High Accuracy Flow Data & Diagnostics Reduces Operational Costs of Pump Stations

This document explains how to detect multiple collection system problems that can eat into an operational budget without anyone knowing about it. It will also explain how to potentially reduce the cost of operating even some trouble-free pump stations.

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Introduction

It is possible to reduce operational costs without breaking the bank? With the right data:

- Wastewater pump stations would be designed more precisely for their present and future needs,
- There would be indicators showing when equipment is reaching the end of its useful life,
- Maintenance staff would be aware of problems while the repairs are less expensive to perform, and
- Flow studies would simply be part of the day-to-day information required to plan the deployment of the human resources and upcoming projects.

This document explains an inexpensive way to achieve all of this with the right data gathered at pump stations and describes how to reduce their power costs.

Problems ...

- Lack of appropriate data is still the main reason behind over or under designing wastewater pump stations.
- The operating life of key infrastructure and equipment must be extended to just before point of failure to maximize investments.
- The maintenance staff only have time to address critical problems. Maintenance departments live with the consequence of not having the time to do preventive maintenance.
- Inflow and infiltration studies provide good information to identify flow issues in critical areas, but are expensive.

To fix these problems, a new method of gathering the required data will be compared to the usual way of getting the information, if any exists. For those who have SCADA systems with huge historical database containing years of every possible type of data, please continue to read. Quantity doesn't mean quality. SCADA systems monitor pump stations but they are not optimized to find problems that affect routine operating costs. There is now software that can do it, if the right data were recorded.

Useful, reliable, up to date, diversified, accurate data in a format that is easy to interpret facilitates the best possible decisions. Simply getting any data isn't enough. How do you get the required data? Who will create the understandable reports? The answers are in the following text.

FLOW 101, IN and OUT

Why start with this one since it is not every day that upgrades are required? Because flow analysis is required to do this properly, but also to detect abnormal pump performance and efficiencies, and, of course, for inflow and infiltration studies.

So, let's start with Flow 101. It won't be what you think you already know.

Basic Report Information

Any good wastewater pump station report should display number of starts and run time, but also real up-to-date pump capacities and pump efficiencies, which is the number of gallons pumped per watt of electricity consumed. This report should also provide information on infiltration, increase in power consumption, abnormal sequence of operations or behavior, pumping capacity safety margins and even the money lost due to inefficient pumps usage just to name a few.

All of these elements are pieces of information that can assist an engineer in proposing the best possible solutions to a problem, quantifying the safety margin that is gained from the upgrade, and predicting the savings to be achieved using the more efficient pumps that are proposed.

All of these reasons are also good for evaluating an existing system. Sometimes, just changing the sequence of operations of the pumps will save a lot of dollars. More on that later.

Run times, number of starts, voltage and current are relatively easy data to get. Anything related to the real flow, like pump capacities (outflow), efficiency or influent flow rate (inflow) is more complicated than some would like to believe. Even using a magmeter usually means only getting the outflow and not the inflow, therefore the peak inflows, which are elements used to determine the design pumping rate and safety margins, are typically estimated from the available outflow data … without true peaks.

The operation of wastewater pump stations with constant speed pumps and variable speed pumps are significantly different. The easiest way to calculate the capacity of variable speed pumps, other than having a magmeter or some type of clamp-on flow meters installed, is to operate them as constant speed pumps for few cycles in order to calculate their true capacity for a known speed.

Draw down calculation (or bucket and stopwatch method) is the most popular method of calculating the flow in and out of wastewater pump station with constant speed pumps. This is the method that is commonly programed in SCADA systems and RTUs when they are used, or performed manually when the maintenance department has the time to do it and the weather permits. Since accurate flow data is so important, it will be described in great detail.

Standard Volumetric Flow Algorithm

The scientific name of the draw down calculation is the standard volumetric flow algorithm, which consists of three equations (Fig. 1). It is simple to understand, to use and to program, with an acceptable accuracy … or is it? In the Support Division's Operating Procedure entitled "Wastewater Flow Measurement" made effective in August 2011, the EPA clearly states that "volumetric flow measurement techniques are among the simplest and most accurate methods for measuring flow." Even the EPA specifies there are multiple techniques and methods to achieve this and they are simple to use, but not necessarily simple to program.

When selecting a clamp-on flow meter, the organization tries it against a magmeter or other means of reference. When a volumetric flow algorithm is integrated in a product, the same treatment goes for that product. The flow algorithm programed in many SCADA systems and RTUs is rarely compared to anything, and when it is, it isn't for all the types of installations where it will be used.

$$Inflow = \frac{Volume}{t2 - t1}$$

$$Inflow\ with\ pumps\ on = \frac{Inflow\ before + Inflow\ after}{2}$$

$$Outflow = \frac{Volume}{t2 - t1} + Inflow\ with\ pumps\ on$$

Figure 1 – Lower Accuracy Standard Volumetric Flow Formula

Higher Accuracy Flow Algorithm

One way to gain 5% or more of flow accuracy is to program a volumetric algorithm* like this patented one (Fig. 2 and 3). This one compensates for inflow rates that are changing rapidly, heads that are not constant or pumps with problems. These are normal events at most of the pump stations. While many SCADA programmers are saying they get the same accuracy from the three previous formulas, because they were never challenged before, the truth is otherwise.

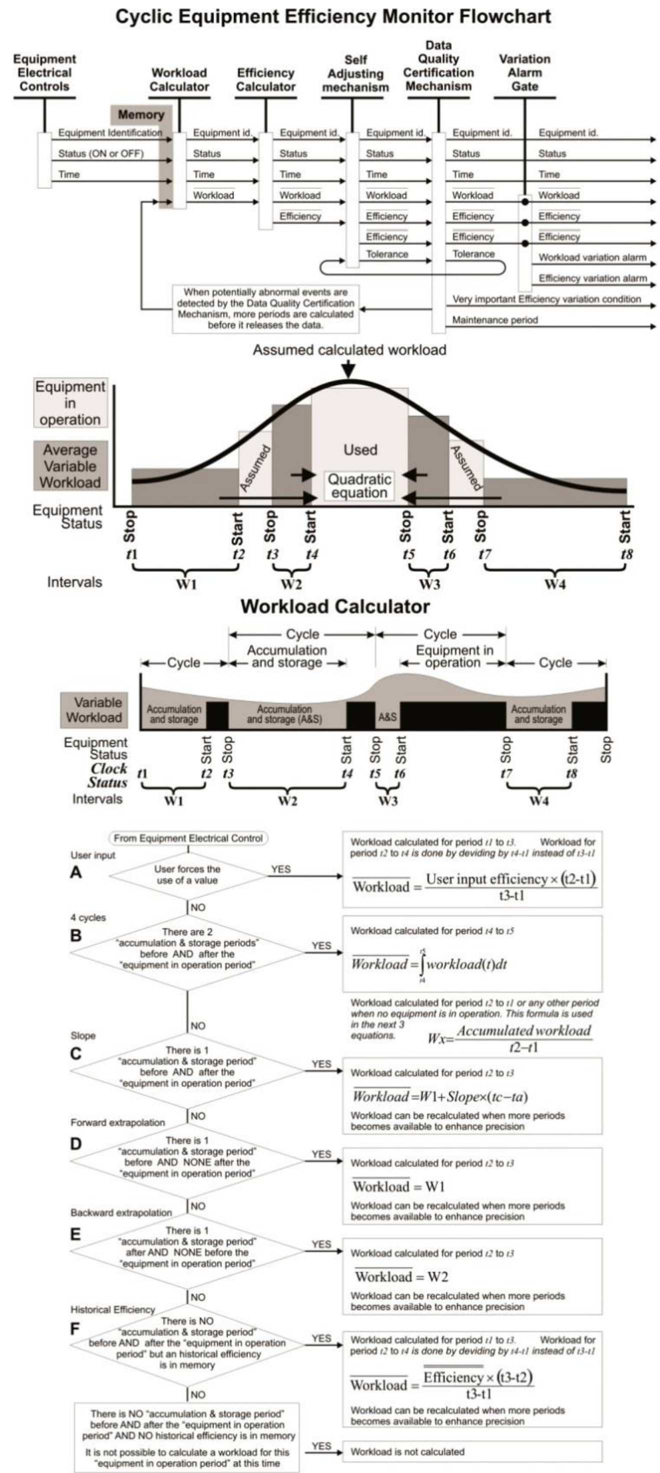

Figure 2 - Part 1 of a High Accuracy Flow Algorithm

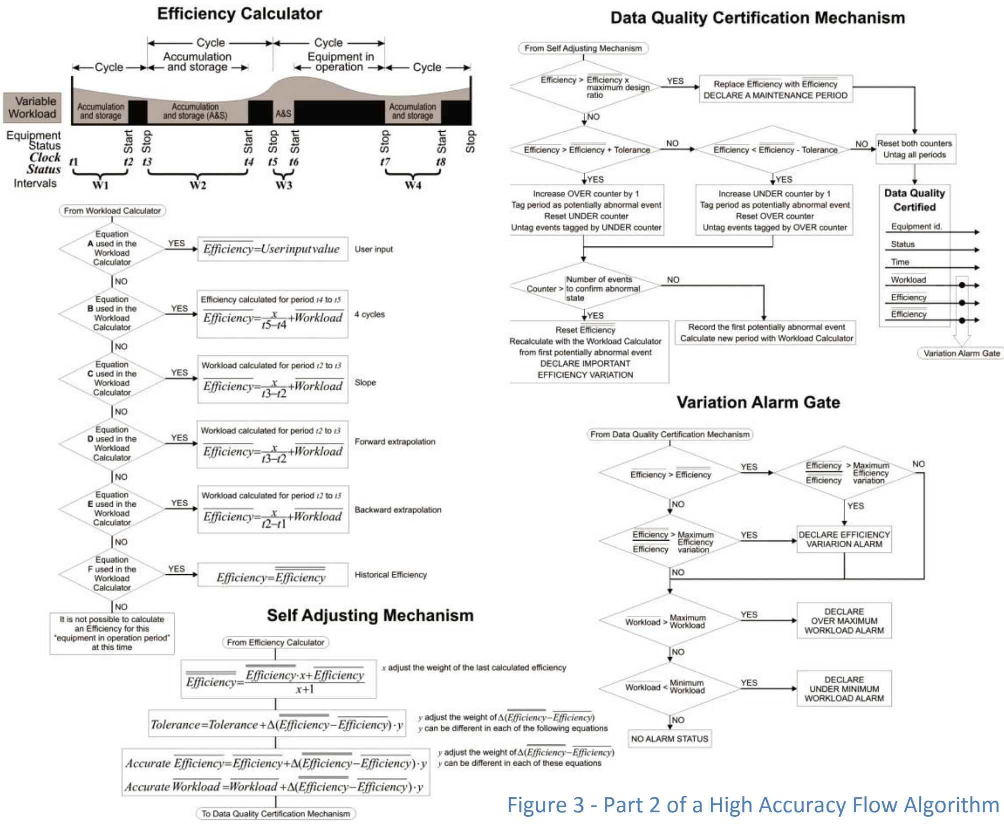

Figure 3 - Part 2 of a High Accuracy Flow Algorithm

Average Flow

The standard and high accuracy algorithms are generating average flow rates for each portion of each cycle, while the reality is that flow is changing all the time. Real time flows, not averages, should therefore be the goal. Here is why.

Let's say the volume and number of flow peaks and their sizes are required to correctly size the pumps for a pump station upgrade. This graph (Fig. 4) shows one day of data calculated using an average based volumetric flow algorithm. The purple line is the inflow and calculated pump capacities are the gray and blue vertical bars.

It shows that the pumps' outflows (height of the bars) are changing all the time, which is, for constant speed pumps, relatively abnormal unless the force main pressure is changing all the time. In this case, the pump station is pumping into a gravity line. This means the pump capacities calculated are mostly wrong (and low), which is caused by using faulty inflows to calculate the outflows.

This graph shows 10 peaks above 1000 GPM, 5 above 1500 GPM and 1 peak above 2000 GPM. The average of the wrongly calculated pump capacities (lower than reality) multiplied by their run times will supply the total volume. The station upgrade will be under designed based on this information.

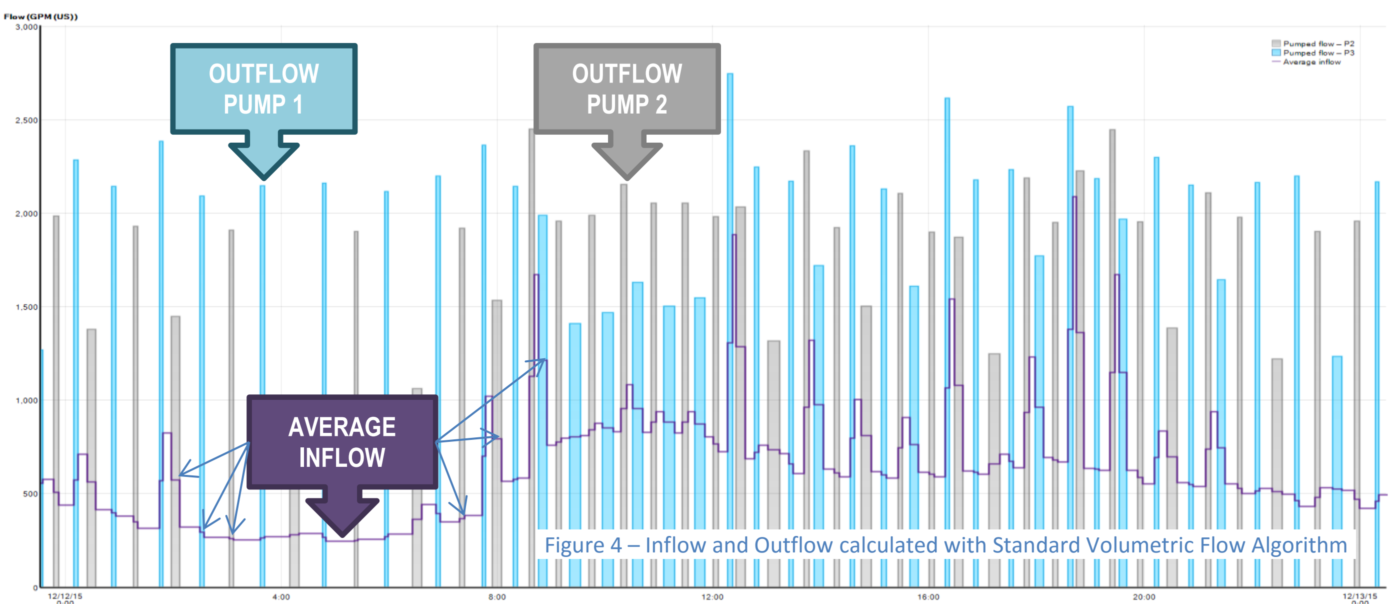

Figure 4 – Inflow and Outflow calculated with Standard Volumetric Flow Algorithm

Real Time Flow Engine

Real Time Flow means the flow algorithm computes the inflow and outflow continuously instead of once per cycle. For patent pending reasons, it won't be detailed here, but it does what it says. What is important to understand is how the decision-making process can be influenced by it. This graph (Fig. 5) shows the same data as the previous one, but with Real Time Flow data. Look at the peaks and the stability and height of the pump capacities.

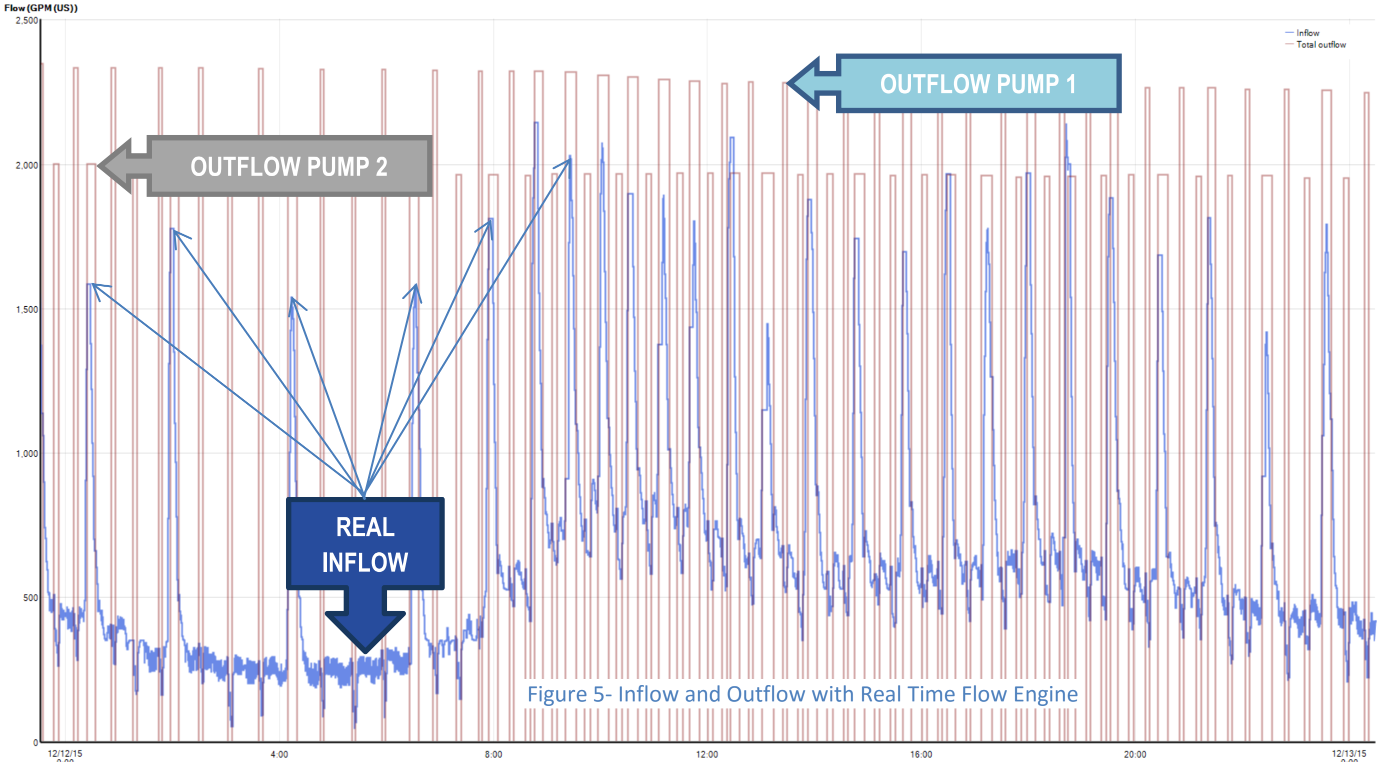

Figure 5- Inflow and Outflow with Real Time Flow Engine

Inflow peak flow isn't the only parameter used in the selection of the right size of pumps for a wastewater pump station, but it is an important one. This table (Fig. 6) represents some of the data used to select the right size of pumps based on the two volumetric algorithms presented. The problem is evident.

PEAK FLOW	Standard Volumetric Flow	Real Time Flow Engine
Peaks above 1000 GPM	10	26
Peaks above 1500 GPM	5	23
Peaks above 2000 GPM	1	5
Pump capacity accuracy	Poor	Excellent
Total volume	Lower than reality	Excellent

Figure 6 - Difference of data between two flow algorithms

The technology behind the results influences the decision-making process. The Volucalc RT, made by MAID Labs Technologies, can generate accurate inflows and outflows in real time, takes few minutes to install, can be used as a portable unit or permanently installed and costs less than most flow meters, a fraction of over or under designing a wastewater pump station.

MAID Labs Technologies also has a software that can do this with SCADA historical data, if the right data were recorded. Now that we have proper flow, let's continue.

Extending Equipment life to just before they fail

What is needed here is a means to "see" the pumps in operation. About 10 years ago, an electrical study was performed on over 200 different types of electrical equipment used by municipalities and industries. Pumps, blowers, compressors, air conditioning, generators and many more types of equipment had their current and voltage monitored and analyzed every second for weeks to see if they were always operating as expected.

This allowed Maid Labs, the manufacturer, to have a new product tested rapidly for multiple applications. The goal was only to be sure this product, which was originally designed to monitor pump stations, would work flawlessly connected to any type of electrical equipment.

It worked better than expected for the product and worse than expected for the equipment tested (Fig. 7). It was found that 32% of the equipment had intermittent problems often and every day that were unknown to the organization and another 18% had intermittent problems only once or twice per week. The conclusion was that most of the electrical equipment becomes sick before they fail without anyone being aware of it.

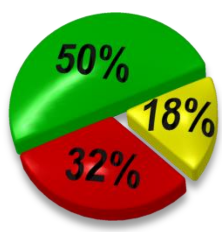

Figure 7 -Average percentage of intermittent electrical problems

The first step in problem solving is to be aware there is a problem. Pump station problems are diversified, like any sickness, but with the right tools in the hands of a good Doctor, the patient might not die for nothing … or $20. This might be the result of not changing a $20 relay during normal working hours at a pump station. More on this soon.

How can you know when equipment getting sick? By recording and analyzing their sequence of operations with a table like this one (Fig. 8). Suspicious events started at 2:13 AM.

Time	Duration	Pump 1	Pump 2	Pump 3	Volume	Inflow	Graph	Outflow
H:mm:ss	hhh:mm…	state	state	state	US gal.	GPM (US)		GPM (US)
1:43:40	0:00:34…	On	Off	Off	626	1,105.4		1,533.1
1:44:14	0:01:44…	Off	Off	Off	1,723	994.3		0.0
1:45:58	0:01:12…	Off	On	Off	1,745	1,454.6		2,890.7
1:47:10	0:00:54…	Off	Off	Off	1,723	1,914.9		0.0
1:48:04	0:00:23…	Off	Off	On	734	1,914.9		1,636.7
1:48:27	0:00:27…	Off	Off	Off	1,085	2,411.7		0.0
1:48:54	0:00:13…	On	Off	Off	415	1,914.9		1,474.4
1:49:07	0:00:27…	Off	Off	Off	1,085	2,411.7		0.0
1:49:34	0:03:57…	Off	On	Off	7,564	1,914.9		2,351.2
1:53:31	0:00:41…	Off	Off	Off	1,648	2,411.7		0.0
1:54:12	0:00:23…	Off	Off	On	672	1,752.8		1,557.3
1:54:35	0:01:05…	Off	Off	Off	1,723	1,590.8		0.0
1:55:40	0:00:28…	On	Off	Off	652	1,396.6		1,417.0
1:56:08	0:01:26…	Off	Off	Off	1,723	1,202.4		0.0
1:57:34	0:01:00…	Off	On	Off	1,129	1,128.7		2,852.1
1:58:34	0:01:38…	Off	Off	Off	1,723	1,055.1		0.0
2:00:12	0:00:37…	Off	Off	On	651	1,055.1		1,552.1
2:00:49	0:00:29…	Off	Off	Off	1,166	2,411.7		0.0
2:01:18	0:00:16…	On	Off	Off	291	1,089.5		1,414.2
2:01:34	0:01:32…	Off	Off	Off	1,723	1,123.9		0.0
2:03:06	0:00:49…	Off	On	Off	1,151	1,409.5		3,519.8
2:03:55	0:01:01…	Off	Off	Off	1,723	1,695.1		0.0
2:04:56	0:00:34…	Off	Off	On	876	1,546.2		1,410.3
2:05:30	0:01:14…	Off	Off	Off	1,723	1,397.3		0.0
2:06:44	0:00:16…	On	Off	Off	246	923.5		1,355.7
2:07:00	0:03:50…	Off	Off	Off	1,723	449.6		0.0
2:10:50	0:00:13…	Off	On	Off	97	449.6		1,019.3
2:11:03	0:00:27…	Off	Off	Off	1,085	2,411.7		0.0
2:11:30	0:01:13…	Off	Off	On	547	449.6		1,866.1
2:12:43	0:00:27…	Off	Off	Off	202	449.6		0.0
2:13:10	0:00:01…	On	Off	Off	7	449.6		0.0
2:13:11	0:02:01…	Off	Off	Off	907	449.6		0.0
2:15:12	0:10:07…	Off	On	Off	8,732	863.1		1,033.4
2:25:19	0:01:21…	Off	Off	Off	1,723	1,276.6		0.0
2:26:40	0:00:19…	Off	Off	On	404	1,276.6		1,533.7
2:26:59	0:00:29…	Off	Off	Off	617	1,276.6		0.0
2:27:28	0:00:08…	On	Off	Off	170	1,276.6		0.0
2:27:36	0:00:26…	Off	Off	Off	553	1,276.6		0.0
2:28:02	0:00:36…	Off	On	Off	766	1,276.6		1,044.5
2:28:38	0:01:21…	Off	On	On	319	236.0		2,000.0
2:29:59	0:00:27…	Off	Off	Off	1,085	2,411.7		0.0
2:30:26	0:00:27…	Off	Off	On	574	1,276.6		1,533.7
2:30:53	0:01:07…	Off	Off	Off	1,426	1,276.6		0.0
2:32:00	0:00:01…	On	Off	Off	21	1,276.6		0.0
2:32:01	0:01:13…	Off	Off	Off	1,553	1,276.6		0.0
2:33:14	0:00:49…	Off	On	Off	1,460	1,787.2		3,897.5
2:34:03	0:00:45…	Off	Off	Off	1,723	2,297.9		0.0
2:34:48	0:00:18…	Off	Off	On	689	2,297.9		1,533.7

Figure 8 - Table showing when abnormal behavior starts

Time	Duration	Pump 1	Pump 2	Pump 3	Volume	Inflow	Graph	Outflow
H:mm:ss	hhh:mm…	state	state	state	US gal.	GPM (US)		GPM (US)
3:01:04	0:00:15…	On	Off	Off	479	1,914.9		1,704.6
3:01:19	0:02:13…	Off	Off	Off	4,245	1,914.9		0.0
3:03:32	0:00:04…	Off	On	Off	128	1,914.9		0.0
3:03:36	0:00:36…	Off	Off	Off	1,149	1,914.9		0.0
3:04:12	0:01:36…	Off	Off	On	3,186	1,991.5		3,068.6
3:05:48	0:00:50…	Off	Off	Off	1,723	2,068.1		0.0
3:06:38	0:00:23…	On	Off	Off	624	1,628.3		1,704.6
3:07:01	0:01:27…	Off	Off	Off	1,723	1,188.5		0.0
3:08:28	0:01:00…	Off	On	Off	761	761.1		2,484.4
3:09:28	0:05:10…	Off	Off	Off	1,723	333.6		0.0
3:14:38	0:01:29…	Off	Off	On	1,359	916.1		2,077.9
3:16:07	0:01:09…	Off	Off	Off	1,723	1,498.6		0.0
3:17:16	0:00:10…	On	Off	Off	252	1,509.6		1,716.6
3:17:26	0:01:08…	Off	Off	Off	1,723	1,520.6		0.0
3:18:34	0:00:49…	Off	On	Off	1,251	1,532.0		3,642.3
3:19:23	0:01:07…	Off	Off	Off	1,723	1,543.3		0.0
3:20:30	0:00:26…	Off	Off	On	801	1,848.8		1,772.9
3:20:56	0:00:48…	Off	Off	Off	1,723	2,154.2		0.0
3:21:44	0:00:11…	On	Off	Off	249	1,356.6		1,714.0
3:21:55	0:03:05…	Off	Off	Off	1,723	558.9		0.0
3:25:00	0:01:11…	Off	On	Off	661	558.9		2,015.3
3:26:11	0:00:41…	Off	Off	Off	1,648	2,411.7		0.0
3:26:52	0:00:16…	Off	Off	On	119	446.2		1,781.5
3:27:08	0:05:10…	Off	Off	Off	1,723	333.6		0.0
3:32:18	0:02:44…	On	Off	Off	1,241	454.0		1,084.5
3:35:02	0:03:00…	Off	Off	Off	1,723	574.5		0.0
3:38:02	0:04:21…	Off	On	Off	2,039	468.6		864.8
3:42:23	0:04:45…	Off	Off	Off	1,723	362.8		0.0
3:47:08	0:01:52…	Off	Off	On	1,028	550.7		1,474.0
3:49:00	0:02:20…	Off	Off	Off	1,723	738.6		0.0
3:51:20	0:03:38…	On	Off	Off	2,531	696.5		1,170.8

Figure 9 - Table showing when abnormal behavior stops, an hour later in the middle of the night

The pumps resumed their normal operation an hour later (Fig. 9) with the last abnormal event of that night at 3:17 AM. This equipment is getting sick and these tables are your stethoscopes. Now, someone needs to play Doctor to diagnose the problem. This is called predictive maintenance.

In this case, the $20 relay activated by the start float did not stay closed until reaching the stop level, but the alternating relay got the message to switch to the next pump. This is why the problem was not always on the same pump. This relay would have continued to deteriorate until pumps only start and stop for few seconds all the time until they all fail, even if their run times would not have changed that much! 95% of intermittent problems in wastewater pump stations are detected this way.

The electrical study described previously pointed out that many PLC had programming errors that caused abnormal behaviors. In the late 1980s, when we started the development of high accuracy volumetric flow meters, pump stations were mostly controlled by relays, which were the main cause of intermittent problems. Be aware of PLCs and RTUs reporting abnormal behaviors caused by them. Never assume that programming error doesn't exist.

Maintenance staff go only where problems are critical

Maintenance departments live with the consequence of not having the time to do preventive maintenance.

In my previous example, when the pumps fail, replacing them becomes critical. The ultimate goal should be to be so effective in the predictive maintenance analysis that staff starts to have more time to do preventive maintenance, which reduces the overall operational cost of the collection system. So the solution to this problem is simple: predictive maintenance generates time and time is money.

Flow studies are reserved to critical areas

Inflow and infiltration studies provide good information to identify flow issues in critical areas and wastewater pump stations can provide valuable additional information to assist in the analyses and evaluation of rehabilitation.

Pumping groundwater (inflow) that should not even be there is very expensive, but how expensive? Reducing the volume pumped means lower electrical and maintenance costs. Before addressing this problem, the administrator should know the degree of an infiltration problem.

- Is it caused by rain?
- In this case, how much more flow is caused by the rain event?
- What is the extra volume pumped because of it?
- How much time does it take to recover from a rain event?
- After a rain starts, how much time it usually takes to reach the pump station?
- Is it possible to narrow down the source of an infiltration problem?

All these questions have their answers in inflow and infiltration studies, but it usually involves expensive studies. Worst, they are the first step in spending even more to correct the problems. After all, a reduction of the volume pumped reduces pump wear, maintenance and the electrical bill. Finding inflow and infiltration doesn't need to be expensive to be useful.

Again, the key to generate a useful graph (Fig. 10) is to have the right tool, recording the correct type of data, presented in a format easy to analyze. In this graph, the extra volume that was pumped during this rain event is equal to the area below the dotted line representing the added flow caused by the event.

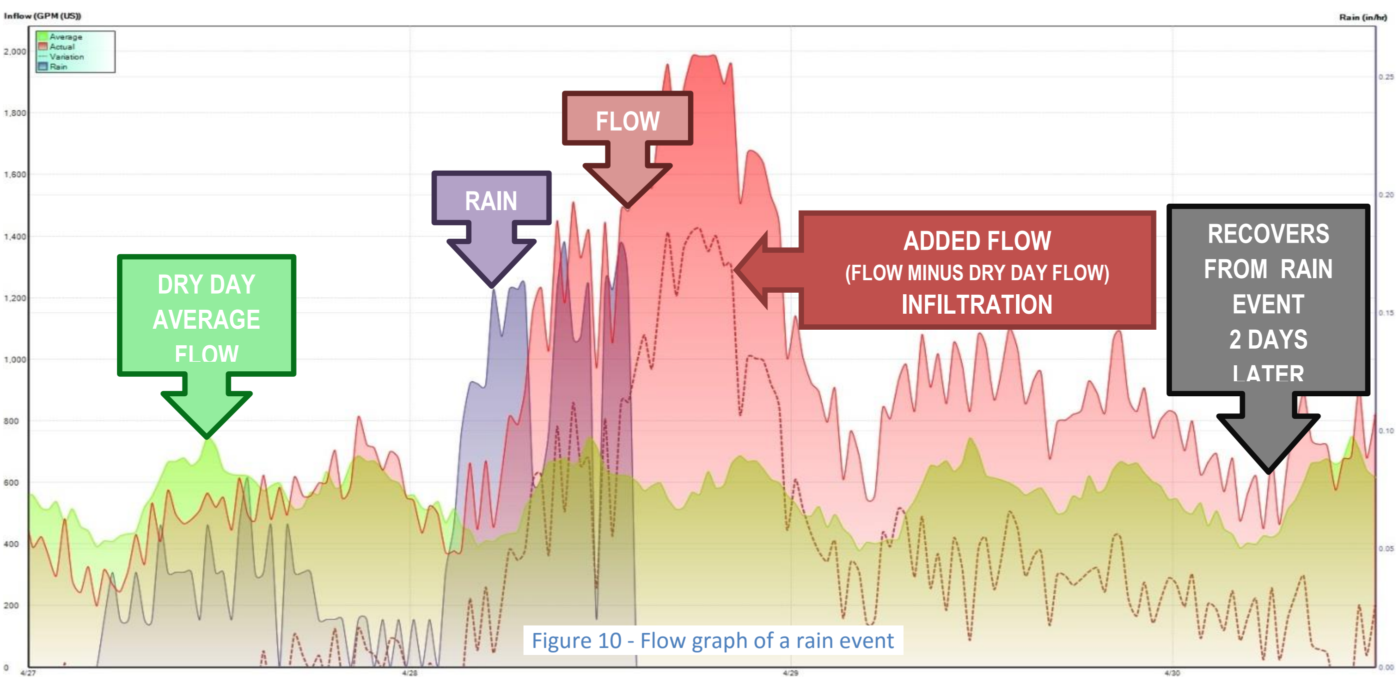

Figure 10 - Flow graph of a rain event

Reducing operating cost of trouble-free pump stations

Why are two identical cars not providing exactly the same miles per gallon? Nobody knows but it is the same for new pumps and even more for old pumps. Generally in pump stations, one pump has a capacity lower than the other pumps while consuming about the same electricity. In other words, its efficiency is lower since it is pumping a lower volume per watt consumed.

Alternating pumps is the most popular way of operating pump stations. The goal behind this technique is to wear them evenly. The reality is that the pump with the lowest flow rate, which is usually the least efficient pump will pump more water than the others. Actuality, they don't wear evenly, only their number of starts is even. The most expensive pump to use always runs longer than the least expensive, therefore wearing it even faster and increasing the efficiency difference between them.

This table (Fig. 11) is showing that pump #2 consumed 53.9% of the electricity while pumping 45.3% of the volume, an efficiency of 1.98 gallons/watt. It did that with about the same number of starts as the two other pumps. (Events in the table). At $0.10 per kilowatt, if the most efficient pump (pump #3 at 3.06 gallons/watt) would have been used to pump all the water, instead of blindly alternating between the three pumps, **this municipality would have saved $3,064 on the electrical bill that year alone!**

The solution here was simply to place pump #2 as a backup to the two other pumps until the staff had a chance to look into it.

Pumps	Total kWh	%	Run time hours	Events	Capacity GPM (US)	Pumped volume US gal. × 1,000	%	Efficiency US gal. / wh	Avg cycle hh:mm:ss
1	2,335	21.8	78.73	1,894	1,355.6	6,403	25.4	2.74	0:02:29
2	5,775	53.9	228.92	1,900	830.8	11,411	45.3	1.98	0:07:13
3	1,861	17.4	64.85	1,893	1,461.1	5,685	22.6	3.06	0:02:03
1 and 2	236	2.2	4.41	11	2,000.0	529	2.1	2.24	0:24:01
1 and 3	38	0.4	0.69	7	1,999.2	83	0.3	2.20	0:05:56
2 and 3	472	4.4	8.92	75	2,000.0	1,070	4.2	2.27	0:07:08
Total	10,717	100.0	386.51	5,780		25,182	100.0		

Figure 11 - Summary report showing power consumption, run time, starts, pump capacity, volume pumped, efficiency and average run time per cycle

When 2 out of 3 pumps have a serious lower efficiency, the culprit could be the check valve of the good pump. Again, playing Doctor can pay off. When a pump in a duplex pump station has a lower efficiency and you know the problem is not the check valve of the best pump, then it would be wise to use this pump when the flow rate is lower and use the best pump when the flow rate is higher.

Alternating twice per day reduces operation cost

The flow study described previously should help in selecting the period of the day with the lower and higher flow rate. In pump stations where the inefficiency of the pumps can be costly, PLCs should be reprogramed to operate the least efficient pumps during the low flow period, like during the night, and the high efficiency pumps should be used during the higher flow rate period, usually during the day. Ultimately, when this is perfectly done, all the pumps have the same run time AND number of starts. This is the easiest way to reduce the electrical bill and extend the life of the pumps since the worst pump won't be used to do most of the work.

SCADA systems with historical database

Municipalities with this type of system could use a dedicated software, if the required data are recorded by the SCADA system. OK, someone just thought that all of this can be done by the SCADA software itself. That person is right!

Exactly like an entire accounting system can be programed in Excel™. However, just because it can be done does not mean that it should be done, or that a custom SCADA function will be less expensive or easier to operate. Before investing many thousands of dollars on a programmer who is not a pump station or flow expert, consider the options already available and in use. Look at the algorithms of page 2 before committing the resources required to program an accurate flow algorithm, to test it in all the conditions where it would be used, and to go back to the drawing board.

A dedicated pump station diagnostic software like MerMaid (Master Export Reporting of Municipal And Industrial Data) is very inexpensive compared to doing it in house. This is another way to reduce the operational cost of the department.

All the graphs and tables in this paper (except Peak table), including those on Figure 12, were generated by the MerMaid software. MerMaid uses patented and patent pending flow algorithms. SCADA drivers can be created to use historical data. A trial version can be downloaded from: [www.maidlabs.com/lift-station-software-mermaid/.](http://www.maidlabs.com/lift-station-software-mermaid/)

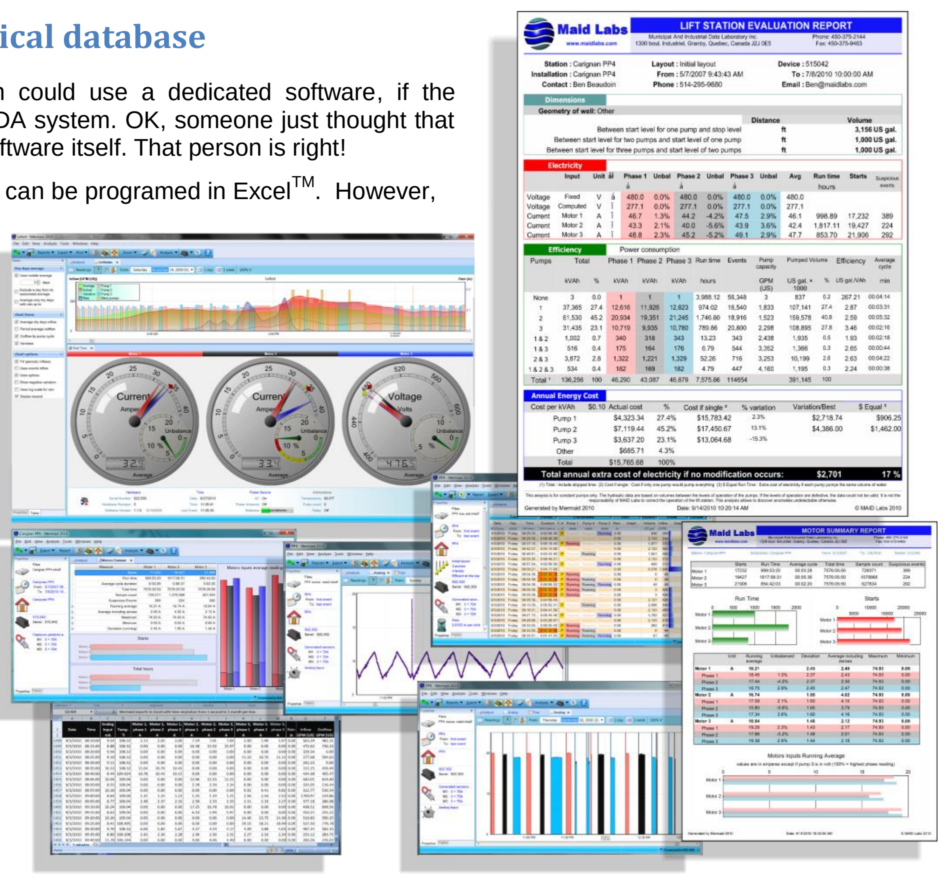

Figure 12 - Reports and screen shot of the MerMaid software

Low Cost Real Time Flow Monitoring and Diagnostic

The data presented in this document were collected using the Volucalc[TM] RT developed by Maid Labs Technologies Inc. The engineers and programmers at MAID Labs created the original Volucalc back in 1992, which became the Teledyne Isco 4501 Pump Station Flow Monitor and PumpLink software in 1996. This system was the only high accuracy volumetric flow meter in production until the Volucalc RT arrived on the market. The 4501 availability stopped in 2015, after 23 years of uninterruptible production. When quality is there, it is apparent.

When an analog level sensor is not available, the levels at which the pumps operate are entered in the configuration software. A USB flash drive can be used to collect the data files. All the data calculated by the instrument including pump capacities, efficiencies and real time flow can be transferred to a PLC using the MODBUS over TCP/IP protocol.

Current clamps (Fig. 13) are used to monitor the operation of the pumps and to collect electrical data. When available, the analog level sensor is used to calculate real time flows. A cellular modem, Wi-Fi or spread-spectrum radio can be used to transfer the data and reports through the free Web SCADA interface, also supplied by Maid Labs.

Figure 13 - Current sensor adjustable for 15 and 75 Amps. Other models available

The Volucalc RT has a 4-20 mA analog output proportional to the inflow, which is the easiest way to supply accurate real time flow to a PLC, RTU or SCADA system.

Suggested retail price for everything described above: Below $3500. Payback period: within a year for many!

Leasing is available.

Variable Speed Pumps

While the accuracy for constant speed pumps is higher, this graph (Fig. 14) compares the accuracy of a properly calibrated Volucalc RT to a magmeter in a pump station having variable speed pumps. The Volucalc RT integrates up to 4 pump curves to derive pumped flow and calculated inflow rates. It uses calibrated pump curves, level and force main pressure to obtain the pumps' flow rate and adjust its 4-20mA analog output proportionally.

In lift stations with 3 pumps or less, Volucalc RT uses the pumps' efficiency to detect abnormal flow rate, like a clogged pump, and generate an alarm indicating that the pump curves cannot be thrusted anymore. Pump's RPM comes from VFDs analog outputs.

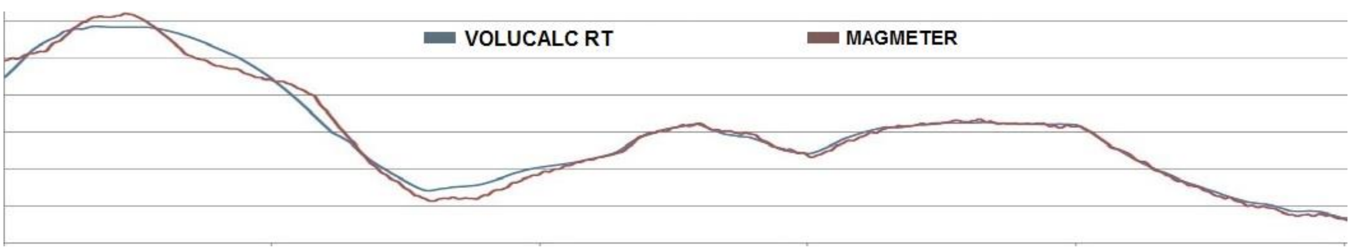

Figure 14 - Magmeter flow curve compared to a properly calibrated Volucalc RT flow curve

Conclusion

Wastewater Pump Stations can be the primary source of data to reduce the operational and maintenance costs of collection systems. The Volucalc[TM] RT (Fig. 15) is the right tool to collect this data and transform it into useful information.

Web page:
www.maidlabs.com/lift-station-brain-volucalc-rt/

Figure 15 - Volucalc RT on DIN rail brackets

* The most accurate volumetric flow algorithms are patented or patent pending. Before spending thousands of hours programing one in a system, it would be prudent to investigate what can be used (patent infringement), what could be risky to program (patent pending) and what should simply be licensed from someone who already did it.

Patent Pending

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