Department of **Water and Environmental Regulation**
Department of **Primary Industries and Regional Development**
GOVERNMENT OF WESTERN AUSTRALIA

Hardy Inlet catchment

HEALTHY ESTUARIES WA

Nutrient report 2023

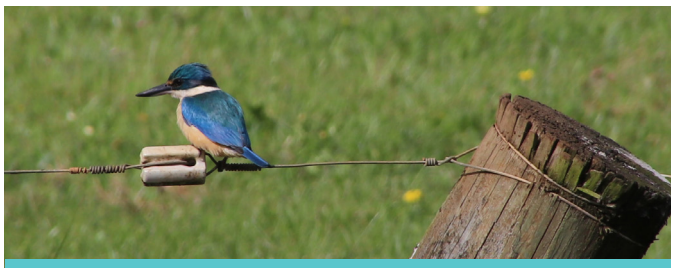
This data report provides a summary of nutrients in the waterways of the Hardy Inlet catchment in 2023. Excess nutrients are one of the most significant pressures on our waterways and estuaries, and can lead to algal blooms and fish kills.

About the catchment

The Hardy Inlet (Talinup-Goorbilyup) has a total catchment area of about 22,490 km^2 which is made up of the Upper Blackwood (21,150 km^2), Lower Blackwood (670 km^2) and Scott (670 km^2) catchments. About 70 per cent of the catchment has been cleared, mostly for wheat, livestock grazing and plantations. Some rivers have been partially modified to allow better drainage and drains have been constructed in some areas to help speed up water removal from the landscape. The combination of increased drainage and the land uses in the catchment increases the concentrations of nutrients in the waterways and changes the hydrological pathways (which determine how much and when water flows into the inlet). Together with climate change, this puts pressure on the Hardy Inlet. Soil types also influence nutrient concentrations (especially phosphorus) as some soil types bind phosphorus, preventing it from entering waterways, better than others.

Two rivers contribute most of the flow to the Hardy Inlet: the Blackwood and Scott rivers. Both the Scott and Lower Blackwood rivers receive flow and nutrients from a number of smaller subcatchments. The Upper Blackwood River catchment extends inland past Kukerin and has a very different climate, soils and land use to the Lower Blackwood and Scott river catchments.

Monitoring is carried out fortnightly at 18 sites in 14 subcatchments with most sites located near the bottom of the subcatchments.



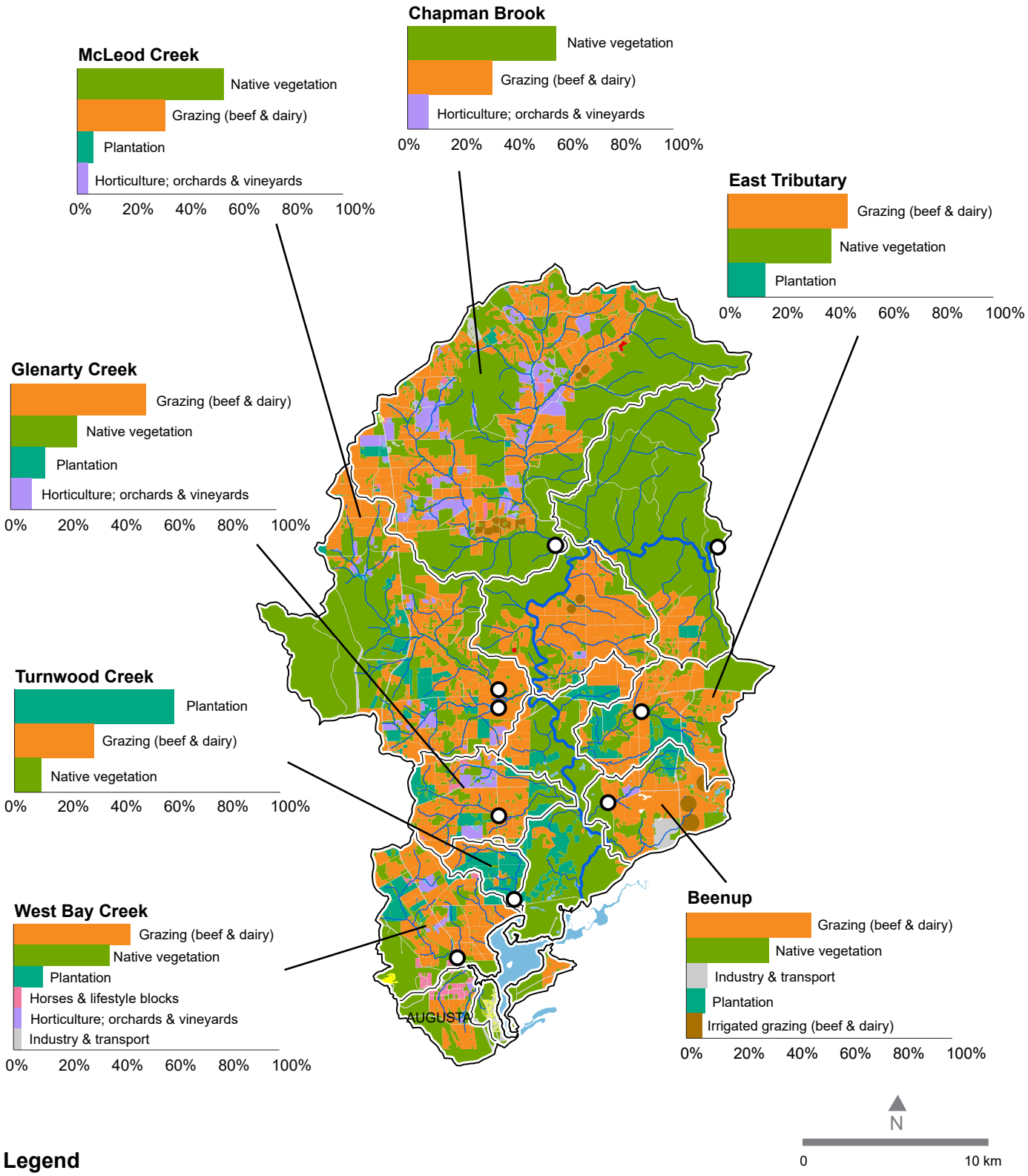
Key points:

- The Scott catchment is a priority for management, particularly the Lower Scott, Four Acres and Dennis subcatchments due to their extremely high nutrient concentrations.
- Nutrient concentrations remain low at the Upper Scott sampling site which has extensive native vegetation upstream.
- The Blackwood catchment generally has good water quality with the East Tributary subcatchment the only one that is a priority for management.

Facts and figures

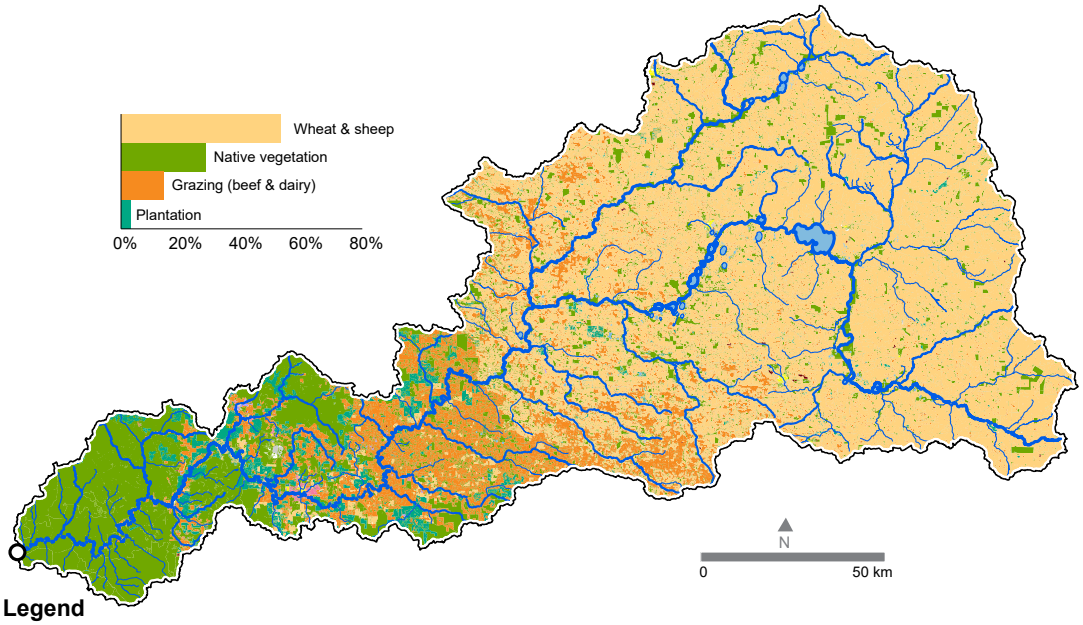
Catchment area	22,490 km^2
Per cent cleared area (2018)	70 per cent
Main rivers flowing into Hardy Inlet	Blackwood and Scott rivers
River flow to Hardy Inlet (2023)	268 GL
Main land use (2018)	Wheat, native vegetation, and sheep & cattle grazing

Lower Blackwood River catchment land use map



The percentage land use graphs show the most common land use in each subcatchment. Graphs have only been prepared for the monitored subcatchments.

Upper Blackwood River catchment land use map



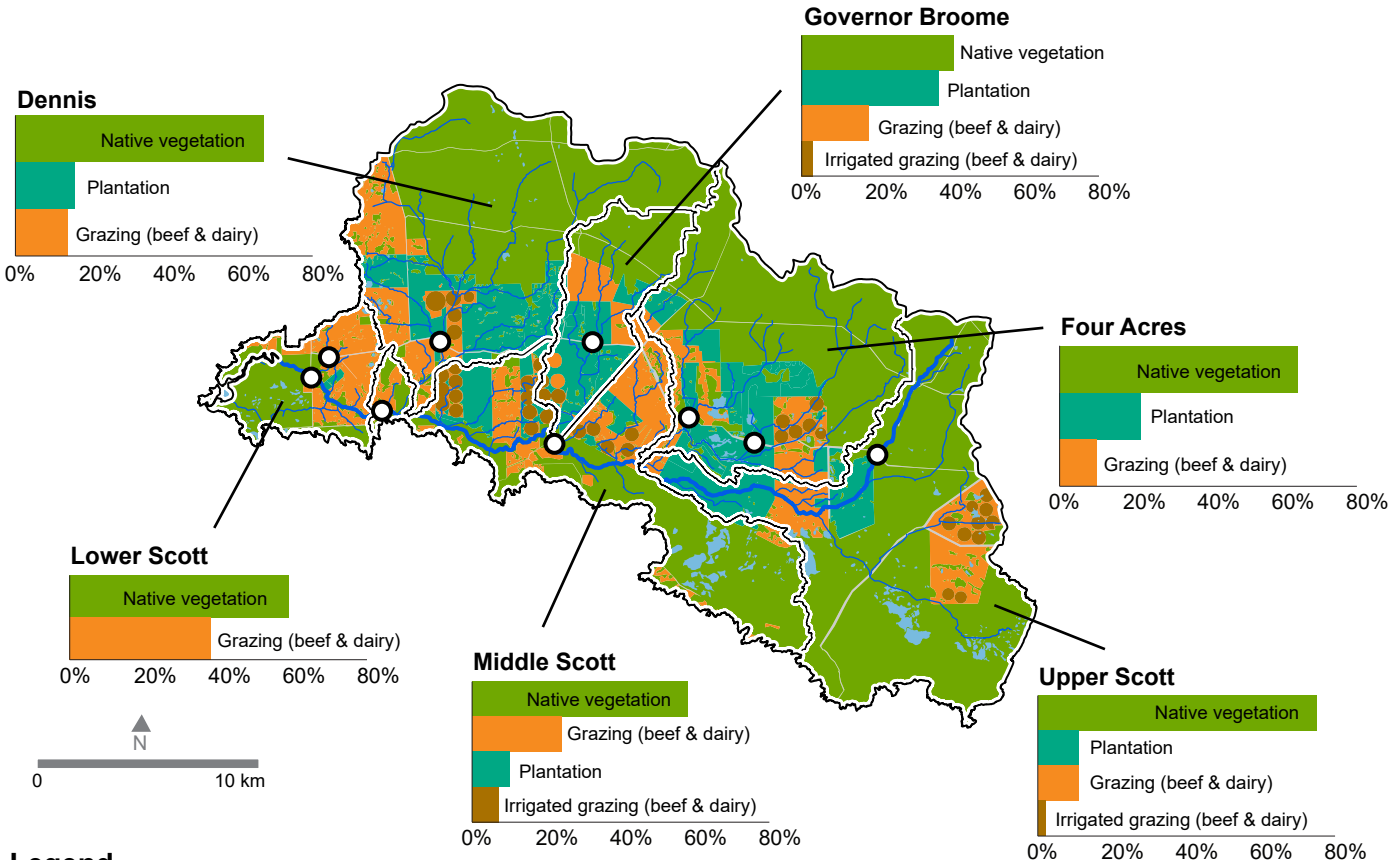
Legend

- Grazing (beef & dairy)
- Horses & lifestyle blocks
- Horticulture & orchards
- Industry & transport
- Intensive animal use & point sources
- Native vegetation
- Plantation
- Urban & recreation
- Water body
- Wheat & sheep
- Sampling site
- Waterways

Map adapted from WA landuse 2018 (DPIRD)

The percentage land use graph shows the most common land use in the subcatchment.

Scott River catchment land use map



Legend

- Grazing (beef & dairy)
- Industry & transport
- Irrigated grazing (beef & dairy)
- Native vegetation
- Plantation
- Urban & recreation
- Subcatchments
- Waterways
- Water body
- Sampling sites

Map adapted from WA landuse 2019 (DPIRD)

The percentage land use graphs show the most common land use in each subcatchment. Graphs have only been prepared for the monitored subcatchments.

Blackwood subcatchment summaries (2023)

Subcatchments are smaller areas of water catchments where all the rain falling in the local area flows to the same waterway or waterways.

Upper Blackwood River

Water quality in the Upper Blackwood is good, meeting both our nitrogen and phosphorus water quality objectives. Because of its large flow volume, it contributes the largest nitrogen load to the inlet, but actual nitrogen concentrations remain low. The Upper Blackwood is the saltiest of all the subcatchments.

Chapman Brook

Water quality in Chapman Brook is good and met our water quality objectives. However, the proportion of nitrogen present as nitrate, which can cause algal blooms and fish kills, is the largest of all the subcatchments.

McLeod Creek

Water quality in the McLeod Creek subcatchment is mostly good with both the Rushy Creek site and the McLeod Creek site meeting our water quality objectives. The McLeod Creek site had the largest range in nitrogen concentrations of the Blackwood subcatchments, with the highest concentrations occurring during the drier months when nitrate concentrations were also high. Targeting these high nitrogen concentrations should be a priority for management.

Glenarty Creek

Water quality in Glenarty Creek is good, meeting our water quality objectives. However, some high nitrogen concentrations were observed when the creek first started to flow (the creek usually dries over summer).

Turnwood Creek

Turnwood Creek has good water quality, meeting both our phosphorus and nitrogen water quality objectives. Nitrogen concentrations are influenced by the growing cycles of the upstream plantations, generally being lower once the trees are established.

West Bay Creek

Water quality in West Bay Creek is good, meeting our water quality objectives. It has the smallest proportion of nitrogen present as dissolved inorganic nitrogen, which can cause algal blooms and fish kills when in excess concentrations.

Beenup

While phosphorus concentrations are higher at Beenup than all other Blackwood sites (except for East Tributary), both nitrogen and phosphorus concentrations met our water quality objectives.

East Tributary

East Tributary is a priority for management. It is the only Blackwood subcatchment that does not meet our nitrogen and phosphorus water quality objectives and there is a large proportion of phosphorus present as phosphate, which can cause excess plant growth, algal blooms and fish kills.

Scott subcatchment summaries (2023)

Lower Scott

Water quality in the Lower Scott subcatchment is poor with both the Brennans Bridge (located on the Scott River) and White Pole (located on a tributary of the Scott River) sites not meeting our water quality objectives. Nitrogen concentrations at White Pole were the worst of the Scott subcatchments, likely due to the upstream dairy land use. This subcatchment is a priority for management.

Middle Scott

Water quality in the Middle Scott subcatchment is poor with both the Brennans Ford and the Milyeannup Bridge sites not meeting our water quality objectives. The nutrient loads at Brennans Ford are large and contribute more than three-quarters of the phosphorus entering the Hardy Inlet. Due to the large load per square kilometre for both nitrogen and phosphorus, the Scott catchment as a whole is a higher priority for management than the Blackwood catchment.

Dennis

Water quality at Dennis met both our nitrogen and phosphorus water quality objectives. This is unusual as nitrogen concentrations usually exceed our objective. Ongoing monitoring will help determine if this was a once-off or if water quality is improving. The large proportion of nitrogen present as total ammonia, which can cause algal blooms and fish kills, is typical of a site which has a dairy shed in close proximity upstream. While this site meets our water quality objectives it remains a priority for management due to the large proportion of total ammonia, and the continued presence of samples with high total nitrogen concentrations.

Governor Broome

The water quality in Governor Broome met our phosphorus but not our nitrogen water quality objective. Water quality, especially nitrogen, at this site appears to be influenced by the growing cycles of the upstream blue gum plantations, generally being lower once the trees are established.

Four Acres

Water quality in the Four Acres subcatchment is poor with both the S Bend and the Electric Fence sites not meeting our water quality objectives. The proportion of nitrogen present as total ammonia, which can cause algal blooms and fish kills, is highest at S Bend and strongly suggests that dairy effluent is contaminating the stream and groundwater. S Bend is the worst site in the Hardy Inlet catchment in terms of nutrients and the highest priority for management.

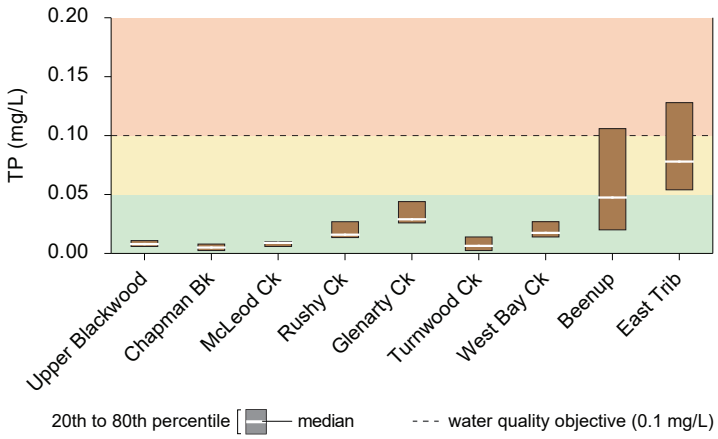
Upper Scott

The Upper Scott catchment has good water quality with both nitrogen and phosphorus meeting our water quality objectives. This is the only subcatchment that is not a priority for management in the Scott River catchment. Almost the entire subcatchment upstream of our sampling site is covered in native vegetation.

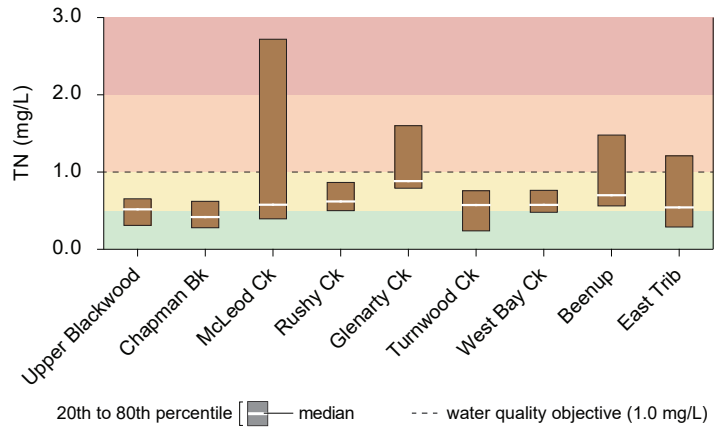
Nutrient concentrations Blackwood catchment (2023)

Nutrient concentrations varied between the monitored sites in the Blackwood catchment. Total phosphorus concentrations were highest at the Beenup and East Tributary sites though all sites' medians were below the water quality objective of 0.1 mg/L. Beenup and East Tributary also had the largest range in phosphorus concentrations. Apart from these two sites, phosphorus concentrations were low with all data between the 20th and 80th percentiles falling in the low category.

Total nitrogen concentrations showed a similar pattern as phosphorus concentrations; however the highest median was recorded at Glenarty Creek, and the largest range in concentrations at McLeod Creek. The highest TN concentrations at McLeod Creek occurred between January and April and nitrate concentrations were also high at this time, suggesting there was runoff from an upstream land use impacting this site.



2023 Total phosphorus concentrations in the Blackwood subcatchments



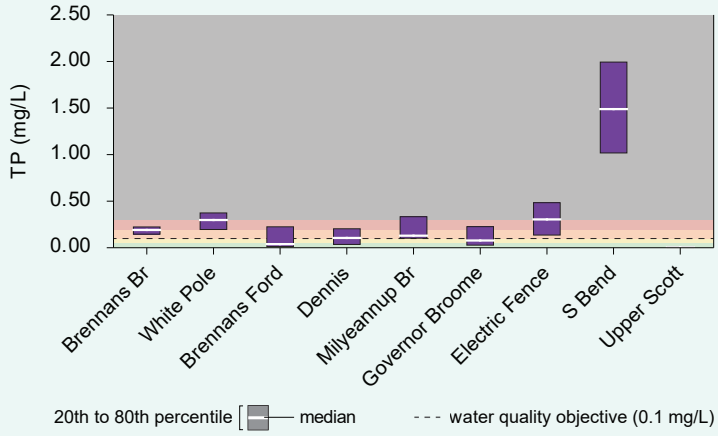
2023 Total nitrogen concentrations in the Blackwood subcatchments

low moderate high very high extreme

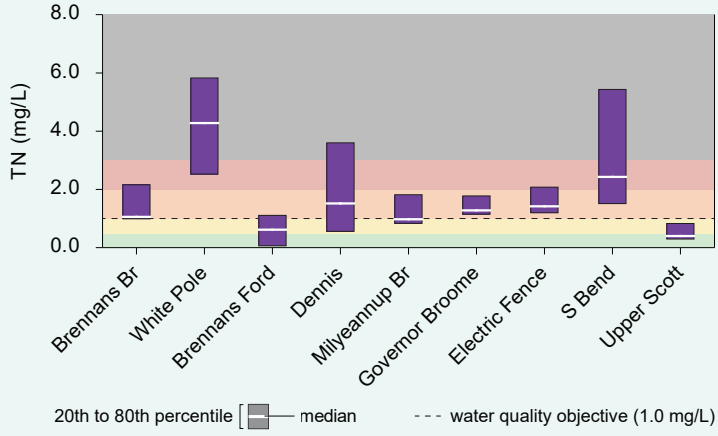
Nutrient concentrations Scott catchment (2023)

Nutrient concentrations at the Scott catchment sites were generally much higher than at the Blackwood catchment sites. Nutrient concentrations were particularly high at S Bend (both nitrogen and phosphorus) and White Pole (nitrogen, though phosphorus concentrations were also very high). Both sites, as well as Dennis, have dairy land use upstream of the sampling sites.

The Upper Scott was the only site with low nutrient concentrations in the Scott catchment. In fact, phosphorus concentrations were so low that they are not visible in the graph on the right. This is because almost the entire catchment above this site is covered in native vegetation. The high nutrient concentrations at the other sites are due to the land use in these subcatchments, the construction of drainage channels to reduce waterlogging and the presence of soils that have a poor ability to bind phosphorus.



2023 Total phosphorus concentrations in the Scott subcatchments



2023 Total nitrogen concentrations in the Scott subcatchments

low moderate high very high extreme

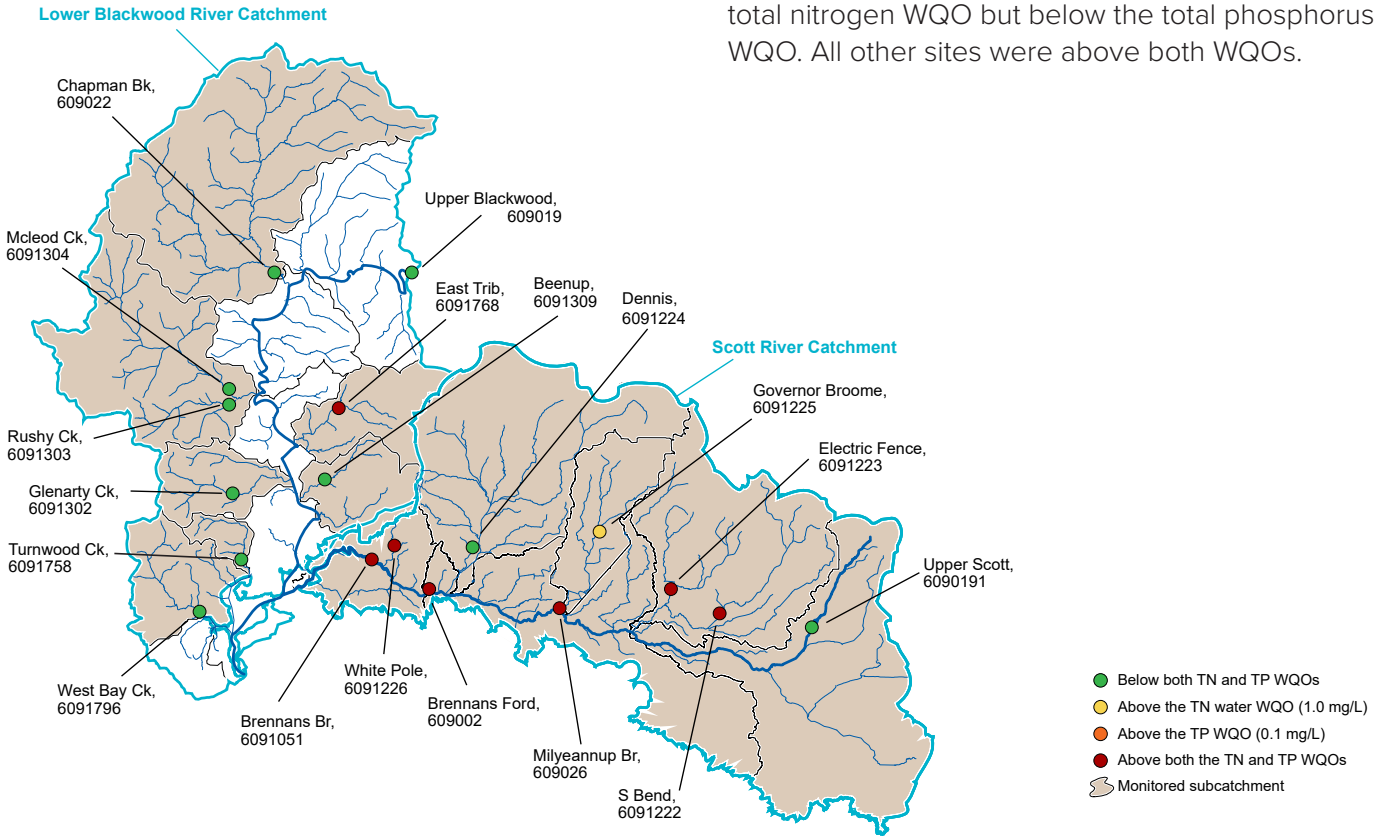
Performance against water quality objectives (2021–23)

Water quality objectives (WQOs) are the nutrient concentrations we aim for to protect the health of the inlet. For the Hardy Inlet, only the Scott River currently has WQOs available. We have chosen to use these WQOs for all sites in the Scott catchment as well as the Blackwood catchment. Performance against the WQOs was calculated by comparing the three-year (2021–23) wet months (June to October inclusive) median to the appropriate WQO.

Nutrient concentrations are higher in the Scott than the Blackwood subcatchments. There are several reasons for this, firstly land use in the Scott tends to be more intensive, with a number of dairy farms operating in the area and more irrigated grazing. Also, most of the Scott catchment lies on the Scott Coastal Plain which is low-lying land prone to waterlogging and tends to have soils with a poor capacity to bind phosphorus. To help alleviate the waterlogging, many drains have been constructed. However, water entering these drains tends to flow quickly with little chance for nutrients (e.g. from dairy effluent or fertilisers) to be assimilated along their length.

The sites located in the Blackwood catchment tended to perform well, with all but East Tributary being below both WQOs. While East Tributary and Beenup both flow into the Lower Blackwood River, the soils in these subcatchments are more similar to the soils found in the Scott catchment. These soils tend to bind phosphorus poorly, allowing it to enter waterways. This, in conjunction with the land uses present, helps explain why nutrient concentrations at these two sites tend to be higher than the other Blackwood catchment sites.

In the Scott catchment, Dennis and Upper Scott were the only two sites that were below both the total phosphorus and total nitrogen WQOs. Upstream of the Upper Scott site is almost all uncleared native vegetation so the nutrient concentrations at this site are representative of a natural catchment and are subsequently low. While Dennis was below both WQOs in 2021–23, this is unusual for this site, especially for total nitrogen. Since 2018, this site was usually above both WQO's. Ongoing monitoring will help determine if nutrient concentrations are improving or if this was an unusual result. Governor Broome was above the total nitrogen WQO but below the total phosphorus WQO. All other sites were above both WQOs.



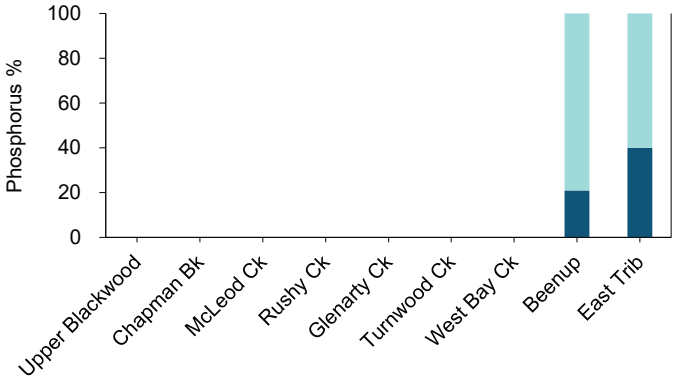
How each site performed against the TN (1.0 mg/L) and TP (0.1 mg/L) water quality objectives in 2021–23

Note: the graphs on the previous page show all data collected in 2023, whereas performance against the WQOs is calculated using three-year (2021–23) wet months (June to October) medians. This is why a median may be below the WQO in the graphs, yet the site may be shown as being above the WQO in the map, for example East Tributary in the Lower Blackwood River catchment.

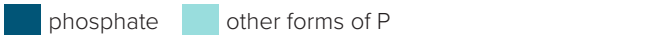
Phosphorus wet month nutrient forms (2023)

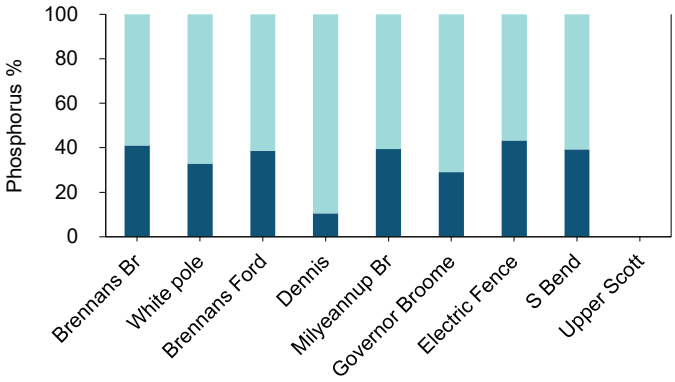
The proportion of phosphorus present as **phosphate**, which can lead to algal blooms and fish kills, was between thirty and forty percent at most sites, with only Beenup in the Blackwood catchment and Dennis in the Scott catchment having a lower proportion present.

At Dennis, the proportion of phosphate is likely influenced by the upstream blue gums. Nutrient contribution from blue gums vary throughout their growth cycle, with increases in nutrients (especially nitrogen) and sediments typically occurring after the trees are cleared and during the early years of re-establishment. During this period, groundwater levels and runoff into the waterways will also increase. The extra sediment entering the waterways binds to phosphate, reducing the amount of phosphate in the water—likely explaining the low proportion observed at Dennis.



Proportion of different forms of phosphorus in the Blackwood subcatchments in the wet months (June to October) of 2023





Proportion of different forms of phosphorus in the Scott subcatchments in the wet months (June to October) of 2023

NOTE: where there is no data shown for a site, it means that a large proportion of the collected samples had very low concentrations, below the laboratory limit of reporting.

Total phosphorus and total nitrogen are made up of different forms, or fractions, of phosphorus and nitrogen. Understanding which forms occur helps us to determine the likely sources of the nutrients, and better target management actions.

Phosphate is readily used by plants and algae and can cause excess plant growth, algal blooms and fish kills. It is mostly derived from animal waste and fertilisers and, to a smaller extent, from natural sources. **Other forms of phosphorus** include either particulate phosphorus, dissolved organic phosphorus, or both. Particulate phosphorus usually needs to be broken down before it can be used by plants and algae. The bioavailability of dissolved organic phosphorus varies and is poorly understood.

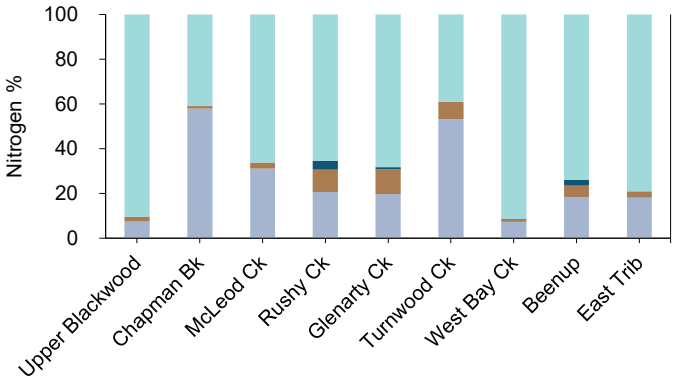
Dissolved organic nitrogen comes from both natural and human sources and consists of various compounds. Some, like urea (found in fertiliser and animal urine), are bioavailable to algae. Others, like proteins and humic acids which mostly come from broken down pasture and manure as well as natural vegetation, need to be broken down further before plants and algae can use them. **Particulate nitrogen**, which comes from plant and animal matter, also generally needs to be broken down before it can be used by plants and algae.

Dissolved inorganic nitrogen (**nitrate** and **total ammonia**) is readily used by plants and algae and can cause excess plant growth, algal blooms and fish kills. These nitrogen forms are typically at their highest levels when waterways begin to flow after autumn or winter rains. This is because, during summer, organic nitrogen in the soil and dry waterways breaks down into nitrate and total ammonia. Additionally, fertilisers and animal waste accumulate on agricultural land. When the rainfall starts, it washes this nitrogen into the waterways.

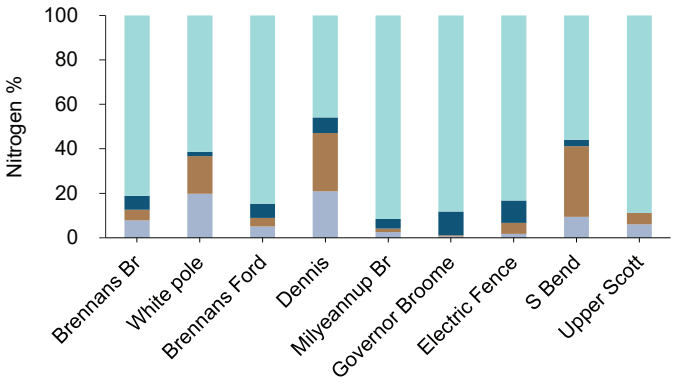
Nitrogen wet month nutrient forms (2023)

Dissolved organic nitrogen was the most common form of nitrogen during the wet months at most sites in the Hardy Inlet catchment. The proportion of nitrogen present as **nitrate**, which can lead to algal blooms and fish kills, was highest at Chapman Brook and Turnwood Creek in the Blackwood catchment.

Total ammonia contributed a significant proportion of nitrogen at multiple sites, especially S Bend, Dennis and White Pole, in the Scott catchment, all of which have dairy land use upstream of the sampling sites. S Bend and Dennis also have dairy sheds, and irrigated dairy pastures associated with these sheds. It is highly likely that the total ammonia at these sites is coming from the upstream dairy land use. Excess total ammonia can lead to algal blooms and fish kills; it also tends to breakdown relatively quickly to nitrate when there is sufficient oxygen present. This usually means that high concentrations of ammonia in a waterway are caused by a point source (such as a dairy shed) not far upstream which may be discharging directly to the waterway, or contaminating the groundwater which then flows into the waterway.



Proportion (percent) of different forms of nitrogen in the Blackwood subcatchments in the wet months (June to October) of 2023



Proportion (percent) of different forms of nitrogen in the Scott subcatchments in the wet months (June to October) of 2023

nitrate
total ammonia
Particulate N
Dissolved organic N

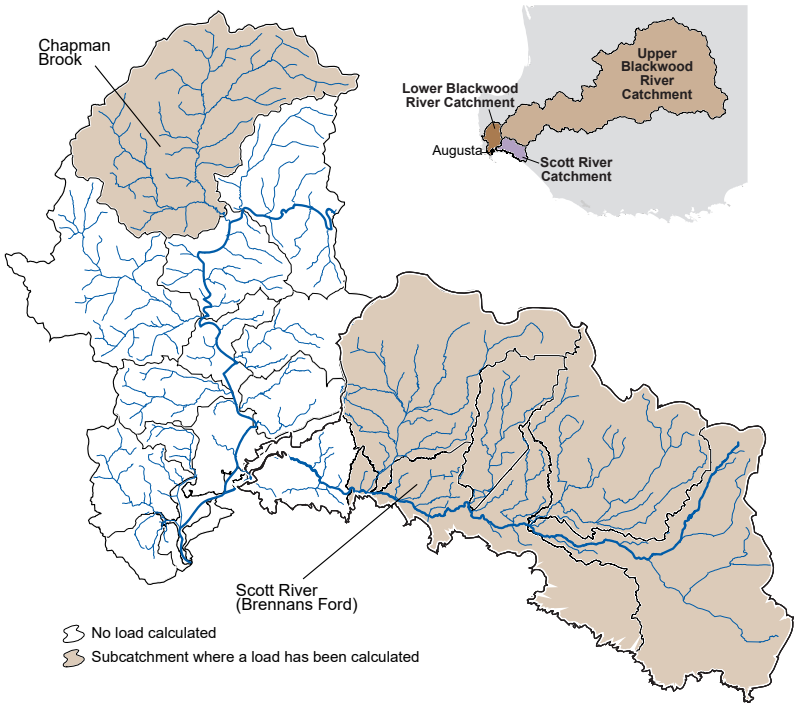
Flow and nutrient loads to the inlet (2023)

The Upper Blackwood River contributes by far the largest amount of flow to the Hardy Inlet (nearly 70 per cent). This is not surprising considering its large size. It is worth noting that a large portion of the Upper Blackwood does not contribute flow year-round, with the upper parts in particular contributing flow only infrequently and draining internally for most of the time.

While there are a number of subcatchments that contribute flow (and hence nutrients) directly to the estuarine portions of the rivers and the inlet, the loads from these subcatchments are small compared to the three presented subcatchments: the Scott (Brennans Ford), Upper Blackwood and Chapman Brook. We also lack flow data for these smaller subcatchments. For these reasons, loads for these smaller subcatchments are not included here.

Total phosphorus loads are not as closely related to flow as total nitrogen loads with the Scott (Brennans Ford) contributing a much larger load than its flow would predict (21 per cent of the flow but 78 per cent of the total phosphorus load). This is due to the much higher phosphorus concentrations in the Scott subcatchment.

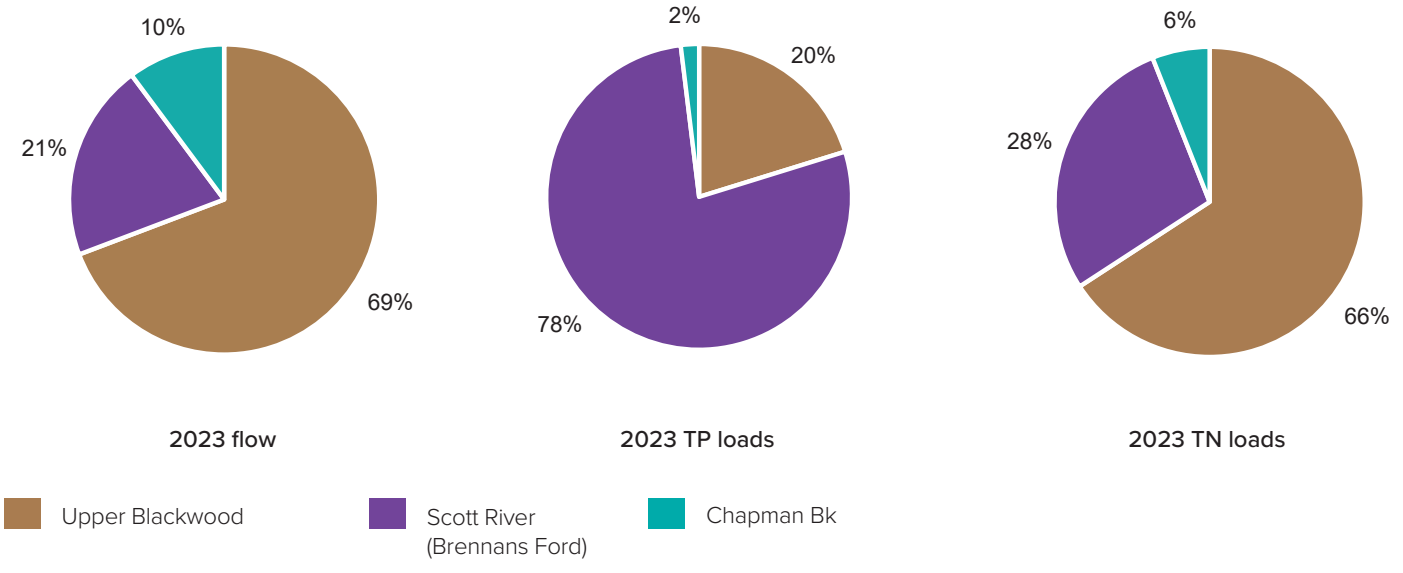
It is also worth noting that nutrients entering the Hardy Inlet from the Blackwood River tend to be diluted by the inlet's waters much more quickly than nutrients from the Scott River. This is because the water from the Scott River tends to get retained behind Molloy Island, significantly slowing down its progress into the rest of the Hardy Inlet. This is why the nutrient concentrations in this portion of the inlet are often high and is also the probable reason that Lyngbya-like blooms have been most prevalent here.



Subcatchments for which a load entering the inlet has been calculated

While nutrient loads show where most of the nutrients are entering the inlet from, they are heavily influenced by annual changes in flow volume. Concentrations, on the other hand, are less affected by flow variations and therefore provide a better measure for water quality objectives than loads do.

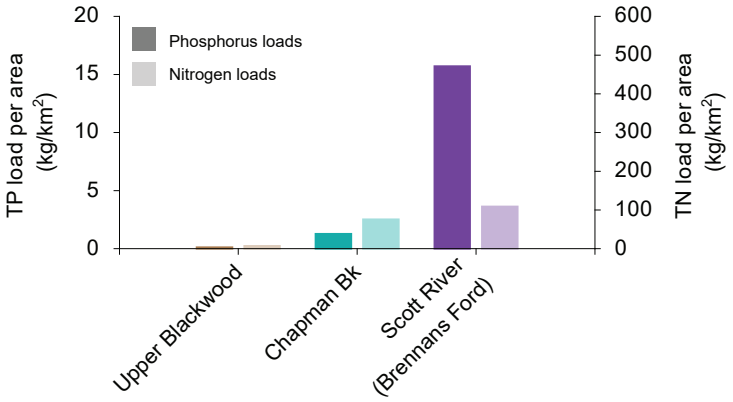
It's important to note, these measurements are taken at the sampling sites, so any flow or nutrients entering the rivers downstream of these locations are not included in the data presented here.



Nutrient loads per square kilometre (2023)

Another way to present nutrient load data is to divide the total annual load at a site by the area of land contributing to that load, giving a load per square kilometre. This helps prioritise management actions as it allows us to identify subcatchments where actions in the catchment to reduce nutrient losses are likely to have the biggest impact.

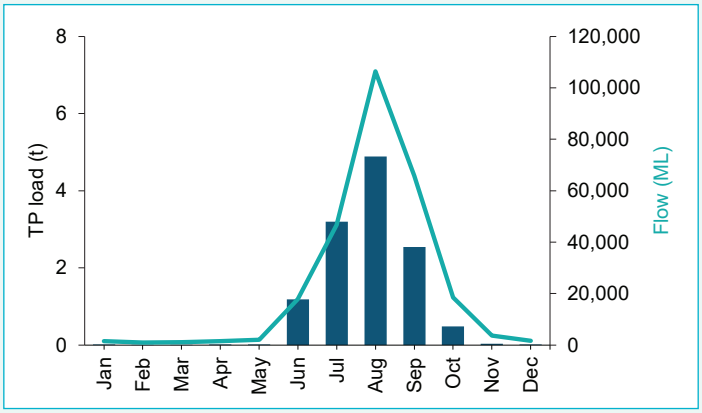
The Scott River (Brennans Ford) has by far the largest load per square kilometre for total phosphorus, as well as the largest load per square kilometre for total nitrogen. This highlights that the Scott as a whole should be prioritised for management. It is important to note that the entire Upper Blackwood area was used for these calculations because it is not possible to determine what portion of the catchment is contributing flow at a given time. While the loads per square kilometre for the Upper Blackwood will be an underestimate, the loads per square kilometre from the Scott are still much larger.



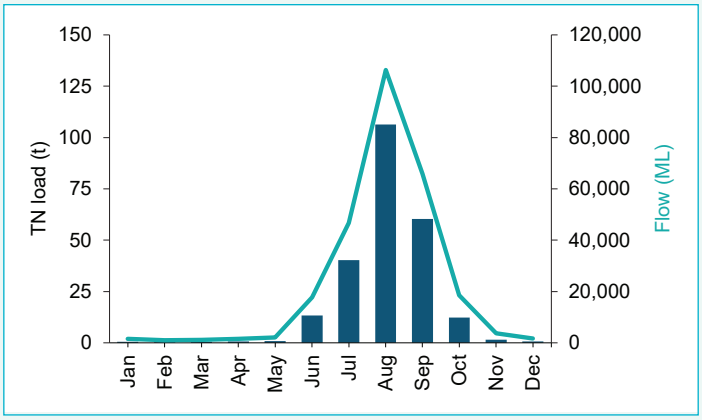
2023 loads per square kilometre for TP (dark columns, left hand axis) and TN (paler columns, right hand axis).

Monthly loads to the inlet (2023)

In 2023, the largest nitrogen and phosphorus loads entered the inlet during August when the flow volume was largest. These graphs clearly demonstrate that loads are closely linked to flow: as the flow decreased, loads also decreased. In a typical year, flow is largest during the wet months and is consequently when most of the nutrients are entering the inlet. Once they reach the inlet, nutrients from the Blackwood are usually diluted by inlet water reasonably quickly. Water from the Scott, however, gets trapped behind Molloy Island due to the narrow channels there, causing nutrients to be taken up by the sediments where they can be re-released when dissolved oxygen levels fall too low.



2023 monthly TP loads (columns) and flow (line)



2023 monthly TN loads (columns) and flow (line)

Background

Healthy Estuaries WA is a State Government program to protect and improve the health of our estuaries. Collecting and reporting water quality data, such as in this report, helps build understanding of the whole system; both the catchment and the inlet. This allows investment to be directed towards the most effective actions in the catchments to protect and restore the health of our rivers, creeks and estuaries.

Nutrients (phosphorus and nitrogen) are compounds that are important for plants to grow. Excess nutrients entering waterways from animal waste, fertilisers and other sources can fuel algal growth, decrease oxygen levels in the water and harm fish and other species.

You can find information on the condition of the Hardy Inlet at estuaries.dwer.wa.gov.au/estuary/hardy-inlet/

Healthy Estuaries WA partners with the Lower Blackwood Land Conservation District Committee (Lower Blackwood LCDC) and industry groups to fund best-practice management of fertiliser, dairy effluent and watercourses on farms.

To find out more about:

- How you can be involved visit estuaries.dwer.wa.gov.au/participate
- The Lower Blackwood LCDC go to lowerblackwood.com.au
- Dairy effluent management visit westerndairy.com.au/healthy-estuaries-wa/
- The health of the rivers in the Hardy Inlet catchment go to rivers.dwer.wa.gov.au/assessments/results

Methods

Information on the methods used can be found here: estuaries.dwer.wa.gov.au/nutrient-reports/data- analysis

Sites sampled

There are eighteen sites sampled in the Hardy Inlet catchment; nine in the Blackwood catchment and nine in the Scott River catchment, see the list below. Not all sites had flow data so it was not possible to calculate loads at all sites. The number next to the site name is the unique Australian Water Resource Council code for that site.

Upper Blackwood
- Upper Blackwood, 609019

Chapman Brook
- Chapman Bk, 609022

McLeod Creek
- McLeod Ck, 6091304
- Rushy Ck, 6091303

Glenarty Creek
- Glenarty Ck, 6091302

Turnwood Creek
- Turnwood Ck, 6091758

West Bay Creek
- West Bay Ck, 6091796

Beenup
- Beenup, 6091309

East Tributary
- East Trib, 6091768

Lower Scott
- Brennans Br, 6091051
- White Pole, 6091226

Middle Scott
- Brennans Ford, 609002
- Milyeannup Br, 609026

Dennis
- Dennis, 6091224

Governor Broome
- Governor Broome, 6091225

Four Acres
- Electric Fence, 6091223
- S Bend, 6091222

Upper Scott
- Upper Scott, 6090191

Want more?

If you would like to access the data used in the analyses in these reports, please visit: wa.gov.au/ service/natural-resources/water-resources/water- information-reporting. The numerical AWRC codes listed above can be used to search for the available data.

Hardy Inlet catchment issue 1 | February 2026

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