ENVIRONMENTAL FARM PLANS – OUR EXPERIENCE IN THE MANGATAINOKA CATCHMENT

Peter Taylor, Derek Ryan, Jessica Hughes, Manas Chakraborty, Maree Clark, Logan Brown and Jon Roygard

Horizons Regional Council, Private Bag 11025, Palmerston North 4442
Email: Jessica.Hughes@Horizons.govt.nz

An Environmental Farm Plan (EFP) was completed for 83 of the 88 dairy farms in the Mangatainoka River catchment over a two year period starting June 2012. Farmer participation was voluntary. This project was under the Manawatu River Leaders Accord and the Fresh Start for Fresh Water Clean-up Fund contributed by Ministry for the Environment (MfE), Horizons Regional Council (HRC) and DairyNZ with payment in kind from Ravensdown and Ballance Agri-nutrients fertiliser companies. A further 15 EFPs were completed for dairy farms in the Tiraumea and Pohangina catchments, however these farms are not included in this report.

The Mangatainoka River is a 70 km tributary of the Manawatu River within the Tararua district, about 44,000 ha in area with dairy farming making up 39% (about 17,000 ha) of the catchment (see figure 1). Rainfall distribution varies throughout the catchment from approximately 1000 mm in the north to 2425 mm in the south, close to its headwaters in the Tararua ranges. Potential evapotranspiration and average annual temperature also decrease from north to south.

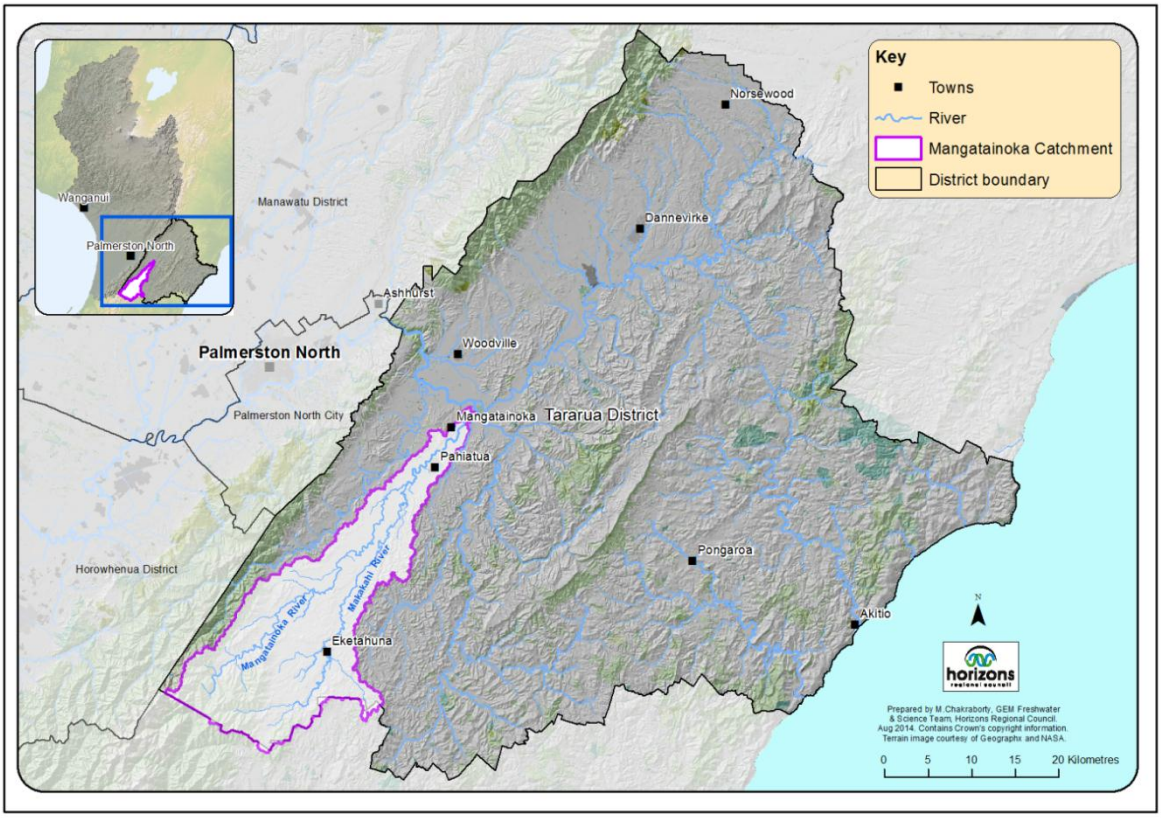

Figure 1: Mangatainoka Catchment and Tararua District

Soils were derived from a mix of loess, alluvium, alluvial gravels, sandstone and some greywacke with drainage characteristics ranging from well drained or moderately well drained to poorly and very poorly drained. Predominant Land Use Capability classes on dairy farms and dairy support blocks are classes II, III and VI all in approximately equal proportions and totalling some 84% of the catchment.

The Horizons Regional Council One Plan is a combined Regional Policy Statement and Regional Plan. It has nine target catchments where intensive land uses, of which dairy is one, are required to obtain land use consent for the management of land use activities affecting groundwater and surface water quality. The Mangatainoka River catchment is one of these.

With respect to water quality, the Mangatainoka River has concentrations of soluble inorganic nitrogen regularly exceeding target values with excessive periphyton and cyanobacteria blooms being prevalent at times. The EFP's therefore identified opportunities to reduce nutrient losses to waterways off dairy farms in the catchment.

Each EFP contained comprehensive information on each individual farm's physical resources such as: total farmed area, general farm and management descriptions including soils, LUC, rainfall, stock numbers, milk solids production, cropping types and areas, amounts and type of imported feed, quantities of nitrogen (N) and phosphorus (P) fertiliser used and farm dairy effluent management and water use. Dairy support blocks were also analysed as part of the total farm system. Overseer®, a nutrient budgeting model, was used to model this farm input data to estimate N and P losses from each farm and to explore nutrient mitigation options for reducing N and P losses. The modelling was completed using Overseer® version 6.0.1 through to 6.1.2.

Over the period of the project approximately 25,000 dairy cows were milked each year averaging 299 per farm at an average of 2.4 cows per ha. Total milk solids production was nearly 9 million kilograms at an average of 361 per cow and 876 per ha. The Mangatainoka catchment, in 2012-2013, produced about 27% of the Tararua District's total production.

Sixty five farms (78%) were low input farms (system 1 and 2 as defined by DairyNZ) based on the amount of imported supplement. Approximately 14,000 tonnes of feed was imported by dairy farmers of which 9,000 tonnes (64%) was maize silage and palm kernel extract. Most farms (77%) carried out some form of fodder cropping with total cropped area 535 ha or 3% of the total dairy farm area. On a per hectare basis this cropping area easily leached the most N, with averages ranging between 94 kg N/ha/yr and 183 kg N/ha/yr for summer and winter crops respectively.

Approximately 850 tonnes of fertiliser N (equivalent of 1,841 tonnes of urea equivalent), and approximately 270 tonnes of fertiliser P (3,000 tonnes of superphosphate equivalent) were applied.

The estimated average predicted N leached per farm was 34 kg N/ha/yr and this totalled about 636 tonnes per year. Approximately 25 tonnes of P is estimated to be lost annually.

Fifty six farms (67%) had some farm dairy effluent storage facility, however at the time the EFPs were prepared only 4 of these ponds were lined and are likely to meet the One Plan permeability standard of $1x10^{-9}$. Of the farms with storage 35 of the 56 (63%) had sufficient storage to enable deferred irrigation to be practiced. For those farms with unlined storage it was estimated, using a prototype Farm Dairy Effluent Leaking Pond Calculator (Dr Dave Horne, Massey University) that, conservatively, between 14 and 28 tonnes of N per year was being leached from them which is not currently accounted for in Overseer®. In addition, for those farms without any storage irrigating effluent daily from a sump, an unknown but possibly significant amount of both N and P is being lost to water due to effluent being

applied at depths greater than the soil moisture deficit causing run-off and drainage through the soil profile.

We partitioned milking platform data from dairy support at nutrient management block level and expressed predicted N leaching and N surplus in total kg N/yr and kg N/ha/yr. Statistical analysis of the data collected from the Overseer® output reports showed the following:

- Analysis incorporating the whole farm entity (milking platform and dairy support) using data from the Scenario Report, Nitrogen Overview report showed a moderate correlation between predicted N leached (kg N/ha/yr) and N surplus (kg N/ha/yr) (R^2=0.47). N surplus is defined as the total of all N inputs minus N removed as product as estimated in Overseer®.
- For milking platforms and for whole farm entities, there is good correlation for total predicted N leaching (kg/yr) against total N surplus (kg/yr) (R^2=0.71 and R^2 = 0.68 respectively).
- For milking platforms there is a weak correlation for predicted N leaching (kg N/ha/yr) against N surplus (kg N/ha/yr) (R^2=0.35).

To help understand why there was a difference in the correlations between total kg N/yr and kg N/ha/yr we found, using a random sample of 31 farms, which included farms with dairy support, there is a significant difference (p = 0.00) between mean whole farm N surplus (kg N/ha/yr) from the Scenario Report, Nitrogen Overview, and the mean whole farm N surplus (kg N/ha/yr) calculated from nutrient management block data found in Scenario Reports, Nitrogen Output report.

Using milking platforms a weak correlation was found between rainfall and predicted N leached (kg N/ha/yr) (R^2=0.31), and no correlation with N surplus (kg N/ha/yr) (R^2=0.00). There was also no correlation between well drained soils and predicted N leaching (kg N/ha/yr) (R^2=0.00), or N surplus (kg N/ha/yr) (R^2=0.00).

Multivariate statistical analysis was then used to determine the best combination of factors, at catchment scale, influencing predicted N leaching (kg N/ha/yr) from farms and found that N applied, cropping area, stock rate, and imported feed explained 64% of the variation (R^2=0.64) (Table 1). With respect to N surplus (kg N/ha/yr) the best combination of variables were N applied, imported feed, and stocking rate (R^2=0.76). In both instances N applied was the dominant variable explaining 32% and 59% of the variation in N leached (kg N/ha/yr) and N surplus (kg N/ha/yr) respectively. Therefore, it was concluded that at catchment scale, farm management practices appeared to have the greatest influence on N leaching regardless of rainfall or soil type.

Table 1: Best possible combination of variables (up to 4) determining predicted N leaching

Independent variables	**R^2**	**P**	**AIC**
N applied	0.32	<0.001	185.17
N applied + Cropping area	0.47	<0.001	153.94
N applied + Cropping area + Stock rate	0.56	<0.001	136.2
N applied + Cropping area + Stock rate + Imported feed	0.64	<0.001	120.4

N applied explains the majority of the variation between whole farms' N surplus (kg N/ha/yr), and contributions to the surplus could happen in two ways: Either directly through inappropriate timing of applications or excessive applications, or, once plants have used what they can, indirectly via other soil sinks of N. Further, if poor pasture utilisation is occurring that will exacerbate N surplus. There is a perception that imported supplements are, in some cases, being used as a substitute for optimum pasture utilisation which in turn appears to also contribute to an increased N surplus.

In conclusion a number of farm management practices have been identified that if changed or implemented would reduce N leaching which in turn, would potentially benefit catchment water quality depending on the extent of implementation. When making these changes there needs to be consideration of the effects on the existing farm system.

- Significantly reduce or eliminate fodder cropping, particularly winter cropping.
- Reduce stocking rates on farms with rates >2.5 cows/ha
- Reduce the amount of imported supplements unless these supplements are high energy and nil or low protein supplements.
- Investigate application practices of fertiliser N in the catchment to understand whether, in the first instance, direct losses are occurring and can be prevented.
- All farms practice deferred or deficit irrigation of effluent by constructing adequately sized and lined effluent storage ponds.
- Reducing N surplus via a range of farm practices.

The extent to which any one practice or combinations of practices will be effective will depend on overarching constraints: For example the current Horizons Regional Council consenting regime, is to reduce N leaching off each individual farm from the 2012-2013 milking season without significantly impacting on farm production or profitability. This in turn constrains the extent of feed and fertiliser reductions which would lead to reduced stocking rates and therefore reduced production unless per cow performance is improved.

Please contact Horizons Regional Council Rural Advice Team on 0508 800 800 for a copy of the full report.