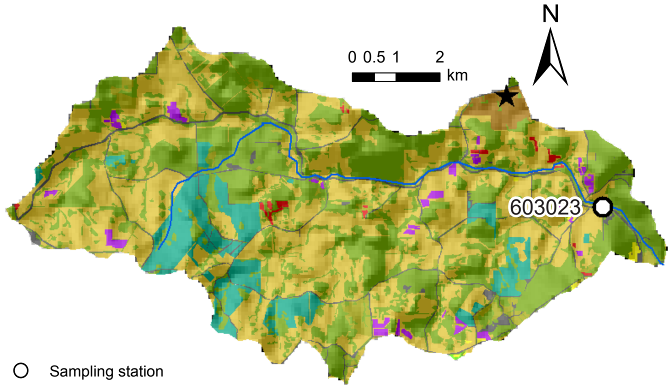
GOVERNMENT OF WESTERN AUSTRALIA
Department of **Water and Environmental Regulation**
Department of **Primary Industries and Regional Development**



# Scotsdale Brook

This data report provides a summary of the nutrients at the Scotsdale Brook sampling site in 2019 as well as historical data from 2005–19. This report was produced as part of Healthy Estuaries WA. Downstream of this site, the brook enters the Denmark River which then discharges to Wilson Inlet.




*Location of the Scotsdale Brook catchment in the greater Wilson Inlet catchment.*

## About the catchment

Scotsdale Brook has a catchment area of about 66 km$^2$, more than half of which has been cleared, mostly for beef cattle grazing (which covers more than 40 per cent of the catchment). The brook does not discharge into Wilson Inlet but, instead, joins the Denmark River in Denmark, a few kilometres above the Denmark townsite and just above the Denmark Ag sampling site.

Soils in the catchment have a good capacity to bind phosphorus, meaning that any phosphorus applied to them tends to be retained, helping to prevent it entering the waterways. While a large portion of the catchment has been cleared, the brook still retains some fringing vegetation along much of its length. Scotsdale Brook is ephemeral during low rainfall years (about half of the years included in this report).

Water quality is measured at site 603023, near Scotsdale Road in Scotsdale, a few kilometres upstream of the confluence with the Denmark River.

## Results summary

Nutrient concentrations (total nitrogen and total phosphorus) in Scotsdale Brook were classified as low (nitrogen) and moderate (phosphorus). The nutrient loads were low to moderate (nitrogen) and moderate (phosphorus) compared with the loads at the other monitored catchments. The loads per square kilometre were also moderate. Both the concentrations and loads were influenced by the agricultural land use in the catchment.

## Facts and figures

| | |
|---|---|
| Sampling site code | 603023 |
| Catchment area | 66 km$^2$ |
| Per cent cleared area (2014) | 60 per cent |
| River flow | Ephemeral, dry for a short period in summer in about half of the past 15 years |
| Main land use (2014) | Beef cattle grazing and native vegetation |

## Estimated loads and flow at Scotsdale Brook

| 603023 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow (GL) | 19 | 5.7 | 6.4 | 14 | 16.3 | 5.0 | 17 | 12 | 19 | 7.4 | 8.6 | 20 | 16 | 9.4 | 5.2 |
| TN load (t) | 18 | 4.8 | 5.7 | 15 | 17 | 4.4 | 17 | 12 | 19 | 6.2 | 7.7 | 19 | 16 | 9.0 | 4.5 |
| TP load (t) | 1.01 | 0.23 | 0.29 | 0.81 | 0.95 | 0.21 | 1.00 | 0.64 | 1.05 | 0.29 | 0.38 | 1.02 | 0.93 | 0.46 | 0.22 |

# Scotsdale Brook

## Nitrogen over time (2005–19)

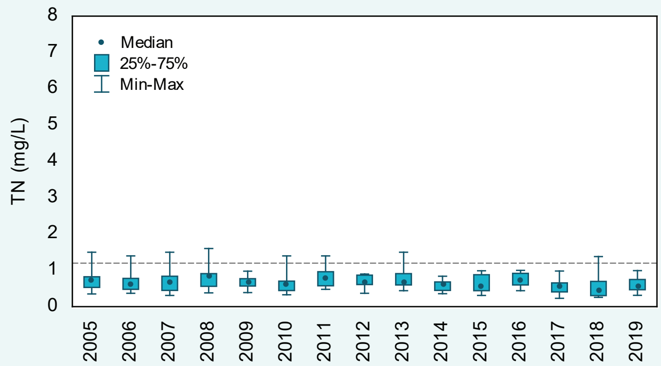
### Concentrations

Annual total nitrogen (TN) concentrations were classified as low using the Statewide River Water Quality Assessment (SWRWQA) methodology. TN fluctuated over the reporting period but the median remained below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value every year. The 2019 median concentration was the lowest of the sampled sites (0.57 mg/L). Both sites on the Denmark River (which Scotsdale Brook discharges into) had higher median concentrations (Denmark ML had a median of 0.59 mg/L and Denmark Ag a median of 0.68 mg/L).

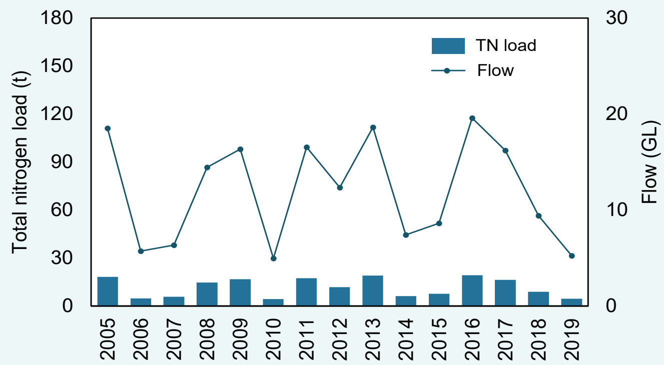
### Estimated loads

In 2019, the estimated TN load at the Scotsdale Brook sampling site was 4.5 t. The load per square kilometre was 69 kg/km$^2$. This is much larger than the load per square kilometre at Denmark Ag (which is downstream of the confluence with Scotsdale Brook) of 11 kg/km$^2$. This is caused by the more intensive land use found in the Scotsdale Brook catchment which contributes more N per square kilometre than the land use in the Denmark River catchment. Annual TN loads were closely related to flow volumes; years with large annual flow volumes had large TN loads and vice versa.

## Scotsdale Brook




*Total nitrogen concentrations, 2005–19 at site 603023. The dashed line is the ANZECC trigger value.*




*Total nitrogen loads and annual flow, 2005–19 at site 603023.*

*High water levels in Scotsdale Brook, September 2017.*

# Scotsdale Brook

## Nitrogen (2019)

### Types of nitrogen

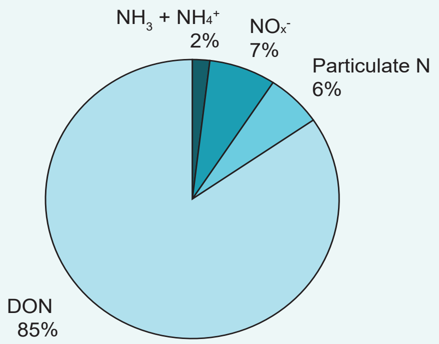
Total N is made up of different types of N. In Scotsdale Brook, most of the N was present as dissolved organic N (DON) which consists mainly of degrading plant and animal matter but may include other, bioavailable types. Particulate N is composed of plant and animal detritus. Most types of particulate N and DON need to be further broken down to become available to plants and algae, though some DON types are readily bioavailable.

Only a small proportion of N was present as dissolved inorganic N (total ammonia – $NH_3$ + $NH_4^+$ and nitrate – $NO_x^-$) which is bioavailable to plants and algae and can fuel rapid growth. Note that 10 of the 26 nitrate samples in 2019 were below the laboratory limit of reporting (LOR).

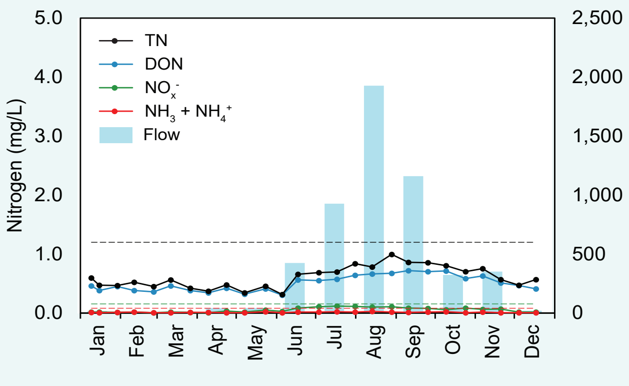
### Concentrations

N concentrations varied throughout the year with evidence of a seasonal pattern in TN, DON and nitrate. These were generally higher during the months when flow was greater. DON contributed a significant proportion of the TN year-round. This suggests DON was entering the brook via a number of pathways including surface flows as well as groundwater and in-stream sources. Overall, nitrate and total ammonia concentrations were low and were below the ANZECC trigger values on all sampling occasions.

## Scotsdale Brook




*2019 average nitrogen fractions at site 603023.*




*2019 nitrogen concentrations and monthly flow at 603023. The dashed lines are the ANZECC trigger values for the different N species.*

*Sand deposits left on the bank after a high flow event, September 2017.*

# Scotsdale Brook

## Phosphorus over time (2005–19)

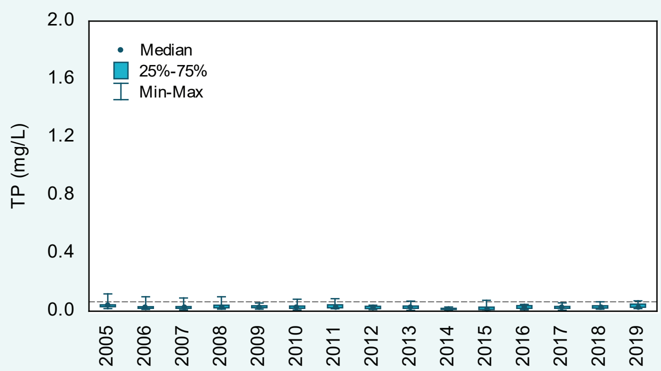
### Concentrations

Annual total phosphorus (TP) concentrations were classified as moderate using the SWRWQA methodology; however, all annual median concentrations were below the ANZECC trigger value. The Scotsdale Brook catchment has soils with a high phosphorus-binding capacity which likely contributed to the low P concentrations observed.

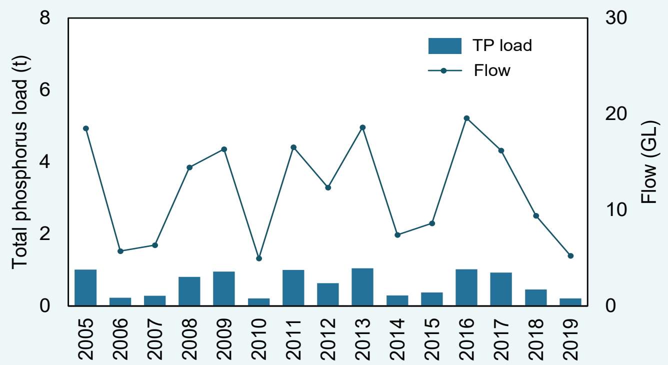
### Estimated loads

In 2019, the estimated TP load at the Scotsdale Brook sampling site was 0.22 t. The load per square kilometre was 3.4 kg/km$^2$. This was much larger than the load per square kilometre at Denmark Ag (which is downstream of the confluence with Scotsdale Brook) of 0.3 kg/km$^2$. This is caused by the more intensive land use found in the Scotsdale Brook catchment which contributes more P per square kilometre than the land use in the Denmark River catchment. Annual TP loads were closely related to flow volumes; years with large annual flow volumes had large TP loads and vice versa.

## Scotsdale Brook




*Total phosphorus concentrations, 2005–19 at site 603023. The dashed line is the ANZECC trigger value.*




*Total phosphorus loads and annual flow, 2005–19 at site 603023.*

*Low water levels in Scotsdale Brook, January 2018. Note the erosion of the banks.*

## Phosphorus (2019)

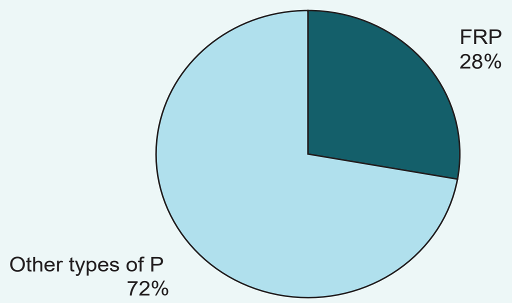
### Types of phosphorus

Total P is made up of different types of P. In Scotsdale Brook, just over a quarter of the P was present as phosphate; measured as filterable reactive phosphorus (FRP), in surface waters this is mainly present as phosphate ($PO_4^{3-}$) species and is readily bioavailable. Phosphate was probably derived from animal waste and fertilisers as well as natural sources. The remainder of the P was present as either particulate P or dissolved organic P (DOP) or both (labelled as 'Other types of P' in the pie chart below). Particulate P generally needs to be broken down before becoming bioavailable. The bioavailability of DOP varies and is poorly understood.

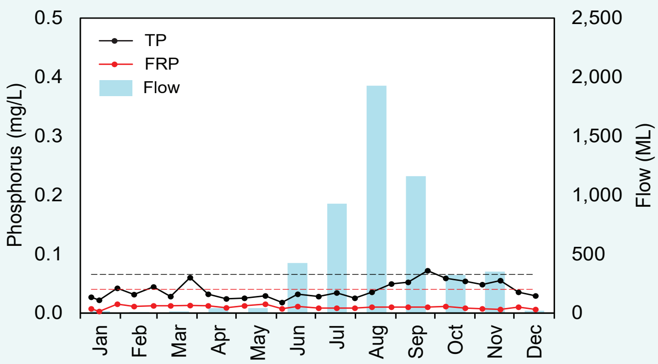
### Concentrations

Both TP and phosphate concentrations were low in Scotsdale Brook in 2019 and fluctuated over the year. TP concentrations showed a relationship to flow, increasing in August when flow volumes were at their largest. This is likely because of winter rains flushing particulate P into the brook from surrounding land use and increased flow mobilising particulate P already present in the brook. One of the reasons for the low P concentrations is the high phosphorus-binding capacity of the soils in the catchment. This means they bind P well, preventing it from entering the brook. The reason for the peak in TP concentrations in March is unknown.

## Scotsdale Brook




*2019 average phosphorus fractions at site 603023.*




*2019 phosphorus concentrations and monthly flow at 603023. The dashed lines are the ANZECC trigger values for the different P species.*

*Taking flow measurements in Scotsdale Brook during high flow, September 2017.*

# Scotsdale Brook

## Total suspended solids over time (2005–19)

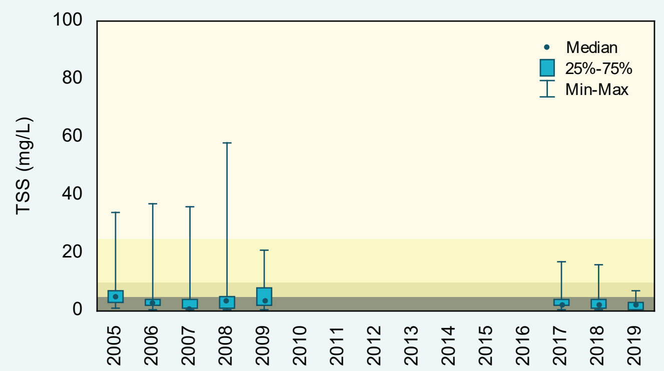
### Concentrations

Annual total suspended solids (TSS) concentrations in Scotsdale Brook were classified as low using the SWRWQA methodology. 2019 was the first year where there were no samples that fell into the high or very high classification bands. Between 2010 and 2016, TSS was collected sporadically so the data have not been graphed.

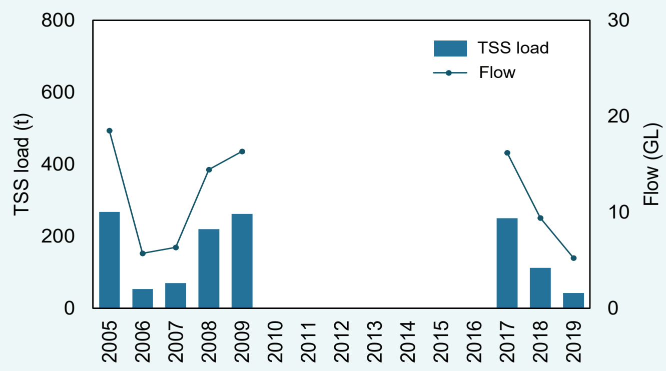
### Estimated loads

In 2019, the estimated TSS load at the Scotsdale Brook sampling site was 43 t. The load per square kilometre was 662 kg/km$^2$. This was much larger than the load per square kilometre at Denmark Ag of 35 kg/km$^2$, most likely a result of the more intense land use present in Scotsdale Brook. Annual TSS loads were closely related to flow; years with large annual flow volumes had large TSS loads and vice versa.

## Scotsdale Brook




*Total suspended solids concentrations, 2005–19 at site 603023. The shading refers to the SWRWQA classification bands.*




*Total suspended solids loads and annual flow, 2005–19 at site 603023.*

low | moderate | high | very high

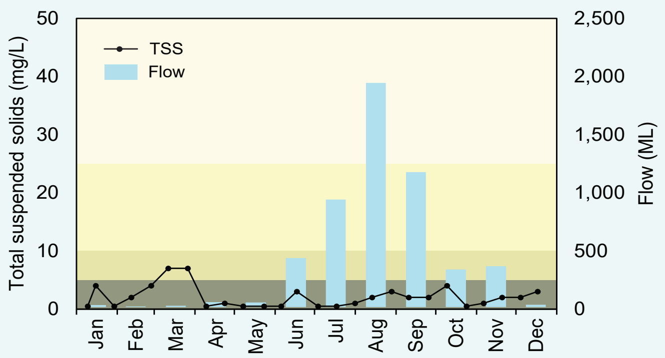
*Scotsdale Brook, showing intact fringing vegetation and a natural stream channel, June 2018.*

## Total suspended solids (2019)

### Concentrations

The seasonal pattern in TSS concentrations present in 2018 was not as evident in 2019. In 2019, the largest peak occurred in March which may be because of rainfall in that month washing particulate matter into the brook. Otherwise, TSS concentrations tended to fluctuate over the year.

## Scotsdale Brook




*2019 total suspended solids concentrations and monthly flow at 603023. The shading refers to the SWRWQA classification bands.*

low moderate high very high

*The weir at the Scotsdale Brook sampling site, note the tannin-stained water, July 2018.*

# Scotsdale Brook

## pH over time (2005–19)

### pH values

The median and most of the pH readings in Scotsdale Brook were within the ANZECC trigger values every year except 2017. pH fluctuated over the reporting period, with the exception of 2016 and 2017 when it was much lower.

There is some concern that the probe used to collect the pH data from the catchments of Wilson Inlet (including the Scotsdale Brook site) from about October 2016 to October 2017 was not functioning correctly. This may have caused the low pH values shown in the graphs below. After October 2017, a new probe was used and the pH values increased and stabilised. Although there is no way of verifying the 2016–17 pH data, they have still been presented here.

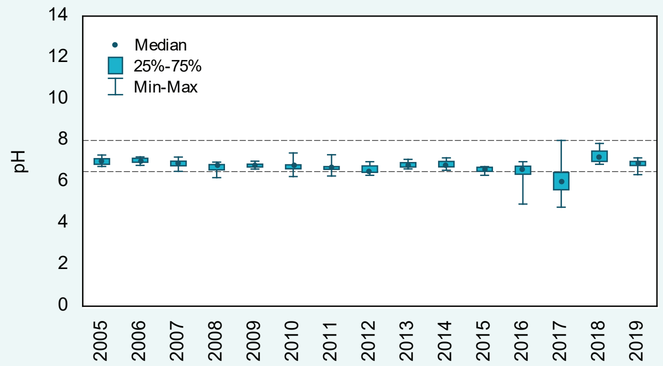
## pH (2019)

### pH values

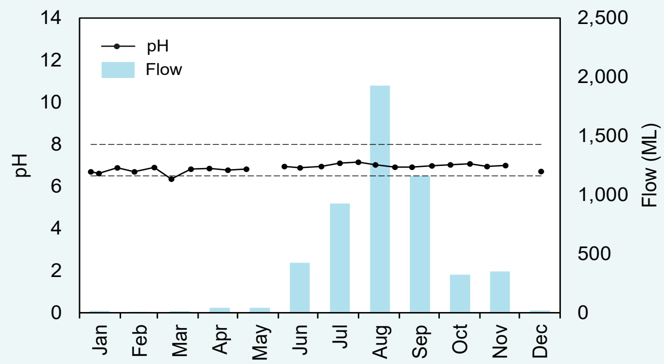
In 2019, all samples except one in March fell within the ANZECC trigger values. Unlike in 2018, there was no evidence that pH was higher in the first half of the year, with values tending to be slightly higher in the middle of the year, when flow was at its largest.

The missing data points were because the probe malfunctioning on those sampling occasion.

## Scotsdale Brook




*pH levels, 2005–19 at site 603023. The dashed lines are the upper and lower ANZECC trigger values.*




*2019 pH levels and monthly flow at 603023. The dashed lines are the upper and lower ANZECC trigger values.*

*A largely natural section of Scotsdale Brook, June 2018.*

# Scotsdale Brook

## Salinity over time (2005–19)

### Concentrations

Using the Water Resources Inventory 2014 salinity ranges, all years were classified as fresh (note, the 2018 nutrient report used the SWRWQA  bands). The 2019 median salinity was one of the lowest of the nine sites sampled (300 mg/L; Little River had a median salinity of 270 mg/L). Salinity was not measured between 2005–11.

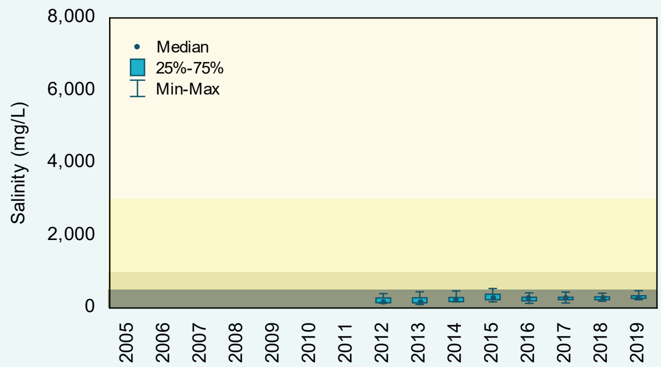
## Salinity (2019)

### Concentrations

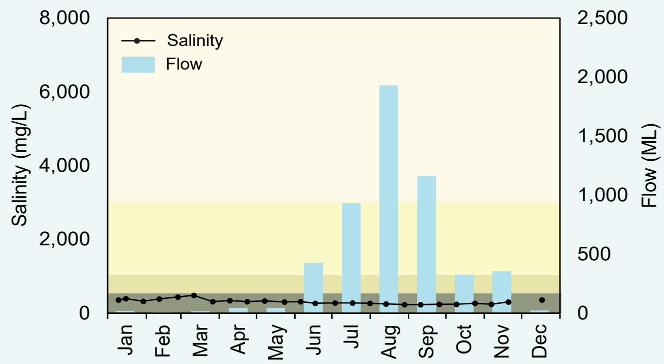
Salinity showed a very slight inverse relationship to flow volume in Scotsdale Brook. That is, when flow volumes were large, salinity levels were marginally lower than when flow volumes were small and vice versa. In 2019, all samples fell into the fresh band. Groundwater is likely slightly more saline than surface water runoff in the Scotsdale Brook catchment, though it is still fresh. Evapoconcentration in the drier months may also be contributing to the slightly higher salinities at this time.

The missing data point in early December was because the probe malfunctioning on that sampling occasion.

## Scotsdale Brook




*Salinity concentrations, 2005–19 at site 603023. The shading refers to the Water Resources Inventory 2014 salinity ranges.*




*2019 salinity concentrations and monthly flow at 603023. The shading refers to the Water Resource Inventory 2014 salinity ranges.*

fresh | marginal | brackish | saline

*Scotsdale Brook sampling site, July 2019.*

# Scotsdale Brook

## Background

Healthy Estuaries WA is a State Government program launched in 2020 and builds on the work of the Regional Estuaries Initiative. Collecting and reporting water quality data, such as in this report, helps build understanding of the whole system; both the catchment and the estuary. By understanding the whole system, we can direct investment towards the most effective actions in the catchments to protect and restore the health of our waterways.

Nutrients (nitrogen and phosphorus) are compounds that are important for plants to grow. Excess nutrients entering waterways from effluent, fertilisers and other sources can fuel algal growth, decrease oxygen levels in the water and harm fish and other species. Total suspended solids, pH and salinity data are also presented as these help us better understand the processes occurring in the catchment.

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

Healthy Estuaries WA partners with the Wilson Inlet Catchment Committee to fund best-practice management of fertiliser, dairy effluent and watercourses on farms.

- To find out how you can be involved visit estuaries.dwer.wa.gov.au/participate
- To find out more about the Wilson Inlet Catchment Committee go to wicc.org.au
- To find out more about the health of the rivers in the Wilson Inlet catchment go to rivers.dwer.wa.gov.au/assessments/results

## Methods

Variables were compared with ANZECC trigger values where available, or the SWRWQA bands or 2014 Water Resources Inventory ranges. They were classified using the SWRWQA methodology. Standard statistical tests were used to calculate trends and loads. For further information on the methods visit estuaries.dwer.wa.gov.au/nutrient-reports/data-analysis

## Glossary

**Bioavailable**: bioavailable nutrients refers to those nutrients which plants and algae can take up from the water and use straight away for growth.

**Concentration**: the amount of a substance present per volume of water.

**Evapoconcentration**: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

**First flush**: material washed into a waterway by the first rainfall after an extended dry period. The first flush is often associated with high concentrations of nutrients and particulate matter.

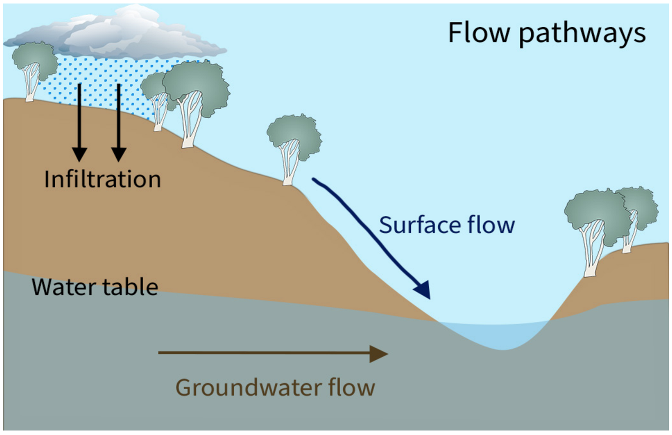
**Laboratory limit of reporting**: (LOR) this is the lowest concentration of an analyte that can be reported by a laboratory.

**Load**: the total mass of a substance passing a certain point.

**Load per square kilometre**: the load at the sampling site divided by the entire catchment area upstream of the sampling site.

**Nitrate**: The measurement for the nutrient nitrate actually measures both nitrate ($NO_3^-$) and nitrite ($NO_2^-$), which is reported as $NO_x^-$. We still refer to this as nitrate as in most surface waters nitrite is present in very low concentrations.

The schematic below shows the main flow pathways which may contribute nutrients, particulates and salts to the waterways. Connection between surface water and groundwater depends on the location in the catchment, geology and the time of year.

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