



Drakes Brook - Waroona Drain

Drakes Brook starts on the Darling Plateau in the Dwellingup State Forest to the east of Waroona. The natural flow of the Brook has been modified by engineering works. There are two dams; Drakes Brook Dam (Lake Moyanup) and Waroona Dam (Lake Navarino) in the catchment. Discharge from Drakes Brook Dam is slowed before either continuing into Waroona Drain or being diverted via Drakes Brook Drain to service the north of the catchment.

The monitoring site at Dorsett Road (6131335) on Waroona Drain downstream of the confluence of Drakes Brook Drain and Waroona Drain and west of Waroona has been sampled for water quality since 2006. There is no flow gauging station located in the catchment. Waroona Drain discharges into the Harvey River, just upstream of the gauging station (613052).

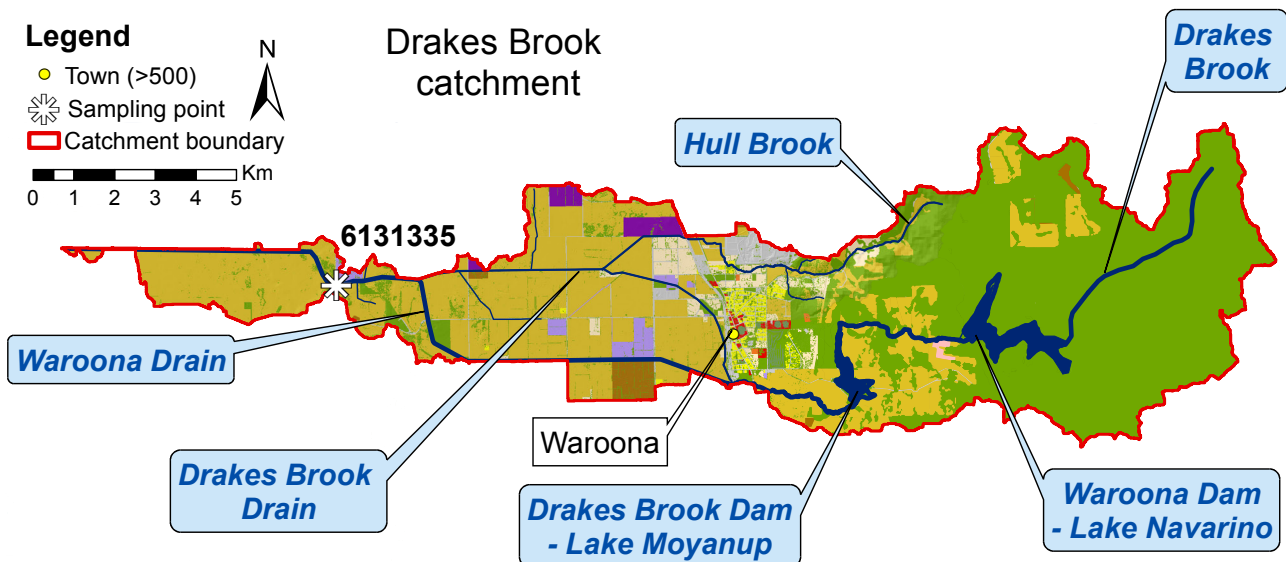
Less than 3% of the Drakes Brook catchment is subject to seasonal inundation, while 11% of the catchment has a high or very high risk of phosphorus leaching to waterways.

The catchment consists of a variety of soil types, including massive rock outcrops with acid red earths, sandy

acidic yellow mottled soils and dark porous loamy soils containing ironstone gravel.

To the east of the Darling Scarp the catchment remains relatively undisturbed. West of the scarp, the land has been cleared, mostly for agriculture such as stock grazing, as well as industry and lifestyle blocks.

Land use classification (2006)	Area	
	(km ²)	(%)
Animal keeping – non farming (horses)	0.06	0.06
Cattle for beef (predominantly)	39	37
Cattle for dairy	1.2	1.1
Conservation and natural	57	53
Horticulture	1.2	1.1
Industry, manufacturing and transport	3.1	2.9
Lifestyle block	2.6	2.4
Mixed grazing	1.1	1.0
Offices, commercial and education	0.23	0.22
Recreation	0.28	0.26
Residential	0.99	0.93
Viticulture	0.14	0.13
Total	107	100



Nutrient summary: median concentrations, loads and status classification at 6131335

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Annual flow (GL)														
TN median (mg/L)											0.56	1.0	0.92	0.77
TP median (mg/L)											0.03	0.04	0.07	0.04
TN load (t/year)														
TP load (t/year)														

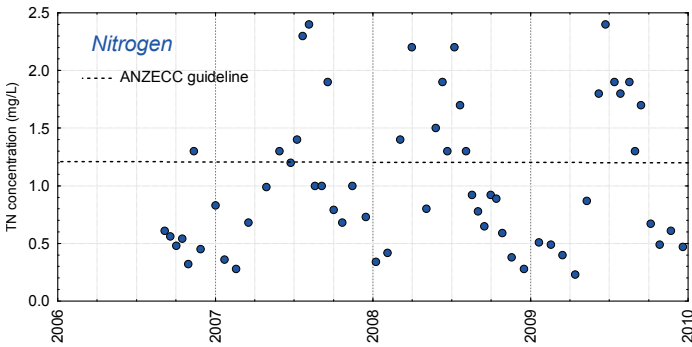
Status classification: Low (Green), Moderate (Yellow), High (Orange), Very high (Red)

Status reported for three-year period end (i.e. 1996 – 1998 reported in 1998)

* best estimate using available data

TN = total nitrogen TP = total phosphorus

Total nitrogen (TN) and total phosphorus (TP) concentrations (2006–2009)



TN concentration:

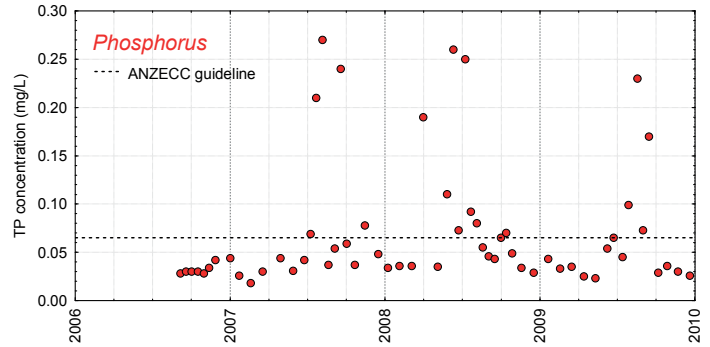
Between 2006 and 2009, an average of 36% of TN samples exceeded the ANZECC¹ guideline for lowland rivers (1.2 mg/L).

The annual percentage of TN samples that exceeded 1.2 mg/L ranged between 29% (2007) and 44% (2009).

TN trend:

Trend analysis was undertaken using data from 2006 to 2009 inclusive.

No trends were detected.



TP concentration:

Between 2006 and 2009, an average of 29% of TP samples exceeded the ANZECC¹ guideline for lowland rivers (0.065 mg/L).

The annual percentage of samples that exceeded 0.065 mg/L ranged between 25% (2009) and 42% (2008).

TP trend:

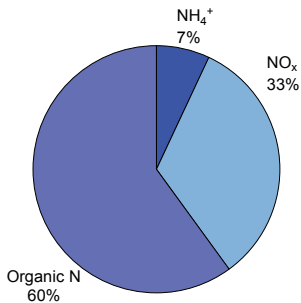
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No trends were detected.



Upstream view of Waroona Drain at 6131335 – February 2008

Nutrient fractions (2006–2009)



Nitrogen:

Most of the nitrogen (N) was organic in nature. Organic N consists of both dissolved organic and particulate nitrogen. It is derived from degrading plant and animal matter and fertilisers. It often needs to be further broken down before it can be used by plants and algae.

The remaining N was dissolved inorganic N (DIN) such as ammonium (NH_4^+) and N oxides (NO_x).

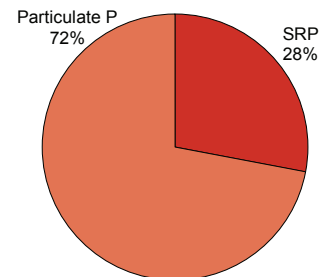
DIN is also derived from animal wastes and fertilisers but is readily available to plants and algae.

Waroona Drain had the highest percentage of NO_x of all the sampled sites. It also had the second-highest average percentage of NH_4^+ (Samson North Drain had the highest - 8%).

Phosphorus:

Nearly three-quarters of the phosphorus (P) was present as particulate P which consists of sediment bound forms of P and organic waste materials.

Particulate P is not readily available for uptake by plants and algae, but may become available over time as particles decompose or release bound phosphate.



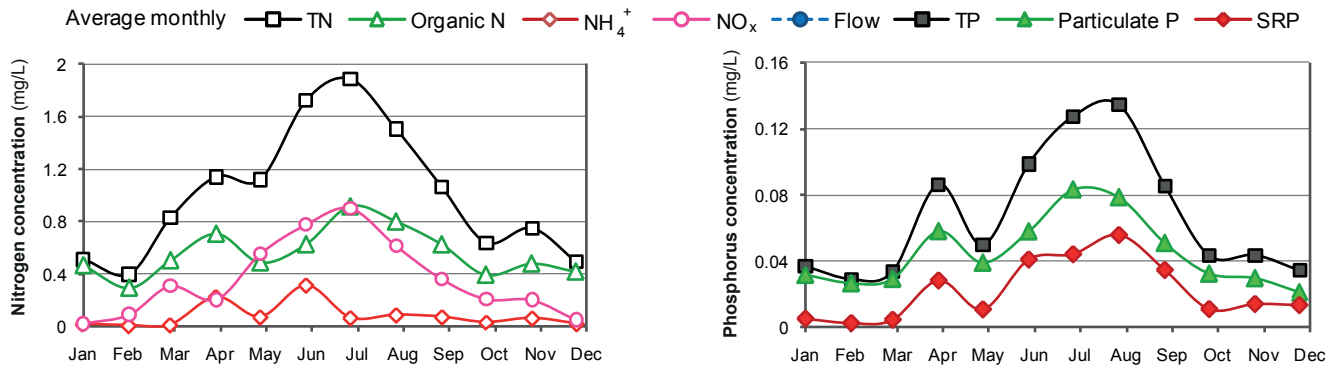
The remaining P was present as soluble reactive phosphorus (SRP). SRP is derived from fertilisers and animal wastes and is readily available for uptake by plants and algae.

Waroona Drain had the second-highest percentage of particulate P of the sampled sites (South Dandalup River had the highest - 75%) and the highest of those draining to the Harvey Estuary.



Waroona Drain – February 2008

Seasonal variation in nutrient concentrations and riverine flow (2006–2009)



Nitrogen:

Average monthly nitrogen concentrations were dominated by organic N throughout most of the year, while DIN was dominated by NO_x.

Nitrogen concentrations were generally related to flow and were greatest during autumn and winter

Average monthly concentrations of TN exceeded the ANZECC¹ guideline during winter, while average monthly NO_x concentrations exceeded the guideline for

most of the year (except summer). Average monthly concentrations of NH₄⁺ only exceeded the guideline occasionally, generally coinciding with an increase in flow.



Erosion along Waroona Drain – October 2009

Phosphorus:

Average monthly phosphorus concentrations were dominated by particular P and were greatest after the first flush in April and during winter.

Average monthly TP concentrations exceeded the ANZECC¹ guideline during April and throughout winter. Average monthly SRP concentrations also exceeded the guideline concentrations during winter

	ANZECC 2000	Months exceeded
TN	1.2 mg/L	Jun – Aug
NH ₄ ⁺	0.08 mg/L	Apr, Jun, Aug
NO _x	0.15 mg/L	Mar – Nov
TP	0.065 mg/L	Apr, Jun – Sept
SRP	0.04 mg/L	Jun – Aug

Lake Navarino, Waroona Dam, Drakes Brook and Drakes Brook Dam (May 2011)



Above: Spillway from Waroona Dam



Above: Drakes Brook flowing downstream at Waroona Dam

Below: Lake Navarino, Waroona Dam



Below: Drakes Brook looking upstream to Drakes Brook Dam (the green in the background)

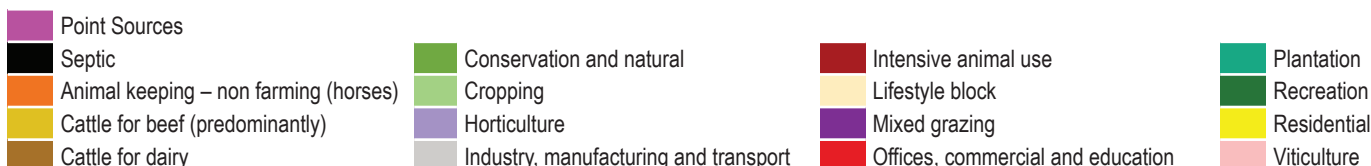
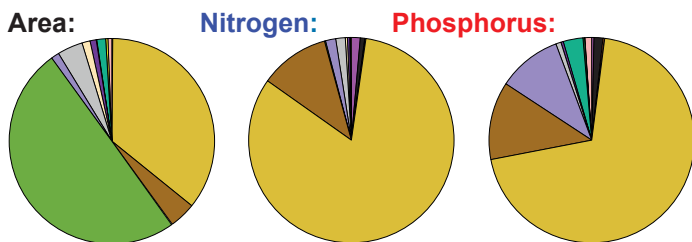


Modelled results (1997–2007)²

This page reports results from the Streamflow Quality Affecting Rivers and Estuaries (SQUARE) model. It estimated flow, nitrogen and phosphorus loads at the outlets of the 13 sub-catchments of the Peel-Harvey estuary. Outputs for the Harvey catchment include the Harvey River, Samson Brook and Drakes Brook - Waroona Drain sub-catchments.

Nutrient sources

'Cattle for beef' followed by 'cattle for dairy' were the dominant nutrient sources in the Harvey catchments. While they only covered 42% of the catchment they contributed 94% of the total nitrogen and 83% of the total phosphorus load. 'Horticulture' contributed a substantial percent of the phosphorus load, despite its small area.



Annual exports to Harvey Estuary

The Harvey catchment is 71% of the area that drains to the Harvey Estuary. On average it contributed to the Harvey Estuary:

- 76% of the flow (142 GL/year)
- 78% of the nitrogen load (259 tonnes/year)
- 57% of the phosphorus load (39 tonnes/year).

Remediation priority

The SQUARE-modelled data indicated that based on nutrient loads per cleared area (kg/ha/year)¹:

- Harvey catchment requires high-priority nitrogen and low-priority phosphorus remediation action

The Harvey catchment had the second-highest nitrogen load per cleared area of all the Peel-Harvey catchments.

It had the highest TP load (tonnes/year) however the load per cleared area was less than those for Coolup (Peel and Harvey) and Meredith Drain.

How Harvey fits within the Peel-Harvey catchment: location and statistics



Catchment draining to estuary	Area (km ²)	Flow (GL)	TN load (tonnes/year)	TN load per cleared area (kg/ha)	TP load (tonnes/year)	TP load per cleared area (kg/ha)
Peel Main Drain	120	11	26	3.0	4.5	0.52
Upper Serpentine	502	55	106	3.8	21	0.75
Dirk Brook – Punrak Drain	134	18	51	7.5	5.6	0.82
Nambeelup	143	19	44	3.6	10.5	0.86
Lower Serpentine	94	6.2	9.7	1.6	2.9	0.49
Mandurah	24	3.0	7.9	5.0	1.3	0.84
Upper Murray	6 752	286	204	0.51	4.9	0.01
Lower Murray, Mid Murray and Dandalup	638	74	198	6.4	4.9	0.16
Coolup (Peel)	151	23	42	3.2	15	1.2
Subtotal Peel Inlet	8 558	496	701	1.4	73	0.14
Coolup (Harvey)	113	16	26	3.3	14	1.8
Mayfield Drain	119	19	33	3.1	7.1	0.67
Harvey	710	142	259	6.9	39	1.0
Meredith Drain	56	11	16	4.3	8.3	2.2
Subtotal Harvey Estuary	998	188	334	5.6	69	1.2
Total Peel-Harvey Estuary	9 556	684	1 035	1.8	142	0.25

References

- ¹ ANZECC & ARMCANZ 2000, *Australian guidelines for water quality monitoring and reporting*, National Water Quality Management Strategy, Paper No 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- ² Kelsey, P, Hall, J, Kretschmer, P, Quinton, B & Shakya D 2010, *Hydrological and nutrient modelling of the Peel-Harvey catchment*, Water Science Technical Series, Report no. 33, Department of Water, Western Australia.