RESOLVING CRITICAL FILTRATION IMBALANCES AND OBSOLESCENCE THROUGH ULTRASONIC FLOW MEASUREMENT AT DUNGOG WTP

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ABSTRACT

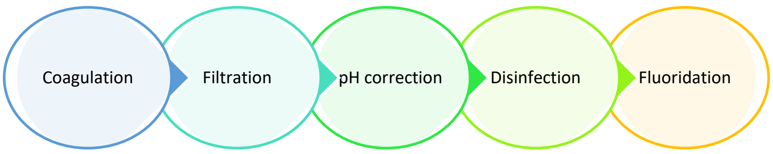
A Drinking Water Quality Risk Assessment at Dungog Water Treatment Plant WTP identified that continued use of the existing Pitot Tube flow meters would expose the filtration system to risks that were out of appetite. The assessment revealed that public health, operational and environmental risks were most acute during low-flow conditions often initiated while the plant is attempting to manage poor raw water quality events.

The risk assessment outcomes prompted market research, a project proposal, and the installation of ten new Ultrasonic Clamp-On Flow Meters that was delivered under Veolia's Minor Capital Works program within the Hunter Water Treatment Alliance.

This paper explores the journey of the complete project lifecycle - from investigation, market research through to installation - while discussing key safety considerations, process considerations, and lessons learned from the project delivery.

1.0 INTRODUCTION

Dungog WTP, built in 1988, treats water from Chichester Dam which was constructed between 1917 and 1926 as the Hunter's first dedicated drinking water storage system. It is one of the Hunter region's most important freshwater storage facilities contributing about 35 per cent of the Lower Hunter's potable water supply. Dungog WTP is one of six drinking water plants under the Hunter Water Treatment Alliance. It uses direct filtration, and includes the following processes:



The Veolia Operations Team and Veolia Technical Team identified an imbalance of flow distribution across the filters. During low flows often initiated to manage poor raw water quality events, they observed an unstable system where filters fail unpredictably, cascading filter backwash and consequently filter failures with potential for complete plant failure.

The two teams suspected the existing flow measurement to the filter outlets to be at the core of the problem. Considering the age of the assets, the existing pitot tube differential pressure flow meters would have suitable and robust for the application at the time of construction. Forty years later, updates to processes, changes to coagulant dosing, tighter operating conditions and legislation, influenced the unintended potential obsolescence for the existing flow meters.

In September 2022, Veolia arranged for a third party to conduct an onsite investigation report to assess the degree in which the flow measurement was impacting operations and how far it has drifted away from updated legislative requirements. This report concluded:

- The existing flow meters had insufficient Inlet/Outlet Runs in the process.
- The existing flow meters had inadequate selection of differential pressure flow element that should not be used for reporting or flows of importance under current legislation.
- The existing flow meters had inadequate choice of flow measurement principle given the process conditions and the purpose of measurement.
- The flow meters were also causing a low flow blind spot with and absence of flow reading below 1ML/d.

Figure 1Existing Pitot Tube removed from pipework and the challenges of the GRP pipework

The impacts of poor flow measurement to operations included:

- *Production / Service interruption* – cascading filter failures during periods of low flows. The periods of low flow is predominantly initiated as a response to either low supply demand or poor raw water quality events.

Figure 2: Cascading filter failure further explained.

- *Environmental risk* - Increased frequency of filter to waste discharge to the sludge lagoons during the poor water quality events consumes additional storage capacity in the lagoons. This increases the risk of overflow to the environment.
- *Condition of Equipment* - The longevity of the valves is being compromised under current conditions. The valves are reacting to erratic and incorrect readings of the flow measurement, and this is leading to unnecessary movements of the valve. The valves are also being flagged for corrective action when the filter is not in operation due to false readings of flow.

2.0 DISCUSSION

The opportunity for improvement transitioned into the care of a Minor Capital Works Team Member. The remedy proposed was to replace the existing flow meters. Going to market required the following set of considerations that would influence the selection process:

- Installation had to be minimally invasive. The pipe was GRP 450mm (fibreglass). Contaminating the drinking water by cutting into this type of pipe >40 years of age rated high in the risk assessment.
- The flow meter is positioned on the outlet of the filter. The amount of down time during installation was a consideration.
- Accessibility. Dense pipework installation in this small area creates accessibility challenges.
- Inlet and outlet runs 2DN or better
- Accuracy robust enough to meet the same requirements legislation as a chemical dosing flow meter
- Minimal ongoing maintenance

	Type 1	Type 2	Type 3	Type 4
Description	Insertion Meter	In-Line Mag-flow Meter	Insertion Ultrasonic Flow Meter	Clamp-on Ultrasonic Flow Meter
Project Duration (Including lead time & electrical upgrades)	16-20 weeks	20-30 weeks	16-20 weeks	12-16 weeks
Raw cost rating	Low	Low	Medium	High
Additional Resources and Costs considerations	Contractor for tap-in activities.	Contractors for cranes. Additional time for SCADA engineer. Longer installation time forecasted.	Contractor for tap-in activities.	Electrical apprentice to assist E&H technician during install.
Safety & Process Considerations	Cutting aged GRP. Risk of contamination to Drinking water. To mitigate requires full plant shutdown and empty all filters	Cutting aged GRP. Risk of contamination to Drinking water. To mitigate requires full plant shutdown and empty all filters	Cutting aged GRP. Risk of contamination to Drinking water. To mitigate requires full plant shutdown and empty all filters.	Extremely low risk and short installation time
Shutdown Required	Yes – likely for 3 to 5 days	Yes – likely for 10 days	Yes – likely for 3 to 5 days	No – only 15 mins out to service for each filter over 2 days
Example				

Figure 3: Flow meter considered during market research.

Following this market research and in collaboration with our client, the Endress+Hauser Ultrasonic clamp on flow meter was selected for the project, with two pairs of sensors to enable the use of Endress+Hauser Flow DC which allows to be two sensor sets are installed offset at a specific angle to one another. The measured values of both sensor sets are averaged. The resulting measurement error is compensated based on set criteria identified during commissioning. The error-compensated average ensures the specified maximum measurement error and repeatability are maintained even under non-ideal flow conditions.

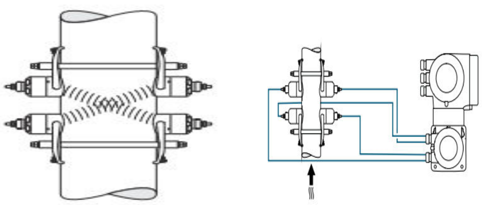


Figure 4: One transverse arrangement on pipe

2.1 Scope of Work

The proposal to install the ultra-sonic clamp on flow meter was an innovative suggestion that moved away from traditional installations observed around the 28 water and wastewater treatment sites operated by Veolia under the Hunter Water Treatment Alliance. To minimise the risk of committing to 10 filter outlet flow meter replacements with an unpopular form of measurement, a staged approach was offered to build confidence. This involved replacing only one filter flow meter (the worst performing of the ten) and observing its performance, capabilities and suitability over an extended period in real time.

A simplified summary of the project's scope of work can be best summarised in figure 5.

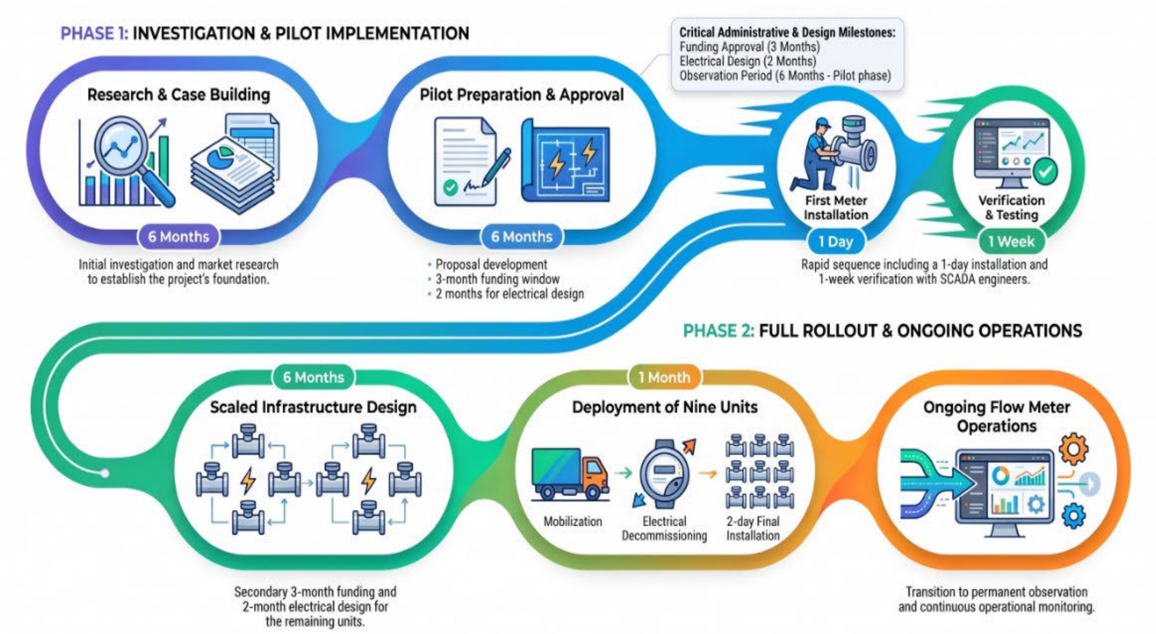


Figure 5: Project Roadmap - A summary of the scope of work.

An advantage of the ultrasonic flow meter was the capability of carrying out a verification process prior to cutting over the new flow meter and giving it full control. The new flow meter could be clamped on and a side-by-side flow reading comparison could be carried out in real time making the roll back plan very simple to implement. The expected accuracy of the flow meter was ~2% however the installation achieved 0.77% @ 15MLD.

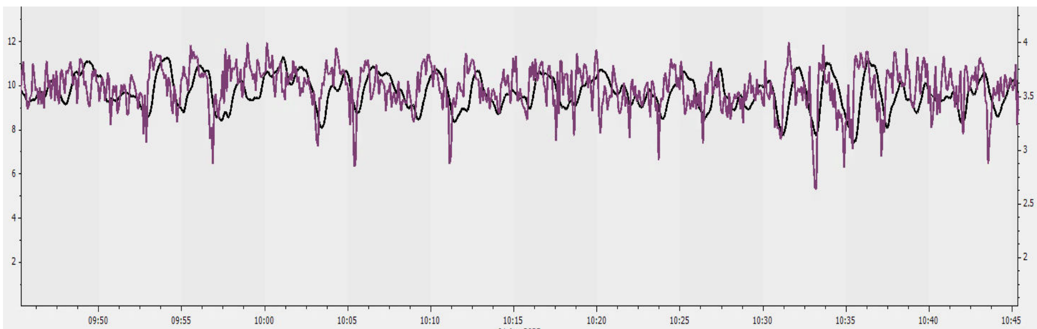


Figure 6: Flow trends from the first hours of comparing the old (purple) and new (black) flow meters side by side

As shown in Figure 6, the ultrasonic clamp flow meter (black line) delivers significantly smoother and more accurate measurements of filter outlet flow than the pitot tube flow meters.

2.2 The outcomes and Lessons Learned

The project successfully delivered the installation of ten flow meters on time and on budget with minimal down time to the process and minimal invasion to the infrastructure.

Figure 7: The Clamp-On Flow Meter in position at filter 5 outlet on site.

There is one key lesson learned that can be held responsible for the success of the project which can be applied to every project. The lesson of multi-disciplinary collaboration that drive positive results. Without the representation, actions, open mindedness and expertise of team members from all work groups, this project would not have been delivered as efficiently as it has been - while achieving the desired results and minimising risk to people, risk to aged infrastructure, and impacts to the treatment process.

Table 1: The involvement of multi-discipline teams

Task	Teams Involved	Critical inputs from the teams
Investigation, case building, market research.	Operations Team, Technical Team, Minor Capital Work's Project Engineer, Flow Meter Suppliers.	Technical data on process and technology
Project Proposal.	Project Engineer, Endress+Hauser, Technical Team.	How the project was going to be delivered, safety and processes impacted.
Funding consultation and Project approval	Hunter Water and Minor Capital Works Team and Project Engineer.	Budget parameters.
Electrical Design.	Electrical Engineering Team, Hunter Water, Project Engineer.	Safety considerations.
Flow meter installation.	Operations Team Electrical Team, Endress+Hauser, Senior site operator, Project Engineer.	On site receival, mobilisation, operations of plant, implementation roll out.
Commissioning and performance observations.	Electrical Team, Senior site operator, Project Engineer.	Performance assessments.
Mechanical removal of old flow meters.	Mechanical Team, Senior site operator, Project Engineer.	Implementation roll out.
Ongoing performance critique.	Senior site operator, Technical Team, Project Engineer.	Performance and long-term outcomes.

Another noteworthy lesson was the advantage of carrying out one single flow meter before committing to the remaining nine. The experience gained from the single installation allowed the right people to be in the right place at the right time for the remaining nine flow meters which drove a truly efficient installation process. This also meant that the project budget forecast could be established with a high degree of confidence.

2.3 Celebrations of the Project

Overall, the project celebrated the following:

- Minimal invasion or destruction of the existing fibreglass infrastructure that would have otherwise taken place with an in-pipe magnetic flow meter.
- Minimal spending of precious capital funding on invasive installation otherwise required for magnetic flow meters.
- A period of verification and confidence building

- Minimal impact to process and production time.
- Reduced wear on associated assets (such as outlet valves).
- Opportunity for coagulant dosing optimisation.
- Provided visibility to low and unauthorised flows.
- Less noise to the recorded flows
- Better accuracy during filter drain down in preparation for backwash. Towards the end of a filter run the flow meter value starts to drop off as the valve position increases. This indicates that the head loss is building at the end of a filter run. The higher precision from the new flow meter can detect the flow drop off much better than the old flow meter.

Figure 8: Additional celebrations of the Project.

3.0 CONCLUSION

The project at Dungog WTP successfully addressed critical filtration imbalances and significant operational risks through a staged implementation approach and robust multi-disciplinary collaboration. The transition has yielded several key benefits, such as enhanced accuracy, operational efficiencies, reduced wear on associated assets and risk mitigation. It facilitated a solution that offered minimal interruption to operations and a non-invasive installation that protected aged assets.

Ultimately, this project celebrates the collaborative approach - how it can effectively resolve complex legacy infrastructure challenges while ensuring value for our client, the reliability of the process, and the continuity of supply of critical drinking water.

4.0 ACKNOWLEDGEMENTS

I would like to acknowledge the following team players:

- Supervisors from both the minor capital works team and the operations team of our contract - Arlo Stanford and Dan Slocombe. They trusted me with the coordination and delivery of this project of which I was extremely grateful for the opportunity.
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- Hunter Water – for trusting me to deliver this project for them. Thank you, Ash Sneddon, and Nick Maus.

5.0 REFERENCES

Proline Prosonic Flow P 500 ultrasonic clamp-on flowmeter July 2026
https://www.endress.com/en/field-instruments-overview/flow-measurement-product-overview/ultrasonic-flow-meter-prosonic-flow-p500-9p5b?t.tabId=product-overview