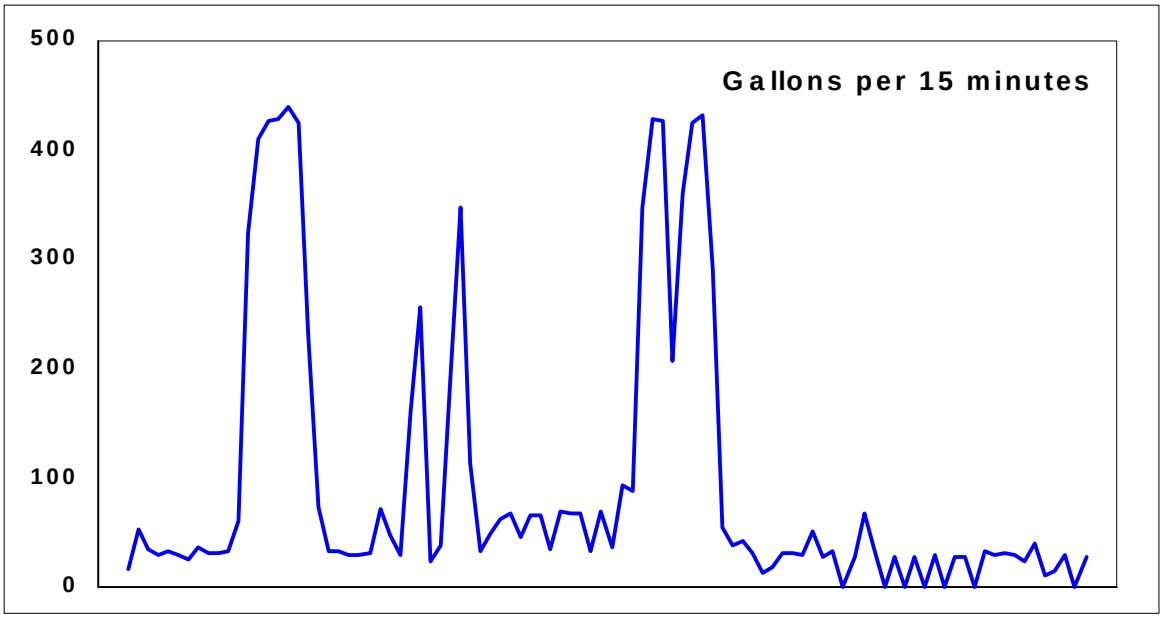
Maxing Out : a Water Supply Case Study

Introduction

Water measurement is becoming increasingly common, but relatively few breeder sites have meters with monitoring.
The site studied is a 2500 sow US breeder site with 16 farrowing rooms and 2 BG barns. Farrowing rooms have meters, and there is also a general site supply meter. Unfortunately, there are no meters in the BG barns. Water consumption here would be expected to dominate the total use and assumptions have had to be made as regards water use in these.

Total daily water pattern

Daily water use varies somewhat, but is typified by the following general curve :



Figures are given per 15 minutes, being the logging interval of the monitoring system.

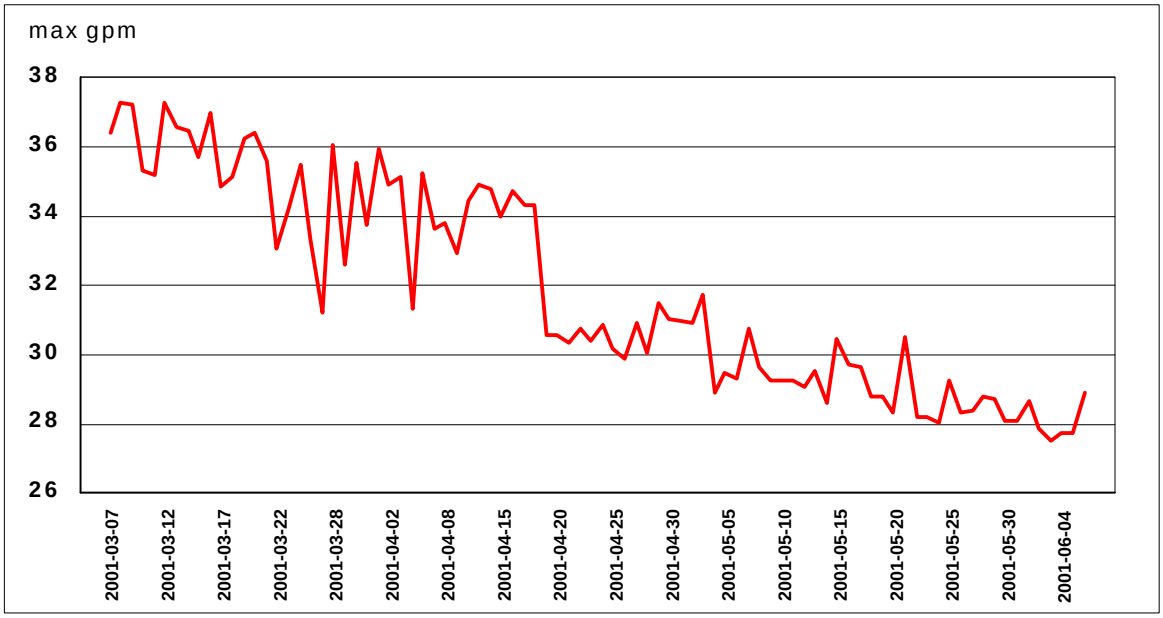
As we can see, total water use is dominated by one large peak in the morning, and two in the evening. From time to time, the two peaks in the evening may be more or less separated. It's presumed these are due to feeding times in the BG barns. In the morning, both barns are fed at the same time, but in the evening they have been at similar but not always the same time.

These amount to around 2/3rd of typical total daily site consumption - around 1.5 to 2 gallons per sow in the BG barns.
The striking feature is that whether the peaks are coincident or not, the peak value is always the same. The variation in volume results in a change in width not height - i.e. the peak value varies in duration.

This indicates that water delivery is limited by supply rather than demand. This raises some question marks over possible stress effects on some sows in the BG barns. Assuming sows in a barn are fed at the same time, it means that some sows in the barn (nearest the incoming water supply) will have feed and water, while some will get feed with reduced water (due to pressure drop).

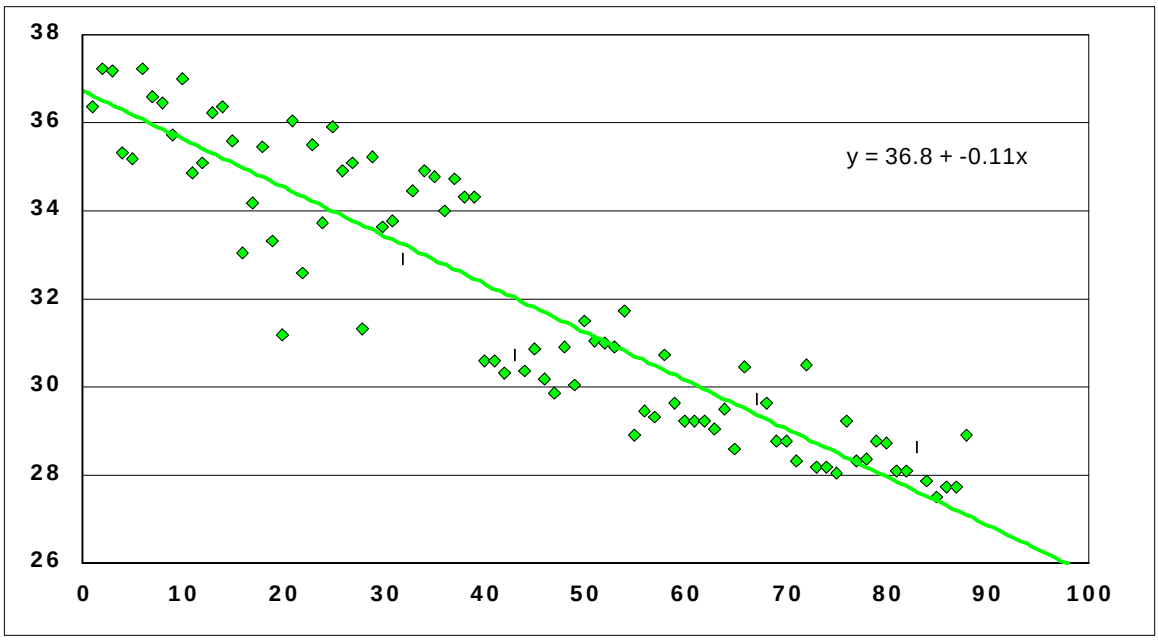
It is possible that this will also have an effect on water supplies to farrowing rooms. Whilst usage in the farrowing rooms is not depressed as such, there are lower peak values noted during periods of high site consumption.

It is a reasonable assumption that the rate of water delivery is limited at the supply by the pumping capacity of the bore hole pump (if applicable) or external water source, and that the peak value measured on any particular day represents the limit of its capacity.
On this assumption, the daily peak delivery rate has been extracted and converted into gallons per minute :



(Some figures have been adjusted/removed for evident data logging anomalies.)

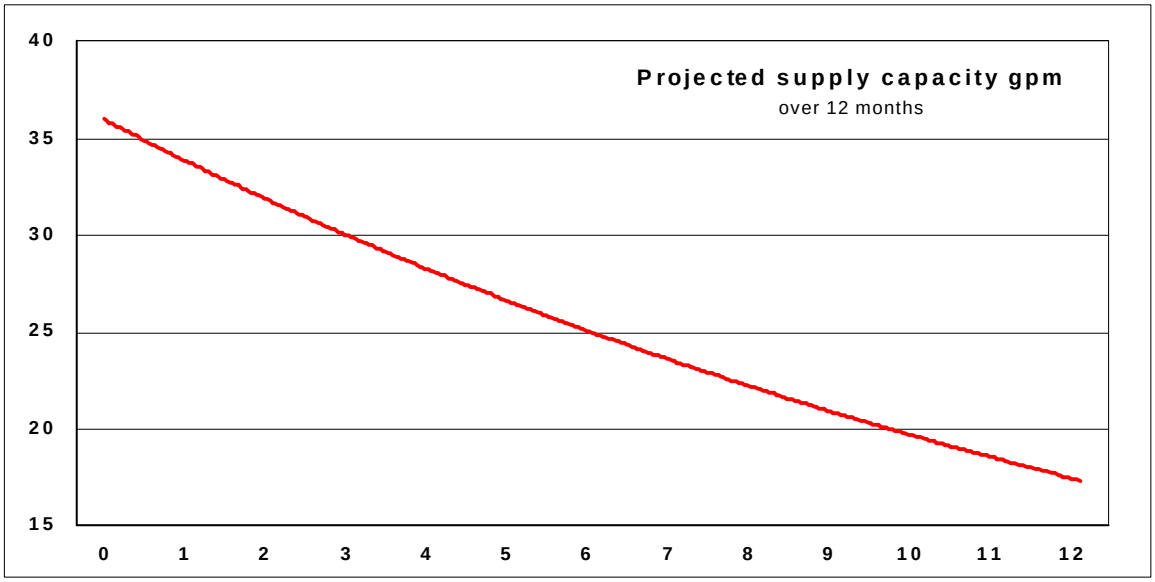
It is clear that the peak delivery rate is falling over a period of time. Carrying out a regression analysis on this data reveals the following approximate relationship :



That is, the site supply is losing peak pumping/delivery capacity at the rate of about 0.11 gallon per day. On this basis, supply would drop to zero within a year.

Closer review of the data suggest that the relationship is actually of two parts. Up to about day 40, then from day 40 on, with a step change in the middle. (Around 20th April 2001.) These two parts have a slightly slower reduction in capacity - 0.072 and 0.064 gallons per day respectively. These figures amount to approximately 0.2% per day.

Based on this relationship, the following peak delivery capacity is predicted :



The exact cause of this progressive reduction is not exactly clear, but the most likely explanation is a progressive blocking of the supply filter by particulate matter (assuming one to be present).

(Note : If reduced capacity is due to resistance such as filters, this will most likely result in a water velocity squared relationship, meaning that supply capacity may drop marginally more slowly that projected in the simple model given above.)

The step change around day 40 in the above data is of concern, since the system appears to have lost around 4% of capacity on a single day. Such problems could occur at any time in the future.

Impact

If these projections were correct, then one would expect progressively increasing impact on the animals due to increasing differences between different points in the installation.

At present, the maximum typical daily demand on the site is around 18,000 gallons (including pressure washing). This total capacity could still be delivered even if supply capacity fell to 12.5 gpm.

However, it would be expected that this would have severe consequences on the livestock, as well as resulting in operational problems such as pressure washers not functioning at certain times.

Review

During the period of logging, the site appears to have lost around 25% of it's water delivery capacity at the start of site water logging. The site had been in operation for some time before that, so it is not clear how much capacity may have been lost before that.

Regrettably, site water meter data on this site has been absent for some time, so it is not possible to determine the outcome as regards whether the situation has been detected and corrected subsequent to the logging.

This is a study of a single site. One cannot project whether this type of issue may be typical or otherwise, as there are relatively few sites where a total supply meter has been connected to Dicam logging.

Progressive reduction in operational performance is, inevitably, much more difficult for operators to detect than acute failure situations. In instances where it is known that filter blockage has occurred (though this may not be the cause here), severe and expensive production performance loss has occurred. And yet detection has not occurred until severe reduction in delivery has occurred.

Some method of indicating such progressive deterioration would appear to be of use in detecting specific faults and indicating when servicing is required.

Whilst one can't know whether there has been any economic impact in this instance, one can guess that it will have unless the supply situation is corrected.

Although many sites now have water meters, these are normally just for measuring drinking water only. This case study suggests that site water meters fitted as well (to measure overall demand) would be beneficial.

It is straightforward to indicate (in Barn Report) the maximum throughput (from a site water meter) on any particular day (as well as total use). However, this will only indicate supply limitations if the site regularly hits the pumping/delivery limit for a significant period (i.e. longer than a logging interval). There are alternatives, which would require additional software development.