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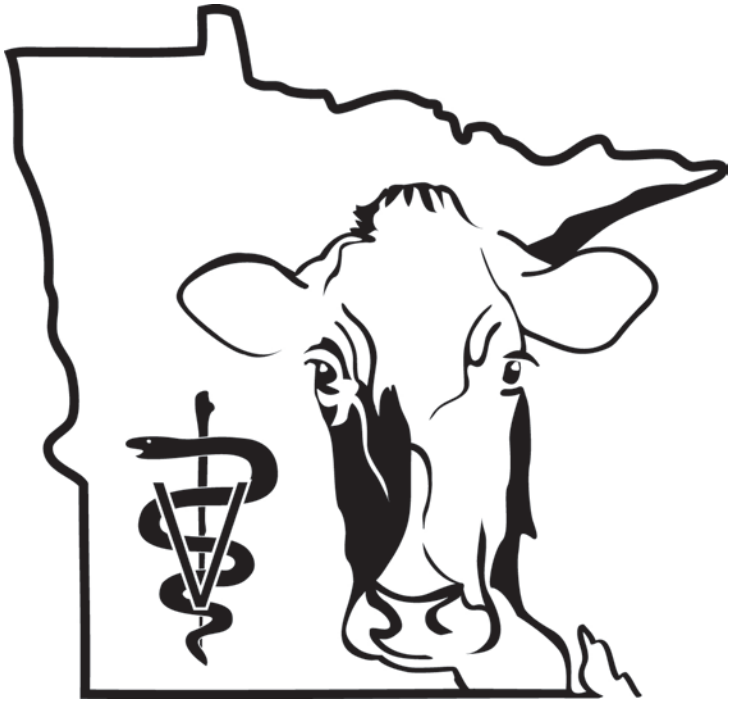


ST. PAUL, MINNESOTA
UNITED STATES OF MINNESOTA

Where Is All the Water Going?
(Flow Monitoring on Large Dairies)

by Ben H. Dorsey III

Introduction

A recent special edition of *Scientific American* magazine refers to water as "our planet's most valuable natural resource."[1] A full 70% of the world's fresh water supply is used for agriculture. True, a relative minority of this percentage is used for concentrated animal feeding operations as opposed to crop irrigation. Nonetheless, dairy operators and regulators share the burden of prudent use of water as pressure increases worldwide for its equitable use and as freshwater supplies diminish while the demand for food increases.

Generally, of course, dairy owners are more concerned with milk than water. Water management typically will not become a priority unless shortages occur in the supply or manure management (overflowing lagoons, fines for overspreading, etc.) becomes a problem.

"Business 101" principles imply that measurement is a prerequisite to management decisions. In order to facilitate wise water management decisions, we must first understand where all the water is going. With this end in mind, Vmark LLC has recently completed a pilot metering project in conjunction with the Ohio State University at a commercial dairy in Northwest Ohio. This paper presents summary results of the monitoring project.

> **Note:** While this article discusses water usage in a large commercial dairy, the per-cow data may approximate water usage in smaller dairies with similar commercial practices.

Project Overview

Timeline

The pilot project commenced on August 1, 2004. The initial phase concluded on August 31, 2005; the overall project continues today. At the outset of the project, several weeks of adjustment were required to ensure proper calibration of the meters and to verify accurate data translation.

Dairy Details and Head Count

The monitoring project has been conducted at the Vander Made Dairy, a Holstein operation in Defiance County, Ohio. This particular dairy was chosen due to its growth plan which would provide an interesting variable for the project.

At the commencement of the project, the dairy had a total of 540 cows. The ratio of lactating to dry cows was 484:56. At the conclusion of this phase, the head count was 988 cows. The ratio of lactating to dry cows as of August 31, 2005 was 832:156. (This represents a presumably momentary and unusually high percentage of non-lactating cows.) Vander Made Dairy currently milks three times per day. Each milk cycle is approximately 6 hours long.

In terms of water usage, note that this farm uses a wash down in the parlor only (as opposed to a full flush system). The ramp to the parlor and barns are scraped.

Climate
As seasonal variations affect both dairy production and water usage, general climate conditions are provided. Defiance County is located in northwest Ohio which enjoys generally understood, full four-season weather.

The coldest month is usually January. The warmest month is usually July. The highest average temperature is 60.33° F. The lowest average temperature is 39.67° F. Mean summer temperature is 76° F. Mean winter temperature is 29° F.

Average precipitation is 32-35 inches per year.

Defiance County averages 700 feet above sea level.

Equipment Used
Thirteen metering stations were installed in July 2004. Each station consists of flow sensor and a flow transmitter. A dedicated computer workstation compiles and displays the measurements.

Meter 1—Parlor Water (used for cleaning parlor floors, walls, and milking equipment)
Meter 2—Cow Drinking Water
Meter 3—All Well Water
Meter 4—Soft Water
Meter 5—Hot Water
Meter 6—Hot Water, Cleaning in Place (CIP)
Meter 7—Cold Water, CIP
Meter 8—Total CIP Water
Meter 9—Plate Cooler Water
Meter 10—Cold Water, Bulk Tank
Meter 11— Hot Water, Bulk Tank
Meter 12—Cold Water, Employee
Meter 13—Hot Water, Employee

Results

Most of following data represents information collected in 2005. Several weeks of calibration were needed in 2004. In addition, there was a period of water system adjustment based on knowledge gained. Thus, the following represents stable data.

An Ordinary Day
The following table is not meant to be an average; rather, it is simply a snapshot. This particular day was 2 May 2005. The day was fairly neutral in terms of climatic extremes.

Meter	Function	24-hour Reading (gal.)
1	Parlor Cleaning	4199
2	Cow Drinking	24409
3	Well	33880
4	Soft Water-Commercial	4200
5	Hot Water-Commercial	1172
6	Hot Water-CIP	837
7	Cold Water-CIP	706

8	All CIP	1595
9	Plate Cooling	21675
10	Cold Water-Bulk Tank	156
11	Hot Water-Bulk Tank	145
12	Cold Water-Domestic	51
13	Hot Water-Domestic	5

At this generalized rate the farm uses approximately 12.4 million gallons of water per year. However, this rate was reduced due to knowledge obtained through the metering projects as will be demonstrated later in this paper.

You may have noted a discrepancy in the CIP figures. Hot and cold do not add up exactly to the total displayed. The difference is attributable to the mixture of hot and cold water which can create turbulence, leading to inaccurate meter readings. Meter placement in the stream can exacerbate, alleviate, or eliminate such resulting discrepancies.

Drinking & Waste Water Summary

Month	Cows	Lactating Cows	Avg. Daily Drinking Water	Avg. Daily Drinking Water/Cow	Avg. Daily Waste Water	Avg. Daily Waste Water/Lactating Cow
Jan	740	666	11919	16.1	5616	8.4
Feb	750	675	12757	17.0	5583	8.3
Mar	770	693	14385	18.6	5410	7.8
Apr	840	711	19151	22.8	5471	7.7
May	850	722	19514	23.0	5513	7.6
June	875	747	29550	33.8	5503	7.4
July	888	780	29150	32.8	5576	7.1
Aug	954	809	28100	29.5	5533	6.8
Sep	988	832	21491	21.8	6083	7.3
Oct	988	844	21664	21.9	6077	7.2
Nov	1000	860	17638	17.6	6307	7.3
Dec	1000	870	12027	12.0	6238	7.2

This highly significant data deserves some explanation.

The count of lactating versus total cows is given because lactating cows account for the vast majority of water usage. Only drinking water is used for non-lactating cows and it is at a much reduced rate as compared with lactating cows.

Note the increase in Average Daily Drinking Water as the months advance. Two factors contribute to this rise. First, the herd size is increasing. Second, like humans, as the weather warms, all cows drink more water. Thus, even the Average Daily Drinking Water Per Cow increases in warmer weather.

June and July were unusually hot and humid months in northwest Ohio. December was unusually cold.

By contrast, and despite the increase in herd size, waste water remains fairly constant, and even decreases per cow, as the herd size increases.

The following two sections provide similar data in summary form.

Water Consumed by Cows

- Winter average: 15.0 gallons/cow/day
- Spring average: 21.5 gallons/cow/day
- Summer average 32.0 gallons/cow/day
- Fall average: 20.4 gallons/cow/day
- Overall average: 22.2 gallons/cow/day

Waste Water

The figure is calculated by combining the CIP (pipeline and bulk tank) and Parlor water. This represents metering stations 1, 8, 10 and 11. Over the 1-year pilot project, the average was 7.5 gallons/lactating cow/day.

The Misting Variable

During summer, it is often necessary to provide misting to the cows in order to keep their body temperatures down (promoting both health and production benefits). This service averaged 1.3 gallons/cow/day for the months of June, July, and August. The following table represents total misting water during these months.

Month	Avg. Gallons Per Day
June	1120
July	1170
August	1213

While most of this water evaporates, it is estimated that 25-35% falls to the ground to become waste water.

Total Water Usage Per Cow

Based on the above data, the overall water usage per cow is described below:

- Winter average: 22.5 gallons/cow/day
- Spring average: 29.0 gallons/cow/day
- Summer average 39.5 gallons/cow/day
- Fall average: 27.9 gallons/cow/day
- Overall average: 29.8 gallons/cow/day

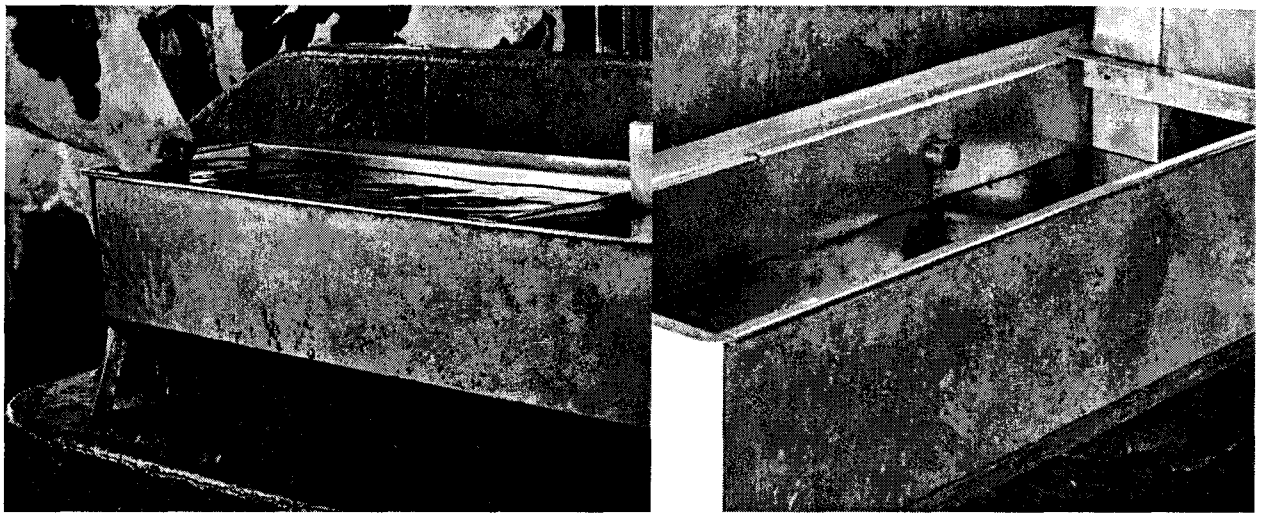
Findings

Metering As Management

Relatively early in the pilot project, metering proved to be an effective management tool as demonstrated below:

- Observation of parlor water data revealed a 6-gallon per minute spike over "normal" usage. This 6-gpm flow remained even during down time of parlor water usage. Investigation eventually led to a faulty valve in the high pressure line. This "leak" was responsible for 8640 gallons of waste water in a single day. Undiscovered, it could have resulted in much greater loss.
- Monitoring parlor water usage also led to observations of shorter and longer wash down cycles. This led management to conduct corrective employee training.
- Bulk tank metering also revealed shorter than recommended wash down cycles, indicating that drivers were not turning the activation knob to the full 60-minute position.

Raising Awareness
In general terms, metering tends to make all parties more conscious of water usage at the dairy. As an example, the pictured overflowing water trough could have been detected through scrupulous observation of the metered data but was, instead, detected by direct observation.



The water trough on the left has a non-functioning or improperly adjusted float, leading to overflowing (waste). The one on the right is functioning and properly adjusted.

Plate Cooler Water Savings
At the outset of the metering project and following system calibration, the flow of water through the plate cooler was metered at 42 gpm. Vmark engineers deemed this to be excessive and gradually lowered the flow while ensuring continued proper cooling of the milk. The rate was eventually lowered to 16 gpm without compromising the capability of the plate cooler. As the herd size grew and longer milking cycles were required, the rate was raised to the current level of 21 gpm.

Nonetheless, this one activity resulted in a 50% savings of plate cooler water usage. In a one year period, this would equate to a savings of over **8 million gallons**!

Lowering the rate of the plate cooler water also resulted in an additional benefit: fewer overflows of the reserve water tank. There is now relative parity in the rate of flow of cow drinking water and plate cooler water. This means that water flows in (from the plate cooler) no faster than water flows out (to the cows). Previously, the overflows were simply creating waste.

CIP Water Savings

Vander Made management initially used four wash cycles in the CIP system (three washings per cycle). Three of the cycles followed each of the three daily milk cycles. An additional wash cycle was used as a extra security measure by the owner prior to the start of each day's milking. With metering data available and in consultation with the owner, Vmark recommended eliminating this initial cycle and increasing the time of the other cycles. There was no compromise made to measured milk quality or required CIP standards.

This action resulted in a direct savings of 405 gallons of water per day (approximately **148,000 gallons per year**).

Domestic Water Usage

As it may be of interest to some, the water usage by the dairy employees was also metered. While shower facilities are provided for employees, they are not highly utilized on this particular farm. Over the year period, the average water usage was 12.7 gallons per person per day.

Future Recommendation

The Vander Made dairy prepares the udders for milking with hand towels that are subsequently washed in soft water. While all soft water was metered, there was no separate meter for the washing machine used for this purpose.

Anecdotally, it was noted that this usage could represent as much as 100 gallons per wash and the dairy averages 10 washes per day.

Future metering projects should require a wash-only metering station on dairies that use this udder cleaning method.

Conclusion

Metering water usage on commercial dairies is the first step to more prudent use of this valuable, natural resource. Operators, regulators, and others can make use of the resulting information for immediate management decisions and to prepare for future initiatives which may have an impact on CAFO operations.

Some of the savings experienced on this pilot project farm are the result of the particular operations. They may or may not be applicable to other farms. Overall, however, metering will reveal deficiencies of operation or verify efficiencies of operation. Both of these measures will be necessary for the future.

Finally, bear in mind that, while the above data is both valid and significant, it is only the result of metering on a single farm. Further metering is important to the continued viability of this knowledge base.

About the Author

Ben H. Dorsey III is VP of Marketing for Vmark, LLC. Vmark provides metering, consultation, and water purification systems and services to dairy and related industries. Reach Ben via email: ben@vmarkwater.com.

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[1] *Scientific American*, Special Report, "The Water of Life," printed July 2005.