Sewer Mining to Supplement Blackwater Flow in a Commercial High-rise

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Project Background or Rationale

Australia’s warm climate and habitual droughts have resulted in innovative water conservation practices in commercial developments, such as 1 Bligh Street in Sydney. Commissioned in May 2011, the highly acclaimed 29 story office tower overlooking the Sydney Harbor captures nearly 100 percent of its wastewater and reuses it in the building. By recycling the vast majority of the waste stream, the developers have avoided sewer capacity issues and reduced the building’s freshwater demand by approximately 90 percent. Not all of the wastewater reused at Bligh Street comes from the building itself.

Calculations revealed the building’s total waste stream would not meet the non-potable demand for cooling tower makeup and toilet flushing (the desired reuse applications). Rather than supplementing non-potable demand with city water, the development has engaged in ‘sewer mining’, which involves tapping into the city’s sewer main as a source of water (see Figure 1).

Capacity and Type of Reuse Application

The blackwater plant, located just off the parking garage in a maintenance room, treats approximately 26,000 gallons (100 m³) of blackwater onsite daily.

A modular membrane bioreactor (MBR) was chosen, which would meet Water Industry Competition Act (WICA) and project objectives. Advances in modular mechanical design, membrane and instrument development, and remote monitoring via the Internet have helped improve the cost and reliability of MBR systems significantly in recent years. The MBR treatment consists of mechanical screening, biological treatment, and ultrafiltration (UV) (0.04 micron membranes). This approach provides the building a small footprint system with high yields (more than 99 percent) and high quality effluent. Disinfection via UV and a chlorine residual follows the MBR to provide multiple barriers of treatment. The recycled water reused for cooling tower makeup is also treated with reverse osmosis to remove salts.

Water Quality Standards and Treatment Technology

The reuse scheme required a New South Wales (NSW) WICA operator’s and retail license. The NSW government introduced WICA in 2006 as part of its strategy for a sustainable water future. WICA is intended to harness the innovation and investment potential of the private sector in the water and wastewater industries. At the same time, the Act establishes a licensing regime for private sector entrants to ensure the continued protection of public
A corporation (other than a public utility) must obtain a license under the Act to construct, maintain or operate any water industry infrastructure, supply water (potable or non-potable), or provide sewerage services by means of any water infrastructure.

The approach in the WICA legislation is based on the Australian Guidelines for Water Recycling (AGWR); a risk based methodology that provides a framework for assessing the risks associated with reuse projects (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and Australian Health Ministers’ Conference, 2006). The Bligh Street treatment program was deemed appropriate for the particular reuse scheme and adequate to manage the associated risks.

The application process for Bligh Street was done at the state level, submitted to the Independent Pricing and Regulatory Tribunal (IPART), which is responsible for ensuring a level playing field for private and public suppliers. IPART then sent the application to Public Health Offices for their input and it was also posted on IPART’s website for public comment. Environmental concerns, plumbing and drainage codes, sewer access, waste disposal licenses, and potable water backup were all taken into consideration at this time. Successfully passing an independent audit of the treatment plant infrastructure and associated system management plans is additionally required for the plant to begin treating wastewater. Next, a verification period was initiated, where the treated water is sampled and tested according to a sampling protocol from the management plan. The plant must demonstrate the water is “fit for purpose” before treated water can be distributed throughout the building.

**Institutional/Cultural Considerations**

The *Australian Guidelines for Water Recycling* employs a “fit for purpose water” methodology (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and Australian Health Ministers’ Conference, 2006). This approach involves an exposure risk calculation adopted from the World Health Organization’s (WHO) Guidelines for Drinking-water Quality (WHO, 2004). The methodology designates tolerable risk to be $10^{-6}$ Disability Adjusted Life Years (DALYs), or 1 infection per 1,000,000 people per year. DALYs have been used extensively to account for illness severity by organizations such as WHO. For this particular site, in order to reach $10^{-6}$ DALYs for Protozoa, Viruses, and Campylobacter, calculations determined Log Reduction Values (LRVs) needed to be 4.6, 6.0, and 4.8, respectively. Information on how these calculations are performed can be found in tables 3.3, 3.7, and 2.1 of the AGWR (2006). Once LRVs have been established, plant performance objectives and components can be determined. In this case, a UV unit provides 1 LRV for Viruses and 4 LRV for Protozoa. A reverse osmosis (RO) unit provides >1 for each and chlorine disinfection provides 4 LRV for viruses. Thus, the performance requirements for the system are met. Note that in the LRV calculations there are no LRV credits sought for the submerged membranes. This may change in the future as California Title 22 gains wider acceptance.

**Project Funding and Management Practices**

The Bligh Street scheme was funded entirely by the building’s developer thus it was critical the blackwater scheme be commercially viable from the outset. An innovative risk management methodology was adopted at first principles to properly address the economic challenges small schemes face with ongoing operations.

For many years the food industry has used Hazard Analysis and Critical Control Points (HACCP) risk management methodology. More recently HACCP has been adopted in the water industry. In a HACCP assessment the process is broken down into steps and at each step the question “what might happen and how might it occur” is asked. At Bligh Street, 6 CCPs were identified. These are influent pH, Turbidity, Electrical Conductivity across the RO, UV dosing, Chlorine residual and effluent pH. For each CCP, upper and lower limits were identified. If, during the course of production any one of the six CCPs is outside the limits, production is halted and an alarm is sent via SMS to a technician. Thus, HACCP ensures water quality fit for purpose will be delivered. As a result, end of pipe monitoring frequency can be reduced accordingly which reduces lab costs and directly effects the viability of the treatment plant without sacrificing public safety. Whereas *E. coli* sampling might have typically been required daily on a project
like Bligh Street, with HACCP real-time verification monitoring in place, regulators agreed to monthly sampling of *E. coli*. The monthly sampling for *E. coli* simply serves as confirmation that the HACCP methodology is functioning properly.

**Lessons Learned**

The Bligh Street project was one of the first NSW WICA licensing schemes in Sydney Central Business District to include sewer mining for cooling tower reuse. Working in an uncharted regulatory environment is always challenging and requires a vendor that fully understands risk assessment, and treatment technology, and has operational experience. Permitting is one of the more significant hurdles often overlooked by private scheme proponents. The permitting process can be time consuming. As new regulations are phased in, there is a period of overlap where the existing and new regulations both apply. The potential for miscommunication and confusion between regulatory bodies and the applicants is real. In order to meet all requirements, applications under the existing and the new regulations have been filed in parallel, which doubles the effort involved. Officials are extremely cautious at every step of the process and this has the effect of slowing down the process to a point where a 12-month lead time for approvals is normal. Accordingly, customers who would like to engage water recycling should be aware that the approval process adds a dimension of complexity and cost to the project. This will change as officials become more familiar with the practice and regulations and requirements for small systems become more transparent.

**References**

