

LAKE WELLINGTON PROJECT · MACALISTER IRRIGATION DISTRICT

Understanding nutrient losses from farms in the Macalister Irrigation District

A summary for farmers, community groups and catchment managers

Research summary 2020–2025

Gippsland, Victoria



Monitoring runoff at a farm drain outlet, June 2023 (winter).

Key takeaways for farmers

1. Manure and effluent, not fertiliser, are the main source of nutrient runoff from dairy paddocks, so maintaining effective effluent storage, avoiding spreading effluent prior to rainfall events, and avoiding spreading in areas where runoff can flow directly to district drains, are the highest-priority actions on farm.

2. Nutrients leave farms mainly in water running across the paddock surface. Ground cover, less soil compaction and surface roughness slow the water and cut losses.

3. A well-sized, well-maintained tailwater capture dam, pumped out before (and ideally after) irrigation, can cut nutrient losses by around half to more than three-quarters. Regular pumping and maintenance will maximise the available storage capacity and reduce nutrient losses during both irrigation and rainfall events.

4. Most applied nitrogen never reaches a waterway, as it is recycled on farm or lost to the air. Drains and creeks provide natural nutrient removal that is worth protecting.

Why this project happened

Over the period 2020 - 2025, researchers worked with dairy, livestock and vegetable farmers across the Macalister Irrigation District in Gippsland to understand where the nitrogen and phosphorus reaching local drains, creeks and rivers comes from, how it gets there, and what happens to it along the way.

This matters because excess nitrogen and phosphorus feed algae and weeds, harm water quality, and affect Lake Wellington and the wider Gippsland Lakes. The project combined on-farm monitoring, water sampling during rain and irrigation events, and detailed testing to trace nutrients from the paddock, through farm drains, and out to the larger waterways.



Runoff flowing towards a drain at a monitoring site during the October 2023 storm (spring).

Where the nutrients come from

The clearest and most consistent finding is that manure and effluent, not fertiliser, are the main source of nutrient runoff from dairy paddocks. Paddocks and drains near dairy sheds and effluent storage areas consistently showed higher nutrient levels than other parts of the farm, regardless of how much fertiliser had been applied. Farms with higher stocking rates, and paddocks where effluent was regularly spread, tended to have higher nutrient concentrations in their drains.

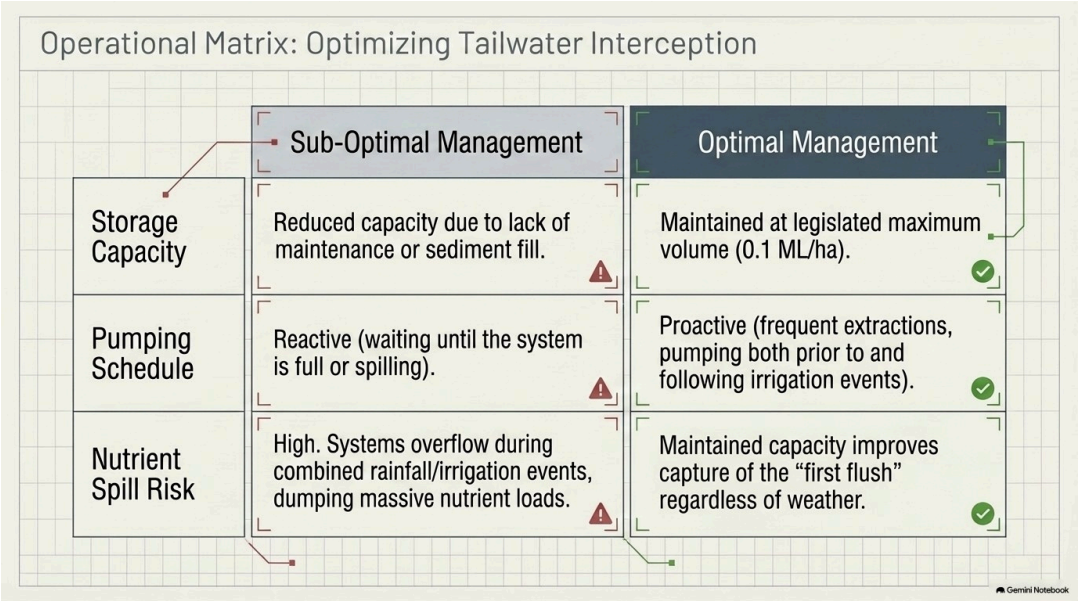
This does not mean effluent reuse is a bad practice, since it reduces the need for bought fertiliser, but it does mean effluent-treated paddocks and the areas around dairy infrastructure deserve extra attention. Getting application rates right, avoiding spreading before rain or heavy irrigation, and keeping re-use dams well maintained are some of the most effective actions a farm can take.

By contrast, farm dams and general stock yards showed little link to nutrient runoff, suggesting the real risk areas on most farms are fairly specific rather than spread evenly across the property. Importantly, these risk areas only matter once rain or irrigation water actually washes over them and carries nutrients into a drain, so hydrology, not just what is on the ground, decides what actually leaves the farm.

How water carries nutrients off the farm

Chemical tracers in farm drain water showed that, on these flat, well-irrigated properties, nutrients travel almost entirely across the paddock surface, briefly soaking into the topsoil before washing into drains. Groundwater played almost no part.

This means the speed and pattern of water moving across a paddock is the biggest single factor controlling nutrient loss. Water running quickly across bare, compacted or heavily grazed ground picks up nutrients rapidly, especially in the first flush at the start of an event, when concentrations are highest. Paddocks with better ground cover, less compaction and more surface roughness let water slow down and soak in, carrying fewer nutrients to the drain. Flood irrigation naturally produces some tailwater, and on well-grazed, smoothed paddocks this runoff carried noticeably more nutrients than sprinkler/spray irrigation, which produced very little runoff by comparison. Even so, the single largest and least predictable source of nutrient loss was large rainfall events (>50 mm), particularly when a farm's reuse dam was already full.



What separates a reuse dam that works from one that does not.

Tailwater capture dams: what works

≈ 50%
less nitrogen and phosphorus leaves the farm when a properly sized reuse dam is pumped out before each irrigation

> 75%
less leaves the farm when the dam is also pumped out again shortly after irrigation

50%
less nutrient is captured by a dam that has lost half its storage to silt or vegetation

One of the most encouraging findings is how effective a well-managed irrigation reuse (tailwater capture) dam can be. A dam built to the current recommended size, and pumped out before each irrigation, reduced phosphorus and nitrogen leaving the farm by around half on average. Pumping it out again shortly after irrigation, to make room for any follow-up rain, lifted the average reduction to more than three-quarters.

The flip side is a caution: a dam that has lost half its storage capacity to silt or vegetation was found to retain only half as much nutrient as one at full capacity, so regular maintenance and active pumping are not minor tasks, they are one of the most powerful water quality tools on these farms. Reuse dams are very good at capturing irrigation tailwater but far less effective against large storms, which can generate more runoff than any dam can hold. Expanding reuse coverage, especially on properties that use effluent irrigation, is likely to deliver the biggest overall improvement for the catchment.

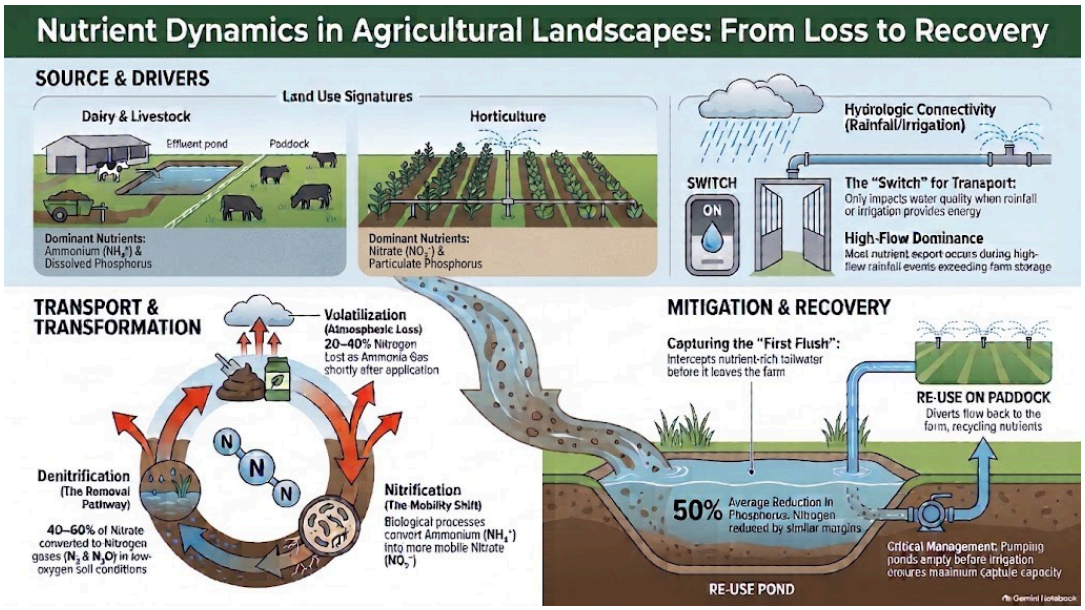


Fieldwork on a vegetable farm in the district after rain, July 2023 (winter).

What happens to the nitrogen, and how farm type matters

Not all applied nitrogen ends up in a waterway. In fact, less than one-tenth of the nitrogen applied across the district is exported downstream, low compared with many farming regions worldwide. Most is taken up by pasture, recycled through the farm, or lost naturally into the air as soils wet up and dry out, particularly soon after manure or urine is deposited and during waterlogged periods, which are common on this flat, heavily irrigated land. This is good for water quality but represents nitrogen the farm paid for and did not use, so better timing of effluent and fertiliser, and avoiding waterlogged conditions where practical, can benefit both the farm and the environment.

There is also early evidence that, in grazed pasture, some nitrogen is converted back into bioavailable nitrogen plants and soil can use again rather than being lost. Farm type may change the picture too. On dairy farms, runoff was dominated by ammonium and dissolved phosphorus tied to manure, while on the one vegetable farm studied it was dominated by nitrate from fertiliser and by phosphorus attached to eroded soil, in keeping with more intensive tillage and higher fertiliser rates. On the beef farm nitrogen was relatively low and phosphorus on the high side, but with a single farm the reason cannot be pinned down. However, only one vegetable farm and one beef property were studied, which is not enough to compare either reliably with dairy farms.



How nutrients move from farm sources to waterways, and where they can be intercepted.

From drains to rivers, and what this means in practice

Beyond the farm gate, district drains showed the strongest and most variable nutrient signals, but also the clearest evidence of natural nitrogen removal, especially in low-flow periods. Creeks, gathering water from several farms, showed a more mixed picture, while larger rivers were comparatively steady, blending and transporting many sources rather than removing nitrogen. This means drains and creeks are not just channels for pollution, they are places where real natural clean-up happens, supporting the case for vegetated buffers and avoiding unnecessary hard-lining of drains. Tracking a major flood in detail showed that at the peak, when water moved fastest, nutrients looked much as they did fresh off the paddock, with too little time for natural removal; as the flood receded and things slowed down, that natural clean-up became evident again.

The first, fast-moving pulse of a big flood therefore carries the least-modified, often most concentrated, nutrient load.

Bringing it together: manure and effluent management matters more than fertiliser cuts alone; slowing water across paddocks through ground cover and reduced compaction is one of the most effective actions available; reuse dams work well but must be the right size and actively used and maintained; large rainfall events remain the hardest challenge and deserve the most attention; and the natural clean-up already happening in soils, drains and creeks is worth protecting alongside every on-farm improvement.

Acknowledgements

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