Good vibrations - A novel approach to reducing lime blockages at Molendinar Water Treatment Plant

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Abstract

This case study examines the challenges of batching lime for water treatment at Molendinar Water Treatment Plant, where inconsistent lime discharge from storage silos was causing blockages and surges associated with rat holing and clumping. To improve feed reliability, a novel retrofit comprising multiple vibrators and an AirSweep® system was installed on two silos. The works were carefully staged to maintain continuous treatment operations during construction and commissioning, requiring close coordination between design, construction and operations personnel. The project demonstrates how targeted modifications to existing lime handling infrastructure can reduce flow interruptions and improve process stability, while also highlighting the practical constraints of delivering upgrades in a live treatment environment. Key lessons learned relate to constructability, staging, operational continuity, commissioning, and stakeholder coordination, with broader relevance to the planning and delivery of water treatment infrastructure projects involving critical process assets.

Introduction

Across the water industry, the dosing of lime (calcium hydroxide) is considered challenging due to the high potential for blockages and surges from the storage and batching systems through to the injection points. This is particularly an issue at coastal Water Treatment Plants (WTP) along eastern Australia where the source water is very soft and alkalinity boosting is required which is best achieved by dosing lime often in combination with carbon dioxide. Failure to achieve sufficient alkalinity and pH within optimal ranges can adversely affect processes such as the coagulation-flocculation-settling process and the final product can be potentially corrosive for the distribution system including cement-lined mains.

Multiple issues existed at the Molendinar WTP lime system due to moisture ingress, rat-holing, and clumping. These problems are exacerbated by changes in batching strengths and the frequent adjustments required for process alkalinity and pH. Blockages and surges were found to affect further downstream processes including carbon dioxide dosing, coagulation and floc formation, filter performance, disinfection efficacy, pH correction and fluoride online monitoring. The current study examined a project to improve lime dosing by introducing larger vibrators and an AirSweep® system to the day hoppers, as well as improving the screw feeders. The AirSweep® system (Controlled Concepts Inc (2026)) is commonly found in hoppers used in applications such as grain storage 'to keep tough materials flowing' where the above issues are prevalent.

The Molendinar WTP lime dosing system comprises two hoppers and batching tanks and this allowed for the project to be carefully staged to ensure minimal disruption to WTP operation. The plant is depended upon to produce up to 140 ML/day in a water grid setting and reducing production places higher demand on other WTPs and costs associated with increased production from the desalination plant. The case study also examined the scheduling and lessons learnt from installing the system on the first hopper and applying lessons for the installation on the second hopper.

Methodology

A well performing hydrated lime system can have multiple main sub-processes. These include vibration systems, internal hopper air movement systems, screw feeder systems and moisture mitigation systems. Reducing moisture in the screw feeder-throat can also be achieved by screw heating systems and reducing the screw drop zone (i.e. lowering the mixing/solution tank level to prevent the ingress of moisture). The lime system upgrade project at Molendinar WTP included the following incremental improvements and upgrades:

- Replacement of existing vibrators with larger vibrator units (figure 1) – February 2026.

- Increasing the length of throats within the screw feeder and improved batching and dosing screws with minimal edge tolerances to throat (figure 2) – February-March 2026.

- Removal of the air vibrator and the installation of an AirSweep® system on hopper 2 (figure 3) and its air pulse control system (figure 4) – May-June 2026 (An air-vibrator was retained on hopper 1 for comparison with the AirSweep® system).

- Planning to install AirSweep® on hopper 1, rotary valves at the bottom of each hopper and wire-guide sensors to replace the current overhead radars for rat-hole detection – to commence after the June 2026 proving period.

Continuous WTP operations were maintained by upgrading each day hopper sequentially so that one hopper was always available for lime dosing.

Figure 1 Vibrator and AirSweep® system installed on Lime Hopper 2

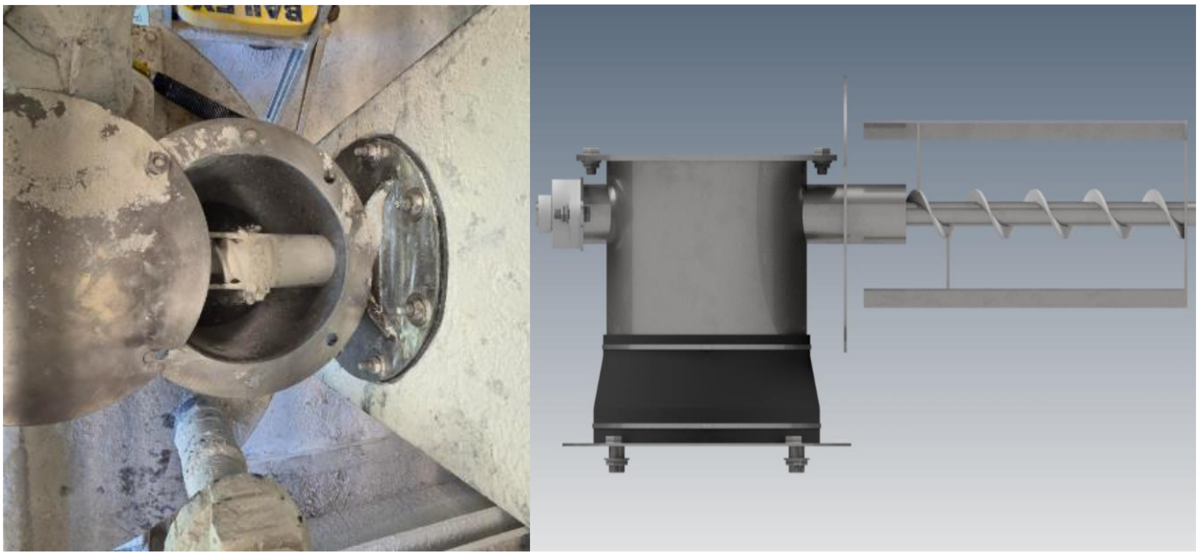

Figure 2 Upgraded screw feeder as seen in the inspection port above the batching tank

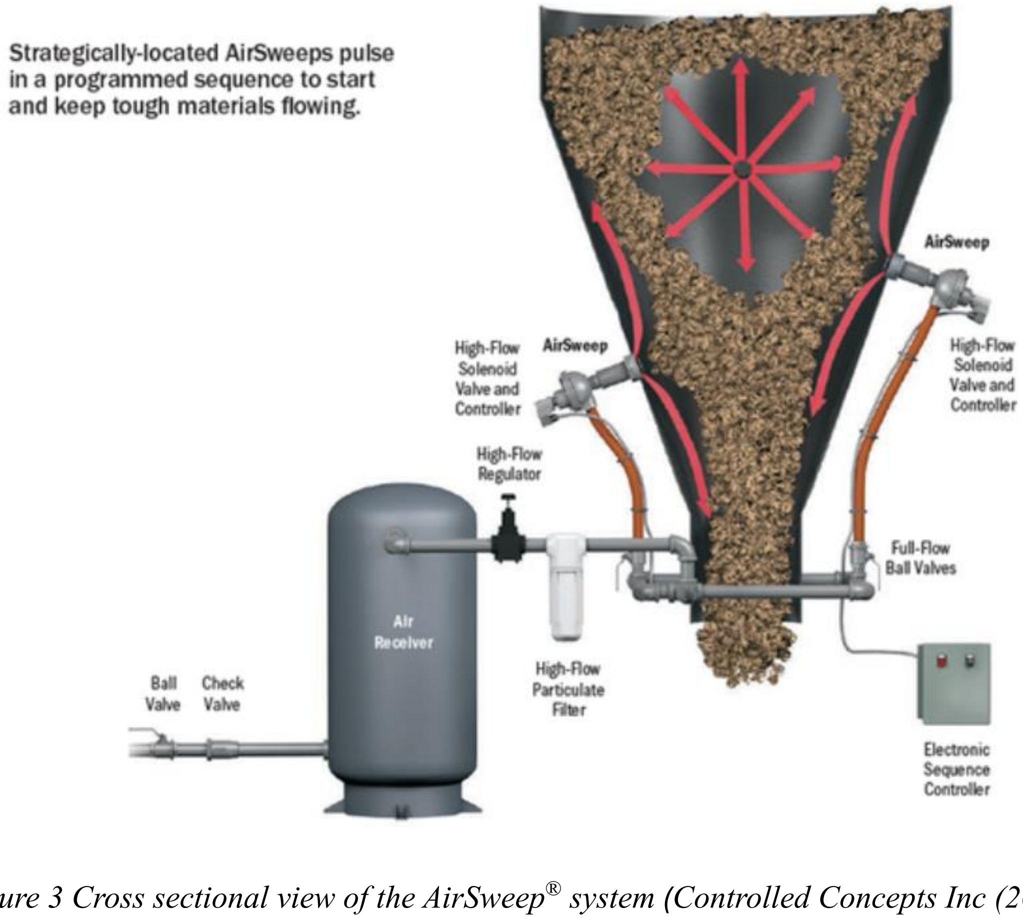

Figure 3 Cross sectional view of the AirSweep® system (Controlled Concepts Inc (2026))

Figure 4 Lime AirSweep® marshalling panel built by Ventia SCAS Services

Results and Discussion

Hopper vibrator upgrade. The increase in vibrator size was found to be highly effective in reducing rat-holing and clumping on the walls of the hopper when operated at 75% power on hopper 1. Following the vibrator upgrade, hopper 1 was able to be operated without any instances of extreme rat holing that would result in loss of lime feeding into the screw feeder. The trend in figure 5 for a hopper operated at 90% levels shows reduced rat holing down to approximately 55-70% hopper levels that closes or collapses relatively quickly. However, there is a risk that the increased vibration causing could cause cracking in the stainless-steel structure and welded joints and the expected benefits of introducing AirSweep® include the ability to maintain effective batching at lower vibration power levels.

Figure 5 Overhead radar trends for hopper 1 with larger vibration units installed

Screw feeder upgrades. The longer throats and reduced tolerances on dosing screws were also found to be effective in reducing blockages within the screw feeder. Previously, the original screw feeder design did not have a throat protruding below the bottom of the hoppers and the hopper outlet was flush with the screw feeder box; the upgrade extended the throat 60-mm inside the screw feeder box. The closer tolerance (1.24 mm) on the screw within the throat feeding the batching tank was also found to minimise the ingress of moisture and prevented fouling as observed from the inspection hatch in figure 2 above.

Performance of the AirSweep® system. The performance trends for the AirSweep® system installed on hopper 2 can be seen in figure 6 and show further system improvement from the trends for hopper 1 (figure 5). This trend shows loading the hopper (from 40% to 100%) and successful operation with rat holing down to approximately 80% quickly closing due to air pulses. Vibrator power levels were as low as 25-35% during this initial period of operation.

Figure 6 Overhead radar trends for hopper 2 with AirSweep® upon initial installation

Whilst initial commission was a first success, there were challenges on the second day of AirSweep® operation on hopper 2 where excessive rat holing occurred, and the hopper was shutdown with operations resuming using hopper 1. The issues with hopper 2 performance was able to be rectified as shown in the trend in figure 7 by increasing the duration of the air pulse from 1 second (with a 10-second frequency) to 0.2 seconds. This meant that there was a smaller duration stronger blast of the same volume of air entering and moving up the walls of the hopper to reduce clumping and close rat hole formation. The vibration was also increased initially to 50% power and rat holing down to approximately 30% hopper level occurred before collapsing. At 60% vibratory power, as seen on the right-hand side of the trend, there was no rat holing observed.

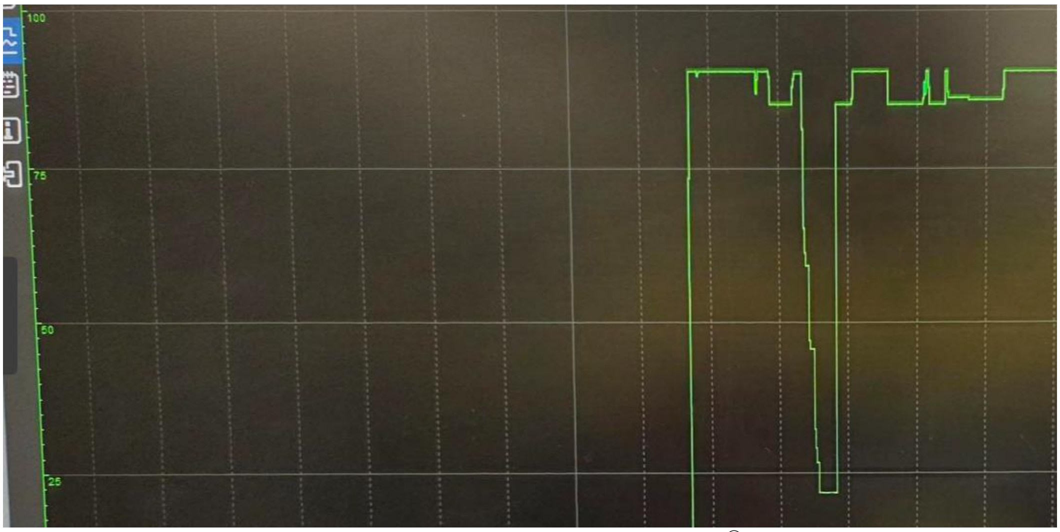

Figure 7 Overhead radar trends for hopper 2 with AirSweep® and 50-60% vibrator power

Project Management. From a project management perspective, the Molendinar WTP lime system upgrade was implemented as a risk-managed improvement program targeting multiple sub-processes within the hydrated lime system. A key project constraint was the requirement to maintain continuous WTP operations throughout the upgrade period. This was achieved by adopting a sequential hopper upgrade approach, ensuring that one lime hopper always remained fully operational. During modifications to hopper 2, the plant relied exclusively on hopper 1 for lime dosing, effectively isolating construction risks and maintaining treatment continuity. This approach required careful planning of commissioning activities, and operational fallback procedures.

Future lime system upgrades include installation of a rotary valve at the base of the hopper immediately above the screw feeder to reduce the risk of clumping by consistently drawing lime product onto the screw. The use of overhead radar systems to detect and respond to rat-holing within the hopper has also been challenging due to obscuration from floating lime dust and the project's next steps will be to install a wire-guided sensor in the centre of the hopper. These changes are expected to optimise the system and complete the project. The radar trends above, however, have still been effective in informing system commissioning and performance for the current study. An interim measure to mitigate the risk of rat-holing through reloading is to use the existing level sensors to control loading from the bulk lime silo into the hoppers.

Conclusion

The upgrades at Molendinar WTP showed that relatively simple changes to the lime system can improve performance and reduce blockages. Larger vibrators and modifications to the screw feeders reduced rat-holing and moisture issues, while the AirSweep® system further improved hopper flow and allowed operation at lower vibration levels. The works were delivered in stages so that the plant could continue operating, with dosing maintained from hopper 1 while upgrades were carried out on hopper 2. This approach reduced operational risk and allowed changes to be tested and adjusted during commissioning. Overall, the project demonstrated that a staged upgrade approach, combined with practical design changes and on-site optimisation, can improve the reliability of hydrated lime systems without disrupting treatment operations.

Acknowledgements

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