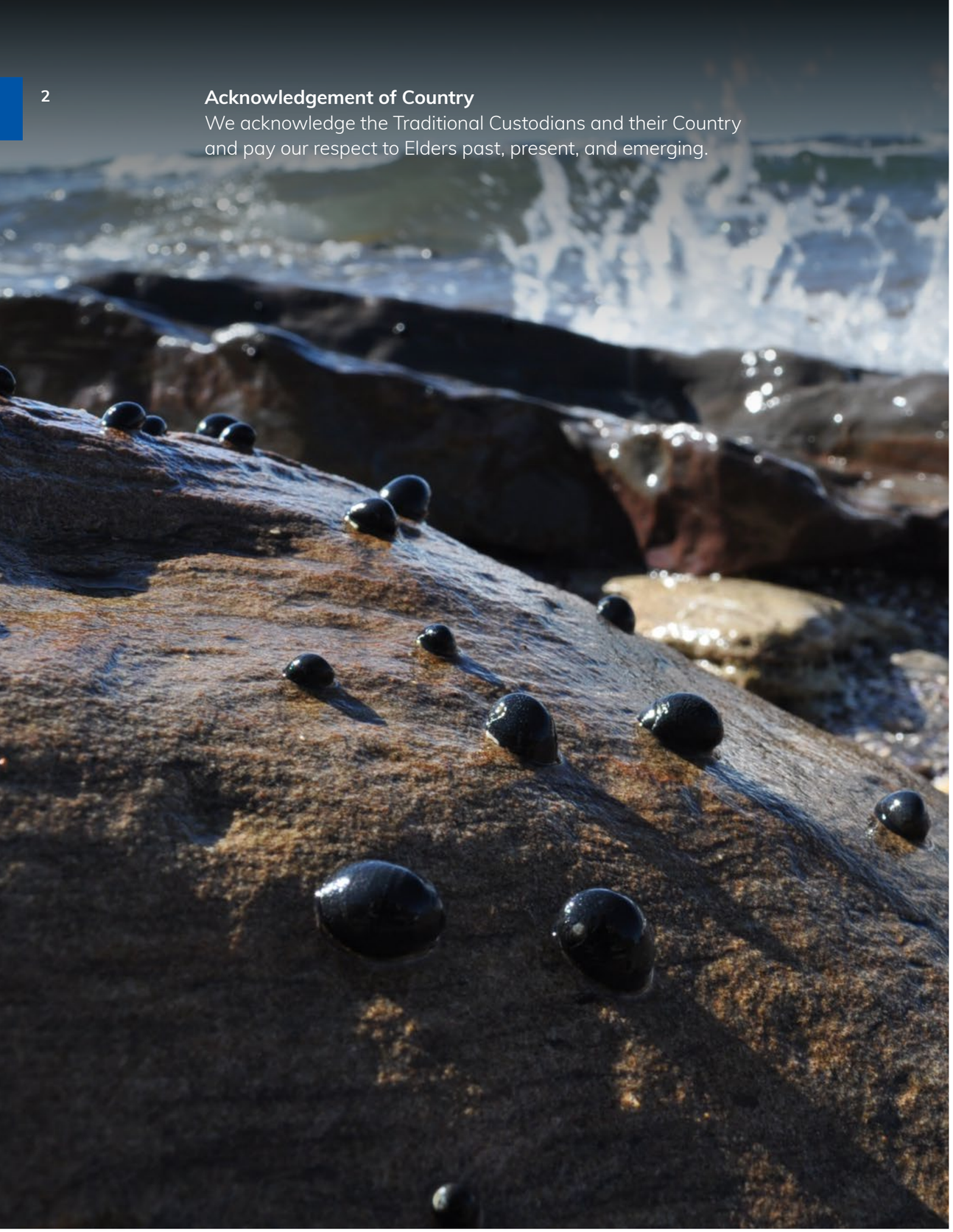
Lagoon Health Report Card 2011-22

Manly Lagoon
Curl Curl Lagoon
Dee Why Lagoon
Narrabeen Lagoon
Pittwater

northern beaches council



Acknowledgement of Country
We acknowledge the Traditional Custodians and their Country and pay our respect to Elders past, present, and emerging.

Contents

Cover image
White-Faced Heron wading at Narrabeen Lagoon.
Credit: Chris Firth

April 2023

Executive summary

The coastal lagoons and estuaries in the Northern Beaches area represent a significant environmental, recreational, scenic, and economic resource, which is highly valued by the local community and by visitors from across Sydney and NSW. These include five coastal lagoons and two open estuaries.

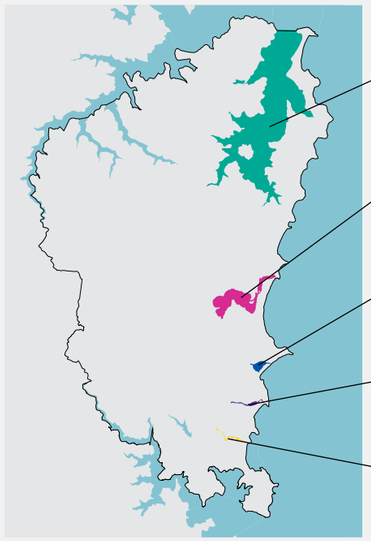
Manly, Curl Curl, Dee Why, Narrabeen and Great Mackerel lagoons are Intermittently Closed and Open Lakes and Lagoons (ICOLLs) that all open and close naturally depending on catchment rainfall and ocean conditions. The Pittwater and Sydney Harbour estuaries are permanently open to the ocean allowing greater flushing of catchment runoff.

In partnership with the NSW Department of Planning and Environment (DPE), Northern Beaches Council undertakes an annual lagoon monitoring evaluation and reporting (MER) program to monitor water quality in the Manly, Curl Curl, Dee Why, and Narrabeen lagoons and Pittwater estuary. Monitoring water quality in these coastal lagoons and estuaries is important to understand their overall environmental health and condition.

Council has been conducting the MER program for over 10 years so is able to identify long-term trends in lagoon ecological health, inform effective management of estuaries, and help make land-use planning decisions to better protect estuaries. DPE uses water quality monitoring data to produce an annual report card allocating a condition ranking for the lagoons in comparison to other NSW lagoons.

Council has prepared this Lagoon Health Report Card for 2011-2022 summarising information on the lagoons and estuaries, water quality results of the MER program (see figure 1) and Northern Beaches Council catchment management practices.

Figure 1: Summary of lagoon health since 2011/12 (including the 2021/22 grade, long-term average and trend since 2011/12)



Pittwater Estuary	2021/22	Long-term average	Trend
	A	A	⊖
Narrabeen Lagoon	2021/22	Long-term average	Trend
	B	B	↑
Dee Why Lagoon	2021/22	Long-term average	Trend
	A	B	↑
Curl Curl Lagoon	2021/22	Long-term average	Trend
	C	D	↑
Manly Lagoon	2021/22	Long-term average	Trend
	D	D	⊖

What makes coastal lagoons and estuaries special?

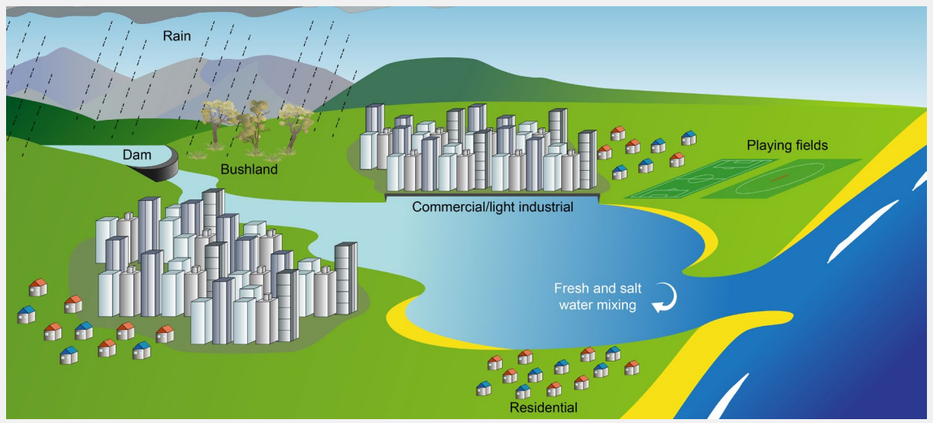
Estuaries are semi-enclosed coastal waterbodies where freshwater from rivers and creeks mix with saltwater from the ocean. Estuaries and their surrounding land are places of transition from freshwater to saltwater environments. Estuaries have significant environmental, cultural, social and commercial value and provide valuable ecosystem services.

Estuaries provide essential ecosystem services such as habitat and food provision, carbon storage, storm protection, and filtering of nutrients and sediment in runoff from the surrounding catchment area. Estuaries contain many types of habitats such as seagrass meadows, mangroves, saltmarshes, mudflats, sandflats, rocky shorelines, rocky reefs, oyster reefs, sandy shorelines, and deep open water areas. These diverse sheltered habitats of estuaries provide breeding and feeding opportunities to support a biodiversity of fish, birds, mammals, and specialised plants.

Estuaries also have an important cultural, social, and economic value (see Figure 2). For thousands of years estuaries have been used as resources by First Nations coastal communities and continue to be used for traditional fishing, and other cultural and ceremonial purposes. Many urban centres are based around estuaries which provide opportunities for recreational activities, serve as a focal point for community connection, and have aesthetic and health benefits. Estuarine waterways support numerous industries, including tourism, recreation, transport, and fishing. Commercial fishing in estuarine waters in NSW is worth more than $80 million a year, while the estimated value of recreational fishing in estuaries is over $500 million.

Estuaries are classified into different types depending on their connection to the ocean and their catchment characteristics. Manly, Curl Curl, Dee Why, Narrabeen and Great Mackerel lagoons are all classified as Intermittently Closed and Open Lakes and Lagoons (ICOLLS) as they alternate between being open and closed to the ocean. Whereas Pittwater and Sydney Harbour are permanently open and classified as drowned valley estuaries as they are large, deep and formed by the ocean flooding river valleys over geological time.

Figure 2: Conceptual diagram of estuary
This figure shows estuarine processes and possible landuse surrounding estuaries.



What is an ICOLL?

Intermittently Closed and Open Lakes and Lagoons (ICOLLs) have distinct open and closed phases with the sand barrier at the entrance changing depending on wave action, tides, and catchment runoff. ICOLLs are commonly referred to as lagoons or coastal lagoons. ICOLLs have different opening and closing regimes, with some becoming isolated from the ocean for long periods of time. The salinity in ICOLLs is highly variable depending on whether the entrance is open or closed to the ocean. When an ICOLL's entrance is open saltwater enters the lagoon and mixes with freshwater upstream. When an ICOLL is closed the salinity is determined by freshwater runoff, evaporation, and intrusion of ocean water though the porous sand barrier. The ecological systems that inhabit ICOLLs have evolved to cope with, and even rely upon, these dynamic changes.

Over the past century, many of the ICOLLs in NSW, including those on the Northern Beaches, have undergone significant changes. Catchment land-use has changed from natural to highly modified in all five of the ICOLLs in the Northern Beaches (Manly, Curl Curl, Dee Why, Narrabeen and Great Mackerel lagoons). This has included infilling of natural wetlands, substantial land clearing, channelisation of creeks and the construction of urban and industrial spaces. These land use changes have allowed for urban and industrial growth but have negatively impacted the ecological health of lagoons. The altered hydrology and increased waterway pollution interferes with natural processes that maintain water quality in coastal lakes and lagoons.

The development of ICOLL foreshores in the Northern Beaches Council area means foreshore properties and infrastructure are at risk of flooding. To mitigate flood risk Council artificially opens the ICOLL entrances depending on water levels in the lagoon, freshwater inflow, tidal height, and wave action. Opening of the lagoon entrance is carefully managed to reduce the impact on ecosystems that rely on the entrance to be closed for extended periods of time.

The 'ideal situation' for NSW estuaries includes intact aquatic habitats like seagrass, aquatic plants and riparian vegetation, minimal algae blooms, and minimal sediment inputs. The vision for our waterways is to maintain or improve their condition in order to protect biological diversity and maintain ecological processes.

Aerial image of Narrabeen Lagoon entrance

Key physical processes in ICOLLs

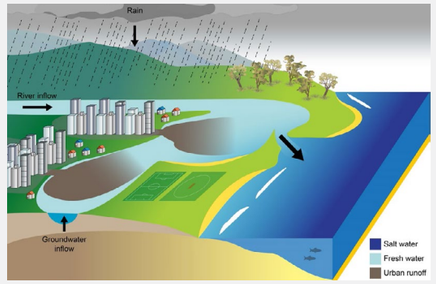
Estuaries and particularly ICOLLs are constantly changing depending on the weather, wave action, tides, catchment and saltwater intrusion.

The two of the main physical drivers are:

- Stormwater and catchment runoff from rainfall
- Entrance conditions and flushing from daily tides

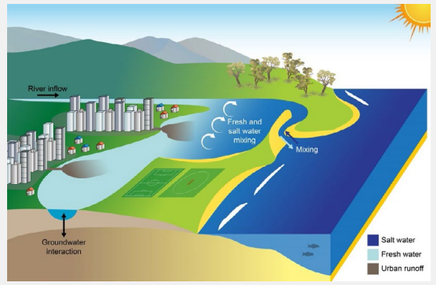
The physical processes of ICOLLs are shown in figure 3.

Figure 3: Physical processes of Intermittently Closed and Open Lakes and Lagoons (ICOLLs)
a) lagoon opening, b) freshwater and saltwater mixing, and c) lagoon closing



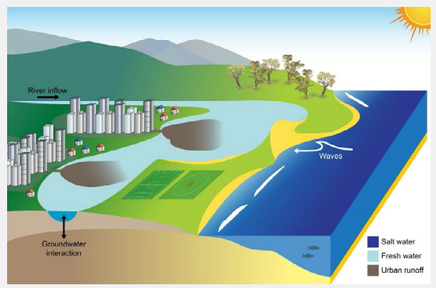
a) Lagoon opening

Heavy rainfall increases freshwater inflows from the surrounding catchment. Catchment runoff collects pollutants as it enters creeks and then lagoons. Water levels in closed ICOLLs rise until the force of the water scours out the entrance sand barrier and the ICOLL connects to the ocean. During these periods, the water in the estuary typically has low salinity. The increased hard surfaces in urban catchments (e.g. pavement, roofs, roads and concrete) has increased the volume and rate at which surface water runoff and pollutants enter ICOLLs.



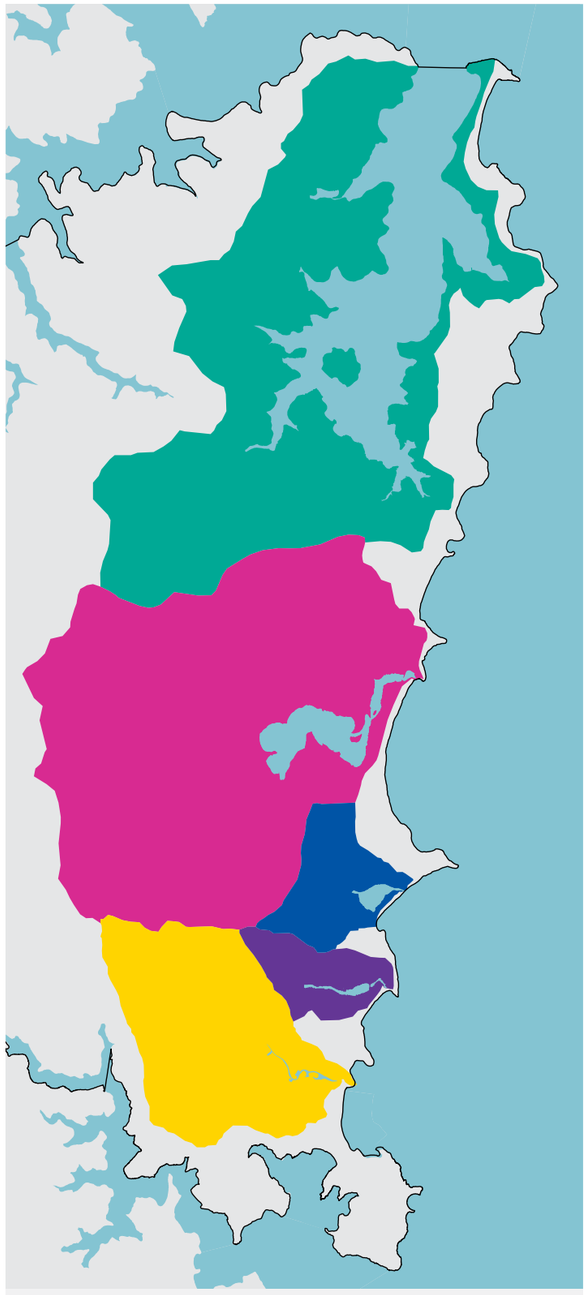
b) Freshwater and saltwater mixing

The entrance of the ICOLL can remain open for some time even after the rainfall has stopped. Small amounts of catchment runoff continue to make their way into ICOLLs. Tidal flushing constantly mixes saltwater and freshwater throughout the estuary, creating brackish conditions. Tidal flushing can minimise the impact of catchment pollutants through constant replacement with clean marine water.



c) Lagoon closing

Sand is moved by tides and wave action and eventually builds up at the ICOLL entrance, closing the connection with the ocean. Some ICOLLs, can close in a matter of days, while others may take months or years to close again. Intermittent closures have been shown to be important for supporting aquatic biodiversity, however, pollutants from urban runoff can accumulate in an ICOLL when the lagoon entrance is closed. This can result in poor ecological health and impact the visual amenity of the ICOLL. The entrance remains closed until sufficient rainfall or wave action scours the sand, and the cycle begins again.



Pittwater

Pittwater is a tide dominated estuary, with a wide, open connection to the ocean through Broken Bay. It is readily accessible by boat and includes numerous beaches popular for swimming and recreation.

Narrabeen Lagoon

Narrabeen Lagoon is the largest ICOLL in the Northern Beaches and its catchment covers a significant area. Due to its size, the lagoon is popular for water sports.

Dee Why Lagoon

Dee Why Lagoon is a small ICOLL and is the shallowest in the Northern Beaches area. The suburbs of Dee Why and Cromer drain to this lagoon.

Curl Curl Lagoon

Curl Curl Lagoon is another small ICOLL that provides localised drainage to the suburbs of Curl Curl and Brookvale (east of Pittwater Road). It has the smallest water area of the ICOLLS in the area.

Manly Lagoon

Manly Lagoon is the southernmost lagoon in the Northern Beaches. While this lagoon is naturally an ICOLL, it has been permanently connected to the ocean through man-made pipes at the Queenscliff Beach.

Sydney Harbour

Nothern Beaches includes a small area of the Sydney Harbour catchment (North and Middle Harbour). The Sydney Harbour catchment in the Northern Beaches area is a mix of residential, parkland and bushland land use.

Catchments in a natural system are vegetated with native plants and water moves slowly over landscape and infiltrates the soil. Soil, trees and plants filter out nutrients and sediments before the water reaches creeks and lagoons.

The catchments and waterways of the Northern Beaches estuaries have changed significantly over the last century as can be seen in the images of Curl Curl Lagoon in 1930, 1951 and as it is today.

By 1930, significant areas around Curl Curl lagoon had been cleared, and early roads had formed. Large sections of the lagoon catchment remained undeveloped or as agricultural land.

By 1951, urban expansion had continued with formalised roads, housing and paved surfaces dominating the landscape. It was around this time that the area we now know as John Fisher Park was used as a tip to dispose of urban and industrial waste.

Today, Curl Curl Lagoon catchment is highly modified and covered largely by hard surfaces. This changes the volume and quality of water flowing into the lagoon. The most important tool for managing water quality in ICOLLs is through managing catchment land use and inputs. We can improve our estuaries through informed choices in how we build (e.g. more green spaces), keeping trees on private property, revegetating public reserves and creek corridors, reducing the use of nutrient rich fertilisers and better management of green waste.

Curl Curl Lagoon - January 1930
NSW Spatial Services

Curl Curl Lagoon - May 1951
NSW Spatial Services

Curl Curl Lagoon - January 2023
NSW Spatial Services

Monitoring Evaluation and Reporting (MER) program for estuarine ecological health

In partnership with Department of Planning and Environment (DPE), Council undertakes an annual lagoon monitoring evaluation and reporting (MER) program to monitor water quality in five of the coastal lagoons and estuaries. The MER program involves fortnightly water quality monitoring of Manly, Curl Curl, Dee Why and Narrabeen Lagoon and Pittwater estuary for six months over the spring, summer, and autumn. Sydney Harbour is not part of MER but a separate long-term monitoring plan is being developed. Great Mackerel Lagoon is also not included in MER as the catchment is largely unmodified. Council has been conducting the MER program for over 10 years so is able to identify long-term trends in lagoon ecological health.

Estuaries act as sinks in the environment and are vulnerable to pollutants from stormwater and sewerage inputs. As part of the MER program Council collects data on several water quality indicators including microalgae (chlorophyll-a), water clarity (turbidity), enterococci (bacteria found in the human gut), phytoplankton, nutrients (nitrogen and phosphorus), pH, dissolved oxygen, water temperature and salinity.

Measures of microalgae and water clarity are water quality metrics used to inform a standard grading system used across DPE's state-wide MER program.

Water quality sampling

Chlorophyll-a concentrations give us an undertanding of how much microalgae (or phytoplankton) is in the water. High levels of chlorophyll-a can indicate excess levels of nutrients are entering the system, usually via stormwater, promoting increased productivity, which can lead to algal blooms and loss of water clarity.

Water Clarity, or turbidity, is a measure of the cloudiness/murkiness of the water. Water clarity naturally fluctuates depending on rainfall and inflow however, extended periods of low water clarity can interrupt the amount of light reaching aquatic plants and can have a negative impact on ecological health.

Enterococci is bacteria that is commonly found in the guts of humans and animals. Large spikes in enterococci concentrations can happen when stormwater and sewage enter waterways after rainfall. High enterococci concentrations in waterways can increase the risk of bacterial infections such as gastroenteritis.

Phytoplankton (or microalgae) are microscopic plants which live within the water column. The amount of phytoplankton (called biomass) and the number of different species (diversity) are influenced by many factors. These include the depth and shape of the lagoon, the way the water moves around the lagoon, and the amount and types of nutrients which enter the lagoon through stormwater and groundwater.

Nutrients, pH, dissolved oxygen, water temperature, and salinity are traditional water quality parameters that can be used to pinpoint the cause of water quality issues. These parameters also indicate ecosystem productivity which is the amount of energy and nutrients an ecosystem cycles.

Report Cards & Grades Explained

The Grades Explained

A — EXCELLENT
The indicators meet all benchmarks almost all of the year. Equal to the best 20% of scores in NSW.

B — VERY GOOD
The indicators meet all benchmarks for most of the year. Equal to the best 20% scores in NSW.

C — FAIR
The indicators meet some benchmarks for part of the year. Equal to the middle 30% of scores in NSW.

D — POOR
The indicators meet few benchmarks for part of the year. Equal to the next 15% of scores in NSW

E — VERY POOR
The indicator almost never meet benchmarks all of the year. Equal to the worst 5% of scores in NSW.

Estuaries are dynamic and complex systems and many of the variations in water quality in these lagoons is natural and healthy. However, with more than 80% of the state's population living in and around the coasts and estuaries, it is important to understand and measure the impact that we have on these waterways.

This Report Card uses a standard grading system to assess the ecological health of the lagoon and estuaries on the Northern Beaches. The grading system was devised by the NSW State Government and allows for each of the estuaries across the state to be compared to one another, and long term changes of these lagoons to be tracked.

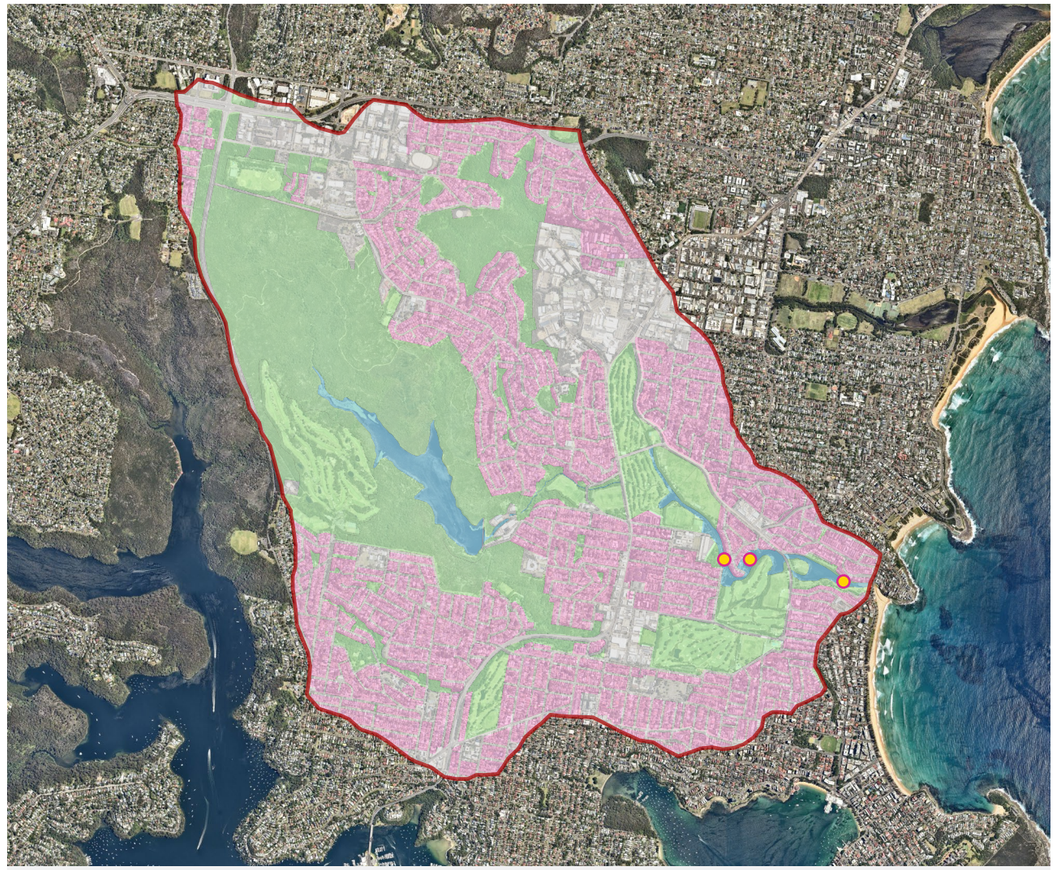
We have been monitoring the health of the lagoons since 2011, and Pittwater since 2017. This Report Card presents a summary of the last decade of ecological health. The standardised system uses two indicators to measure ecological health of estuaries in NSW:

Summary of estuary ecological health grades over time

Monitoring period	Manly Lagoon	Curl Curl Lagoon	Dee Why Lagoon	Narrabeen Lagoon	Pittwater
Overall health 2011-2022	D	D	B	B	A
2021/22	D	C	A	B	A
2020/21	C	B	B	B	A
2019/20	D	C	B	B	A
2018/19	C	E	B	B	A
2017/18	C	C	C	C	A
2016/17	D	C	B	B	
2015/16	D	D	B	B	
2014/15	C	D	C	C	
2013/14	C	C	B	B	
2012/13	D	E	B	B	
2011/12	D	E	C	D	

Key	A	B	C	D	E
	Excellent	Very Good	Fair	Poor	Very Poor

Manly Lagoon



2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
D	D	C	C	D	D	C	C	D	C	D

Trend in water quality in Manly Lagoon is stable

Catchment Area - 17.2km²
Estuary Area - 0.1km²

Major Creeks

- Burnt Bridge Creek
- Brookvale Creek
- Manly Creek (including Manly Dam)

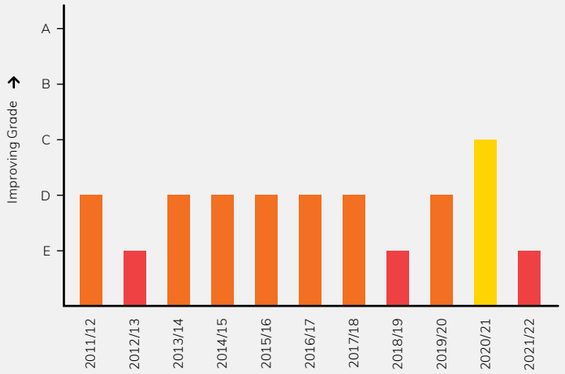
Manly Lagoon has three main creeks (Manly, Brookvale and Burnt Bridge creek) and its catchment includes Manly Dam. Manly Lagoon discharges to the ocean at Queenscliff Beach. The catchment that flows into the lagoon includes a number of urban suburbs, as well as part of the Brookvale industrial area and Manly Dam. While this lagoon would have been an ICOLL that naturally opened and closed, the entrance to Manly Lagoon has been modified through the construction of low flow pipes that maintain a permanent connection to the ocean.

The overall water quality in Manly Lagoon has been consistently rated as **FAIR** to **POOR**. This means that the water quality is typically worse than at least 50% of estuary systems in NSW. There are no distinct long-term trends in overall health in this estuary.

Manly Lagoon
Trends in algae concentration

Algae concentrations in Manly Lagoon are stable long-term

Figure 4
Annual grades for algae concentrations in Manly Lagoon since 2011/12



Algae concentrations in Manly Lagoon are typically **POOR** to **VERY POOR**. These high algae concentrations in Manly Lagoon are partly driven by large amounts of nutrients entering the lagoon from surrounding catchments after rainfall events.

Regular monitoring shows algae levels are typically higher further up the estuary (away from the ocean). While Manly Lagoon is permanently connected to the ocean via the low flow pipes, a natural rock weir underneath Queenscliff Bridge means that only large high tides flush the lagoon. The reduced flushing volume provides better conditions for algae growth.

Algae levels in Manly Lagoon are consistently higher than expected in an ICOLL of its type (3.3 µg/L), with more than 90% of samples collected exceeding this value. The 2012/13 summer period was ranked as **VERY POOR** primarily due to extremely high chlorophyll-a concentrations (greater than 80 µg/L) at two locations during a single sampling event, rather than persistently worse conditions.

The source of high nutrients that feed algae growth in Manly Lagoon is not yet fully understood. However, preliminary sampling has suggested that nutrient rich groundwater inflows and catchment runoff contribute significantly. Investigations are currently underway to improve our understanding of the nutrient cycling processes in Manly Lagoon.

Manly Lagoon
Trends in water clarity

Water clarity in Manly Lagoon fluctuates between **GOOD** to **POOR**.

Improved water clarity in Manly Lagoon is typically associated with lower than average rainfall (and less catchment runoff). This lagoon is long and narrow, which means when catchment inflows enter the lagoon, the water in the lagoon is essentially replaced (and the previous water is pushed to the ocean) instead of the two water sources mixing. This means Manly Lagoon is more sensitive to pollutants entering the catchment after rainfall and more susceptible to episodic periods of poor water quality.

In the last seven years, **GOOD** water clarity occurred when summer rainfall (October to April) was below 600 mm. However, moderate summer rainfall (700 - 800mm) has resulted in worse outcomes for water quality. This may be due to changes in the catchment inflows, or a deterioration in the ability of the lagoon ecosystem to process incoming sediment.

Water clarity is stable at Manly Lagoon, but poor water clarity is an issue during wet years

Figure 5
Annual grades for water clarity in Manly Lagoon since 2011/12

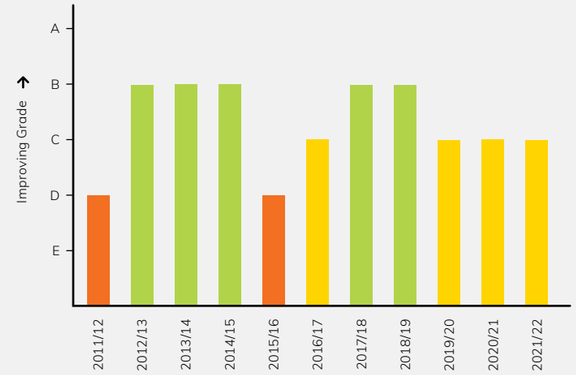
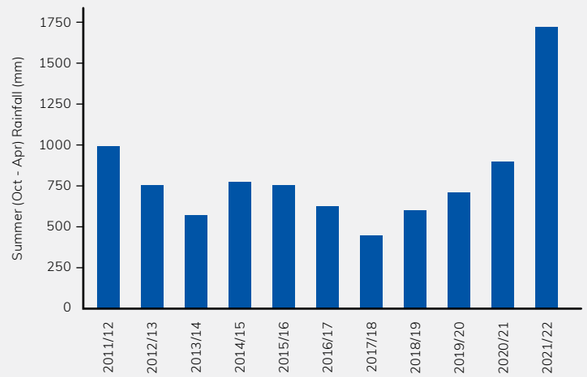


Figure 6
Total local summer (Oct - Apr) rainfall for Manly Lagoon since 2011/12



2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
E	E	C	D	D	C	C	E	C	B	C

Overall water quality in Curl Curl Lagoon has been improving over the last 10 years

Catchment Area - 4.65km²
Estuary Area - 0.07km²

Major Creeks

- Greendale Creek

Curl Curl Lagoon has the smallest waterway area of the Northern Beaches estuaries and is one of the most highly modified catchments. A significant area around the foreshore of the lagoon is reclaimed land, meaning there are areas that would have historically been wetlands and part of the lagoon, but have since been infilled to create more usable spaces. Groundwater inflows, which flow through this reclaimed land and landfill, have been shown to play an important role in water quality, particularly when the lagoon water levels are low.

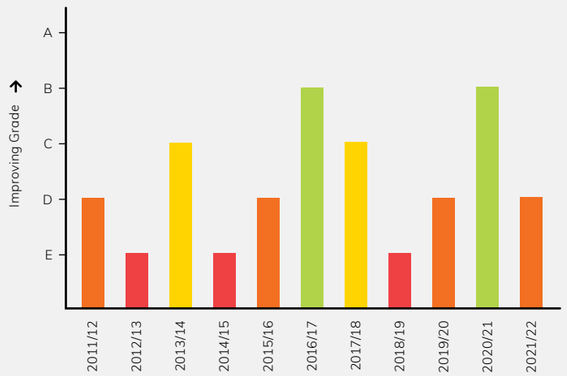
Curl Curl lagoon opens more regularly than other ICOLLs in the Northern Beaches. The opening of Curl Curl lagoon allows landfill leachates to flow out of the lagoon and for the lagoon to be refilled with cleaner water.

Water quality in Curl Curl Lagoon has been shown to typically fluctuate between **FAIR** and **VERY POOR**, although there is a trend towards improved water quality, including **GOOD** water quality in 2020/21.

Curl Curl Lagoon
Trends in algae concentrations

Algae concentration is variable year to year and is influenced by entrance opening conditions/times

Figure 7
Annual grades for algae concentrations in Curl Curl Lagoon since 2011/12



Algae concentrations in Curl Curl Lagoon fluctuate significantly and have been rated as **GOOD** to **VERY POOR** periodically over the last 12 years.

Curl Curl Lagoon is an ICOLL which episodically opens to the ocean after rainfall or large ocean swell. However, this particular lagoon closes relatively quickly once catchment runoff reduces and is closed approximately 80% of the time. Over the last decade, water samples have been collected while the lagoon entrance is open and closed. Sampling has shown that the highest algae levels are associated with periods when the entrance is closed.

The catchment of Curl Curl Lagoon is almost entirely modified through urban and industrial development, which leads to high nutrient levels in the catchment runoff. Groundwater inflows into the lagoon flow through old land fill sites, which carries significant risk of poor water quality. When the entrance is closed, nutrients can accumulate in the lagoon and lead to excess algae growth.

Curl Curl Lagoon
Trends in water clarity

Water clarity in Curl Curl Lagoon is typically **GOOD** to **POOR**, although it was classified as **VERY POOR** in 2011/12.

The influence of catchment run-off and ocean influence for water clarity at Curl Curl is complex. Both catchment run-off when the lagoon is closed and saltwater intrusion when the lagoon is open can reduce the water clarity at Curl Curl. Water clarity may improve when there are reduced sediment inputs from catchment run off. The worst period occurred in the 2011/12 summer season when the Lagoon was disconnected from the ocean 62% of the time, far less than the long-term average (80%) and results can be varied.

Often, there is a misconception in ICOLLs that water quality is always bests when the entrances are open to the ocean. However, connection with the ocean is not necessarily the best outcome for all water quality indicators in these systems.

In the last three years, the water clarity in Curl Curl Lagoon has been classified as **GOOD**. As a result, a long-term improvement in water clarity has been observed in the lagoon. Improvements in water clarity can be an indicator of reduced sediment inputs from upstream catchments.

Water clarity has been improving at Curl Curl Lagoon

Figure 8
Annual grades for water clarity in Curl Curl Lagoon since 2011/12

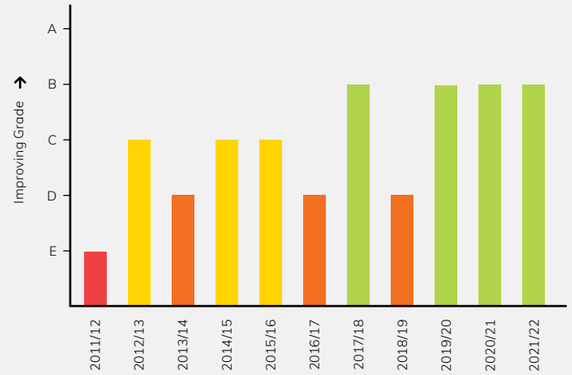
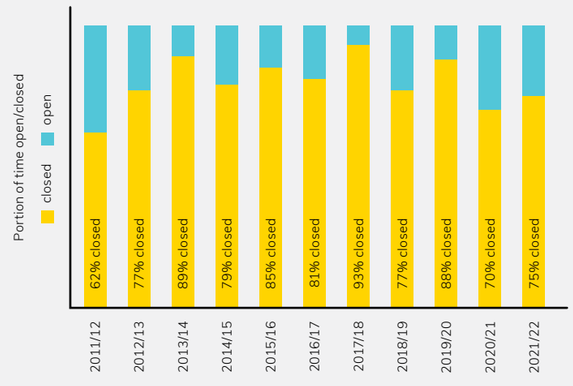


Figure 9
Proportion of the year when Curl Curl lagoon is open/closed since 2011/12



Dee Why Lagoon

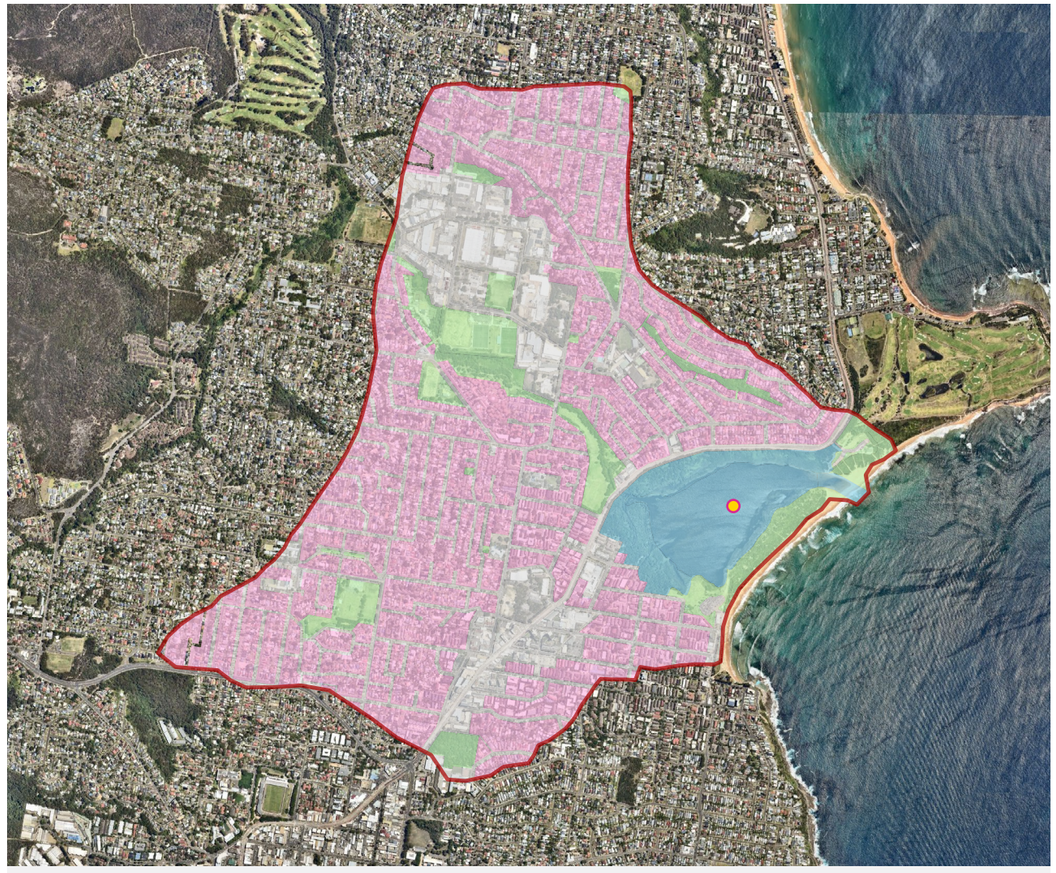
2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
C	B	B	C	B	B	C	B	B	B	A

Overall water quality in Dee Why Lagoon has been improving over the last 12 years

Catchment Area - 4.3m²
Estuary Area - 0.3km²

Major Creeks

- Dee Why Creek



Dee Why Lagoon is a small lagoon and periodically discharges to the ocean between Dee Why Beach and Long Reef Beach. The lagoon is predominantly closed and is estimated to be connected to the ocean less than 20% of the time. Unlike Manly and Curl Curl Lagoons, the shallow and wide nature of Dee Why Lagoon means it is generally well mixed.

The majority of the catchment that flows into this lagoon has been highly modified for urban and industrial uses.

However, Dee Why Lagoon and the surrounding parkland is recognised as a wildlife refuge because of its significance in supporting coastal and wetland ecosystems within an urban setting.

The water quality of Dee Why Lagoon is surprisingly good given it is such as modified catchment. Reasons for this could be its shallowness, shape, physical processes and surrounding wildlife refuge

Dee Why Lagoon
Trends in algae concentration

Algae concentration has been improving over the long-term at Dee Why Lagoon

Figure 10
Annual grades for algae concentrations in Dee Why Lagoon since 2011/12

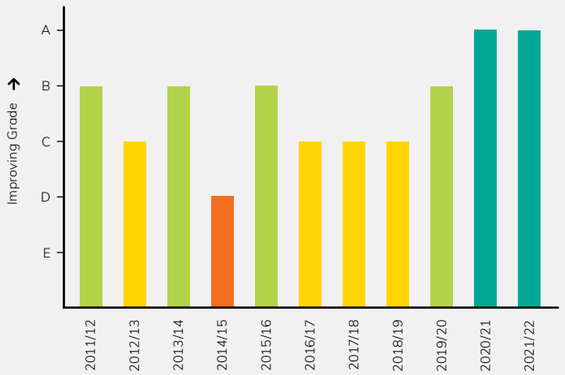
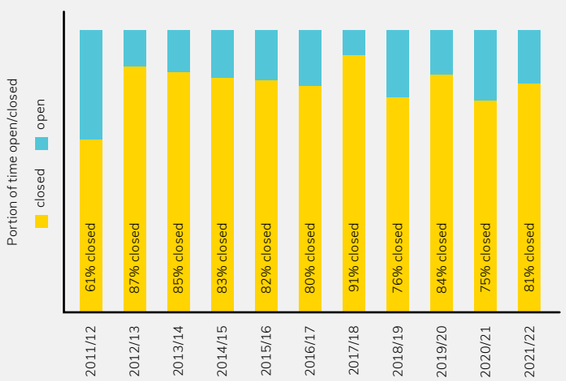


Figure 11
Proportion of the year when Dee Why lagoon is open/closed since 2011/12



Algae concentrations in Dee Why Lagoon are typically rated as **EXCELLENT** to **FAIR**, although it was rated as **POOR** during the 2014/2015 summer season. Algae concentrations have been observed to be below trigger levels more than 75% of the time, and the highest possible rating (**EXCELLENT**) has been observed in the two most recent summer seasons (2020/21 and 2021/22). Trigger levels are values established by NSW Department of Planning and Environment to indicate when values for water quality metrics, such as algae concentrations, are outside of expected values.

There are three physical attributes that often lead to increased algae levels in Dee Why lagoon:

- A closed entrance
- Higher than average (~24°C) daytime temperatures
- Low lagoon water level

Dee Why Lagoon is a predominantly closed ICOLL with a highly modified catchment. Runoff from urban catchments are often associated with higher nutrients (e.g. nitrogen and phosphorus) from fertilizers, pet waste and garden waste that get washed into the waterways. These nutrients accumulate in the waterway and are fuel for algae blooms.

When the entrance is closed, nutrient rich runoff from the catchment can get trapped in the lagoon. When the lagoon water levels are low and the air temperature is warm, the abundance of nutrients can lead to ideal conditions for algae growth. We can minimize nutrient inputs from our catchments by reducing the use of fertilizers, using green waste bins to collect garden waste, and by washing cars over grass instead of hard surfaces to reduce nutrients flowing into the lagoons.

Dee Why Lagoon
Trends in water clarity

Water clarity in Dee Why Lagoon is typically rated as **EXCELLENT** or **GOOD**, although it was rated as **FAIR** in the 2011/2012 summer season.

In general, monitoring has shown water clarity in Dee Why Lagoon is more likely to be poor when the entrance is open. The 2011/2012 summer season was associated with higher than average rainfall resulting in the Dee Why Lagoon entrance was open almost 40% of the summer. It is common for water clarity to decrease following rainfall as sediments from the catchment are washed into the lagoon. Interestingly, Dee Why maintained a **GOOD** water clarity rating in 2020 - 2022, despite high rainfall.

The good water clarity ratings support flora and fauna of the Dee Why Lagoon wildlife refuge and are especially impressive considering the highly urbanised catchment that drains to the lagoon.

Water clarity has been improving over the long-term at Dee Why Lagoon

Figure 12
Annual grades for water clarity in Dee Why Lagoon since 2011/12

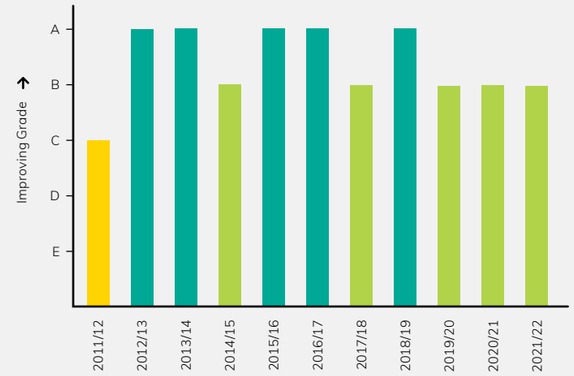
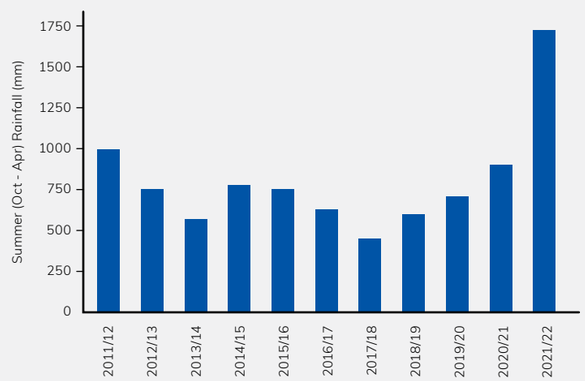


Figure 13
Total local summer (Oct - Apr) rainfall for Dee Why Lagoon since 2011/12



Narrabeen Lagoon

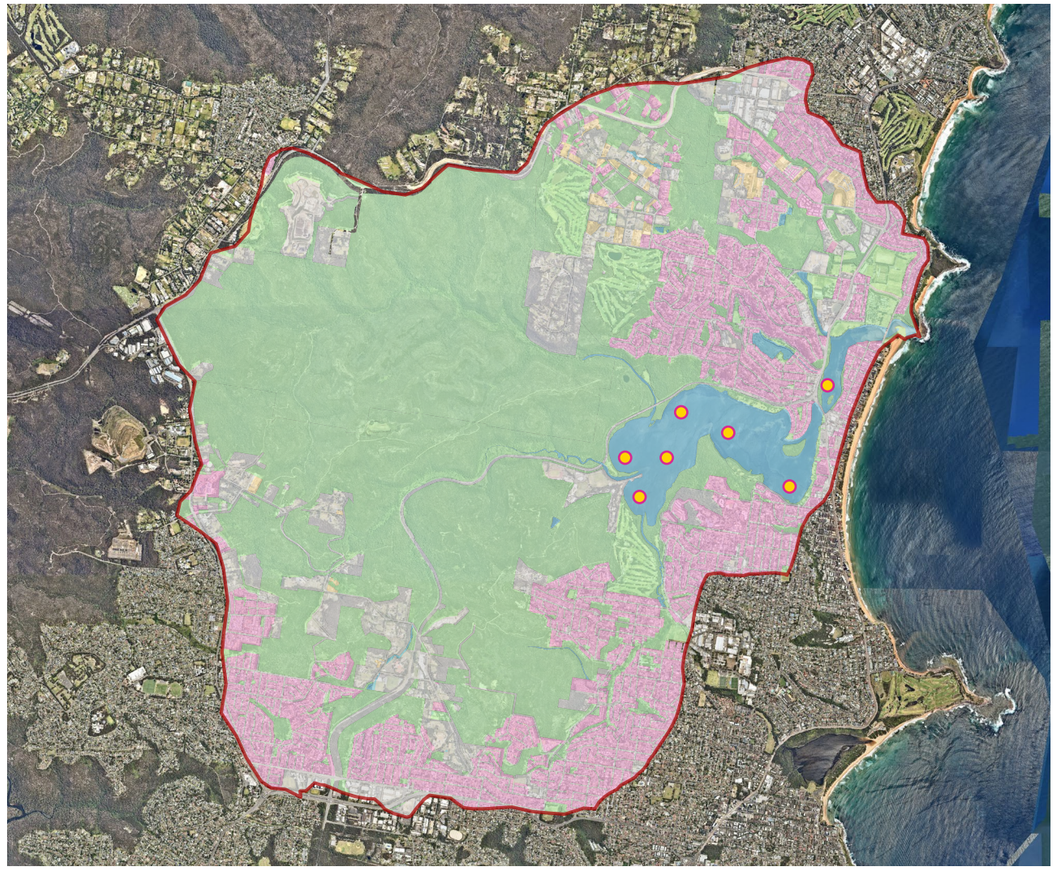
2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
D	B	B	C	B	B	C	B	B	B	B

Overall water quality in Narrabeen Lagoon has improved in the last decade

Catchment Area - 52.4km²
Estuary Area - 2.32km²

Major Creeks

- South Creek
- Middle Creek
- Deep Creek
- Mullet Creek
- Narrabeen Creek



Catchment area
Grassed and natural areas
Urban residential
Services, industrial and roads
Other
Water
Sampling Site

Narrabeen Lagoon is the largest of the lagoons in the Northern Beaches area, draining a catchment more than 50km² in size. Unlike its southern neighbours, more than two thirds of the catchment is natural and largely unmodified. Having less hard surfaces reduces the amount of stormwater runoff, and the unmodified catchment minimises pollutants entering the lagoon.

Narrabeen Lagoon and it's surrounding catchment are of high ecological value.

The entrance to Narrabeen Lagoon has been cleared four times during the monitoring period: 2011, 2016, 2018 and 2021. Entrance clearance is completed to manage flood risks and to improve tidal flushing of the lagoon.

Narrabeen Lagoon
Trends in algae concentrations

Algae concentration has been improving over the long-term at Narrabeen Lagoon

Figure 14
Annual grades for algae concentrations levels in Narrabeen Lagoon since 2011/12

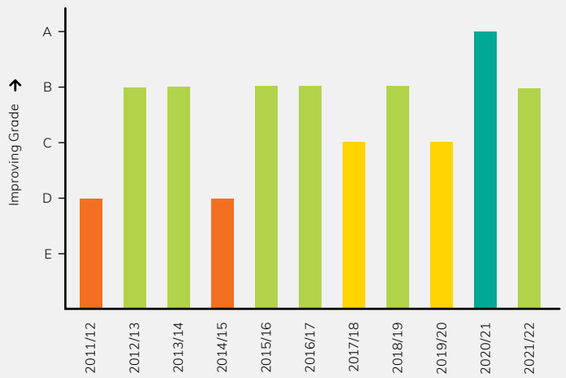
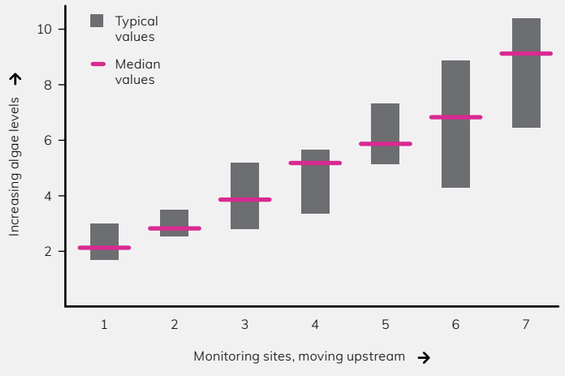


Figure 15
Typical algae concentrations at Narrabeen Lagoon from downstream to upstream monitoring sites in Narrabeen Lagoon since 2011/12



This figure shows that algae concentrations increase from downstream to upstream sites. Higher algae concentrations upstream in the lagoon are driven by nutrients entering the lagoon via creeks from the catchment. The downstream monitoring sites are closer to the lagoon entrance so experience increased tidal flushing which reduces nutrients and algae levels.

Algae concentrations levels in Narrabeen Lagoon have fluctuated from year to year and have generally been rated as **GOOD** to **POOR** (see figure 14). Encouragingly, no **POOR** ratings have been recorded in the most recent seven years of monitoring and **EXCELLENT** algae levels were observed in 2020/21, suggesting long-term improvements in algae levels in Narrabeen Lagoon.

Algae concentrations levels in Narrabeen Lagoon are spatially variable (see figure 15). At the monitoring sites near the ocean entrance, algae concentrations are typically low. Peaks in algae near the entrance of the lagoon are generally related to entrance closures, when regular tidal flushing is limited.

Median algae concentrations are two to three times higher in the upstream locations of the lagoon compared to the most downstream locations. Entrance openings tend to result in lower algae concentrations even at upstream locations, however the impact is most pronounced in the downstream locations nearer to lagoon entrance. While tidal flushing does occur throughout the whole lagoon, algae concentrations in the upstream locations of the lagoon are also driven by nutrients brought into the lagoon from catchment runoff.

Narrabeen Lagoon
Trends in water clarity

Narrabeen Lagoon is more than 7 times larger than any other ICOLL on the Northern Beaches.

To understand the ecological health of the lagoon, monitoring of water clarity and algae concentrations in Narrabeen Lagoon is completed at seven monitoring zones. Analysing spatial trends in water quality and eco health can provide insights into the function of the waterway.

Water clarity in Narrabeen Lagoon has typically been rated as **GOOD** to **FAIR**, although it was rated as **POOR** in the 2011/2012 summer season and **EXCELLENT** in the 2021/22 summer season.

When we investigate the monitoring data closely, water clarity tends to decrease in Narrabeen Lagoon moving away from the entrance. The monitoring site in the entrance channel and the one near Sanctuary Island typically have very good water clarity. However, the three sites near the major creek inflows (Deep Creek, Middle Creek and South Creek) are generally more turbid. The upstream areas of Narrabeen Lagoon are more impacted by sediment from the catchment after rainfall, while the tidal flushing in the lower lagoon helps to maintain clear water conditions.

Water clarity has been improving over the long-term at Narrabeen Lagoon

Figure 16
Annual grades for water clarity in Narrabeen Lagoon since 2011/12

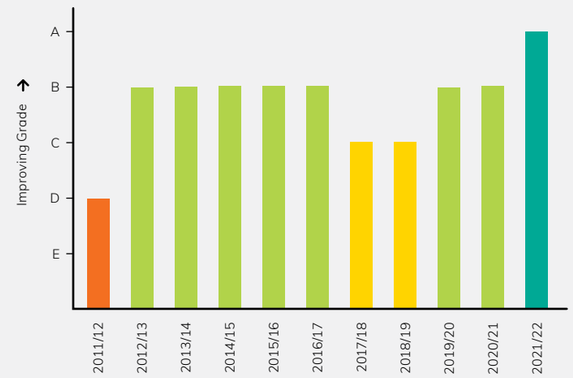
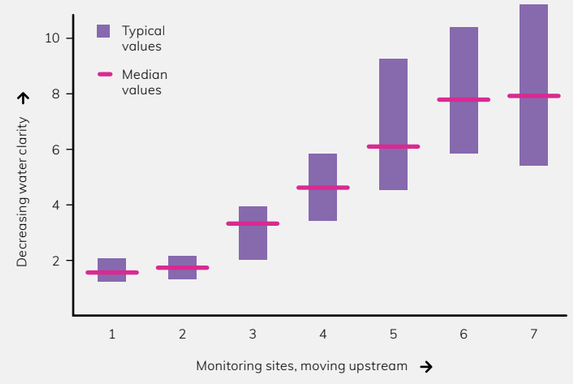
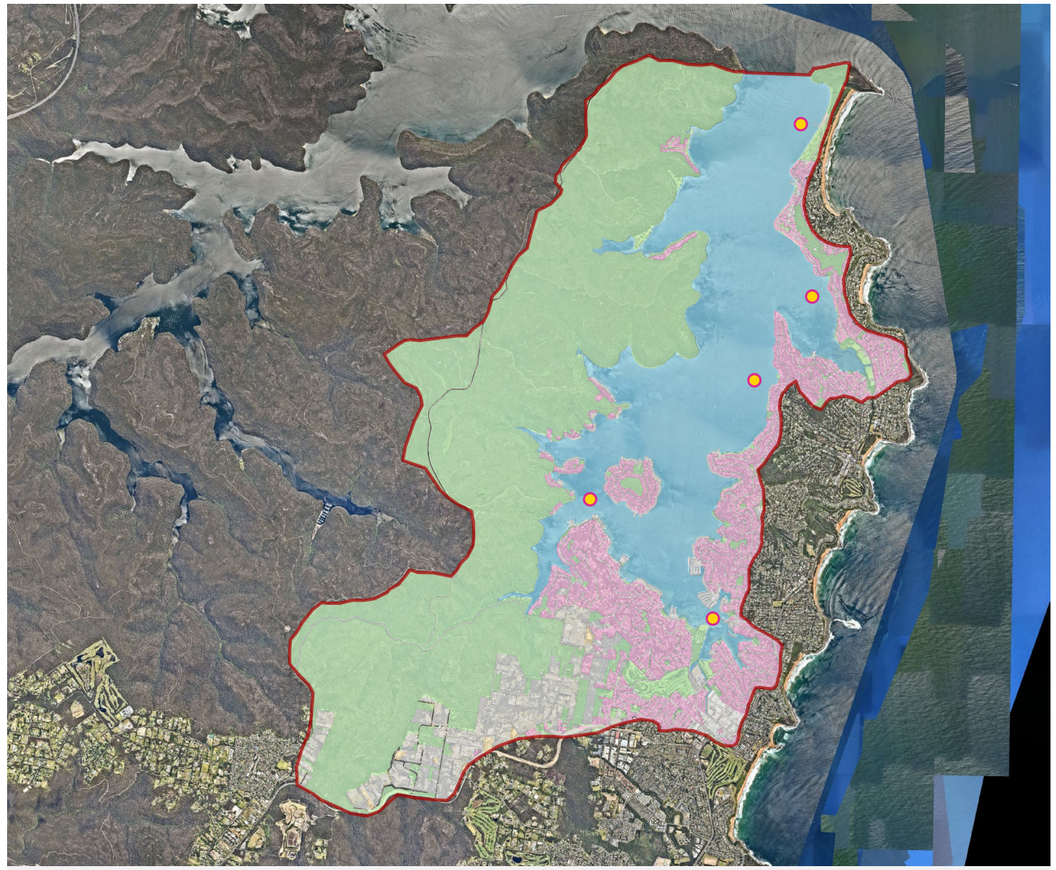


Figure 17
Typical water clarity at Narrabeen Lagoon from downstream to upstream monitoring sites in Narrabeen Lagoon since 2011/12



This figures shows that upstream monitoring sites typically have lower water clarity and downstream monitoring sites have higher water clarity where there is increase tidal flushing and reduced catchment run off.



We have been monitoring the health of Pittwater since 2017

2017/18	2018/19	2019/20	2020/21	2021/22
A	A	A	A	A

Pittwater estuary has been rated as excellent in terms of overall estuary health every year

Catchment Area - 50.8km²
Estuary Area - 18.4km²

Major Creeks

- Careel Creek
- Cahill Creek
- Salvation Creek
- McCarrs Creek

The Pittwater estuary is located at the entrance of the Hawkesbury-Nepean River system. Like Sydney Harbour, Pittwater is permanently open to the ocean.

Pittwater being permanently open to the ocean means the estuary is constantly being flushed with marine water which maintains the good water quality.

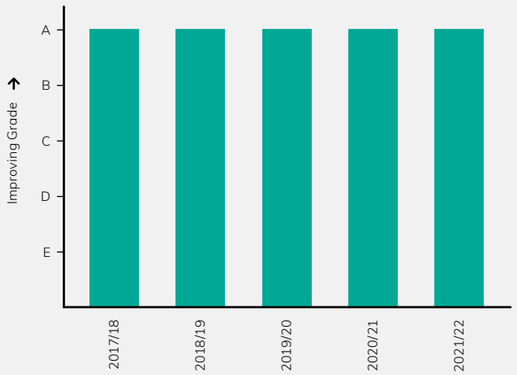
More than half of the catchment area is natural bushland, including over 20km² of Ku-ring-gai Chase National Park to the west.

Pittwater is a popular waterway for recreational and commercial water users, with both locals and tourists alike visiting for activities including swimming, boating, and fishing. Maintaining ecological health and water quality in the estuary is essential to maintaining the social, environmental and cultural values of this estuary.

Pittwater Estuary
Trends in ecological health

Pittwater estuary has been rated as excellent or good for algae and water clarity in each monitoring period, and the ecological health is stable.

Figure 18
Annual ecological health grades in Pittwater since 2017/18



The Pittwater estuary has maintained an **EXCELLENT** ecological health rating since monitoring began in 2017. This indicates the ecological health of the estuary is amongst the best in NSW. Strong tidal flushing and a predominantly unmodified catchment reduces the pressure on this estuary.

In five years of monitoring, algae concentrations across the Pittwater estuary have always been observed to be **GOOD** or **EXCELLENT**. Algae concentrations have been observed to increase marginally following periods of heavy rainfall, which is related to nutrients in stormwater runoff from the catchment.

Water clarity is measured in five locations throughout the estuary and has also been consistently rated as **EXCELLENT** over the last three years. Trigger levels have been exceeded in two locations (in Careel Bay and near Clareville) in late 2019.

The levels of water clarity measured were still within the typical range of turbidity for river systems and did not appear to persist in the estuary.

Swimming and recreation
NSW Beachwatch

Separate to the MER water quality program, the NSW State Government undertakes the NSW Beachwatch program. This includes regular monitoring and water quality forecasting of open coast beaches and 10 locations within Pittwater estuary for swimming. While the ecological health of Pittwater has been consistently rated as excellent, this does not directly reflect on the suitability for swimming.

The NSW Beachwatch program provides daily forecasts of pollution based on rainfall, but also includes information about sewage overflows reported by Sydney Water.

In general, Beachwatch recommends no swimming at ocean beaches for at least one day after rainfall, and swimming in estuarine waters is not recommended for three days after rainfall. Stormwater and other pollutants can enter waterways after rainfall, which can cause spikes in bacteria levels that are harmful to human health.

For daily information on the suitability of swimming, search for NSW Beachwatch and navigate to the beach you are interested in.

Typical Beachwatch ratings

Less than 10 mm of rain in the last 4 days

GOOD

★★★★

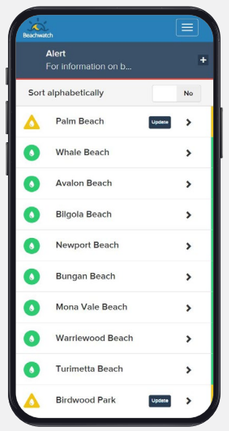
(Minimal risk of illness to bathers, suitable for swimming)

More than 10 mm of rain in the last 4 days

FAIR

★★★☆

(Increased risk of illness to bathers, especially those with reduced immune systems. Consider not entering the water.)



What's happening in your catchments?

The coastal lagoons and estuaries are sensitive environments of high environmental and community value. Northern Beaches Council works with local community members to help manage ecological health across these estuaries and their catchments. This includes:

- **Land use planning and development controls** are used to ensure new developments or additions to existing buildings are sensitive to the surrounding catchment. This includes applying building controls to ensure developments minimize hard surfaces and install filtration systems to catch sediment before it enters creeks, wetlands, and lagoons.
- **Bush regeneration** is undertaken in bushland and riparian areas. Alongside community groups, we carry out bush regeneration activities around creeks and waterways to improve areas of degraded bush that can sometimes contribute to sediment in creeks.
- **Water quality devices** are installed to catch litter, pollutants and sediment before it enters the lagoon. These are regularly maintained.
- **Curl Curl Lagoon Catchment**
  Council installed a temporary floating wetland at Curl Curl Lagoon as a trial seeding point for aquatic plants to populate the lagoon and potentially improve water quality. A 3-year grant-funded program has also been completed at Curl Curl Lagoon, planting 3000 plants to restore the habitat and amenity of the area.
- **Dee Why Lagoon Catchment**
  Council installed a water sensitive urban design swale to capture and filter stormwater before entering Dee Why Lagoon. We also involve local community groups, such as Friends of Dee Why Lagoon, in bush regeneration works around the Lagoon.

Floating wetland in Curl Curl Lagoon

What can you do to improve Lagoon health?

Daily activities in a lagoon's catchment have an impact on water quality. There are several things you can do to help protect waterway and lagoon health in the Northern Beaches area:

In and around the home:

- Use eco-friendly or grey water safe cleaning products that are free from phosphates.
- Dispose of household chemicals, oils, paints and pesticides at one of Council's Chemical CleanOut collection days. Never dispose of them down the sink, stormwater or in your bin.
- Install a rainwater tank to water your garden, flush your toilets and to connect to your washing machine.
- Make sure your household sewerage pipes are not connected illegally to stormwater.
- Maintain your car, making sure there are no oil leaks. Wash cars on the lawn, minimise detergent use and empty the soapy water down the sink or toilet. Alternatively, take the car to a car wash where the water gets treated and recycled.

In the garden:

- Sweep your gutter and driveway regularly and place the sweepings in the compost or vegetation bin to avoid it being washed down the drain and into our creeks.
- Plant native species in your garden and avoid invasive weeds.
- Avoid unnecessary use of fertiliser on your property. Fertilisers are easily washed into creeks and result in elevated levels of nutrients and algal growth.
- Avoid large-scale clearing of vegetation and stabilise disturbed soil by replanting. This will help prevent erosion of creek banks and reduce sediment and nutrients entering streams.
- Consider natural alternatives to pest control chemicals in the garden.
- Replace impermeable surfaces (e.g. concrete) with permeable surfaces such as timber decks and pavers (with gaps between pavers) to allow rainwater to infiltrate into the ground.
- Clean up pet droppings and dispose of them in the rubbish bin or in the toilet.

In the community:

- Report pollution events immediately to Northern Beaches Council via the Council website or by calling 1300 434 434.
- Become a local bushcare volunteer via the Bushcare Volunteers page on the Council website.
- Pick up litter and be mindful of how you dispose of your rubbish and where it ends up.

Dee Why swale and bush regen work

northern
beaches
council