INFORMATION SHEET

Floating wetlands as a retrofit pathway to reduce greenhouse gas emissions from wastewater lagoons

For water utilities working toward emissions reduction targets, there is increasing interest in interventions that operate with low energy demand to deliver measurable emissions reductions under real operating conditions.

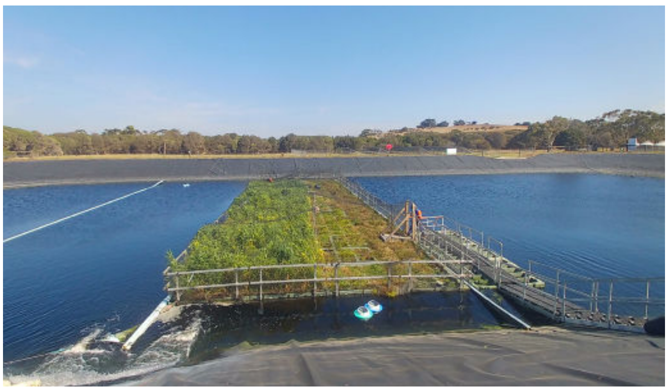
About the project

Wastewater lagoons can be a material source of greenhouse gas (GHG) emissions, particularly methane (CH_4), because they commonly operate under low-oxygen conditions that favour anaerobic breakdown of organic matter. Nitrous oxide (N_2O) may also be emitted depending on nitrogen cycling pathways, and carbon dioxide (CO_2) is emitted through biological respiration and related processes.

Constructed floating wetlands (CFWs) are one option being investigated for lagoon systems. Wastewater treatment plants are looking for practical and scalable solutions to the GHG emissions problem, and CFW are one option being investigated. CFWs are buoyant structures planted with wetland vegetation, with root systems extending into the water column.

While floating wetlands are often discussed in the context of water quality and habitat, there is growing evidence that they can also influence net GHG fluxes through changes in microbial pathways and oxygen availability.

The roots and associated surfaces provide habitat for microbial biofilms and can influence oxygen conditions and biogeochemical processes that affect GHG production and consumption.



Constructed floating wetlands at Cowes Wastewater Treatment Plant, 2025.

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Field evaluation in an operational lagoon

To assess these effects in a real operating environment, a CFW was installed and monitored in a wastewater storage lagoon of approximately 4,500 m² surface area (up to ~14 ML capacity). This project was a collaborative effort led by Westernport Water, alongside RMIT University, CSIRO and Covey Associates funded by Westernport Water, the Victorian government and the Intelligent Water Networks (IWN).

The lagoon inlet zone was configured into parallel treatment and control channels using baffle curtains, allowing side-by-side comparison under comparable influent conditions. Baseline monitoring was undertaken prior to installation to confirm there were no systematic differences between channels. A 331 m² commercial floating wetland planted with native wetland vegetation was installed in May 2023, and monitoring continued through April 2025, covering two full growing seasons.

A key element of the work was the use of continuous GHG monitoring. Floating sensor platforms ("Pondi") were deployed to measure CO_2, CH_4 and N_2O fluxes continuously at the start and end of both the treatment and control channels. Continuous monitoring was used because lagoon emissions can vary substantially over time and can be influenced by short-lived events, including methane ebullition ("bubbling") and operational disturbances. In parallel, monthly sampling was undertaken for nutrients (total Kjeldahl nitrogen, ammonium, nitrate, total phosphorus) and water-quality parameters (temperature, pH, dissolved oxygen) to provide context for interpreting emissions patterns.

Summary of observed outcomes

Across the monitoring period, nutrient concentrations in the treatment and control channels were broadly comparable. No persistent reductions in nitrate or total phosphorus were detected at the deployed wetland coverage and under prevailing hydraulic conditions, and a modest reduction signal was observed for total Kjeldahl nitrogen at the end of the treatment channel. This indicates that, for this lagoon configuration and wetland footprint, nutrient removal was not an observed outcome.

In contrast, clear reductions were observed in greenhouse gas fluxes in the floating wetland channel relative to the control. Average CO_2 fluxes were approximately 30% lower. Methane reductions were more pronounced, with CH_4 fluxes up to around 63% lower at the start of the treatment channel and around 39% lower at the end. Nitrous oxide fluxes were also lower at the end of the treatment channel (approximately 17% reduction). When combined into overall climate impact, the floating wetland channel showed a reduction on the order of approximately 22–31% in CO_2-equivalent emissions relative to the control, with the aggregated value influenced by short-lived methane spikes following vegetation management events.

Lukas Schuster, RMIT University with a "Pondi" sensor platform at Cowes Wastewater Treatment Plant, 2025.

Water-quality results help explain why emissions reductions can occur even when nutrients do not change substantially. Dissolved oxygen was higher at the end of the floating wetland channel than in the control (approximately 15% higher), indicating that the system influenced oxygen conditions. Increased dissolved oxygen supports aerobic microbial activity, including processes such as methane oxidation (where microbes consume methane in the presence of oxygen). This is consistent with a mechanism in which emissions reductions are driven by enhanced microbial consumption pathways and altered local conditions around roots and biofilms, rather than by bulk nutrient removal alone

Operational considerations

Continuous monitoring also identified operational effects relevant to implementation. Two harvesting events (September 2024 and March 2025) were followed by short-lived methane spikes. These transient increases are consistent with disturbance of the root-associated zone and release of dissolved or trapped methane that may otherwise have been oxidised or emitted more gradually. While temporary, such spikes matter because they can influence net cumulative emissions and should be considered when developing maintenance protocols. Harvesting method, timing, and biomass handling options are therefore relevant levers for sustaining emissions benefits.

What this means for the water industry

These findings support constructed floating wetlands as a potentially scalable, retrofit-compatible intervention for reducing lagoon GHG emissions, particularly methane. Importantly, the work indicates that emissions benefits can be realised even where bulk nutrient concentrations were not observed to reduce, which broadens the potential applicability of floating wetlands across lagoon assets with differing hydraulic conditions. The results also demonstrate the value of continuous monitoring for understanding variability, quantifying net outcomes, and identifying operational trade-offs that may not be visible through infrequent sampling.

The outcomes provide a strong foundation for further work to test performance across additional lagoon types and operating conditions, evaluate scaling (including wetland coverage ratios and placement), refine operational practices such as harvesting, and improve understanding of the biological mechanisms driving emissions changes. Building this evidence base is important for utilities as they develop credible and cost-effective emissions abatement pathways

Constructed floating wetlands installed in a treatment lagoon at Cowes Wastewater Treatment Plant.

Proposed next phase

Westernport Water, in collaboration with RMIT University and partners including other water utilities, IWN, and the Department of Energy, Environment and Climate Action, is preparing an application to the Australian Research Council (ARC) to further this work through an ARC Linkage Grant. The purpose of Linkage Grants is to generate new knowledge and practical outcomes by bringing research expertise together with partner organisations that can help define real-world problems, provide co-investment, and support translation of findings into operational or policy settings.

For the water sector, an ARC Linkage project would enable a coordinated program of research and field demonstration that expands beyond a single site and addresses questions directly relevant to utility decision-making: where floating wetlands are most effective, how benefits scale, what monitoring is appropriate for verification, and how operational practices can be standardised to maintain net emissions reductions over time.

Partnering agencies at the Wetlands Showcase hosted by RMIT Center for Nature Postivie Solutions in Melbourne, 2025.

FURTHER INFORMATION

Contact the project team via email westport@westernportwater.com.au or call 1300 720 711.

Project partners

RMIT UNIVERSITY

COVEY ASSOCIATES PTY LTD Consulting Engineers

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intelligent water networks 10+ years

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