nullaki	607	-	-	-	-	-	-	-	-	-45	-7.5%	-96	-16%	-	-
Wilson Inlet	107,627	29,519	-27%	4,645	4.3%	577	0.5%	16,371	15%	-11,926	-11%	-16,545	-15%	-258	-0.2%
Reporting catchment	Basecase kg/yr	Load reduction target (excess load)		Septic tank removal (690 tanks)		Denmark WWTP (2015 upgrades)		Combined actions							
		kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	Agricultural actions		Non-agricultural actions		All actions			
Ocean Beach	2,581	1,150	-45%	-398	-15%	-	-	-	-	-716	-28%	-716	-28%	-	-
Little River	6,188	-	-	-233	-3.8%	-	-	-	-	-822	-13%	-822	-13%	-	-
Koorabup	2,077	830	-40%	-	-	-	-	-	-	-498	-24%	-498	-24%	-	-
Lower Denmark	7,491	-	-	-	-	-419	-6%	-38	-0.5%	-647	-8.6%	-686	-9.2%	-	-
Upper Denmark	4,639	2,362	-51%	-	-	-	-	-44	-0.9%	-375	-8.1%	-419	-9.0%	-	-
Scotsdale	11,651	-	-	-	-	-	-	-21	-0.2%	-1,299	-11%	-1,320	-11%	-	-
Foreshore	3,878	1,065	-27%	-1,161	-30%	-	-	-	-	-1,433	-37%	-1,433	-37%	-	-
Sunny Glen	4,379	1,848	-42%	-	-	-	-	-64	-1.5%	-794	-18%	-858	-20%	-	-
Lower Hay	5,382	224	-4%	-	-	-	-	-35	-0.7%	-780	-14%	-815	-15%	-	-
Upper Hay	20,561	9,038	-44%	-	-	-	-	-	-	-2,460	-12%	-2,460	-12%	-	-
Sleeman	16,232	5,148	-32%	-	-	-	-	-28	-0.2%	-3,181	-20%	-3,237	-20%	-	-
Cuppup	19,056	6,811	-36%	-	-	-	-	-	-	-5,112	-27%	-5,112	-27%	-	-
Lake Saiide	2,906	1,043	-36%	-	-	-	-	-	-	-543	-19%	-543	-19%	-	-
Nullaki	607	-	-	-	-	-	-	-	-	-96	-16%	-96	-16%	-	-
Wilson Inlet	107,627	29,519	-27%	-1,792	-1.7%	-419	0%	-230	-0.2%	-18,757	-17%	-19,015	-18%		

Table E.9: Phosphorus load removal from all individual and combined management scenarios

Reporting catchment	Load reduction target (excess load)			Urban expansion		Maintain 2020 plantation area		Extensive plantation reversion		Riparian fencing		Riparian fencing & revegetation		Fertiliser management		Fertiliser management with LWSP		Dairy effluent management		Soil ammendment	
	kg/yr	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)	kg/yr	(%)
Ocean Beach	230	110	-48%	2	1.0%	-	-	-	-	-5	-2.3%	-5	-2.3%	-43	-19%	-51	-22%	-	-	-79	-35%
Little River	526	-	-	-1	-0.3%	-	-	40	7.6%	-51	-10%	-51	-10%	-132	-25%	-132	-25%	-	-	-	-
Koorabup	133	30	-22%	45	34%	-	-	-	-	-1	-1.0%	-1	-1.0%	-1	-0.5%	-1	-0.5%	-	-	-	-
Lower Denmark	200	-	-	1	1%	6	3.2%	18	8.8%	-16	-7.8%	-17	-8.3%	-35	-17%	-38	-19%	-3	-1.4%	-35	-17%
Upper Denmark	141	47	-34%	-	-	-1	-1.0%	141	100%	-11	-7.6%	-11	-7.7%	1	0.7%	-1	-0.6%	-3	-2.2%	-7	-5.2%
Scotsdale	488	-	-	-1	-0.1%	59	12%	274	56%	-35	-7.1%	-54	-11%	-141	-29%	-142	-29%	-1	-0.3%	-1	-0.1%
Foreshore	202	-	-	58	29%	0.1	<0.1%	1	0.4%	-3	-1.7%	-3	-1.7%	-17	-8.5%	-19	-10%	-	-	-22	-11%
Sunny Glen	687	476	-69%	-	-	-	-	310	45%	-19	-2.8%	-19	-2.8%	-225	-33%	-259	-38%	-5	-0.7%	-344	-50%
Lower Hay	563	133	-24%	-	-	4	0.7%	150	27%	-15	-2.6%	-15	-2.6%	-111	-20%	-139	-25%	-3	-0.4%	-280	-50%
Upper Hay	472	94	-20%	194	41%	28	5.9%	937	199%	-53	-11%	-54	-11%	-89	-19%	-97	-21%	-	-	-84	-18%
Sleeman	2,097	1,173	-56%	-	-	-	-	135	6.4%	-63	-3.0%	-63	-3.0%	-485	-23%	-569	-27%	-4	-0.2%	-836	-40%
Cuppup	2,804	1,783	-64%	-	-	2	0.1%	26	0.9%	-113	-4.0%	-113	-4.0%	-578	-21%	-578	-21%	-	-	-2	-0.1%
Lake Saide	94	-	-	-	-	1	0.7%	7	7.8%	-2	-2.5%	-2	-2.5%	-8	-8.5%	-10	-10%	-	-	-67	-72%
Nullaki	92	39	-43%	-	-	-	-	-	-	-3	-2.8%	-3	-2.8%	-20	-21%	-23	-26%	-	-	-46	-50%
Wilson Inlet	8,729	3,886	-45%	299	3.4%	98	1.1%	2,038	23%	-389	-4.5%	-410	-4.7%	-1,884	-22%	-2,059	-24%	-18	-0.2%	-1,804	-21%

Reporting catchment	Load reduction target (excess load)			Septic tank removal (690 tanks)	Denmark WWTP (2015 upgrades)	Combined actions							
	kg/yr	kg/yr	(%)			Agricultural actions		Non-agricultural actions		All actions			
						kg/yr	(%)	kg/yr	(%)	kg/yr	(%)		
Ocean Beach	230	110	-48%	0.1	0.0%	-	-	-107	-47%	-5	-2.2%	-113	-49%
Little River	526	-	-	-23	-4.4%	-	-	-132	-25%	-74	-14%	-206	-39%
Koorabup	133	30	-22%	-	-	-	-	-1	-0.5%	-29	-22.1%	-30	-23%
Lower Denmark	200	-	-	-	-	-28	-14%	-66	-33%	-17	-8.3%	-83	-41%
Upper Denmark	141	47	-34%	-	-	-	-	-9	-6.7%	-11	-7.7%	-20	-14%
Scotsdale	488	-	-	-	-	-	-	-143	-29%	-54	-11%	-198	-40%
Foreshore	202	-	-	-54	-27%	-	-	-38	-19%	-57	-28%	-95	-47%
Sunny Glen	687	476	-69%	-	-	-	-	-461	-67%	-19	-2.8%	-480	-70%
Lower Hay	563	133	-24%	-	-	-	-	-346	-61%	-15	-2.6%	-360	-64%
Upper Hay	472	94	-20%	-	-	-	-	-157	-33%	-54	-11%	-211	-45%
Sleeman	2,097	1,173	-56%	-	-	-	-	-1,151	-55%	-63	-3.0%	-1,216	-58%
Cuppup	2,804	1,783	-64%	-	-	-	-	-579	-21%	-113	-4.0%	-692	-25%
Lake Saide	94	-	-	-	-	-	-	-72	-77%	-2	-2.5%	-74	-79%
Nullaki	92	39	-43%	-	-	-	-	-57	-63%	-3	-2.8%	-60	-65%
Wilson Inlet	8,729	3,886	-45%	-77	-0.9%	-28	0.0%	-3,321	-38%	-516	-5.9%	-3,838	-44%

