

Department of Climate Change, Energy, the Environment and Water

dcceew.nsw.gov.au



Estuary Report Card 2024-2025

Lower Hawkesbury River

July 2025





Acknowledgement of Country

The Department of Climate Change, Energy, the Environment and Water acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past and present through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

Published by NSW Department of Climate Change, Energy, the Environment and Water

dcccw.nsw.gov.au

Estuary Report Card 2024-2025

Lower Hawkesbury River

First published: July 2025

Cover photo: Mangrove Creek in the lower Hawkesbury – Jezebel Sherborne (DCCEEW)

Acknowledgements

This program was funded by the Central Coast Council.

Copyright and disclaimer

© State of New South Wales through the Department of Climate Change, Energy, the Environment and Water 2025. Information contained in this publication is based on knowledge and understanding at the time of writing, July 2025, and is subject to change. For more information, please visit dcccw.nsw.gov.au/copyright

TMP-MC-R-DC-V1.2

Contents

- Acknowledgement of Country 2
- 1 Introduction 4
 - 1.1 Background 4
 - 1.1.1 Location 4
 - 1.1.2 Program outline and scope 4
 - 1.1.3 Aims and objectives of the program 4
- 2 Methodology 5
 - 2.1 Monitoring zones & frequency 5
 - 2.1.1 Sampling methods 6
 - 2.2 Laboratory analysis 7
 - 2.3 Indicators/parameters 8
 - 2.4 Data analysis 9
 - 2.4.1 Water quality grade 9
 - 2.5 QA/QC 10
- 3 Results 11
 - 3.1 Report Card Grades 11
 - 3.1.1 Patonga Creek 11
 - 3.1.2 Mullet Creek 12
 - 3.1.3 Mooney Mooney Creek 13
 - 3.1.4 Mangrove Creek 14
- 4 Summary and discussion 15
- 5 References 19

1 Introduction

1.1 Background

The Central Coast Council (CCC) engaged the Estuaries and Catchments Team of the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to assess water quality in the Lower Hawkesbury River over the 2024-2025 financial year and provide Council with an estuary report card. The monitoring program commenced in 2018 as a 6-month program and was expanded to a 12-month program in 2023-2024 at the request of CCC. CCC recognises that long term monitoring programs are essential for tracking the ecological health of an estuary and to help identify potential areas of concern that may require additional management.

1.1.1 Location

The Lower Hawkesbury River lies to the north of Sydney, has its mouth at Broken Bay, and is known as Dyarubbin to the Darkiñung and Dharug First Nations people. The northern side of the Lower Hawkesbury River and the catchment fall within the Central Coast Council (CCC) Local Government Area (LGA).

1.1.2 Program outline and scope

The Lower Hawkesbury River water quality monitoring program was designed by DCCEEW following standardised sampling, data analysis and reporting protocols outlined in the NSW Natural Resources Monitoring, Evaluation and Reporting (MER) Program for assessing estuary health (OEH, 2016). The project monitored water quality monthly in the four tributary creeks feeding into the Lower Hawkesbury River.

1.1.3 Aims and objectives of the program

The monitoring program aims to assess water quality in the four tributary creeks of the Lower Hawkesbury River using methods that are scientifically valid and standardised. The objectives are to:

- Track change in condition and continue to build a long-term dataset to support management decisions by CCC.
- Provide CCC and the community with an annual report on estuary health.
- Establish standardised grades and reporting of estuary health that other councils with LGAs in the large catchment of the Hawkesbury River can adopt.

2 Methodology

2.1 Monitoring zones & frequency

The spatial scale of interest for the state-wide MER program is whole-of-estuary condition. As such, the state-wide program targets the assumed chlorophyll-a and turbidity maxima (OEH 2016), which is the mid to upper reaches of rivers/creeks. If feasible, rivers/creeks are sampled using a longitudinal transect from the mid-section to the upper section (OEH 2016). However, localised sampling programs such as Council MER programs, often need to consider condition at spatial scales that are smaller than the whole estuary. Localised issues may also require assessment of indicators in areas other than the assumed chlorophyll-a and turbidity maxima. In these instances, sampling zones may be smaller in size and additional zones may be added, in tributaries for example (OEH 2016).

Sampling zones were established in four tributaries to the Lower Hawkesbury River (Figure 1) based on sampling protocols outlined for the MER estuary health assessments (OEH 2016), giving consideration to:

- estuary type, size and morphology,
- access and WHS issues,
- location of established or historical monitoring sites,
- location of tributaries or other major inputs,
- local knowledge of current water quality issues.

Over a 12-month period, water quality sampling was carried out at two zones in Mullet Creek, Mooney Mooney Creek, Mangrove Creek and Patonga Creek (Figure 1). Sampling at this frequency allows both monthly and seasonal variability in water quality to be assessed.

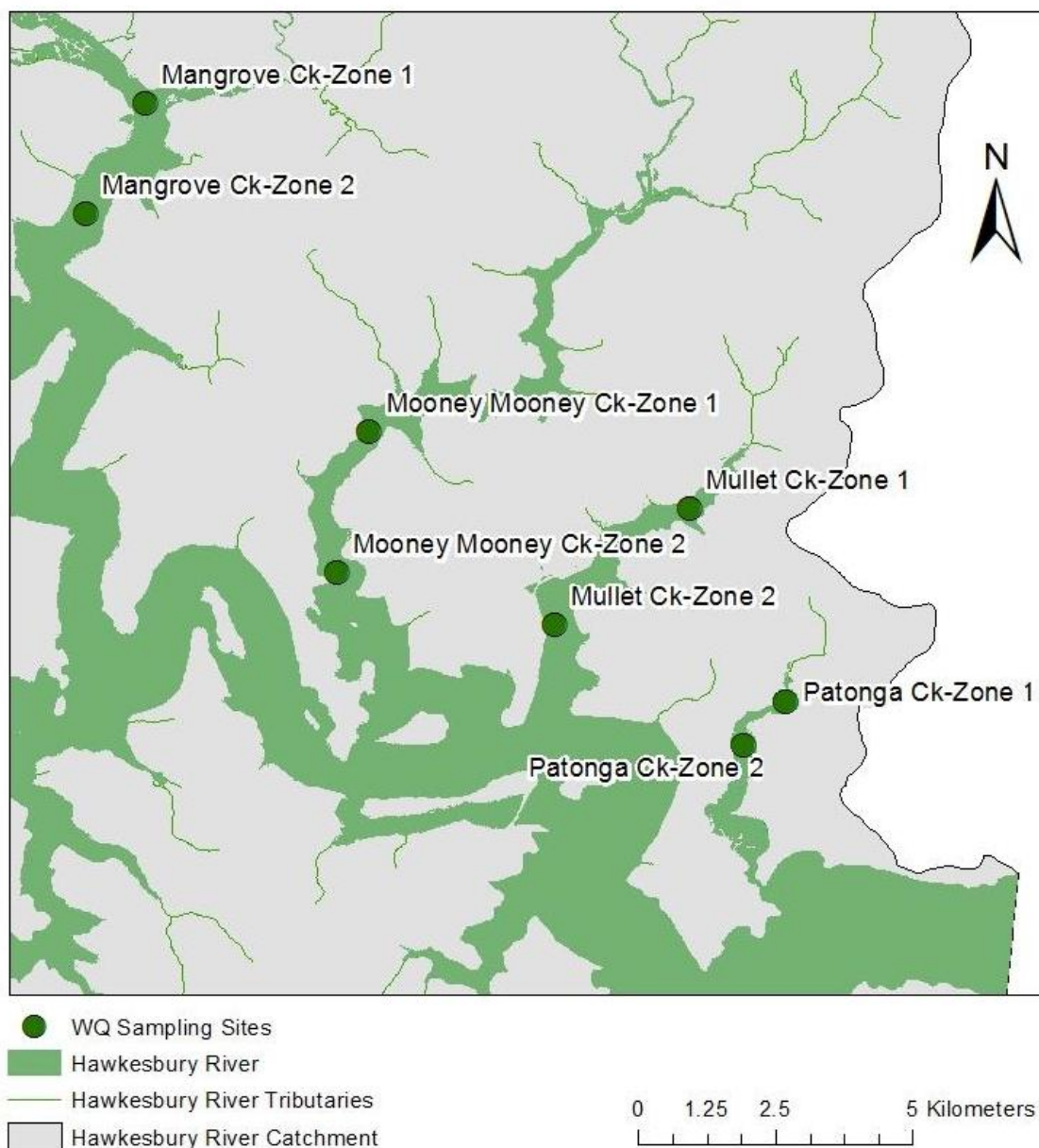


Figure 1 Sampling locations in the Lower Hawkesbury River for the CCC estuary monitoring program 2024-2025

2.1.1 Sampling methods

Water quality

All sampling was conducted from a 4.5 m research vessel fitted with a water intake to allow continuous logging of water quality data along a longitudinal transect from downstream to upstream in each creek (OEH 2016). Water from 0.3-0.5 m below surface is pumped continuously to the Xylem EXO-2 multiparameter water quality sonde (WQ sonde) fixed to the back of the vessel. Physicochemical water quality parameters were continuously recorded along the longitudinal transect by the WQ sonde, including:

- Turbidity,

- Temperature,
- Salinity,
- pH,
- electrical conductivity and specific conductivity,
- chlorophyll-a (by in-situ fluorometry),
- dissolved oxygen,
- fluorescent Dissolved Organic Matter (fDOM).

Data was logged on the handheld device of the WQ sonde which was downloaded from the device upon return to the office and laboratory.

Two zones in each creek, one mid-stream and one upstream, were sampled for chlorophyll-a, total suspended solids (TSS) and nutrients. At each zone, a clean bucket was filled with approximately 10 litres of estuary water, collected from within 0.5 m of the surface using an integrated sampling pole, while drifting for 3 minutes in the sampling zone. The water in the bucket was used to collect samples for the analysis of chlorophyll-a, TSS and a suite of nutrients (total nitrogen, total dissolved nitrogen, ammonium, nitrate/nitrite, total phosphorous, total dissolved phosphorous and free reactive phosphorous). Total nutrient samples were directly transferred from the bucket to 30 ml vials using a clean 50 ml syringe barrel. All other nutrient samples were filtered immediately with 0.45 µm syringe-filters into two 30 ml vials. Nutrient samples were kept cool and frozen as soon as possible, in a portable freezer unit in the DCCEEW vehicle or, upon return to the laboratory.

Plastic bottles (111 ml) were filled with water from the bucket for chlorophyll-a analyses, taking care to exclude air bubbles. Chlorophyll-a samples were kept cool in an esky away from light until returning to the laboratory. One litre plastic bottles were filled with water from the bucket for TSS analysis, after mixing the water with the bottle to resuspend any solids. TSS samples were kept cool in an esky and stored in a cold room at 1-4 °C until analysis.

2.2 Laboratory analysis

Nutrient samples (frozen) were sent to Yanco Soil Laboratory or Sydney Water for analysis. Chlorophyll-a samples, kept cool in an esky and away from light, were filtered upon return to the laboratory, through 0.45 µm glass fibre filter papers under vacuum. Filter papers were frozen in labelled 50 ml vials until analysis. TSS samples were kept at 1-4 °C until analysis. Chlorophyll and TSS analyses were done in-house using American Public Health Association (APHA) methods. Chlorophyll-a concentrations were determined by UV fluorometry following extraction with 95 % acetone solution using method APHA 10200H (APHA 2012). TSS samples were analysed using APHA methods 2130B and 2540D (APHA 2012).

2.3 Indicators/parameters

Turbidity and chlorophyll-a are considered appropriate measures of estuarine ecological health as they are short-term indicators of ecosystem performance in response to catchment pressure. Using turbidity and chlorophyll-a as the primary indicators to assess estuary condition is consistent with the state-wide MER program protocols (OEH 2016). Data for other standard physicochemical parameters are also collected in the monitoring program, to provide context for the primary indicators and more information about water quality.

- **Chlorophyll-a** concentrations in the water column is used as a proxy for phytoplankton biomass and typically reflects the nutrient load into the system. Algae grow rapidly in response to inorganic nutrients; ammonia, nitrate and phosphate, which can lead to algal blooms if nutrients are present in excess.
- **Turbidity** measurements reflect water clarity and may reflect the sediment load to the estuary, including resuspension of catchment-derived fines from bed sediments. High turbidity can result in a reduction of light available for photosynthesis, limiting algal and seagrass growth. Thus, turbidity can be viewed as a surrogate for potential seagrass distribution.
- **Dissolved oxygen** is important for survival of most animals in aquatic systems and shows considerable variation during the daily cycle due to plant photosynthesis and respiration. Very high or very low concentrations of dissolved oxygen can indicate poor estuary condition. Sampling and assessment of dissolved oxygen presents many challenges as instantaneous dissolved oxygen levels depend on a few factors including salinity, temperature, time of day, cloud cover extent etc. when the sampling occurred. Surface water dissolved oxygen, as monitored in the MER program, is only useful for determining whether the entire water column is deoxygenated which occurs in severe situations. To gain a more wholistic understanding of oxygen demand and production in the area of interest, dissolved oxygen should be measured across the complete diurnal cycle by data loggers deployed near the estuary floor.
- **Salinity** is a measure of the dissolved salts in the water. **Salinity** and **temperature** are measured to provide context for the other indicators.
- **pH** reflects the amount of hydrogen ions in lake water and is reported in pH units. Estuarine waters are typically slightly alkaline pH 7.5-8.0.
- **Electrical conductivity** measures the ability of water to conduct an electrical current which depends on the concentration of dissolved salts (i.e., the salinity). Electrical conductivity increases with increasing water temperature. **Specific conductivity** is calculated (by the WQ sonde software) from electrical conductivity corrected to a standardised temperature, usually 25 °C.
- **Fluorescent Dissolved Organic Matter** (fDOM) refers to the fraction of coloured dissolved organic matter (CDOM) that fluoresces. fDOM is a surrogate for CDOM and a fast and easy means of tracking DOM in waterbodies. DOM is a heterogenous mixture derived primarily from the decomposition products of terrestrial plant material, bacteria and algae.

Turbidity and chlorophyll-a data collected from NSW estuaries by DCCEEW as part of the state-wide estuarine MER Program have been used to develop trigger values specific to NSW estuaries (OEH 2016). Trigger values are derived from the 80th percentile values for variables measured in estuaries at seaward end of low disturbance

catchments, for each estuary type (e.g., lake, river, lagoon etc). Compliance against a guideline or trigger value is commonly used to assess the status of a condition indicator. Exceeding the trigger value frequently, or by a large extent, should prompt further investigation or management action. Table 1 shows updated trigger values established for NSW Rivers that were generated from the state-wide estuarine water quality dataset (OEH 2018) and are used for grade calculations in this report.

Table 1 Trigger Values for water quality indicators in NSW rivers derived from the 80th percentile of data collected in all rivers in the NSW MER program (OEH 2018).

Indicators	Rivers Lower (>25psu)	Rivers Mid (10-25psu)	Rivers Upper (<10psu)
Turbidity NTU	3	3.1	6
Chlorophyll-a µg/L	2.7	4.3	4.8
Ammonia µg/L	10	29	52
NOx µg/L	5	40	34
TDN µg/L	270	320	550
TN µg/L	270	420	670
Phosphate µg/L	2	2	5
TDP µg/L	6	6	6
TP µg/L	12	14	16

2.4 Data analysis

Estuary report card grades for the Lower Hawkesbury tributaries were calculated using salinity, turbidity and chlorophyll-a data collected during the water quality monitoring program. Since program inception, there has been no further analysis of any additional water quality data (outlined in Section 2.3), however, all data from the program is compiled and sent to CCC in Microsoft Excel format each year. The data compilation includes all water quality parameters, total suspended solids (TSS), chlorophyll-a and nutrient concentration data.

2.4.1 Water quality grade

Water quality grades were calculated using a subset of turbidity and chlorophyll-a data from the 2024-2025 sampling period, using only data collected over during the MER sampling season, the warmer months from October 2024 to April 2025, consistent with MER protocols (OEH 2016). Grades for water quality were calculated by looking at how often and to what extent the values for turbidity and chlorophyll-a exceed the state-wide 80th percentile trigger values. Data collected in Mullet Creek, Mooney Mooney Creek, Mangrove Creek and Patonga Creek were compared to the NSW Trigger Values for Rivers (Table 1). Chlorophyll-a and turbidity scores determine the grades for these indicators, which were then averaged to get the overall water quality grade.

Grades assigned to turbidity, chlorophyll-a and overall water quality (**A** – very good, **B** – good, **C** – fair, **D** – poor and **F** – very poor) are determined by the zone score (0 - 1.0, Figure 2). The grade reflects the condition of a zone in comparison to the overall condition across all NSW estuaries with cut-off values for each grade defined by the percentage of estuaries in the state that received a score in that range (Figure 2). For example, a zone score of

less than 0.07 is equivalent to the best 20% of scores in the state and receives an A (very good) grade (Figure 2, OEH 2016).



Figure 2 Relationship between distribution of NSW scores, grades and zone scores (OEH 2016)

An additional metric is provided in the sliding scale diagram of the turbidity and chlorophyll-a grades shown below each table of grades (Tables 2-5). A percentage value is shown for each indicator based on the score received in the grade calculation. The percentage grade reflects the number of exceedances and the extent of exceedance of the respective trigger values and is calculated using the equation below. If there were no exceedances of the trigger value, a percentage grade of 100% is awarded. Lower percentages indicate that one or more samples exceeded the trigger value, with extent of exceedance further lowering the percentage grade.

$$\text{Percentage grade [turbidity] (\%)} = 100 - ([\text{turbidity score}]) * 100)$$

$$\text{Percentage grade [chlorophyll] (\%)} = 100 - ([\text{chlorophyll score}]) * 100)$$

Provision of the percentage grade allows for a finer scale assessment of change in chlorophyll-a and turbidity in the system, including occasions where the grade (A-F) remains the same.

A comprehensive description of how the water quality grades are calculated is available in *Assessing Estuary Ecosystem Health: Sampling, data analysis and reporting protocols*, NSW Natural Resources Monitoring, Evaluation and Reporting Program (OEH 2016).

2.5 QA/QC

The following QA/QC protocols were adhered to as part of this study:

- Standard operating procedures, best practice methods and peer-reviewed methods for completion of all field sampling, equipment operation and laboratory analyses.
- Equipment was calibrated at an appropriate frequency and well maintained to ensure highest quality field data collection.
- Maintain a high level of quality control of data management and file sharing and its interaction with end users and other external parties.
- Adhere to the principles in the DCCEE Scientific Rigour statement.

3 Results

3.1 Report Card Grades

3.1.1 Patonga Creek

Overall water quality within Patonga Creek remained stable, scoring an A (very good) grade in 2024-2025 (Table 2). Despite the overall water quality grade remaining stable, a decrease in grade to B (good) was recorded for chlorophyll-a due to two minor exceedances of the trigger value, resulting in a percentage grade of 92 % (Table 2, Figure 3). Three very minor exceedances of the trigger value were recorded for turbidity, however turbidity scored an A (very good) grade for the third consecutive year and a percentage grade of 94 % (Table 2, Figure 3).

Table 2 Calculated water quality grades for Patonga Creek during the 2024-2025 monitoring period and previous years for comparison.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	A	A	A
2019 - 2020	A	A	A
2020 - 2021	B	A	A
2021 - 2022	B	B	B
2022 - 2023	A	D	B
2023 - 2024	A	A	A
2024 - 2025	A	B	A



Figure 3 A sliding scale diagram of the percentage grades for turbidity and chlorophyll-a in Patonga Creek. Arrows indicate change from last year's percentage grades.

3.1.2 Mullet Creek

Overall water quality in Mullet Creek improved from a C (fair) grade in 2023-2024 to a B (good) grade in 2024-2025, despite the grades for turbidity and chlorophyll-a remaining stable (Table 3). The trigger value for turbidity was exceeded on five of the seven sampling occasions over the MER sampling period, resulting in an improved percentage grade of 90 % and a B (good) grade, as most exceedances were relatively minor (Table 3, Figure 4). The trigger value for chlorophyll-a was exceeded on all occasions in the MER sampling season, with chlorophyll-a levels often more than double the trigger value. This resulted in chlorophyll-a receiving a C (fair) grade for the fourth consecutive year and an improved percentage grade of 70 % (Table 3, Figure 4).

Table 3 Calculated water quality grades for Mullet Creek during the 2024-2025 monitoring period and previous years for comparison.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 – 2019	B	B	B
2019 – 2020	B	C	B
2020 – 2021	B	B	B
2021 – 2022	B	C	C
2022 – 2023	B	C	B
2023 - 2024	B	C	C
2024 - 2025	B	C	B

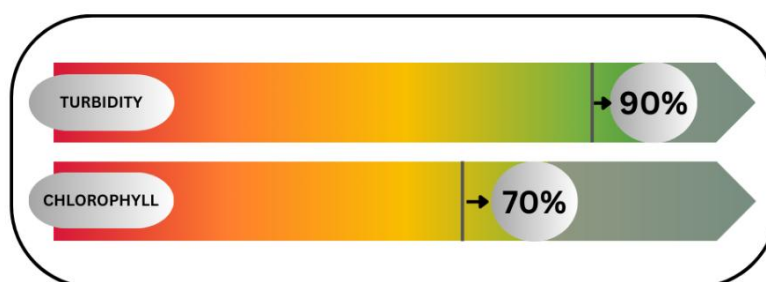


Figure 4 A sliding scale diagram of the percentage grades for turbidity and chlorophyll-a in Mullet Creek. Arrows indicate change from last year's percentage grades.

3.1.3 Mooney Mooney Creek

Overall water quality within Mooney Mooney Creek retained a C (fair) grade in 2024-2025 (Table 4). An improvement in grade from a C (fair) to B (good) was recorded for turbidity (Table 4). Despite the improvement in grade for turbidity, the trigger value was exceeded on all occasions resulting in a percentage grade of 76 % (Figure 5). Chlorophyll-a exceeded the trigger value on all occasions with chlorophyll-a concentrations usually more than double the trigger value, resulting in a percentage grade of 66 % and a C (fair) grade for chlorophyll-a (Table 4, Figure 5).

Table 4 Calculated water quality grades for Mooney Mooney Creek during the 2024-2025 monitoring period and previous years for comparison.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	C
2019 - 2020	B	D	C
2020 - 2021	C	C	C
2021 - 2022	C	D	D
2022 - 2023	B	D	C
2023 - 2024	C	C	C
2024 - 2025	B	C	C

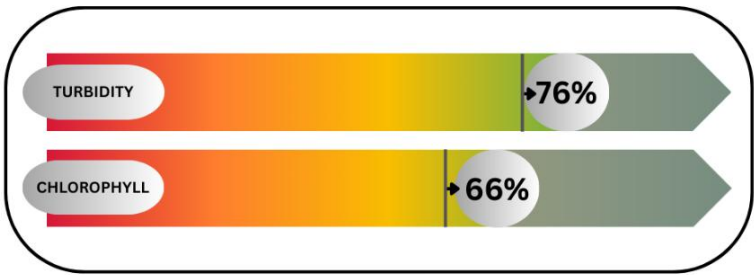


Figure 5 A sliding scale diagram of the percentage grades for turbidity and chlorophyll-a in Mooney Mooney Creek. Arrows indicate change from last year's percentage grades.

3.1.4 Mangrove Creek

The overall water quality grade for Mangrove Creek, and the chlorophyll-a and turbidity grades remained stable, all scoring a B (good) grade in 2024-2025 (Table 5). Despite the B grade for turbidity (Table 5), the trigger value was exceeded on all occasions over the MER season, however most of these exceedances were relatively minor resulting in an improved percentage grade of 86% (Figure 6). While chlorophyll-a only exceeded the trigger value on one sampling occasion in mid-December, this exceedance was close to double the trigger value, resulting in the same percentage grade of 86 % for chlorophyll-a (Figure 6).

Table 5 Calculated water quality grades for Mangrove Creek during the 2024-2025 monitoring period and previous years for comparison.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	C
2019 - 2020	B	B	B
2020 - 2021	B	A	B
2021 - 2022	B	C	B
2022 - 2023	B	D	C
2023 - 2024	B	B	B
2024 - 2025	B	B	B



Figure 6 A sliding scale diagram of the percentage grades for turbidity and chlorophyll-a in Mangrove Creek. Arrows indicate change from last year’s percentage grades.

4 Summary and discussion

The overall water quality grades within the Lower Hawkesbury River during 2024-2025 remained stable in Patonga (A-very good), Mooney Mooney Creek (C-fair) and Mangrove Creek (B- good), while an improvement in grade was recorded for Mullet Creek (C-fair to B-good). The improvement in the overall water quality grade in Mullet Creek was driven by slight improvements in the turbidity and chlorophyll-a scores, as reflected in the small increase in the percentage grades relative to last year's results. A slight improvement in the percentage grades for turbidity and chlorophyll-a were also observed for Mooney Mooney Creek and Mangrove Creek, however, the grades for turbidity and chlorophyll-a remained stable.

Patonga Creek was the only site to score an A (very good) grade for overall water quality and turbidity in 2023-2024 and 2024-2025. There are several factors that drive good water quality grades in Patonga Creek in comparison to the other creeks. Mooney Mooney, Mangrove and Mullet Creeks have larger, more modified catchments compared to Patonga Creek. Those creeks also have relatively high tidal exchange with the main river channel, where resuspension of fine sediments is characteristic of water quality due to tidal movements, and a highly modified mid-catchment. Conversely, the shallow narrow entrance to Patonga Creek minimises tidal inflow from the main river channel, reducing wave energy and allowing seagrass beds to flourish. Patonga Creek is the most downstream location of the lower Hawkesbury River so also receives more flushing with oceanic waters compared to the other creeks. The presence of extensive seagrass beds (an indicator of ecological health) in Patonga Creek reflects the very good grade attained for water quality. Seagrass beds trap suspended sediments, improving water clarity, and utilise inorganic nutrients for growth reducing the nutrient pool available for microalgal growth.

Total monthly rainfall at Gosford (AWS 61425) over the MER sampling period October 2024 to April 2025 was below average (Table 7). In October 2024, December 2024 and February 2025 monthly rainfall was less than half the long-term average, with higher-than-average rainfall recorded in January 2025 and April 2025 (Table 6). Lower than average rainfall overall is one factor leading to better than average water quality observed in 2024-2025. Only two of the seven sampling dates (where data collected is used for calculating grades) had rainfall in the 3 days prior to sampling. There was, however, moderate rainfall (10 – 26 mm) in the 7 days prior to five of the seven sampling dates (Table 7).

Only nutrient data for July 2024 to February 2025 sampling trips are currently available for analysis. The highest concentrations of nutrients in the tributary creeks in the lower Hawkesbury River occurred in July and August 2024 which cannot be explained by recent rainfall in the 7 days prior to sampling. However, there was 50 mm of rainfall in the first week of July which may have delivered nutrients in surface runoff from the agricultural catchment to the mid-upper estuary, influencing in-water nutrient concentrations downstream 3 weeks later. In July and August 2024, concentrations of nitrate/nitrite (NO_x) ranged from 90 – 230 $\mu\text{g/L}$ at the upstream and downstream zones in Mangrove Creek and Mooney Mooney Creek, and downstream in Mullet Creek. Salinity in Mangrove Creek is fresher than the other creeks, being further upstream, with salinity ranging from 12 – 23 psu from July 2024 to February 2025. The highest concentrations of NO_x and ammonium were observed in Mangrove Creek, probably due to more direct influence of catchment runoff from the middle region of the Hawkesbury River. Phosphate concentrations exceeded the NSW trigger value of 2 $\mu\text{g/L}$ on most sampling occasions at all

monitoring zones, except for the downstream zone of Mullet Creek. Surprisingly, phosphate concentrations were the highest in Patonga Creek ranging from 4-9 $\mu\text{g/L}$. The small urban area of Patonga is not on the reticulated sewage network and so relies on on-site sewage management, such as septic tanks for wastewater treatment. Thus, wastewater from Patonga is the most likely source of persistent high levels of phosphate in Patonga Creek. The Redfield ratio of 16:1 is the consistent atomic proportions of nitrogen (N) to phosphorous (P) in marine phytoplankton. Molar ratios of DIN:DIP in the environment that deviate from 16:1 indicate nutrient limitation, with ratios less than 16 indicating the system is N-limited, and ratios above 16 indicate the system is P-limited. Based on this dataset, phytoplankton growth in Patonga Creek appears to be N-limited due to the high availability of phosphate and a Redfield ratio of 6-8. Phytoplankton growth in Mangrove Creek and upstream in Mullet Creek appears to be P-limited (due to high availability of inorganic nitrogen) with a Redfield ratio of 58-79 and 33 respectively. Dissolved inorganic nutrient concentrations in Mooney Mooney Creek and downstream in Mullet Creek are more balanced, suggesting that phytoplankton growth is not limited by nutrient availability, with Redfield ratios 13-16.

Table 6 Monthly rainfall totals (mm) from October 2017 to June 2025 at Gosford Australian Weather Station (AWS, 61425, Bureau of Meteorology). Monthly totals in green font are from Ourimbah AWS (61093) as data were not available from Gosford AWS. Long-term monthly average rainfall at Gosford AWS from 2013-2025 are shown. Total annual rainfall from 2017 to 2024 at Gosford AWS is shown, with values in green font being a combination of data from Gosford AWS and Ourimbah AWS.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2017	35.6	152.4	399.2	113.4	36	173.2	7.8	10.6	2.4	79.2	78	61.8	1150
2018	26.6	163.2	102.8	73	17.8	213.6	12	17.6	58.2	258	131.4	68.6	1143
2019	57	109	256.4	40.2	17.6	161.2	46	212.6	112.6	49.8	21.8	3	1087
2020	125.6	538.6	180.4	39.8	50.2	56.4	171.6	51.2	50.2	253.2	36.2	197.6	1751
2021	119.6	91.4	467.6	41.4	81.4	67.6	44.8	72.2	46.2	55.6	190.2	150.6	1429
2022	116	340.2	579	225.2	129.8	14	448.8	30.2	149.4	160.6	25.2	49	2267
2023	88	173.4	74.6	133.2	46.8	21.2	22.2	57.4	16.8	58.8	135	66	893
2024	85.4	121.6	22.4	305.6	245.2	196	68.6	39.4	74.2	46.6	81	16.8	1303
2025	197.4	51.4	137.4	204.6	367.2	7.4							
Monthly and annual means (2013-2025)	118.9	115.5	214.9	153	100.5	118.6	87.4	76.7	64	97.6	91.4	75.7	1314

Table 7. A. Total rainfall (mm) recorded from October to April for each monitoring season (2017/18 to 2024/25) at Gosford/Ourimbah AWS are shown. Water quality data collected in this period are used to calculate the water quality grades. B. Rainfall recorded at Gosford AWS in the 3-days and 7-days prior to water quality sampling are shown as recent rainfall can affect water quality.

A.

Sampling period	Total rainfall (mm)
Oct 2017 - Apr 2018	585
Oct 2018 - Apr 2019	859
Oct 2019 - Apr 2020	677
Oct 2020 - Apr 2021	1207
Oct 2021 - Apr 2022	1763
Oct 2022 - Apr 2023	704
Oct 2023 - Apr 2024	795
Oct 2024 - Apr 2025	735
8-year average	916

B.

Sampling date	Rainfall mm 3-days prior	Rainfall mm 7-days prior
23/07/2024	0	0.2
26/08/2024	0.8	1.0
18/09/2024	0	10.4
22/10/2024	0.2	17.2*
20/11/2024	11.8	15.8
13/12/2024	0	1.6
4/02/2025	0	24.2
25/02/2025	0	26.2
18/03/2025	0	4.6
11/04/2024	6.6	12.8
12/05/2025	28.2	32.2
17/06/2025	0.4	1.0

*Rainfall mm 8-days prior

5 References

APHA 2012, *Standard methods for the examination of water and wastewater*, 22nd edition, American Public Health Association, Washington DC.

OEH 2016, *Assessing Estuary Ecosystem Health: Sampling, data analysis and reporting protocols*, NSW Natural Resources Monitoring, Evaluation and Reporting Program, Office of Environment and Heritage, Sydney.

OEH 2018, *NSW Estuary Water Quality Trigger Values, How new water quality Trigger Values for estuaries in NSW were derived*, Office of Environment and Heritage, Sydney.