A Year in Action – Hybrid MABR-MBR WWTP in Te Kauwhata New Zealand

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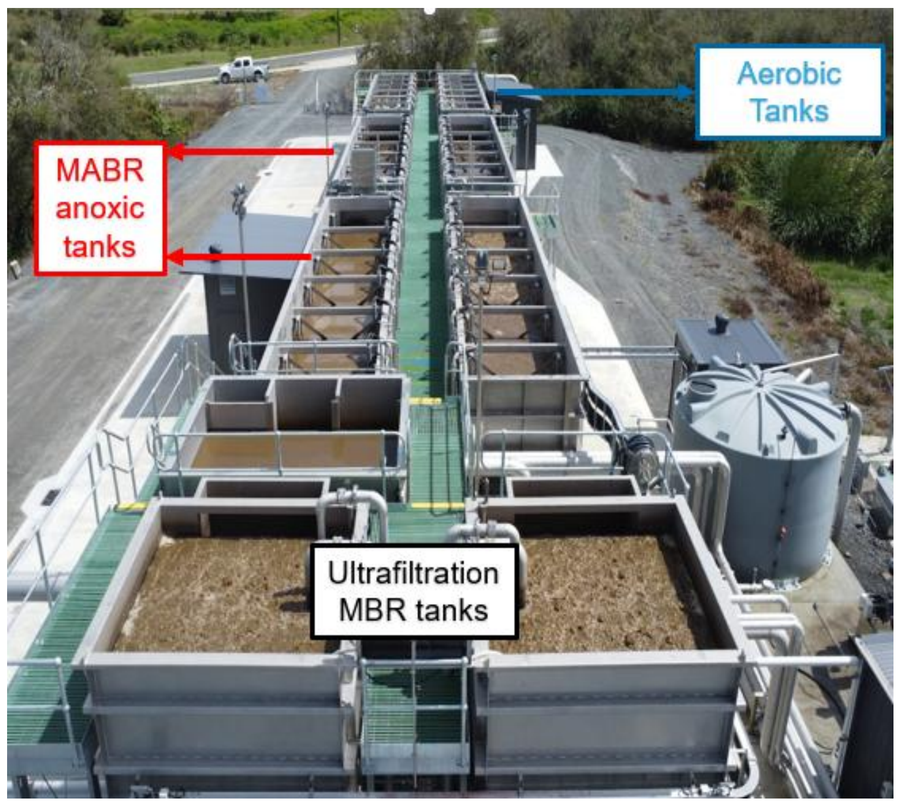
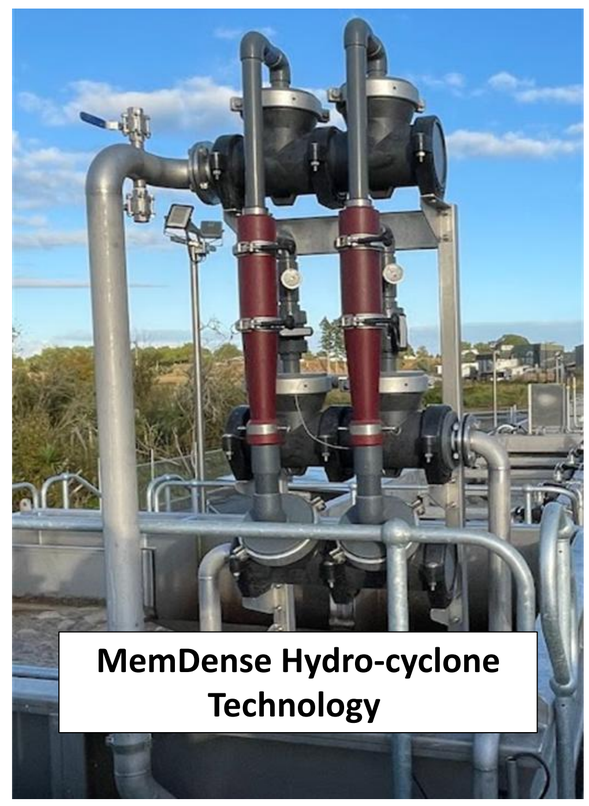
Priority Topic Area: **Water and Sanitation**

1 – Technology Innovation at Te Kauwhata WWTP

The Te Kauwhata WWTP project aimed to upgrade its aging oxidation pond system to a compact, high-performance biological treatment plant capable of meeting discharge limits to Lake Waikare, a culturally significant site. The upgrade introduced a hybrid membrane aerated biofilm reactor and membrane bioreactor (MABR-MBR) system, first installation of its kind at full-scale. Planned deliverables included achieving reliable nitrogen removal at low emissions, robust solids separation, and operational resilience within a small footprint. The project also aimed to demonstrate the feasibility of biofilm-based treatment in municipal wastewater systems while generating full-scale greenhouse gas emission datasets to benchmark N_2O and trial intensification through MemDense.





2 – Hybrid MABR-MBR + MemDense Technology

The upgrade implemented a hybrid biological treatment configuration combining MABR with downstream MBR ultrafiltration. In MABR systems, oxygen is delivered through gas-permeable membranes where it diffuses into the biofilm while ammonia diffuses from the bulk liquid, enabling counter-diffusion and simultaneous nitrification and denitrification. Performance monitoring during the first operational year evaluated ammonia removal, total nitrogen removal, nitrous oxide emissions, and membrane performance. Off-gas analyzers measured N_2O emissions from the MABR tanks, while liquid sensors monitored downstream concentrations. In 2025, MemDense technology was introduced to selectively retain dense biomass while wasting lighter flocs to enhance sludge settleability.

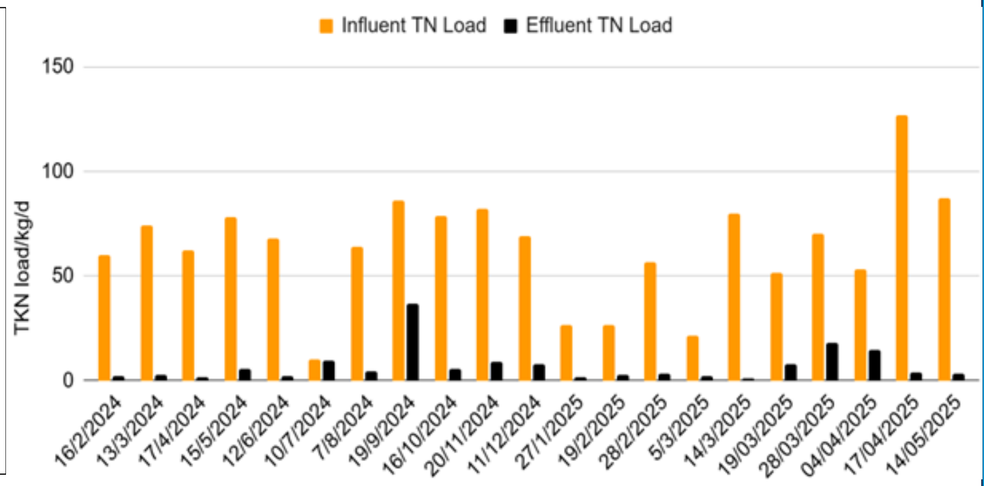


Figure 1 – Total Nitrogen Removal

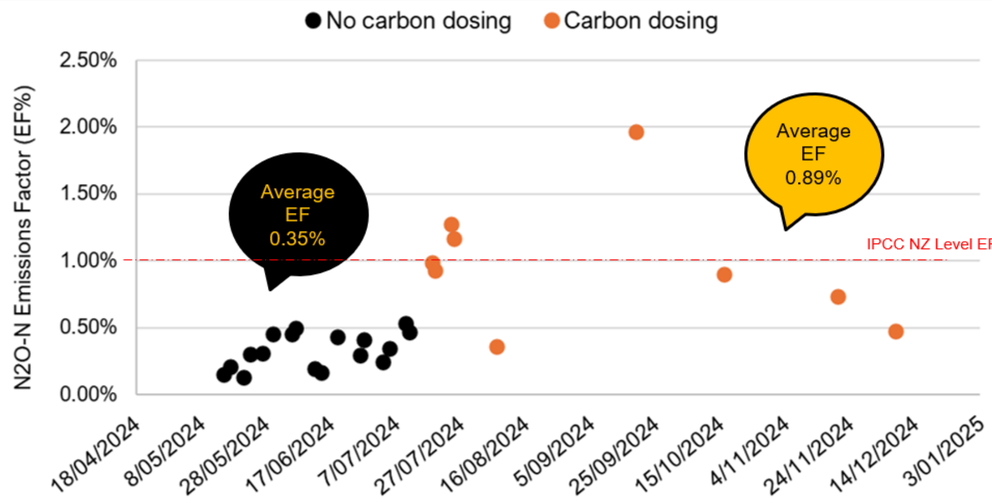


Figure 2 – Nitrous Oxide Emissions

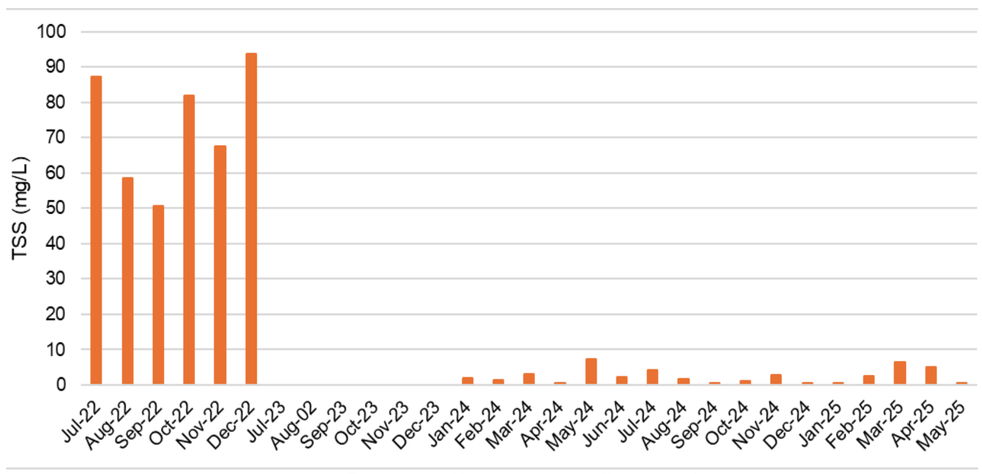


Figure 3 – Total Suspended Solids Removal

3 – Nitrogen Removal Performance, N_2O Emissions & Membrane Performance

- The plant demonstrated strong treatment performance and resilience under real operating conditions. Ammonia removal averaged 97%, exceeding the plant design target of 92%. Despite process upset caused by excessive sludge wasting that reduced the solids retention time to 3.4 days, the system maintained~90% ammonia removal, highlighting the resilience of the biofilm-based MABR process.
- Total nitrogen removal averaged ~ 90%, consistent with design expectations (Figure 1). During a temporary biomass loss event, removal efficiency dropped below 75% and effluent total nitrogen exceeded 10 mg/L; however, the plant recovered within twelve days, demonstrating the robustness of the hybrid process configuration.
- Nitrous oxide emissions were monitored (Figure 2) using off-gas monitoring from the MABR tanks. Average emissions were 0.35% of ammonia load under baseline conditions and increased to 0.89% during periods requiring external carbon dosing due to low influent C/N ratios. Both values remained below the New Zealand IPCC benchmark emission factor of 1%, indicating strong greenhouse gas performance.
- MemDense technology improved sludge characteristics, with sludge volume index reductions and increased granular biomass fractions indicating improved settleability and potential for enhanced membrane performance.

4 – Benefit to society

Remarkably, the team achieved fully compliant wastewater within three weeks from seeding (Table 1). Improved effluent quality protects receiving waterways connected to Lake Waikare, which holds cultural and ecological importance to local communities and iwi. The compact design enables smaller towns to implement advanced treatment technologies without large land requirements. Demonstrating successful implementation of hybrid MABR-MBR technology in Aotearoa New Zealand provides a scalable model for upgrading aging wastewater infrastructure nationwide and globally without risking ratepayers' money or compliance. Overall, this plant is a testament of how even smaller towns can set a benchmark for sustainable wastewater solutions, inspiring others to follow.

Table 1: Median Consent & Effluent

Median Data	cBOD	TKN	TN	TP	TSS
Consent	10	6	8	5.6	15
2022	18	38	39	4.2	63
2024-25	1	3	5	2	2

5 – Next steps

Future work will focus on optimizing process control, further evaluating MemDense sludge densification performance, and refining strategies to minimize greenhouse gas emissions. Long-term monitoring will support optimization of hybrid MABR-MBR systems and guide adoption of intensified wastewater treatment solutions across New Zealand and other regions.

References/Acknowledgement

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