Australia's National
Science Agency

Water quality on Norfolk Island

This brochure has been co-created with Norfolk Island collaborators, to explore the findings of our Norfolk Island Water Quality Assessment Technical Report.



Credit: Rob Ryan

Overview

The ocean around Norfolk Island is home to vibrant and unique marine ecosystems. The coral reefs surrounding the island have cultural, historic, ecological, and economic value, and are protected by the Norfolk Marine Park. The park spans over 188,000 square kilometres, with no-take areas in place to safeguard biodiversity.

In recent decades, marine experts and community members alike have raised concerns about the declining health of the lagoonal reef near the island, and the delicate ecosystems it supports. Norfolk Island's nutrient run-off and declining water quality have been linked to reduced coral cover and disease outbreaks in the lagoon. Rising sea surface temperatures, driven by climate change, also harm reef health and contribute to coral bleaching and algal growth.

In 2019, CSIRO – Australia's national science agency – was commissioned by the Australian Government to assess Norfolk Island's water resources. This research was expanded in 2021 to monitor water quality and develop guideline values for contaminants, to inform the protection of marine ecosystems around Norfolk Island.

Our water quality work had four main aims:

1. Setting up a water quality monitoring program and database.
2. Developing marine water quality guideline values.
3. Identifying key contaminants and their potential sources.
4. Understanding how contaminants enter the Kingston bays.



Credit: Susan Prior



Here's what we found

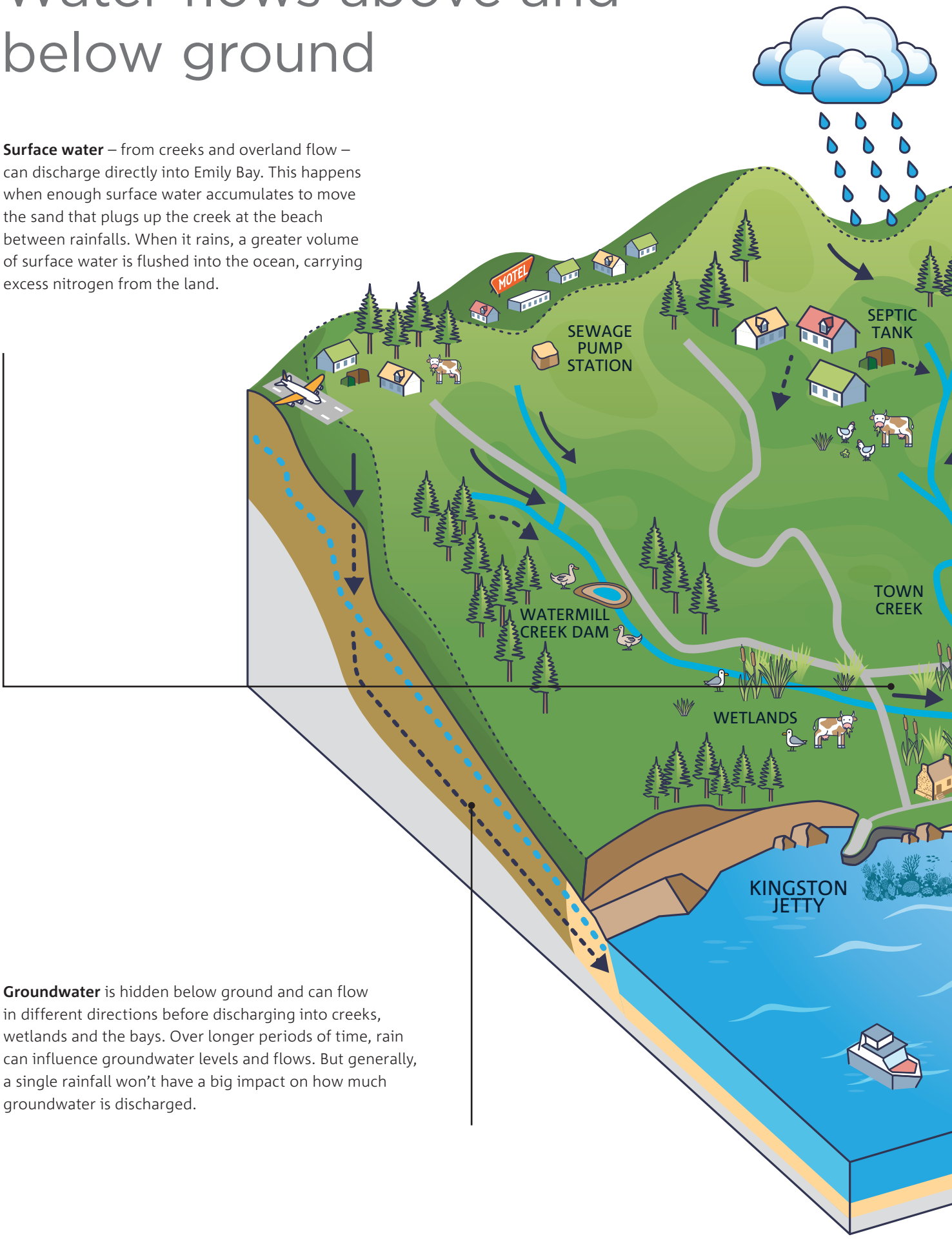
Surface water and groundwater from the island carry contaminants into the ocean.

By comparing water quality in the Kingston bays with less affected reference sites, we identified the main contaminants potentially impacting coral reefs. As of 2026, Emily Bay and Slaughter Bay are most affected by excess nutrients and copper, especially after rain.

Acid sulfate soils present another threat to water quality, if they are disturbed or dry out. Higher levels of nitrogen and other contaminants harm the health of coral reefs and marine life and feed the spread of algae.

Water flows above and below ground

Surface water – from creeks and overland flow – can discharge directly into Emily Bay. This happens when enough surface water accumulates to move the sand that plugs up the creek at the beach between rainfalls. When it rains, a greater volume of surface water is flushed into the ocean, carrying excess nitrogen from the land.



Groundwater is hidden below ground and can flow in different directions before discharging into creeks, wetlands and the bays. Over longer periods of time, rain can influence groundwater levels and flows. But generally, a single rainfall won't have a big impact on how much groundwater is discharged.

On Norfolk Island, water can flow into the ocean via overland flow or streamflow, or through the soils and aquifers underground.



Contaminants from the island wash into the ocean

As they flow towards the ocean, surface water and groundwater pick up contaminants from a range of human activities and land uses. From 2021, our researchers began monitoring water quality at several sites on and around Norfolk Island. Acid sulfate soils – which can release acid and heavy metals or remove oxygen from water – also threaten water quality. We have also mapped where acid sulfate soils are known to occur across the island, including in Watermill Dam, Watermill Creek and large wetland areas near Watermill Creek and Town Creek.

We analysed a wide range of parameters to characterise water quality and understand how it is influenced by natural and human pressures. We analysed pH, temperature, dissolved oxygen, salinity, nutrients, metals and metalloids, hydrocarbons, pesticides, and other organic chemicals like PFAS, pharmaceuticals and personal care products.

We used naturally occurring environmental tracers to understand groundwater origin and flow, and markers for faecal contamination. We tested seawater from the Norfolk Marine Park, surface water in Watermill Creek and Town Creek catchment, and groundwater across the southern part of the island.

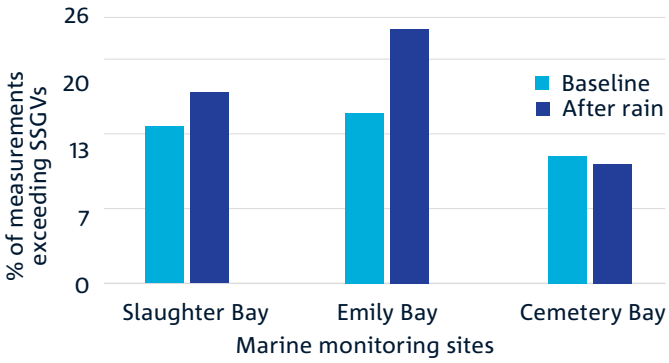
We also measured seawater quality in places with little to no impact from the island. These are our reference sites, which we use to develop marine water quality guideline values and compare with places affected by contamination.

We found higher levels of contaminants at Emily Bay and Slaughter Bay than at other sites, especially when we took measurements after rainfall. Between 2022 and 2024, these bays exceeded their site-specific marine water quality guideline values developed for Norfolk Marine Park, more often than Cemetery Bay.

We collected water quality data from up to four sites in each bay when there had been less than 20mm of recent rain (our baseline conditions), and when there had been more than 20mm of rain in the past 24 to 48 hours. So, for example, in Emily Bay our water quality measurements exceeded guideline values 16% of the time under baseline conditions, and 24% of the time after rain. This took into account both physical and chemical measurements.



Credit: Rob Fitzpatrick



Under baseline and rain event conditions, Slaughter and Emily Bays have a higher percentage of water quality measurements that exceed site-specific guideline values (SSGVs for protecting 95% of species from toxicants) compared to Cemetery Bay.

How we created the water quality guideline values

To develop water quality guideline values for Norfolk Marine Park, we monitored our reference sites every month for two years. This gave us an understanding of what 'normal' amounts of acidity, salinity, oxygen and nutrients look like in coastal waters less impacted by land use.

We also drew on the default water quality guideline values of the Australian and New Zealand governments – which are based on toxicity – to assess levels of metals like copper and nickel. The concentrations were well below the default guideline values (with the exception of copper following large rainfall events), so they were not considered to be of concern in the Kingston bays. If land uses or contamination risks change in the future, our marine water quality guideline values may need to be updated.

Guideline values are tailored to the state of the ecosystem being monitored. The guideline values can be set to protect 95% of species (where ecosystems are slightly or moderately disturbed, like in the Kingston bays) or 99% of species (where ecosystems are pristine or undisturbed). The desired level of protection can be decided with community input.

The main contaminant our researchers detected was nitrogen. Soils naturally contain a certain amount of nitrogen. But human activities like fertilising plants, rearing animals and disposing of wastewater can all add extra nitrogen to the soil and water. When there is excess nitrogen, researchers consider it a contaminant, because it has the potential to harm the environment.

On Norfolk Island, animal manure, failing wastewater systems and fertiliser are all potential sources of excess nitrogen. Tests using genetic markers for human and animal faecal contamination confirmed that multiple sources of waste impact on water quality. Human, bird, cattle and dog waste was detected in the surface water. Only human waste was detected in the groundwater. As well as nitrogen, our researchers identified phosphorus, silica and copper as other contaminants to continue monitoring.



Credit: Tatiana Samuel

There were two main ways our researchers investigated the key sources of contamination and estimated how much each was generating.

We used **water quality monitoring** informed by a **land use assessment** to identify which contaminants have the greatest impact on water quality in the Kingston bays. The **land use assessment** compiled potential contaminants that could be present. Then we monitored a comprehensive suite of parameters over one year, to identify the key contaminants and refine the marine monitoring program.

Nitrogen was identified as the key contaminant affecting water quality in the bays. We estimated that altogether, wastewater, livestock and fertiliser could add up to 9 tonnes of nitrogen per year in the Watermill Creek and Town Creek catchment. Some of the added nitrogen can be taken up by plants or stored in soil. However excess nitrogen, often in the form of nitrate, dissolved in water can contaminate surface water and groundwater.

Other land uses, such as the former tip at Point Hunter, were considered lower risk as we didn't identify any trace metals or chemicals that might have come from Point Hunter in our water quality monitoring.

The other way we examined how nutrients were ending up in sea, surface and groundwater was through **Microbial Source Tracking (MST)**. This technique traces the origins of faecal matter by checking for the genetic markers of microorganisms that live in the intestines of different species. For our research, we looked at markers for human, bird, cow, dog, and pig faeces.

This confirmed that livestock and wastewater management in the Watermill Creek and Town Creek drainage division are sources of contamination to bodies of water on and around the island. Emily Bay and the creeks had markers of contamination from human, bird, cow and dog faeces, indicating the potential for contaminants coming from the discharge of surface water into the bay. Groundwater had markers of contamination from human faeces, suggesting that groundwater discharge can transport nutrient-rich waste from leaking septic tanks.



Credit: Susan Prior

Acid sulfate soils also threaten water quality

Acid sulfate soils form naturally under waterlogged conditions. When exposed to air, they react with oxygen to create sulfuric acid. This sulfuric acid can dissolve metals in the soil, making them more likely to be released into ecosystems.

Generally, acid sulfate soils pose little risk when they remain waterlogged and undisturbed. But if disturbed and exposed to air, they can release acid, metals or gases and deoxygenate water, which can harm plants and animals or corrode and damage buildings and infrastructure.

Acid sulfate soils are found in Norfolk Island's wetland and lower landscape positions. In the Kingston and Arthur's Vale Historic Area (KAVHA), acid sulfate soils have been confirmed in Watermill Dam, Watermill Creek, and large wetland areas adjacent to Watermill Creek and Town Creek. On-ground mapping has given us a high degree of confidence in the identified locations of acid sulfate soils. However, it is possible that acid sulfate soils may be elsewhere on the island, especially where they may have been covered by thick layers of soil during erosion.

Previously, acid sulfate soils were kept saturated by groundwater. But in 2020, acidification was caused by an extended dry period during which groundwater levels declined, and by soil disturbance by excavation or livestock. The acidic conditions released iron and aluminium into nearby water and soils. Following wet periods in 2021 and 2022, the soils were re-saturated and the acidic conditions were reversed in locations where drying occurred without major disturbance. Rewetting and recovery from acidic conditions did not occur in locations of major soil disturbance, such as from extensive excavation, erosion or deep cattle pugging.

The potential damage caused by acid sulfate soils can be managed with careful planning, monitoring and expertise. Planned or unavoidable disturbances - like heritage works or vegetation reduction - can be subject to a management plan and executed by qualified personnel. Maintaining groundwater levels and soil cover, and preventing disturbance by excavation, human traffic and livestock grazing will also help. Regularly checking pH levels as part of water quality monitoring can provide early warning of acidification.

Read more in our 2023 report on managing acid sulfate soils in KAVHA: https://doi.org/10.25919/g6qw-r502



Credit: Rob Fitzpatrick



Credit: Susan Prior

Contaminants harm marine life and ecosystems

Nitrogen naturally flows into the ocean from soils, providing important nutrients to marine organisms. But too much nitrogen entering the marine environment can cause an overgrowth of algae. As algae takes up more space on the reef, it reduces corals' ability to grow and fight off disease. Over the long term, this can result in coral die-back. This in turn damages the health of the marine ecosystem, because lots of species rely on corals to thrive. It also risks algal and microbial outbreaks that can pose a risk to human health.

Improving water quality helps coral reefs be healthier and more resilient to the combined impacts of climate change and contaminants. Reducing the flow of contaminants into the ocean from the island gives local reefs the best chance of recovering from rising sea surface temperatures, which are causing coral bleaching all around the world.

What happens next?

Changing rainfall patterns and warming sea temperatures are likely to increase the pressures on Norfolk Island's coral reef ecosystem. Improving water quality from the Island's surface and groundwater will help corals to better withstand and recover from marine heatwaves and extreme rainfall events. A coordinated suite of actions to manage contaminants like nitrogen, and to prevent it from entering surface water, groundwater and the ocean, will help to produce a sustainable long-term improvement in water quality and ecosystem health. Various investigations and studies have already been undertaken to progress this.

Upgrading wastewater management systems, continuing scientific monitoring, and works to protect waterways and their banks are among the actions being undertaken by governments and agencies. Success requires coordinated action, supported by scientific evidence and funding to implement measures to improve water quality. Continuing to monitor water quality is also critical to determine the effectiveness of different management strategies, and to help understand whether water quality is improving over the long-term.



Credit: Susan Prior

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