Effluent Reduction Project

Waiotu Farms Limited

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Project Team

A number of individuals and companies committed resources to the project. These included:

- Kevin and Michelle Alexander, owners of Waiotu Farms Limited.
- Myles Stenner of Klasse and Hydrofan NZ Ltd who contributed, at his own cost, expertise, time and travel. Myles donated water meters, a large range of hose and sprinkler nozzles and various fittings.
- Water Supply Products Ltd distributors of BIL water meters.
- WaterCheck Ltd who provided and installed telemetry for four meters and use of their website for data collection and formatting.
- Northland Regional Council, Farm Dairy Effluent (FDE) monitoring team.

Contents

1. Background

1.1. The issue

Northland Regional Council has for many years promoted large storage/treatment ponds and land application as the preferred means of farm dairy effluent (FDE) management. Despite this, the volumes of effluent being discharged to water, and compliance with regional rules and conditions of resource consents have been unsatisfactory.

It is obvious that it is common practice on a lot of dairy farms to add copious amounts of clean water to relatively small amounts of effluent and turn it into excessive and unmanageable volumes of effluent. This practise has also resulted in over-investment in capital and operating costs for effluent disposal.

Unfortunately some farmers believe that there are benefits in increasing effluent volumes in order to irrigate pasture. Using the effluent disposal infrastructure for pasture irrigation is nonsensical. The benefits are very limited at best and greatly increase the risk of non-compliance with effluent rules and consent conditions. The major benefit which accrues from well managed land application of effluent is improved pasture/crop growth from good utilisation of nutrients in the effluent.

In mid-2013, it was decided to instigate trial work on at least two farms to reduce effluent volumes. Waiotu Farms Limited, owned by Kevin and Michelle Alexander was one of the farms.

1.2. The project farm

The farm is situated on Waiotu Block Road at Hukerenui within the Whangarei District. The total farm area is 148 ha. The contour is flat with some easy rolling hills. Soil types on the flats are sandy clay or mottled clay loams. The hills are predominantly imperfectly drained, moderately podzolised Hukerenui clays. 340 Friesian cows are milked through a 36 aside herringbone shed. For the majority of the project the farm had an all-spring calving and twice per day milking regime.

Water is sourced from the Umuwhawha Stream which runs through the property. Water is pumped from the stream to a holding tank. Water for stock drinking, and some household take is gravitated to point-of-use from the tank. Water for use at the dairy gravitates to a tank at the dairy. Milk cooling water is circulated from this tank through the plate cooler and back to the tank. Water used within the dairy is also supplied from the tank. The operating pressure throughout the dairy is 600 kPa.

Sources of effluent include the dairy shed and yard, a 2400m^2 feedpad and two shavings based stand-off pads (total 2,500 m^2). Effluent from the feedpad is periodically scraped into a solids retention pond and liquid from the ditch is gravitated to the main pump sump. This sump also collects effluent from the dairy and stand-off pads. From here it is either pumped to a Williams Spider travelling irrigator which is used to irrigate up to 85 ha or to the first pond of the three pond storage/treatment system. The three pond system provides a total storage volume of 11,800 m^3. The ponds are typically empty prior to winter each year. Figure 1 shows the dairy and associated infrastructure including the effluent ponds.

Waiotu Farms Ltd holds resource consent to allow for the discharge of treated effluent from the ponds to a tributary of the Wekaweka Stream, a small ephemeral stream, typical of many receiving waters on Northland farms. Consent conditions require that the ponds must be empty before winter and that treated effluent may only be discharged when conditions are not suitable for land application. There are also consent conditions which impose limits on water quality parameters. Historically, compliance with the water quality conditions of consent has been difficult to achieve.

Figure 1: Aerial map showing infrastructure on Waiotu Farms Ltd.

2. About the project

The purpose of this project was to:

- Quantify the volume of water used at the dairy by metering;
- Quantify the volume of effluent being generated (by metering and estimates); and
- Implement changes to improve water use efficiency and reduce effluent volumes.

The broader goals of the project were to achieve the following benefits:

Environmental benefits
- Less water extracted from the Umuwhawha Stream.
- Increase retention time of effluent in effluent ponds resulting in improved effluent treatment.
- Reduced volume of treated effluent being discharged into the tributary of the Wekaweka Stream.

Economic benefits
- Reduce water pumping costs.
- Reduce cost of effluent application to land.
- Reduce fertiliser costs by better use of the nutrients contained in the effluent.

Regulatory benefits
- Ongoing compliance with resource consent conditions and regional plan rules.

3. What we did

3.1. Water metering and telemetry

Ten water meters were fitted to measure water volumes being used (Table 1). A magflow meter was installed on the effluent line to the irrigator at the start of the 2015/16 dairy season. A schematic of the system and meter placements is shown in Figure 2. Daily readings from four meters were telemetered to the WaterCheck website. The data was collated and formatted by WaterCheck. Council and Waiotu Farms Ltd had access to the data on the website.

It was intended that one-off changes would be made to the infrastructure and/or operating procedures with the effects of each change being measured. The effectiveness of each change was to be assessed before the next agreed change was made. However, due to the enthusiasm of the people involved and the need to better control effluent volumes during a relatively wet spring period, this did not happen. Numerous changes were made “on the run”. From an overall project management point of view, this caused issues around proper documentation of the changes and their effectiveness.

Table 1: Placement of water meters at Waiotu Farms Ltd

Meter No.	Position	Purpose
1	Main pump shed	Total volume from water take at Umuwhawha Stream
2	Total dairy shed	All water use at the dairy shed
3	Circular yard wash	Backing gates and 1 yard hose
4	Water driver 1	1 backing gate water drive
5	Water driver 2	1 backing gate water drive
6	Households x 2	

7	Household	
8	Existing yard hose meter	
9	Effluent to irrigator	Magflow meter – installed October 2015
10	Vacuum pump cooling water	Installed September 2014 (not shown on figure 2)

3.2. Changes made

Changes made to reduce effluent volumes and the dates they occurred are shown in Table 2.

Table 2: Changes made at Waiotu Farms Ltd

Change No.	Date of change	Description of changes implemented
1	July 2014	Permanent diversion of roof water away from the effluent disposal system
2	September 2014	Permanent diversion of vacuum pump cooling water
2	November 2014	Modifications to the backing gate drives
3	November 2014	Modifications to the circular yard wash system
5	November 2014	Replacement of two circular yard hand held hose nozzles with Hydrofan nozzles
6	November 2014	Replacement of entry/exit yard and milking pit area hoses with Hydrofan nozzles

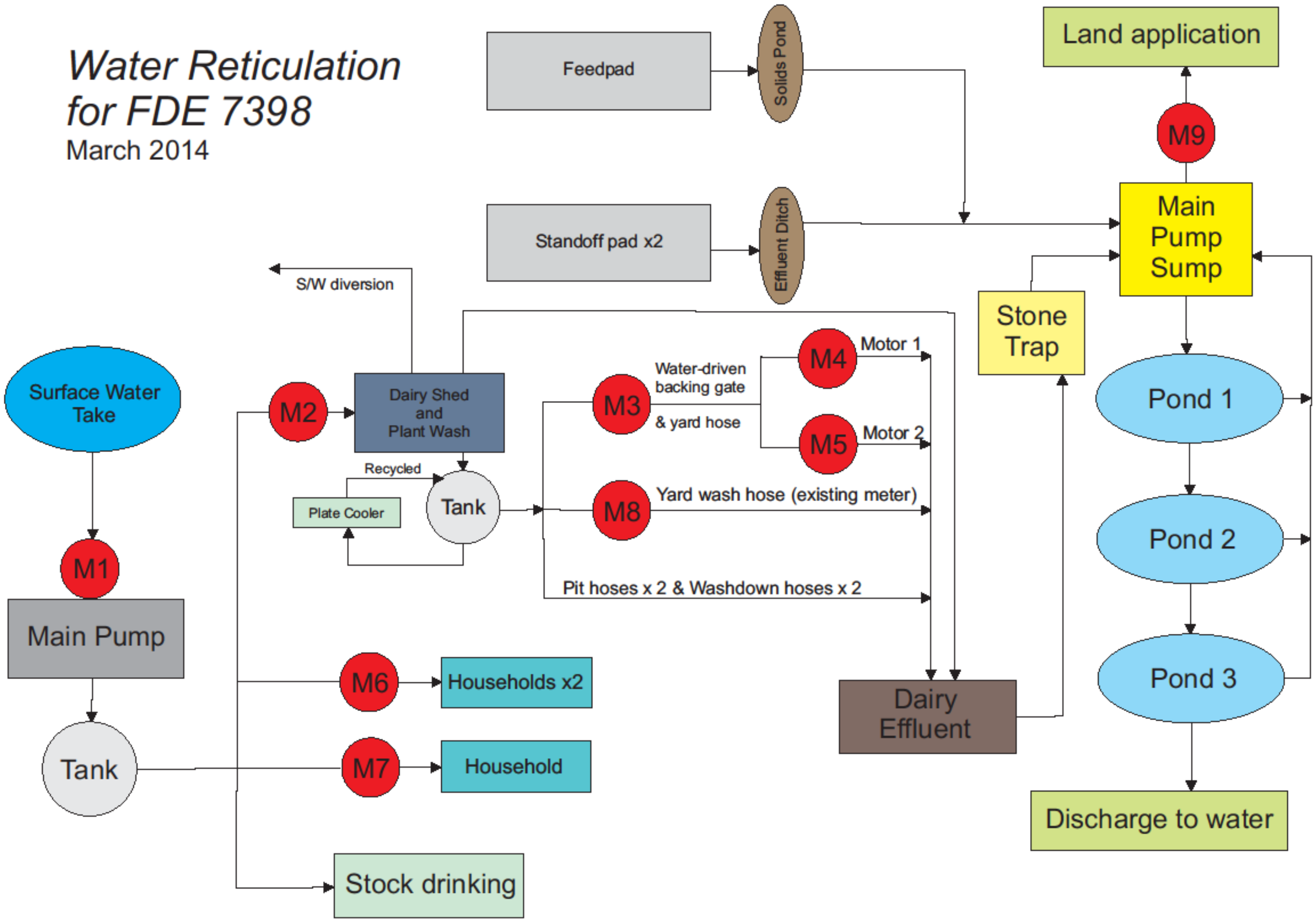

Figure 2: Schematic showing meter placement on Waiotu Farms Ltd.

4. What we found

4.1. Baseline data

Data was collected for 76 days before any changes were made. Total daily water use at the dairy over this period varied from 17.8 m^3 up to 32.9 m^3 (Figure 3). The average total water use at the dairy over the 76 days was 24.5 m^3 – this figure has been used as the “baseline” for the project. The baseline for water used on the circular yard was 7.4 m^3 (also recorded over the 76 days).

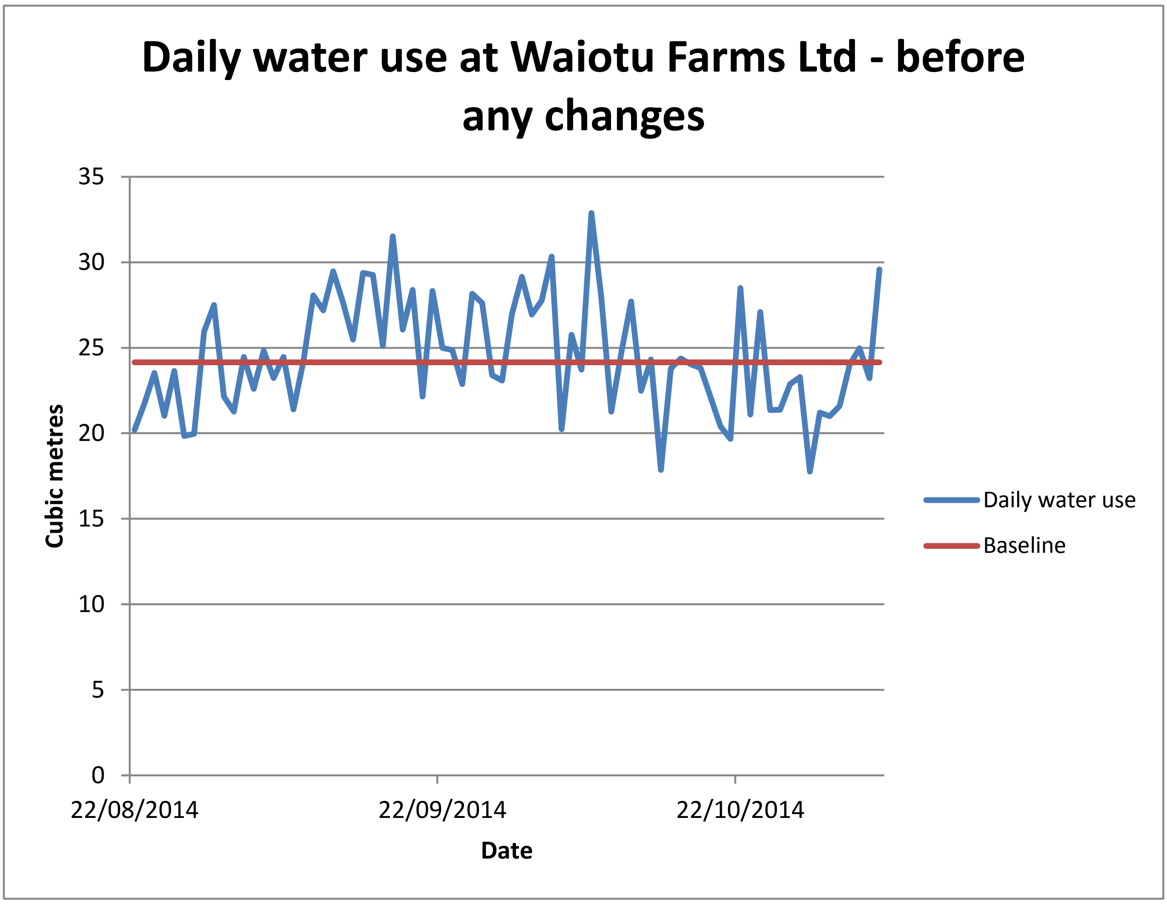

Figure 3: Daily water use at Waiotu Farms Ltd prior to any system changes

4.1.1. Change 1 - permanent diversion of roof water away from the effluent disposal system

At the commencement of the project, the dairy roof water discharged onto the dairy yard. Spouting and downpipes were fitted to the dairy roof during winter 2014. In an average rainfall year the total volume of roof water excluded from the effluent system would be 445 m^3. Prior to the change some of this volume would have been diverted via the yard stormwater diversion system, however, this volume is unknown.

4.1.2. Change 2 – permanent diversion of vacuum pump cooling water

At the commencement of the project, the vacuum pump cooling water discharged onto the dairy yard. In September 2014 a hose was installed to permanently reticulate the water away from the yard. Based on the measured 5 litres per minute and the 2.5 hrs average run time per milking the daily volume contributed by the cooling water was 1.8 m^3/day. This volume was later confirmed by the installation of a meter on the cooling water line. In a normal season, with twice-per-day milking, the volume of water diverted away from the effluent system is approximately 500 m^3.

4.1.3. Change 3 - modification to the backing gate drives

The drive nozzles were changed from the standard 9.5 mm to 7 mm diameter nozzles and two valves were installed to control the water supply to achieve the desired 12 m/min travel rate of the gate while retaining the required torque. The drive units with 9.5 mm nozzles used 140 L/min each. The 7 mm nozzles used 90 L/min**.** A subsequent change to 4 mm nozzles and adjustment of the gate valves resulted in water use of 20 L/min. Based on a 7 minute travel time to traverse the circular yard the volume of water used has been calculated under each nozzle scenario (Table 2).

Table 2: Calculated water use by backing gate drives with different nozzle sizes

Nozzle size	Litres per minute per gate	Litres per round per gate	Total litres per day for both gates	Total water used per season for both gates (m3)	Savings
9.5 mm	140	980	3920	1176	-
7.5 mm	90	630	2520	756	420 m^3 (36% reduction)
4 mm	20	140	560	168	1008 m^3 (86% reduction)

4.1.4. Change 4 - modifications to the circular yard wash system

At the commencement of the project, the backing gate system included:

- A rubber scraper blade, which was designed to spread effluent pats and make cleaning easier.
- A 50 mm sparge pipe on the bottom rail on one backing gate, with a series of holes which directed water onto the yard.

The system was water inefficient and did not clean the yard adequately.

In November 2014 the following changes were made:

i. The water supply to the sparge pipe was disconnected.
ii. The scraper on the backing gate was adjusted downwards to compensate for wear on the blade.
iii. Multiple nozzle types were trialled on one of the backing gates. Some nozzles cleaned satisfactorily, however the desired reduction in water use was not achieved. The preferred option was found to be 30 nozzles fitted vertically behind the scraper on the backing gate. The nozzles applied 3.2 L/min each. These nozzles lifted and aerated the effluent on the yard which made manual scraping or cleaning by hand held hose easier.
iv. Manual scraping was introduced as part of the routine yard cleaning procedure. Manual scraping of the circular yard could be complete in 6-8 minutes.

4.1.5. Change 5 - replacement of two circular yard hand held hoses with Hydrofan nozzles

The high-volume, low-pressure nozzles on the yard wash-down hoses were replaced with more water efficient Hydrofan nozzles. The Hydrofan nozzles were developed during the project. Water use on the wash down hoses was metered. The Hydrofan nozzles used less water and cleaned the yard faster (Table 3). This was due to the improved shape and action of the water jet.

Table 3: Wash down hose nozzle results

Hose Nozzle	Litres per minute	Minutes taken for circular yard wash	Total litres used per day	Result
Original	380	15	5700	Original use
Large Hydrofan	220	6	1320	77 % reduction
Small Hydrofan	180	7	1260	78 % reduction

Measured results from changes 3, 4 and 5

The baseline for the 76 days prior to any changes for the circular yard was 7.4 m^3 per day. Changes commenced in early November 2014. Average water use from 6 November 2014 (after the changes commenced) through to 1 May 2015 was 2.0 m^3. Thus daily water use dropped by an average of 5.4 m^3 per day (73% reduction). The cumulative result of changes 3, 4 and 5 are shown in Figure 4.

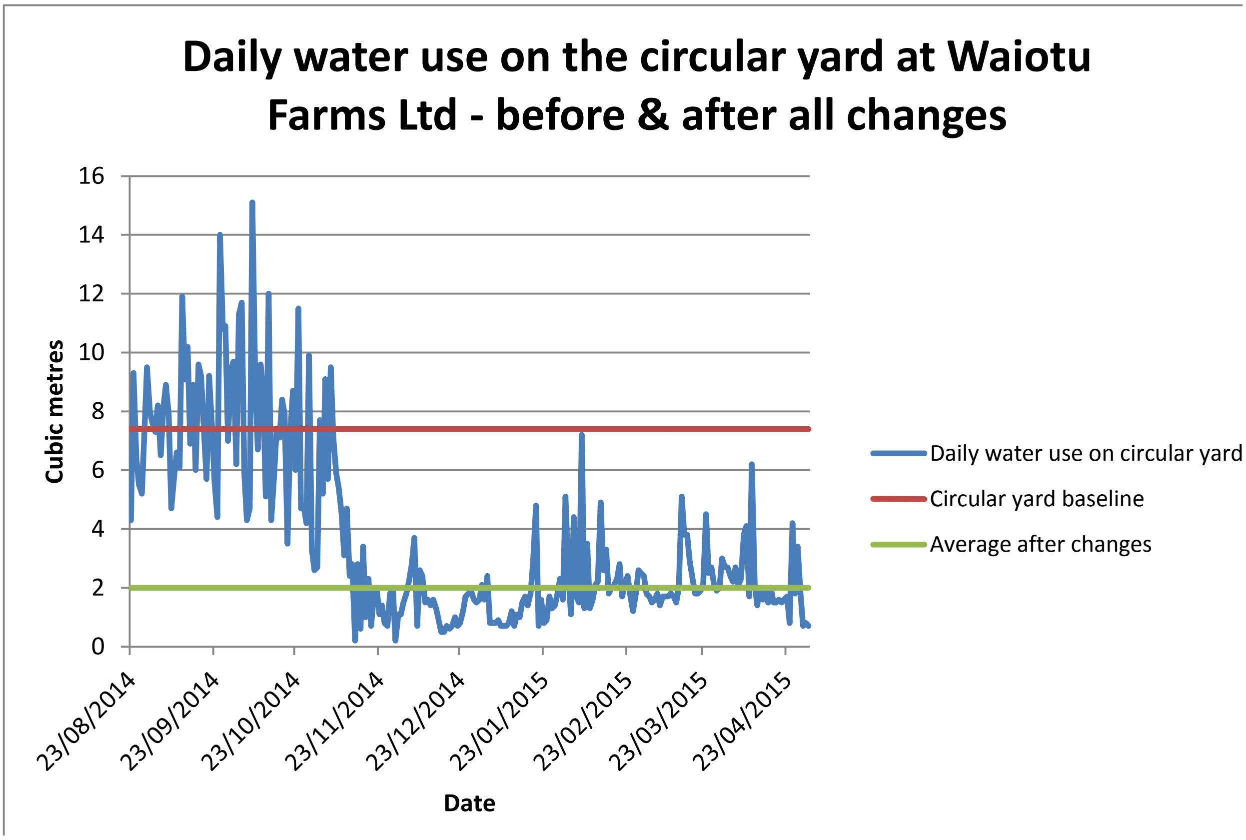

Figure 4: Daily water use on the circular yard at Waiotu Farms Ltd – before and after changes, which started on 6 November 2014.

4.1.6. Change 6 – replacement of entry/exit yard and milking pit area hoses with Hydrofan nozzles

The nozzles on the two hand held hoses were replaced with Hydrofan nozzles. The results of these changes are the same as those described in section 4.1.5 above.

4.2. Total reductions in water use

The average total daily use before any changes was 24.5 m^3. The average total daily water use after all changes was 15.08 m^3. Thus daily water use dropped by an average of 9.4 m^3 per day (38% reduction) as shown in Figure 5.

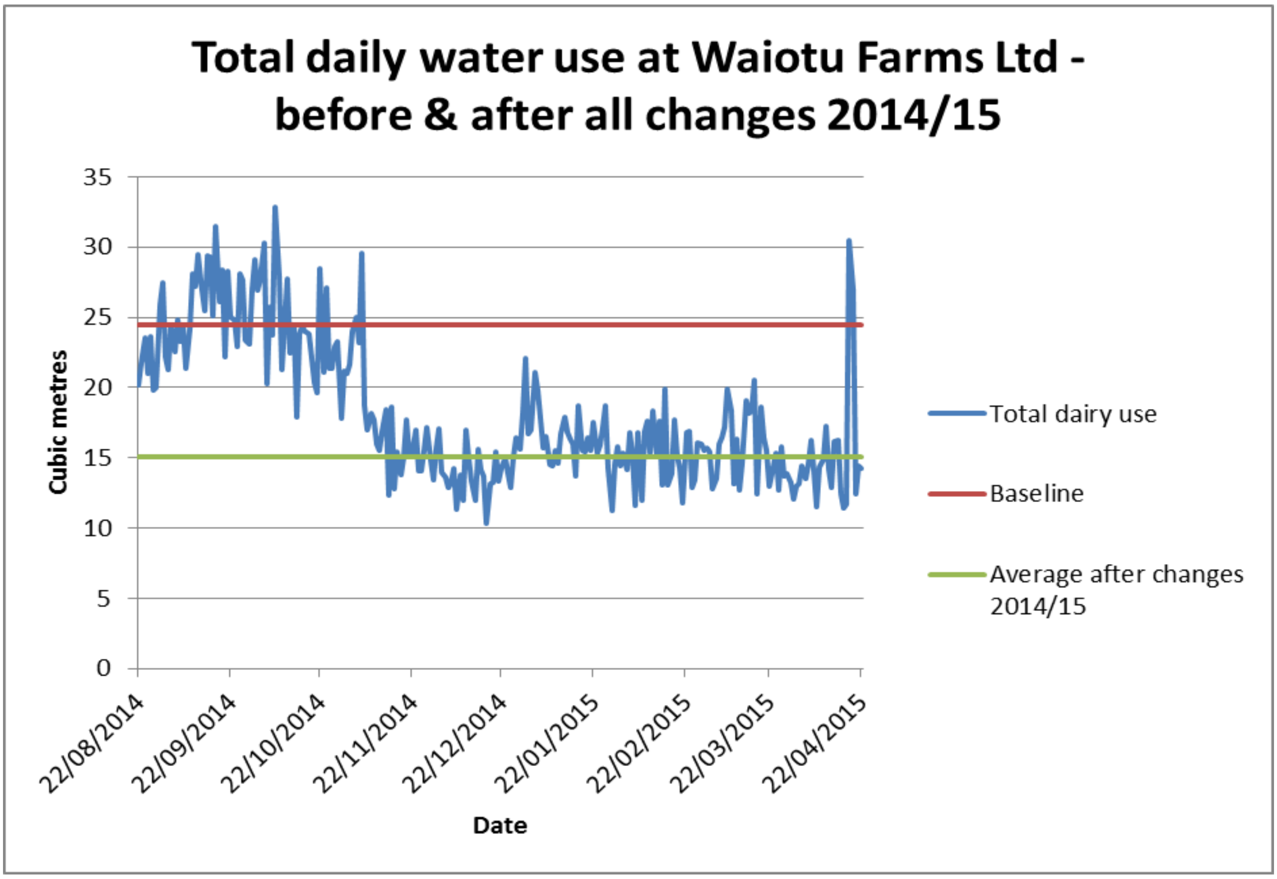

Figure 5: Total daily water use at Waiotu Farms Ltd – before and after all changes, which started on 6 November 2014.

4.3. Total reductions in water going into effluent

The volume of water added to the effluent system before changes was the metered total water use of 24.5 m^3 per day. This volume included the vacuum pump cooling water which was discharged to the dairy yard. After all changes and the removal of the vacuum pump cooling water the volume of water added to the effluent system was an average of 13.3 m^3 per day. This is a reduction of 46%. This does not include rain water which was permanently diverted from the roof of the dairy. Assuming a 300-day milking season, the annual reduction in clean water going into the effluent from the dairy would be 3,360 m^3.

4.4. 2015/16 season results

Data collection continued throughout the 2015/16 dairy season. The milking regime was changed from the usual twice-per-day to once-per-day on 22 December 2015.

Circular yard

The average daily water use for the circular yard for the 2014/15 season was 2.0 m^3 (after all the changes).

i. The average daily water use for circular yard wash for the period 1 July 2015 to 21 December 2015 was 3.4 m^3 per day.
ii. The average daily water use for circular yard wash for the period 22 December 2015 to 1 May 2016 was 2.6 m^3 per day.

One of the possible explanations for the increase in 2015/16 season compared to 2014/15 was that manual scraping was discontinued and more changes were made to the backing gate in order to do away with manual cleaning.

Total dairy use

The average total dairy water use for the 2014/15 year was 15.1 m^3 (after all the changes).

i. The average total daily water use for the period 1 July 2015 to 21 December 2015 was 15.1 m^3 per day.
ii. The average total daily water use for the period 22 December 2015 to 1 May 2016, with once per day milking, was 8.9 m^3 per day.

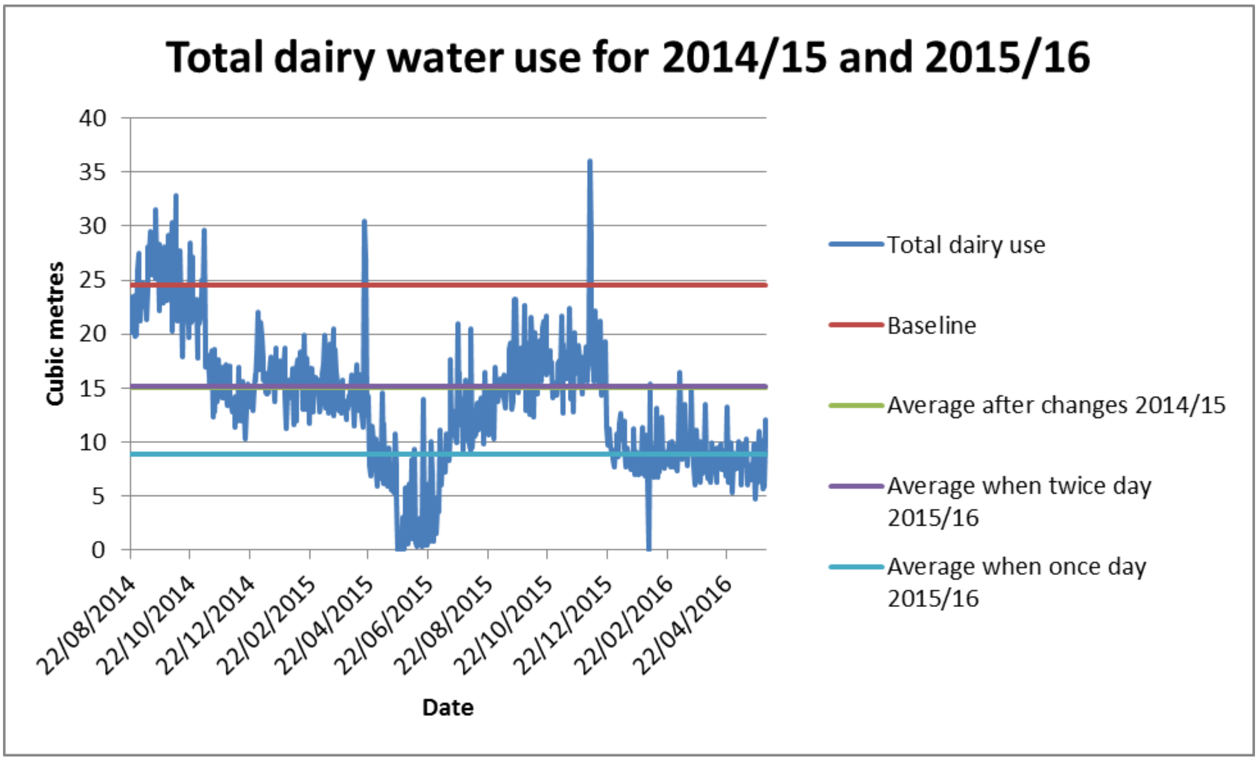

Figure 6: Total daily water use at Waiotu Farms Ltd – for 2014/15 and 2015/16 seasons. Note – the purple average line obscures the green average line, as the values are the same.

5. What else can be done

There are further opportunities to reduce the volume of water extracted from the Umuwhawha Stream and to reduce effluent volumes entering the system. These include:

- Adding additional water storage tanks and collecting roof water from the dairy and adjacent implement shed.
- Reducing the area of feedpad used when the herd is split over winter and early spring. This would allow diversion of significant volumes of clean water from the un-used portion of the pad. On average 2240 m^3 of rain falls on the feedpad during the period 1 May to 1 October.
- Construct a roof over the pad. On average 4600 m^3 of rain falls on the pad annually. This does not include rainfall on the collection pond below the pad.

6. The benefits

Environmental benefits

The project resulted in approximately 2.8 million litres of water per year not being taken from the Umuwhawha Stream. The volume of effluent going to the ponds was reduced by about 3.4 million litres per year. This will vastly improve the probability that Waiotu Farms Ltd will achieve their objective of eliminating or greatly reducing the discharge of treated effluent to water.

It is reasonable to expect that the improvements achieved will contribute to improved water quality within the Wekaweka Stream catchment.

Cost savings for the farmer

Much of the water is pumped up to five times before it gets to the irrigator. A reduction of 3.4 million litres, resulted in the irrigator operating for 260 hours less in the 2014/15 season compared with the previous season. This means significant savings in energy, maintenance and labour.

Reducing the effluent volume also concentrates the nutrients in the effluent and makes them less mobile. Therefore they are retained in the pasture root zone longer. With good management this can result in significant savings in fertiliser costs.

7. Our conclusions

In summary, the project has met the primary objectives by:

- Improving water use efficiency by 38%;
- Reducing the volume of water going from the dairy into effluent by 46%;
- Reducing on-farm operating costs; and
- Improving water quality by reducing the discharge of treated effluent to water.

The results have proved that the objectives were met over a relatively short period of time and at moderate cost. The savings achieved in year one were maintained in the second year.

On an industry wide basis there is potential to implement cost effective measures which will not only enhance environmental performance but also improve financial results by reducing capital and operating costs.

If the dairy industry is to achieve its stated environmental objectives, resources must be provided to ensure that farmers are educated to practice better water use efficiency and reduction of the excessive effluent volumes currently produced.

8. Running a successful effluent volume reduction project

The key ingredients in running a successful effluent reduction project are:

1. Meters – allow you to know how much water you are actually using, increase awareness of water use and accurately measure results of changes. Without meters you are flying blind.
2. Understanding – that the effluent disposal infrastructure is not designed and does not work as a pasture irrigation system.
3. Attitude – management and staff need to understand potential benefits and have a desire to implement changes.
4. Time and effort – a commitment to read and record meters and trial changes.
5. Patience – sometimes good things take time.

NORTHLAND REGIONAL COUNCIL

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