RECOVERING BRISBANE'S SECOND LARGEST WASTEWATER TREATMENT PLANT AFTER THE 2022 FLOODS

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ABSTRACT

Oxley wastewater treatment plant is the second largest treatment plant in Brisbane, and home to Urban Utilities' major biosolids processing hub. It processes around 60ML/d of sewerage and imports biosolids from nine other treatment plants for processing in addition to the plant's native sludge. During the 2022 floods, the plant was heavily inundated, with flood waters reaching over 2 metres in some areas.

After the flood, it took around 9 months and millions of dollars to recover the plant and achieve full production. We encountered problems, such as supply chain issues which delayed recommissioning, but also managed to make the best out of the situation by finding creative solutions and improving our future resilience. The unique recommissioning process that we undertook gave us a better understanding of our assets and has helped inform our pathway forward to mitigate critical business risks.

This paper will detail the flood event and the aftermath, the recovery process, and the effectiveness of past resilience projects. It will also describe the lessons learned from the flood recovery project and actions we have taken to minimise the impact of future floods.

1.0 INTRODUCTION

Oxley Creek resource recovery centre (RRC), located in south-west Brisbane, is the second largest treatment plant in Urban Utilities' service territory, after Luggage Point. The plant treats approximately 60 ML/d or around 300,000 equivalent persons worth of wastewater. Oxley RRC is also the location of a critical biosolids processing hub for Urban Utilities, as it processes sludge from 9 other treatment plants making the total amount of sludge processed around 800,000 equivalent persons worth. The biosolids processing facility typically processes 121kt annually, equivalent to 63% of the biosolids produced across Urban Utilities sites, which is why it's such a critical site. The technology used reduces the volume of solids by 74% and saves approximately $18 million annually in trucking costs. The sludge treatment process used at Oxley involves thermal hydrolysis (through a 3-reactor CAMBI unit, which until recently was the only one of its kind in Australia), anaerobic digestion and dewatering.

Oxley Creek RRC is located in a low-lying, flood-prone location and during the 2022 floods the water level rose quickly, with two operators needing to be rescued from site by the SES. Some parts of the plant avoided significant inundation, however, some treatment trains were completely flooded (Figure 1). The on-site inlet works pump station was flooded, along with the admin office, which is a hub for our process engineering team, trade waste officers and other site staff, such as project managers and maintenance engineers. Crucially, our biosolids processing area was severely flooded. In fact, some parts of the site reached more than 2 metres of inundation. As a result of the floods, more than 85 pump sets, motors, gearboxes, compressors or other assets were replaced – this number doesn't include replaced instrumentation or any pumps that were refurbished instead of replaced. Overall, Urban Utilities spent more than $3 million in 6 months during the recovery of Oxley RRC.

Figure 1: *Aerial view of the flooded treatment plant and surrounding area*

2.0 DISCUSSION

2.1 Recovery Project Timeline

Between February and April of 2022, Southeast Queensland experienced a series of major flood events. On the 27th February, Oxley Creek RRC was inundated following heavy rain in the Brisbane catchment. Subsequently, a project was kicked off to recover the plant. Key events from the project timeline have been listed in Table 1.

Table 1: *Summary of flood recovery timeline*

Date	Time elapsed	Significant Event	Reason
Mar 5	~6 days	Preliminary treatment recovered	Waiting on mains power
Mar 7	~8 days	Operations & maintenance site walkthrough	Identified all assets that required refurbishment or replacement
May 3	~9 weeks	Dewatering recovered	Waiting on main bearings and replacement ground level motors
Sept 15	~6 months	Sludge treatment ramp-up starts	Waiting on digester clean out and instrumentation/PLC modules
Oct 19	~7 months	Gas train recovered	
Dec 13	~9 months	Sludge handing fully recovered	Waiting on digester clean out and ramp-up time for digesters.

Due to the loss of the digester compressors and pumps for an extended period, stagnation in the digesters meant that grit began to settle, struvite formed, and the sludge began to solidify. Therefore, the digesters needed to be completely cleaned out prior to recommissioning. Each digester took around 5 weeks to completely de-sludge, and these had to be done in series due to resourcing constraints with our tankering contractor.

The sludge handling facility took 9 months to fully recover with pre-flood levels of production being achieved by December 13th. This was partially due to the long wait time for instrumentation and PLC modules for the sludge area, which was around 15 weeks. It

was also partially due to the 13 week ramp up time to reach full CAMBI throughput. We began the ramp up of the CAMBI unit in mid-September, however then had to wait on the last digesters to be cleaned out. Additionally, since the digesters are a biological treatment system, the bacteria can become stressed if they are fed too quickly and overloaded. So, we had to slowly ramp up the feed through the digesters to reach full production.

2.2 Effectiveness of Historical Resilience Projects

After the 2011 floods, Urban Utilities did a lot of work to improve the resilience of the site. Some of the resilience projects included raising switch rooms and blower rooms above the flood height plus 300mm, and installing wind-up control panels, distribution boards and junction boxes (Figure 2). Overall, we invested $15M after the 2011 floods to improve flood resilience at Oxley. This expedited the flood recovery effort in 2022, as in 2011 it took us 6 weeks to recover **preliminary treatment**, compared to 6 days in 2022. Additionally, in 2011 the cost to recover the plant post-flood was approximately $25.7M compared to an estimated $8M to recover the plant from the 2022 flood.

Figure 2: ***Example of the wind-up control panels installed after the 2011 flood***

In 2011, the critical bottleneck faced was recovering and rebuilding the MCCs, which is why all of the electrical control rooms were raised. It's also why there's such a big difference in time taken to recover the preliminary treatment, as well as the recovery costs. However, in 2022, the critical bottleneck faced was supply chain issues and long lead times for asset replacements.

2.3 Supply Chain Issues

At the time of the flood, we were holding some spare compressors and motors, however it wasn't enough to replace all the flooded assets. This is due to the sheer volume of assets impacted, as we had to replace more than 85 motors, pump sets, dryers, blowers and gearboxes of varying sizes. Additionally, there were some control system assets that were inundated that are now obsolete and couldn't be replaced exactly, instead needing to be replaced with similar models. This was not a simple fix however, as the systems needed to be re-wired and re-coded to match the new control system which took some time.

An interesting point to note is that Urban Utilities had done a critical spares list for the sludge processing facility in late 2021 prior to the flood and had begun ordering the critical spares identified. This meant that some spares were already on order when the flood hit. However, major events world-wide, such as covid and the war in Ukraine, have massively pushed out lead times, and this was the major factor influencing the delay in re-commissioning the sludge treatment facility.

2.4 Risk-based Commissioning

It was identified early on in the flood recovery process that in order to ensure we were starting up steam and biogas facilities safely, we needed to formally analyse and assess the possible risks. Therefore, a risk assessment on the whole biogas facility was conducted in parallel with the flood recovery project. The risk assessment consisted of 12 workshops done over 12 weeks which identified 10 major accident scenarios. These 10 scenarios each had a bowtie safety assessment completed and over 300 controls and 200 actions were identified as a result. The controls and actions identified in the risk assessment helped inform the commissioning test sheets that were completed as part of the flood recovery re-commissioning. This risk-based commissioning process helped us recognise and rectify gaps in our operation and identify opportunities for improvement. As a result of the risk assessment, we were able to ensure that we were starting up our steam and biogas facilities safely, and we had no lost time injuries and no major accidents during re-commissioning.

2.5 Silver Linings

Despite the challenges, there were some silver linings that came out of the recovery project. Firstly, we were able to enact some creative solutions to help maximise the plant's treatment capacity while our major sludge processing facility was out of action. The process engineering team decided to repurpose existing bioreactors from a separate treatment train to act as an aerobic digester to treat and stabilise a portion of the sludge being produced. This involved building a temporary transfer pipeline between the two separate treatment trains, which was completed in March.

Another small win that we achieved was improved resilience. When the inundated instrumentation on our thermal hydrolysis unit was replaced, we converted the older, hard to procure or obsolete connections with a more common alternative. We also raised instrument interface switchboards above the flood level.

Finally, through this recovery and re-commissioning process, we gained a better understanding of our assets. All of the issues and gaps that we identified during the risk assessment and commissioning process resulted in process and operational improvements through changes to physical wiring, coding, maintenance schedules and standard procedures. We're also in a much better position in terms of understanding our process risks and what our pathway forward should be to minimise these risks.

3.0 CONCLUSION

3.1 Lessons Learned

This project has provided us with several lessons learned. First of all, as previously noted, is the supply chain issues. If we had been holding the right critical spares at the time of the flood, it would have significantly reduced the sludge facility downtime.

Secondly, when the flood occurred our construction contractor was working on two

different projects on site which were heavily impacted by the flood. The flood recovery for these two areas was managed via scope changes to these projects, rather than being handled by our maintenance contractor, who managed the flood recovery work on the rest of the site. Having multiple contractors working on the flood recovery resulted in some overlaps around battery limits, which wasn't ideal.

A positive lesson learned however, is that the mechanical maintenance walkthrough conducted early on after the flood was highly beneficial in systematically listing the impacted assets and ensuring operations and maintenance were on the same page.

The key lesson learned from the second flood in just over 10 years, is that we need to prioritise resilience and sustainability in design. The impacts of climate change are going to make extreme weather events even more common, and it's not feasible to repeatedly recover one of the largest treatment plants in Queensland every time it floods. Additionally, resilience strategies need to consider availability of assets over their full lifecycle. During this project, we struggled with needing to replace assets that were now obsolete. We also struggled with needing to replace a lot of instrumentation on our CAMBI unit, because it is a unique piece of equipment which, until recently, was the only one of its kind in Australia. Understanding whether the asset you are proposing for a project is truly resilient over its whole lifecycle is crucial. Overall, as a business, we need to make resilience a key driver for any new projects we are delivering, but we also need to consider long-term planning for future-proofing existing assets.

3.2 Future Planning

After the flood, Urban Utilities considered what the best option for protecting Oxley treatment plant from future flood events was. Different options were considered, such as raising critical sludge processing assets, like the CAMBI. Ultimately, the preferred solution was found to be a flood barrier, which would surround the sludge processing facility and protect the site from inundation (Figure 3). The barrier was partially deployed on site at the beginning of this year, and we plan to leave it partially assembled during wet seasons for rapid deployment if needed.

Additionally, we have raised instruments where practical and ordered critical spares worth $1.3M which would help us get the facility back up and running much quicker if it was to be inundated again.

3.3 Summary

Overall, it took around 9 months of effort to recover the plant, and although the resiliency projects implemented post-2011 expedited the process and reduced the cost, we encountered supply chain issues that heavily delayed the re-commissioning. There were some unexpected benefits to the risk-based re-commissioning activity, such as helping us identify areas for improvement in our processes, systems and physical assets. Many lessons learned have come out of the project, and we've been able to implement some changes based on these lessons and start planning for any future flood events.

Figure 3: *Flood barrier during assembly at Oxley RRC*

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