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Wastewater inlet works structural condition assessments – lessons learned

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1 Introduction

Whitsunday Regional Council and Mackay Regional Council, neighbouring councils located in Central and North Queensland, joined together on a collaborative joint project in 2018-19 to transition from external contractor delivered operations and maintenance to inhouse sourcing of wastewater treatment plants and their operation. To successfully transition the infrastructure, operations and staff under each council's jurisdiction, a program of works was undertaken including preliminary condition assessments of each wastewater treatment plant. These plants include: Mackay North Water Recycling Facility (MNWRF), Mackay South Water Recycling Facility (MSWRF), Cannonvale Sewage Treatment Plant (CSTP) and Proserpine Sewage Treatment Plant (PSTP), servicing the populations of Mackay, Proserpine, Cannonvale and Airlie Beach, respectively. An inspection program at MSWRF was deferred to July 2019 to allow for comprehensive planning required for an inlet works bypass design and as such preliminary findings only are available at the time of writing of this extended abstract.

Based on visual inspections and anecdotal evidence from operations and maintenance staff, a preliminary structural condition assessment with limited concrete testing was commissioned for the inlet works of all plants and the bioselectors at CSTP and PSTP. This required comprehensive operations and maintenance planning to allow for bypassing sections of the plant without disrupting treatment performance, managing environmental compliance and that activities were completed in a safe and timely manner. Following on from the findings of the structural condition assessment, odour condition assessments were undertaken to further investigate the root cause of the structural issues.

2 Methods

All condition assessments were undertaken in accordance with Practice Note 7: Water Supply & Sewage v2, published in 2016 by the Institute of Public Works Engineering Australasia (IPWEA PN7, 2016). All condition assessments included a remedial scope of works, a +/- 30% cost estimate developed in accordance with an externally validated cost estimating manual with water and sewerage infrastructure unit rates adopted by the region and a high level remedial works schedule.

The preliminary structural condition assessments purpose was to determine the current condition of the assets, recommend remedial actions where required and estimate the remaining useful life of the assets, based on a design life provided in each respective council's contract. The scope of work for Proserpine STP and Cannonvale STP included the inlet works and bioselectors, and if time allowed, the bioreactors. The scope of work for MNWRF and MSWRF included the inlet works and general purpose pump station (GPPS). The sequence batch reactor (SBR) distribution chambers were also assessed at MSWRF.

The odour condition assessment consisted of an onsite audit and desktop assessment. The onsite audit included visual assessments, airflow measurements and contaminant monitoring. The scope of work included foul air extraction and treatment through each plant process configuration, which ranged from biotrickling filter (BTF), activated carbon filter (ACF) and associated control and monitoring instruments, mechanical and electrical equipment.

A joint approach to scoping and engaging of asset condition specialists between both councils resulted in significant cost savings and lessons learned from each inspection. Project management fees were shared across both organisations and a flexible approach for

scheduling the work minimised the potential for variations.

3 Findings and Argument

The findings of the preliminary structural condition assessment consistently identified significant localised concrete deterioration / friability at multiple locations throughout the inlet works, bioselectors and GPPS, from 50 mm to 75 mm, requiring extensive remedial works. (Prasad et al., 2019).

The protective coating of the inlet works and bioselectors at CSTP and at the bioselectors at PSTP had completely delaminated and required replacement to protect the concrete from hydrogen sulphide attack. This is possibly due to poor protective coating choices and/or poor installation of the protective coating system resulting in loss of adhesion from the concrete substrate. (Prasad et al., 2019).

The protective coating at MNWRF had flaked from the concrete surface. At these locations, the concrete substrate showed signs of hydrogen sulphide degradation, becoming soft and friable. Condition rating scores for each structural component are shown in **Table 1**.

Table 1: Condition Rating Scores as per IPWEA PN7 2016 for Each Plant Area

Plant Area	Estimated Date of Construction	Condition Rating Score (0-5)
CSTP inlet works	2014	3 (fair or moderate, maintenance required)
CSTP bioselectors & bioreactors	2014	2 (very good, requiring normal / routine maintenance)
PSTP inlet works & bioselectors	2013	2 (very good, requiring normal / routine maintenance)
MNWRF inlet works	2008	4 (poor, requiring renewal or significant remedial works)
MNWRF GPPS	Refurbished 2008	3 (fair or moderate, maintenance required)

Source: (Prasad et al., 2019).

Given the linkages between concrete degradation (friability and softness) from the preliminary structural condition assessment report, further investigation of the odour systems at each plant were undertaken to better understand the root causes of the structural issues.

The findings of the odour condition assessment at each respective plant identified numerous defects associated with degradation, improper design, improper installation and improper maintenance, several of which posed a risk to workplace health and safety. These specific defects were raised immediately for rectification.

General common findings include:

1. Insufficient odour extraction design, both in terms of extraction points, air inlets and extraction volumes.
2. Use of underground ductwork is ill advised especially in areas with high humidity.
3. Humidity control mechanisms (e.g. heaters) on air flow between the BTF outlet and ACF inlet curbs excessive moisture being carried over to the ACF, decreasing ACF efficiency and should be part of best practice design.
4. System documentation (e.g. standard operating procedures, operations and maintenance manuals, drawings) and operator training is a key area for improvement. (Evanson et al., 2019).

Commons defects across all inspections included:

1. Failure of odour covers, potentially due to excessive loading, insufficient design, poor foul air extraction or quality assurance issue during manufacture.
2. Corrosion of concrete structure due to acidic condensate attack of exposed concrete and drip points.
3. Hydrogen sulphide attack resulting in corrosion of mechanical and electrical equipment across inlet works and bioselector areas.
4. Lack of foul air extraction testing points at the air regulating dampers indicating no air balance testing during commissioning. Almost all air regulating dampers were not in the

correct position preventing sufficient extraction of foul area from these plant areas.

5. General poor performance or failure of monitoring and control instruments, such as hydrogen sulphide analysers, differential pressure indicators due to incorrect installation and maintenance. (Evanson et al., 2019).

4 Conclusions

From these assessments, it is clear that properly designed, constructed, installed, operated and maintained odour control systems are linked to ensuring structural assets such as protective coatings, concrete substrates, mechanical and electrical equipment and odour covers achieve their design lives.

Inadequate extraction of foul air results in high risk of exposure to hydrogen sulphide gas especially during operations and maintenance activities. From these assessments, WRC implemented specific safety practices such as wearing mandatory portable gas detectors, following short term exposure limits (STEM) and time weighted averages (TWA) for hydrogen sulphide from Safe Work Australia along with a comprehensive odour awareness training program. MRC had practices in place from historical issues with hydrogen sulphide.

Both councils are in the review stage for future options to better operate and maintain their current assets, to mitigate odour issues within their networks and treatment areas, and to identify what design options address the workplace health and safety and residual useful lives of their wastewater assets.

Through regional collaboration, both councils were able to better their understanding of their assets using consistent approaches to condition assessments, remedial works and associated cost estimations and schedules.

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