INNOVATIONS IN UV TECHNOLOGY AT THE EASTERN TREATMENT PLANT IN MELBOURNE, AUSTRALIA

Paper Presented by:

Alastair MacNab

Authors:

Wayne Lem, Katrina Williams,
Jennifer Muller & Alastair MacNab

Trojan Technologies

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INNOVATIONS IN UV TECHNOLOGY AT THE EASTERN TREATMENT PLANT IN MELBOURNE, AUSTRALIA

Wayne Lem, **Katrina Williams, Jennifer Muller, Alastair MacNab**, Trojan Technologies

ABSTRACT

The Eastern Treatment Plant (ETP) is located approximately 40 km southeast of the city of Melbourne, Australia. All flows entering the treatment facility receive secondary treatment via activated sludge. This plant, constructed in 1975, is the largest activated sludge wastewater treatment plant in Australia and treats approximately 40 percent of Melbourne's sewage. The existing activated sludge secondary treatment plant was recently upgraded to an advanced tertiary treatment plant to significantly improve the discharge water quality. The secondary process was augmented by further treatment comprising of pre-ozone, biological media filtration, post-ozone, UV and chlorine. The UV facility, designed to provide a 4-log inactivation of Cryptosporidium, is based on an innovative UV reactor design and validation strategy which were key elements in the successful implementation of UV disinfection at the Eastern Treatment Plant. The advanced tertiary upgrade will significantly improve the discharge quality of the facility, reducing its impact on the receiving marine environment and creating a high quality recycled water resource suitable for a broad range of non-potable applications. The pathogen reduction requirements to produce "fit-for-purpose" recycled water in accordance with current Australian recycled water regulation and guidance was based on a quantitative microbial risk assessment approach. Ozone disinfection was designed to provide 4-log virus and bacteria inactivation in addition to a minimum 0.6- log inactivation of protozoa. The UV system was designed to achieve 4-log inactivation of Cryptosporidium, and is the primary barrier to address protozoa risks to the recycled water product and associated protection of public health.

1.0 INTRODUCTION

UV disinfection systems have been successfully designed, tested and installed in very large municipal treatment plants around the world. The tender for the UV system at Eastern Treatment Plant was open to both in-channel and closed vessel UV reactor configurations employing either medium pressure (MP) or low pressure high output (LPHO) lamp technologies. Eastern Treatment Plant was not forced to choose between energy efficiency and a small footprint/low lamp count as many municipalities had to do in the past when evaluating and selecting UV technology. The innovative UV system installed at Melbourne's Eastern Treatment Plant, the TrojanUVFlex™, offered the advantages of both existing medium pressure and low pressure high output lamp technologies by utilizing Trojan's newest lamp technology, SOLO lamp. By combining the best features of low power consumption of a low pressure UV lamp with high output that is characteristic of a medium pressure UV lamp, leading to low lamp count, this new platform of advanced UV technology has enabled Eastern Treatment Plant to achieve maximum disinfection performance with a system incorporating new design features allowing for easier installation, maintenance and operation. In addition, this combination allowed having a significantly lower environmental impact compared to other UV lamp technologies as measured by carbon footprint and lifecycle assessment.

2.0 DISCUSSION

2.1 Design Goals

One of the key goals for ETP was to develop a cost effective method for increasing the discharge water quality of the facility. The current ocean discharge area is located on the coast at Boags Rocks. Boags Rocks is an environmentally sensitive area which is surrounded in close proximity to multiple public beach areas. What the plant needed was a treatment process that could improve the discharge quality from class "C" to class water. In addition to the increasing the discharge quality, the facility was looking to supply class water for non potable purposes throughout the area. The high quality recycled water would be used for a broad range of non potable recycling applications. These include residential third pipe schemes for toilet flushing, garden watering, car washing) along with watering of public gardens, open areas, sports grounds and irrigating food crops.

Following treatment, the water is pumped 56km to this location where it is discharged into Bass Strait. You can clearly see along this stretch of shoreline there are multiple public beaches, which adds greatly to the public interest in obtaining high quality discharge water. With the new expansion and process treatments installed at the plant, the beach goers and the environment will both benefit from the improvements at the plant.

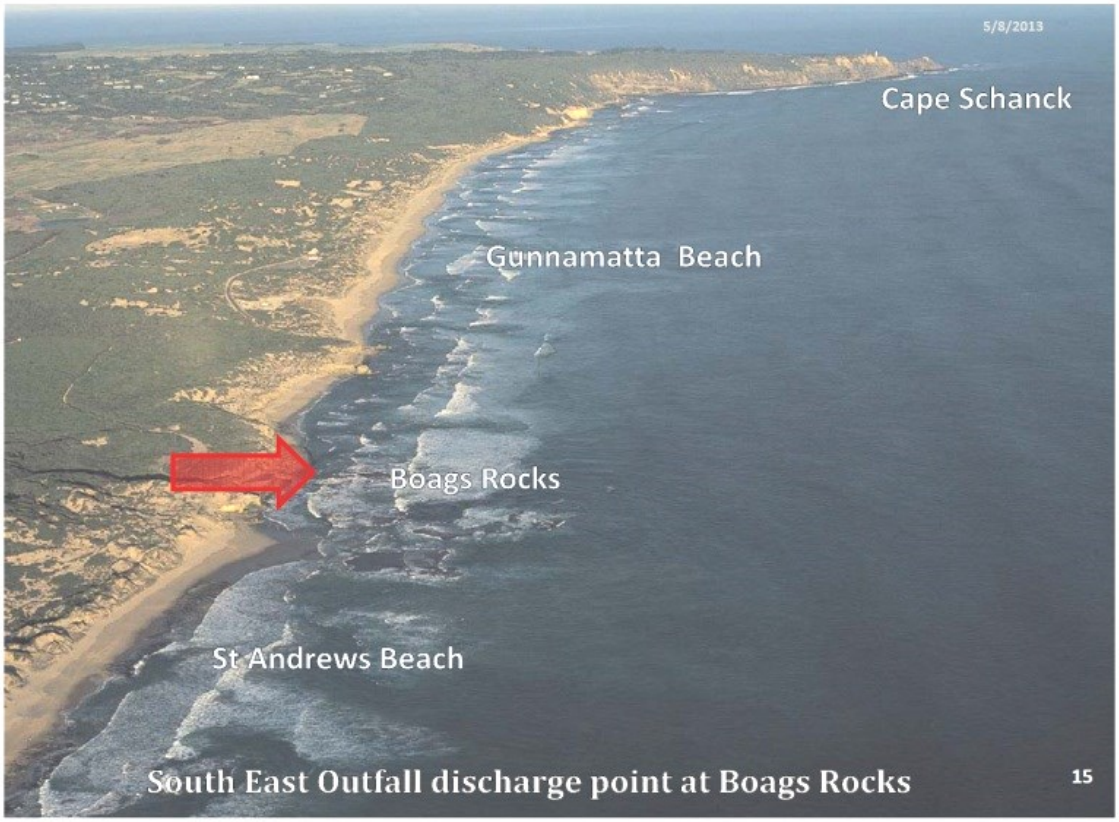

Figure 1: ***South East Outfall discharge point at Boags Rocks***

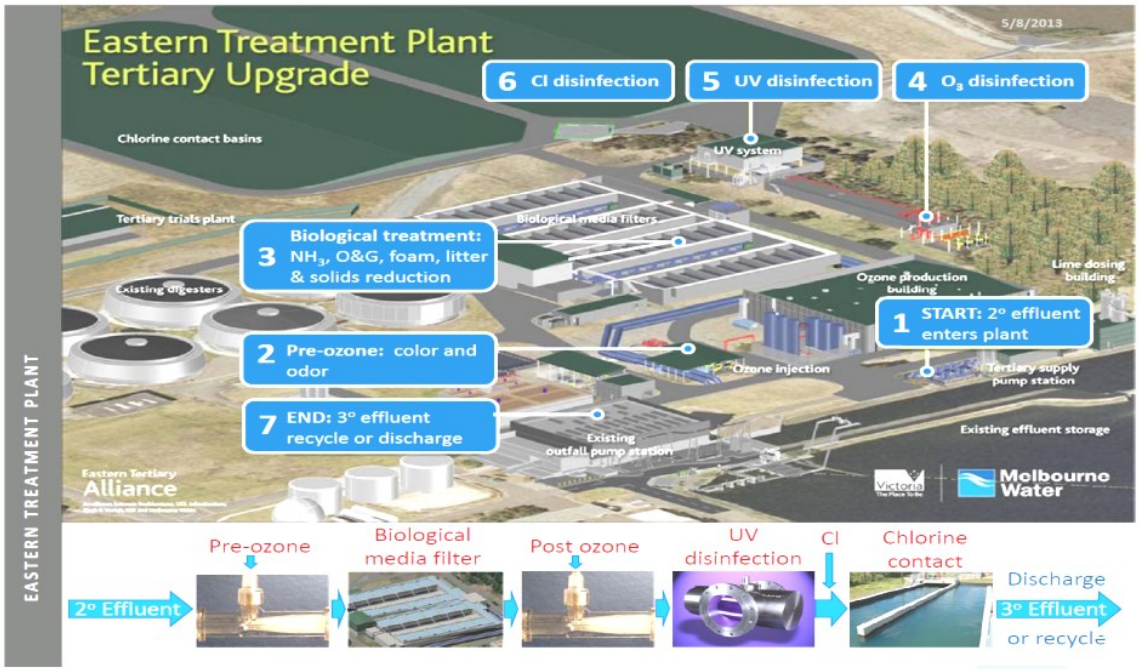

Figure 2: ***The Eastern Treatment Plant***

Secondary wastewater is generated by primary sedimentation, biological treatment and chlorine disinfection. This secondary water is now augmented to produce tertiary "Class A" wastewater. The additional treatment methods added to produce the tertiary reuse water include:

- Pre-Ozonation
- Biological Media Filtration
- Post-Ozonation
- Ultraviolet (UV) Disinfection
- Chlorine Disinfection, completing the total Multi barrier approach

Step 1 starts when secondary Effluent from the existing plant enters the new advanced treatment facility via the new Pumping Station. This station draws the effluent out of the existing Holding Basins to begin its further treatment.

In step 2 of the process pre ozonation occurs. Ozone is used to help in the reduction of colour and odor and helps to optimize the rest of the treatment process.

From there the water enters the biological filtration area in step 3. The filters are a key part of the tertiary process. Here, helpful bacteria biodegrade the organic matter and reduce ammonia, oil, grease, foam, and solids from the effluent.

Step 4 consists of some basic disinfection using ozone, which is generated by an on-site oxygen generation facility.

From there, the effluent is exposed to the Trojan ultraviolet disinfection system where the water is disinfected to obtain a 4 Log reduction of Cryptosporidium.

To round out the multi barrier approach, the effluent enters a two large Chlorine contact basins.

When the whole process is completed, the final treated water is transferred to the existing outfall pumping station where a portion of the volume is piped for reuse needs and the remainder is discharged to the ocean under the sites EPA Victoria license.

The owners at Melbourne water had some specific requirements around the UV portion of this project. Some of those included:

- The UV system was to be designed to achieve a 4-log inactivation of Cryptosporidium
- It had to be a state of the art system that would undergo industry best practice validation in accordance with the USEPA UVDGM
- It had to prove to be an Energy efficient solution that would provide the lowest lamp count and lowest total cost of ownership
- As well as to have Local sales and service support personnel from a highly reputable manufacture
- The choice for using UV as part of this multi barrier approach was to avoid the use of chemical alternatives to inactivate Cryptosporidium. Since some of these chemicals can lead to the generation of unwanted and potentially harmful disinfection by-products. Since UV is free of chemicals and has been technically proven around the world in many municipal installations over many years, UV was a low risk option for the Eastern Treatment Plant.

2.2 Plant UV Design Specifications

Design flow 708 MLD

Average flow of 280 MLD

UVT ranging from 67.5 to 80%. (For this project the design was based on 67.5% UVT)

4 Log reduction of cryptosporidium

To achieve the required 4 Log reduction in Cryptosporidium a dose of 22 mj/cm2 was used based on USEPA design recommendations. The final system that was chosen to supply UV disinfection was the TrojanUV™Flex closed vessel system.

The TrojanUV™Flex units installed at the Eastern Treatment Plant are validated units capable of providing 4-log inactivation of Crypto. This validation was completed in strict accordance with the (USEPA) (UVDGM) as part of the project requirements to meet local regulations.

The Eastern Treatment Plant in Melbourne installed 7 parallel TrojanUVFlex™ reactors making it the largest UV installation in Australia.

Each Flex reactor contains 96 1000w SOLO™ Low-Pressure High-Output Lamps and each unit is capable of treating approximately 1500 L/s

Each of the Trojan UVFlex systems houses many energy efficient features that combine to provide both reliability and the lowest operating costs. Each unit house High power, high efficiency Solo lamps. The 1000w Solo lamp when paired with the Solo lamp driver offer a balance of power to lamp quantity ratio that is hard to beat when looking at cost of ownership.

Part of which makes this system so efficient is the capability to dose pace. Dose pacing maintains the optimum lamp power to meet the required dose target while minimizing the overall electrical needs of the system. The dose pacing algorithm uses inputs such as Flow, UVT and UV intensity sensor readings to adjust the operating parameters of the unit to best match the plant operating conditions. Each of the UVFlex units has the capability to individually turn off any of the reactors 6 individual lamp sections as well as dim lamp power from 100% to 30% to best meet the dose requirements whilst maintaining the lowest possible operating costs. Trojans patented automatic Chemical/mechanical cleaning system is also used to reduce sleeve fouling and maintain optimum sleeve transmission in all water qualities.

The Solo lamp and driver combination started development over five years ago. During that time Trojan has created a lamp and driver system that is not only efficient but also robust and flexible. Solo lamps have been extensively tested at both the component and system level and have demonstrated excellent stability, and reliability. Solo Lamps are guaranteed for 15,000 hours of lamp life minimizing lamp changes and maximizing energy savings. The lamps have the capability to go from 100% power down to 30%. While maintain dose within design parameters. With Solo lamps more energy is converted to useable UV in the 254nM spectrum. When compared to MP lamps in similar flow conditions the result is ~70% less energy required for the same UV dose.

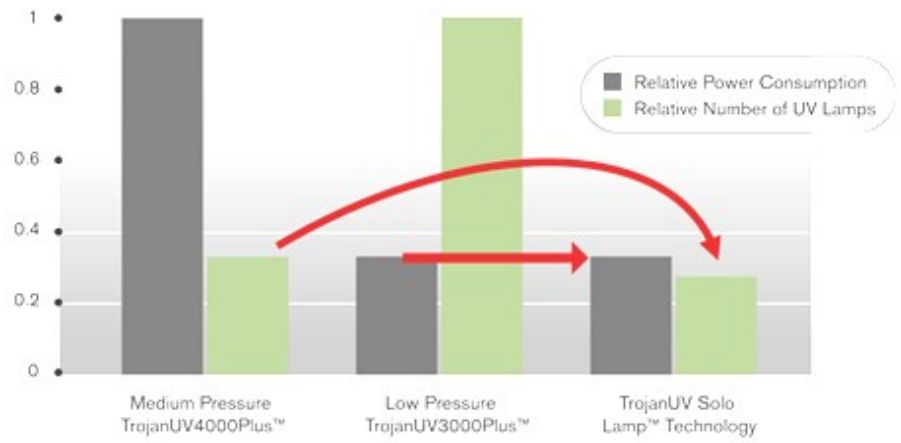

Figure 3: ***Solo Lamp Technology –less power and fewer lamps***

The power to drive the Solo lamps comes from it partner the Solo lamp driver. These high efficiency next generation drivers lose less energy to heat. Maintaining over 95% efficiency. This means less cooling required for the power panel and higher component reliability. Along with the higher efficiency numbers, comes lower harmonic distortions. The smart drivers have all digital communications and have built in programming to control the lamps filament temperature. This helps prevent the lamps from overheating and contributes to longer lamp life. Built in driver diagnostics help trouble shoot any issues for increased run time and less diagnostic time. Changing out the driver is easy with the slide out feature of the driver rack system. Simply undo 2 cables harnesses and remove a set screw and the whole driver assembly slides out for easy replacement. Power panels also benefit from Solo lamp and driver technology. Due to small size and density, the foot print required for the driver panel space is greatly reduced. Panel cooling costs are also reduced due to the smaller panel volume and reduced complexity. These energy saving initiatives greatly reduce the overall power requirements resulting in lower life time costs and a reduced greenhouse gas footprint.

2.3 System Selection Criteria

The UV system needed to be he designed to achieve 4-log inactivation of Cryptosporidium validated in accordance to the UVDGM.

It had to be an Energy efficient solution with the lowest lamp count and lowest total cost of ownership.

Local sales and service support personnel from a highly reputable manufacture was required.

The equipment had to have low maintenance requirements for their operators with few parts required for inventory.

2.4 So what is the current Status of the Facility?

After a trouble free installation of the UVFlex equipment last June, the facility soon after received approval from the Australian department of health to produce Class A recycled water for the area. As mentioned this water will be used for Residential purposes as well as general watering of open spaces and food crops.

In addition the water that is now being discharged into the ocean is of a much higher quality than in years past.

3.0 CONCLUSION

UV was selected for use at the Eastern Treatment Plant because it was evaluated to be the best technology for the removal of Cryptosporidium as part of the overall multi barrier treatment system resulting in world class recycled water.

The UV system was validated in a 3rd party facility in up State New York, in accordance with the USEPA Ultraviolet Disinfection Guidance Manual for the final Long Term 2 Enhanced Water surface Treatment Rule (2006) (UVDGM) as required by regulators in the State of Victoria.

The TrojanUVFlex system was designed and built for 4-log Cryptosporidium removal.

Trojan UV SOLO lamp and driver technology provided a highly efficient UV system using fewer lamps.

Eastern Treatment Plant has met its goals for producing “Class A” wastewater and has started distribution of this water.