ON-FARM DRAINAGE REMEDIATION PROJECTS

TO PROTECT WAIRARAPA MOANA

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The Wairarapa Moana Wetlands Project began in 2008 to enhance the native ecology, recreation and cultural opportunities and values on the public land in the area. This project was extended with funding from the Ministry for the Environment's Fresh Start for Freshwater Clean Up Fund in 2012 focusing on the health of the edge wetlands that fringe the eastern shore of the lake. This has supported projects to both improve the quality of water entering Lake Wairarapa and enhancing biodiversity across farmland and the edge wetlands. Projects are co-funded by a range of partners, including landowners, and administered by the Greater Wellington Regional Council.

Projects have included riparian plantings, improvement of effluent systems, optimisation of water use and irrigation, pest and weed control and modification of drainage. The work has also included surveys of fish and birds, removal of exotic fish and aerial application of herbicide on the extensive alder and willow infestations on the eastern lakeshore. Landowner engagement has been a crucial component of the projects success. This has been supported by the technology transfer aspect of the project, which is ongoing.

A feature of the area is the extensive drainage network which connect the farms with the lake. This connection has been enhanced by on-farm actions. A particularly interesting project was the construction of a wetland on a dairy farm adjacent to a remnant kahikatea stand. In combination these areas will add significant biodiversity to the farm and the region as well as improving water quality by removing contaminants from farm drainage water.

Introduction

Wairarapa Moana, meaning "sea of glistening waters" and is associated with the largest wetland complex in the southern North Island. The area is situated in the southern catchment of the Ruamahanga River on the southern Wairarapa Plains and includes Lakes Wairarapa and Onoke, their surrounding wetlands, the Western Lake Scenic Reserve and Onoke Spit. Lake Wairarapa covers an area of 78 square kilometres which makes it the third largest lake in the North Island of New Zealand. However, the lake also has the dubious honour of being described as one of the country's 10 most polluted water bodies. The lake is described as 'super-trophic' due to high levels of nitrogen, phosphorus and algae and poor water clarity.

The Wairarapa Moana Wetlands Project began in 2008 to enhance the native ecology, recreation and cultural opportunities on public land in the area. Funding from the Ministry for the Environment's (MfE) Fresh Start for Freshwater Clean Up Fund in 2012 boosted this project and enabled the major partners Department of Conservation , Greater Wellington Regional Council, South Wairarapa District Council, Ngāti Kahungunu ki Wairarapa, Rangitāne o Wairarapa and Papawai and Kohunui marae to accelerate some of its work programme. The additional $1 million of funding has brought to the table expertise from NIWA and other scientists, consultants and contractors and is supported by DairyNZ, Fonterra and locals such as Farmlands and RD1. Funding has been matched by the partners and farmers involved during the three years of the project. Details can be found at www.waiwetlands.org.nz.

The project is primarily focused on the quality of water leaving the farms and wetlands on the eastern edge of Lake Wairarapa and the biodiversity in these areas. Work in the edge wetlands includes surveying of flora and fauna, spraying of willow and alder, vertebrate pest control (cats, stoats, ferrets, rats etc) and removal of exotic fish.

On-farm Projects

Farmers volunteered to be involved in the project and their farms were assessed using the DairyNZ Farm Enviro walk questionnaire or the Beef & Lamb LEP1 where appropriate. Additional questions on hydrology, biodiversity and cultural aspects of the farm were discussed during a 2-3 hour visit. A quick tour of the farm was carried out at which time potential on-farm projects to improve the quality of water leaving the farm and biodiversity on-farm were identified and discussed. From this a short report was prepared which included a brief description of resources, a list of potential projects and copies of soil maps (regional S-map level), soil descriptions including farm dairy effluent risk category, where necessary and in most cases a detailed map of topography from airborne LiDAR (Light Detection and Ranging) survey. After a number of farms had been visited projects were selected for further development and scored for their feasibility, interest, budget, and benefits. To date approximately 50 projects have been developed over 35 farms. Riparian retirement and planting dominated the range of projects with 11km of waterways being fenced and over 47,000 seedlings planted. Riparian work was in addition to that required by supply agreements such as the Fonterra Dairying and Clean Streams Accord (now replaced by Sustainable Dairying: Water Accord).

Projects which could be described as tweaks to existing farm systems include extension of effluent areas, crop removal of potassium from effluent areas, installation of soil moisture monitoring equipment and greenwash systems in the dairy shed, improving drain spraying techniques and planting of flood protection banks. More significant projects include installing a lined effluent pond and feedpad and constructing wetlands. On-farm works are co-funded by MfE and farmers with the level of support from the fund increasing in proportion with the level of off-farm benefits. A series of Fieldays have shared information on effluent management, features of soils, managing irrigation, soil nutrient flows, drains and water quality. This technology transfer aspect has been supported by water quality sampling and fishing of farm waterways.

A key feature of the farms in the eastern area of the lake catchment is an extensive network of drains into the lake and associated wetlands which total about 1300km in length. The project team considers these drains as extensions to the wetlands and has focused on understanding more about the flora and fauna residing in them. For example drains with close connection with the lake (within 1km) have literally 1000’s of fish present in them including native species short fin eel, longfin eel, common bully, smelt, koura, inanga, and exotic species such as brown trout, perch, rudd and goldfish. Further up the catchment waterways which drain the springs which are common around the north end of the lake provide habitat for shortfin eel, longfin eel, common bully, koura and banded kokopu. On the other hand the drains in low lying areas where water is lifted by pumps into the lake provide a protected habitat for mudfish. It has been encouraging to find significant diversity and abundance of fish in farm waterways where water quality attributes can range from 0 to 8 mg/L nitrate and from 0 to 1.4 mg/L dissolved reactive phosphate. The project team have been looking for ways to maintain drainage performance while enhancing water quality and fish life.

An example of a significant on-farm project in this regard is the construction of a wetland. Wetland areas are useful in helping restore water quality as they are the "kidneys" of the landscape. They provide an efficient system to remove contaminants from drainage water, particularly nitrate through denitrification and allow time for any sediment to settle out. Contaminants such as nitrogen and phosphorus enter waterways through groundwater, surface runoff and direct application. Left unchecked these nutrients feed algal growth which degrades water quality. In a wetland anaerobic bacteria in the sediment convert the nitrate-nitrogen in the water to nitrogen gas which is then released into the atmosphere. This is known as denitrification.

Wetland

During the farm tour in July 2013 a 0.7 ha native bush remnant (130 year regrowth) was noted on Kaiwaiwai Dairies. This was poorly fenced with an understorey of 3m high blackberry. Adjacent to this was a "wet" area evidenced by rushes, poor pasture species, pugging damage and surface water in some places. Subsequent survey work showed that a drain from an area of peat to the north flowed all year round and the water level was slightly elevated (0.1m) relative to the north edge of the wet area in February 2014. A flow of 60 litres / second was measured at the time in the drain and was considered normal flow. Observation pits dug also in February showed water levels in the "wet" area were close to the surface and revealed a compacted layer of gravel approximately 0.6 below the soil surface. On this basis it was decided to look more closely at constructing a wetland in the already "wet" area. While this area displayed relatively low productivity over a year it provided some valuable pasture during the routine summer dry period on the farm. Key considerations included:

- Nominal hydraulic loading rate should be between 11.5 to 15.4 L/s/ha of wetland (C. Tanner pers comm 2013). This could be achieved by appropriate selection of pipe size based on distance and fall.

- For a given area of wetland, stable uniform flow will remove twice the nitrogen from the water as compared with non-uniform flow (Tanner and Kadlec, 2013). This is possible by redirecting a portion of the permanent flow from the peat drain. A drain is also available at the exit so flow from the wetland could be returned downstream to the original drain system

- Maintaining maximal volumes in the wetland (holding capacity) by engineering an average depth of 0.4m,(range 0.3m to 0.5m) and avoiding preferential flow paths. Dense plantings and bunds are being used to achieve this. Initial the design required a continuous drain to minimise soil movement, to keep construction costs down and to maximise water/bank interface where the biodiversity is maximised

- Eventually a unique design of 3 separate wetlands was preferred providing a constant depth of 0.3m with a serpentine flow path of water down 6m wide bays. These bays trend back and forth across the gradient to slow down water flow, maximise residence time and water treatment.

- The project includes a plan to restore the remnant stand of large kahikatea and totara by mulching the blackberry, spraying the regrowth and planting open spaces with colonising species

Construction - A 200mm pipe was buried to carry water the 180m from the peat drain to the start of the wetland marked as "Inflow" on Figure 1. At the inflow a 100 L tank receiving tank was installed with an adjustable outlet to the wetland to provide one, three or ten litres per second flow. Flow was gauged by providing an overflow outlet above the wetland to give a constant head. Overflow discharges to a drain which returns water to the original drain system. A 13 tonne excavator transformed the traditionally "wet" 0.75 ha of pasture to three separate wetlands providing a serpentine flow path of water down 6m wide bays (Figure 1). These bays cross the gradient with about 200mm height difference between each wetland. Total length is 900m with 1800m length of bank/water edge providing about 0.5 ha of open water. The wetland has been planted with aquatic plants including raupo (*Typha orientalis*), lake clubrush (*Schoenoplectus tabernaemontanii*) and a cutty grass (*Carex geminata*). They provide good dispersion and even flow through the majority of wetland and minimise channelisation or dead-zones. The balance of the area is planted with natives including flax, *Coprosma robusta*, manuka and cabbage trees. The area has been fenced to exclude dairy cattle.

Figure 1 Map showing location remnant bush and design of wetland with entry and exit points.

Monthly water quality sampling is being carried out at Kaiwaiwai. An initial sample (January 2015) showed denitrification and/or plant uptake is already occurring with drain water entering with 0.8 mg/L nitrate-N and exiting with less than 0.02 mg/L. This potential for denitrification is encouraging but not unexpected as about half of the base of the wetland is peat and a topsoil of mainly peat was spread on compacted gravel in the other half. This is providing organic carbon as an energy source for denitrification which is undertaken by bacteria. The wetland will take one to two years to become fully established. It is expected the wetland will maintain itself with wetland plants growing and dying in an annual cycle. Organic matter will accumulate in the base of the wetland and continually convert nitrate to nitrogen gas. Figure 2 shows clubrush growing well in the constructed wetland.

As far as fauna in the wetland are concerned, eels and koura and most likely other fish are found in the drain at the exit of the wetland. A fish pass is planned so that bird life including pukekos, shags and hawks, and the frogs in the wetland will have new neighbours.

Figure 2 Clubrush growing well in a wetland bay (January 2015)

How much nitrogen will the wetland remove? - Overseer® can estimate the nitrogen (N) removed by a wetland. The amount removed depends on the size of the area the water comes from, the size of the wetland and how well the wetland is functioning. Using a catchment of about 300 ha for the peat drain, a one hectare wetland (minimum size available in Overseer) and an efficient wetland (constant flowing shallow water, no dead zones). Given these settings Overseer estimates N loss from the farm will be reduced by 273 kg of N per year by the wetland. While this does not reduce the average leaching value for the farm which is 14 kg N/ha because the total loss for the farm is 6203 kg N this is a step in the right direction.

Larger systems would be required to handle the full flow and thus significantly reduce overall losses from the farm.

Two investments in on-farm infrastructure at Kaiwaiwai have reduced N loss to water from the farm, a holding pond for effluent and the wetland. These investments represent a (relatively) permanent reduction in N loss. Table 1 compares the cost of reducing N loss for the effluent holding pond and the wetland. Estimates of N loss reduction are determined using Overseer. The wetland cost does not include the loss of grazing land at $32,000/ha or reduced annual dry matter available from the area. The costs and benefits are only indicative for other farms as these costs and benefits are farm specific and will vary significantly between farms as systems and resources differ significantly among farms.

Table 1 Relative cost of reducing N loss from Kaiwaiwai Dairy Farm for an effluent holding pond and a wetland

	Cost	Reduced N leaching	$/kg N
Holding pond plus irrigation equipment *****	$80,000	562	$142
Wetland [#]	$55,000	273	$201

* additional benefits in likely improved nutrient efficiency and pasture growth as less N lost to water and greater flexibility in management to cope with breakdowns and staff changes

[#] additional benefits include an increase biodiversity and aesthetic value

Learnings – Constructing a viable wetland is a reasonably complex project and valuable in terms of improving the quality of water going off the farm and significantly increasing biodiversity on the farm and in the region. This particular project came together on this farm due to a special set of skills and attitudes. Key among those are:

- A willingness of the landowner and business partners to sacrifice a portion of grazing land to a community good task.
- Farm management with engineering skills to brainstorm and install clever and easy to manage systems which will deliver a reliable and uniform flow to the wetland at lowest possible cost
- Farm management with sufficient knowledge and interest in ecology to carry out installation and establishment efficiently, particularly the ability to adjust water levels and flows during the planting of aquatic plants e.g. these require wet feet and they will not establish unless the leaves are above water level. In this case water level was gradually increased from 0.15m to 0.3m over a six month period.
- Access to specialist engineering and ecological skills (NIWA and other consultants)
- Financial support / incentive as installing a wetland is costly with benefits largely occurring off-farm. In this case 75% of the cash cost was met by MfE funding which still left significant cost for the farm business in management time and opportunity cost.
- It also helps to have a resident landowner with the interest, time and energy to check on progress frequently during the establishment phase so that crucial aspects such as weeding and watering new plants is carried out when necessary. Also checks on water levels and flows, making sure the gate is shut and observing wildlife behaviour, shooting hares included, all help to get the wetland functioning properly as quickly and cheaply as possible.

A particularly useful benefit which has accrued from this project is that now there is a demonstration of very visible and tangible action which a farmer can undertake to reduce nutrient loss from the farm and provide a significant lift in biodiversity. This may prove to be a very valuable asset for farms in the future.

Conclusion

The Wairarapa Moana Wetlands Project received a significant boost in funding from the Ministry for the Environment’s Fresh Start for Freshwater Clean-Up Fund. This has financially supported both off-farm and on-farm projects. The on-farm actions identified during the project are diverse and farm specific with each contributing in a different way to improving water quality and biodiversity. This has demonstrated that for solutions to improve water quality and biodiversity to be effective they need to be farm specific. There are no silver bullets for this task, farmers need to do lots of little things right to make a difference. The keys for success which have been identified from this and other similar projects include:

1. Engage an outside facilitator and form a group of interested people

2. Start on the premise that everybody uses the lake so have a vested interest and that previous landowners did the best they could all be stewards of the land

3. Good information underpins a necessary good relationship with the regional council. There has been a lot of sharing of knowledge and analysis of data.

A combination of on-farm and off-farm skills and support can facilitate and demonstrate innovative solutions.

References

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