ROTORUA WWTP SIDESTREAM MBR UPGRADE

Iain Conroy – Downer New Zealand

Abstract

The Rotorua District Council (RDC) as part of the Rotorua Lakeside Communities Sewerage Scheme Programme identified the need for improvement to allow greater treatment capacity in Rotorua, securing growth for the next 30 years within the existing infrastructure & allowing for the potential connection of new communities through population growth.

The decision was made to proceed with the installation of MBR (Membrane Bio Reactor) technology, the detailed design was awarded to AWT Water with GE Water & Process Technologies being the nominated membrane supplier & Downer New Zealand were appointed as principal Contractor for the execution of the project.

The upgrade was introduced as a Sidestream to run parallel with the existing Biological Nitrogen Removal (BNR) plant, providing greater flexibility by having two nutrient removal processes running concurrently. An existing, decommissioned clarifier was identified to house the new installation, with 4 new tanks being constructed to house the membrane filters.

RDC decided to procure all major equipment through NZS:4911, with the installation standard at NZS:3910, thus free issuing these items to Downer for installation, this approach whilst being commercially beneficial to RDC was not without challenge, chiefly with the management of risk & liability of equipment, however the exercise was a complete success, further enhancing the collaborative nature of the project between client (RDC), Designer (AWT) & Contractor (Downer).

Further challenges to the installation were the geothermal activity associated with Rotorua & the high water table within the area however due to swift preventative action, Downer New Zealand& RDC were able to identify and deal with potential seepage enabling the eventual successful application of the protective membrane coating contractually required by GE to protect the integrity of the concrete tank from chemicals used during membrane cleans.

This paper outlines information which led to the successful conclusion of this project:

- First hollow fibre submerged ZW MBR on wastewater application in New Zealand.
- Excellent example of collaborative effort by RDC, Downer New Zealand, AWT & GE.
- Membrane Technology for high specification treatment.
- Highly competent design & build capabilities & methodologies.

KEYWORDS: Membrane Bio Reactor, Project Execution, Project Delivery, Rotorua.

1. Introduction

The MBR process is intended to produce to produce final effluent quality that can be directly discharged from the WWTP and disposed at the land disposal site currently operated by Rotorua District Council (RDC). The aim of the overall project is to provide a treatment solution that allows the communities to grow and develop around the many lakes of specific cultural and historical interest as well as ensuring the environment of these lakes is protected for the enjoyment of future generations.

The MBR project was identified as essential to ensure greater treatment provision for the next 30 years and was determined to be the most economical option to be considered compared to other methods such as extending the existing Bardenpho or constructing a new clarifier.

The project has also allowed for future development within the existing catchment to be undertaken, which would not have been possible if the project did not go ahead.

"The key to the successful delivery of the project was the collaborative culture between Downer & Rotorua District Council, underpinned by both technical and professional excellence" – Greg Manzano, General Manager, Hydrus Engineering Consultants

2. Background

2.1 Project Description

The project involved upgrading the existing Waste Water Treatment Plant by constructing a standalone Membrane Bio Reactor (MBR) plant designed to operate in parallel to the main Biological Nutrient Removal BNR plant. The main objective of the upgrade is to increase its current capacity so as to accommodate future population growth in the Rotorua District.

The MBR plant runs in parallel to the existing Biological Nitrogen Removal (BNR) plant, allowing operational flexibility. The process will aid the current nutrient removal performance of the existing plant and enable operational flexibility and redundancy, chiefly when any of the BNR clarifiers from the existing plant are taken off line during periodic maintenance and repair.

Rotorua District Council (RDC) identified an existing, redundant 'doughnut' tank to house the new system, therefore reducing the footprint by eliminating the requirement of a new building structure.

The choice of MBR technology was chosen due to its capability to treat relatively large amounts of wastewater over small footprints. This is of significant benefit to the Rotorua Waste Water Treatment Plant due to the limited available space on site.

2.2 Partners

AWT Water provided the overall design of the project and are leaders in their field, providing process and design solutions for many applications in the industry. It is acknowledged that their design for the Rotorua Waste Water Sidestream MBR Project has been a fantastic testament to their knowledge and skill.

GE Water & Process Technologies are globally recognised as technical experts in water treatment. Their hollow fibre membranes are just one of many facets of their portfolio as well as highly knowledgeable expertise provide solutions in the treatment of waste water.

Although there were no formal arrangements in place between the membrane supplier, designer and constructor, all had previous experience in working together on other projects. This was a key factor in the level of cooperation during the project and an attribute that we would strongly recommend clients to include as part of their procurement and evaluation processes.

3. Early Contractor Involvement

Early Contractor Involvement (ECI) was instigated by Rotorua District Council (RDC) with the intention of attaining relevant ideas & methodologies to ensure a more cohesive delivery of the project. The basis of an early engagement provided the Contractor (Downer) the opportunity to digest the complexities of the project and allow sufficient time and opportunity for the principal to incorporate ideas into the master contract document & drawings.

Although the approach taken did not follow a standard ECI format it did promote some healthy discussion and identify a number of areas for Council to revisit prior to the final release of the tender documentation.

Participating in the process was voluntary and prior to agreeing to take part we thought carefully before sharing our ideas that could ultimately have benefited our competitors.

Some items that were discussed with Council included:

- Contract duration; the initial contract duration was set at 5 ½ months but it was clear that this was an unrealistic timeframe combined with the uncertainty around the extent of the remedial works to the existing structures. As a result the contract duration was extended out to nine months with the actual construction period taking twelve months due to the extent of the tank remedials. The relevance of this is that had the duration not been changed the risk of late completion could have been factored into the cost when it was neither appropriate nor necessary.
- Commissioning; having experienced commissioning engineers and plant operators allowed us to offer an alternative approach to having the plant commissioned and monitored by the designers.
- Chemical usage; being treatment practitioners as well as constructors we were interested in aspects of the operations such as chemical usage so as to potentially offer more practical solutions where designers may inadvertently over engineering. By enquiring about chemical usage combined with our own knowledge we were able to better assess the storage requirements taking into account delivery frequencies and delivery options.
- Risk; project risks were identified and we collectively discussed who was in the best position to manage.

4. Contract Model

The contract model used followed the design/ bid /build concept. This project delivery method dictates that the project owner contracts with separate entities for both the design and construction of the project. Responsibilities for project outcome are divided between the designer and builder. All associated project risks are allocated appropriately to both designer and builder but the project owner takes significant risk if a dispute arises between the designer and the builders. AWT Water was the designer with Downer New Zealand being the successful installation contractor.

As lead contractor, Downer New Zealand was charged with the delivery of the project from earthworks and civils, mechanical and electrical installation as well as pre commissioning and membrane installation. This was then followed by process commissioning by AWT Water and GE Process Technologies for their equipment.

5. Alternatives

As part of the tender process we were able to offer a number of alternatives for Council to consider and value.

It is often the case that standard engineering specifications and practices do not cover or promote alternative materials or reflect best practice and new products and technologies. We always endeavour to provide alternative and choice particularly where whole of life costs are a key driver.

5.1 Materials

Alternative materials were considered for the protective coating however given the nature of the application, Polybrid was decided upon as this had been used successfully on a similar project in Australia – they key function is to protect the tank from chemicals used to perform maintenance cleans on the membranes.

5.2 Chemical Dosing Structure

The original design for the chemical dosing building was to be stainless steel in composition, however after dialogue with a local concrete specialist. Downer proposed the use of pre cast concrete supported by steel supports, providing significant cost savings without compromising the durability and integrity of the building.

5.3 Tinned Copper Cables

Due to the atmospheric presence of H2S (which is highly corrosive to metals) within the area the electrical design specified that all cables should be tinned to avoid degradation especially termination points, however after review, Downer proposed that it was safe to avoid having tinned cable above 6mm core as the cable is manufactured with armoured coating, advising that all cable below 6mm can be tinned with only termination points having to be tin coated on anything above 6mm. RDC sought independent advice and decided to accept the proposal, thus allowing them to make a substantial cost saving.

6. Risk

As most of the major equipment items were free issued to Downer, this presented potential risks in terms of contractual liability and obligation. Through careful planning and collaboration between Downer and RDC, specific risks were allocated to the relative entity that would best manage them. This clear and concise communication helped to minimise any potential problems with uplifting and installation of equipment.

During construction, Downer also had to ensure that disruption to the existing plant was kept to an absolute minimum, working on a 24hr operational sewage plant, it was paramount that the operation could not tolerate any outage caused by problems with the new installation. Key to achieving this was excellent planning and communication strategies.

7. Collaborative Approach

7.1 No Surprises

"The Rotorua District Council undertook the WWTP MBR Upgrade with a philosophy of collaboration and 'no surprises'. In partnership with AWT, GE and the main installation contractor, Downer, this philosophy has been the main driver in the successful completion of this project. The plant is now commissioned and in the optimization phase and producing results that are meeting the minimum performance standards". – Murray Callingham, RDC

"The whole project team, including Downer, worked in a very collaborative style with a 'no surprises' philosophy which resulted in the best for project solutions being put forward at all junctures. The plant is the largest municipal plant in the country and one that all contributors can be proud of" – Raj Valabh, AWT Water

7.2 Alliance Behaviour

The project has also highlighted the strong alliance between RDC, Downer, AWT Water & GE Water & Process Technologies. The complexity of delivering a highly technical installation whilst maintaining a daily operational treatment plant presented numerous challenges, however the relationship of the key project teams ensured that the execution and delivery were achieved with minimal disruption. The feedback from RDC was that due to the engagement of the contractor with the alliance approach ensured that there were minimal to no adverse effects to Budget & Quality.

8. Challenges

8.1 Retrofit of Existing Clarifier

The main challenge of the project was the retrofit of the existing redundant clarifier which was to house the MBR Sidestream Upgrade, this was due to the nature of the atmospheric conditions in Rotorua, seasonal fluctuations in ground water levels and that the tank was over 40 years old meaning the integrity of the composite materials were not known.

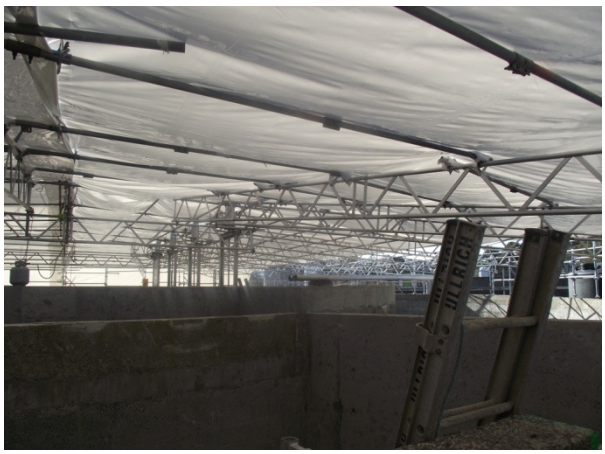
8.2 H_2S Attack on Electrics during Control Building Mods

The control of the new upgrade was designed to be incorporated into the existing system, with a new Motor Control Centre (MCC) being manufactured and this being programmed into the existing Supervisory Control And Data Acquisition (SCADA) system. The main challenge was the physical installation of the MCC into the existing control room which is operated in a controlled environment with constant high grade filtration to ensure no H_2S can enter the area. With that in mind, and given that the only method available to install the sizable new panel was to remove a wall and replace after installation, through careful planning, Downer provided a strategy to install the MCC with absolute minimal disruption of hours to the filter system, this was essential to avoid corruption of the existing system and was concluded with great success.

8.3 Tank Integrity, Sealing Methodology, Shrink Wrap for Winter Working

The project encountered some delay in the physical works due to penetration of ground water entering the tank at around 50% of the construction phase, this meant that Downer could not have access to the tank until remedial repairs were undertaken, a slow and painstaking process of compartmentalising areas of the floor, drying so as to ascertain if there were leaks in that area and if found to be, injecting resin to trace back into the concrete hence stopping the penetrative seepage into the tank.

Due to the delay of several weeks, the caveat was that the programme had pushed back into the winter months, Downer then decided to cover the tank by installing a scaffold structure and applied shrink wrap to create a weather resistant, controlled environment – this yielded great dividend to regaining valuable weeks in the programme, allowing the repair team better opportunity to perform their scope without interference from the elements. Once repairs were completed, the cover also provided a controlled environment for the tank coating specialist, again keeping all internal surfaces intact from adverse weather.



9. Conclusions

Having the opportunity to have ECI engagement provided Downer the chance to offer advice gained by vast experience within the construction industry and more acutely, the expertise of its Mechanical & Electrical capabilities that is perhaps not a commonly understood medium of the organization. Through meticulous value engineering and the technical knowledge of its Water business, Downer were able to not only offer the principal significant cost savings but also sound engineering practices & methodologies, this was instrumental in maintaining the highest standard of Quality and delivery of the 1st hollow fibre MBR in New Zealand & the largest MBR on a municipal application.

RDC & Downer together with their partners displayed a togetherness in the approach to the construction whereby risk was minimised by an open forum and robust construction programme, forecasting potential problems through regular engineering meetings and a hands on approach to solving issues in an informal manner meant that progress could be maintained without the formal barrier and processes that are typical in contractual obligation, which through the nature of protocol can impact the critical path.

The challenges that were encountered had already been tagged as potential risk which again highlights the benefit of ECI and the collaborative spirit of the contract.