Mangawhai Wastewater Treatment Plant Upgrade

Stage 2 Summary

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Contents

List of Figures

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Draft 1	7/12/2018	J Moser	A Springer		
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Revision Details

Revision	Details

1 Introduction

As outlined in the Offer of Service for Upgrade of Mangawhai WWTP, 20 June 2018, the technical support that WSP Opus will provide shall be broken into four stages;

- Stage 1: Needs Assessment
- Stage 2: Develop Solutions
- Stage 3: Procurement
- Stage 4: Delivery

This approach is based on determining the root cause of existing and future issues and understanding the associated risk in order to prioritise the required upgrades. This report summarises the findings from Stage 2; the development of solutions to meet the needs identified in Stage 1. The assessment involved investigation of potential solutions that would resolve the needs highlighted in Stage 1. The following sections are in order of priority as determined in Stage 1.

2 Spare Decanter Drive

2.1 Issue

The decanter drives are wearing out and there is a long lead time for them to be replaced. This means that in the event of a drive wearing out, the process would be restricted to one tank for approximately 6 weeks while waiting for the replacement drive to arrive to site. The quality of the effluent would be compromised during the time that the plant would run on one tank.

2.2 Solution

This issue was prioritised as the most important. It can be easily resolved by buying a drive to keep as a shelf spare. The cost to purchase a spare decanter drive is approximately $12,069.

3 Aeration Capacity

3.1 Issue

The capacity of the existing aeration system is insufficient for consistently meeting the dissolved oxygen (DO) setpoint. The design point has already been exceeded and the issue will continue to get worse as the population of the catchment increases. There is a compliance risk, particularly for ammonia and TN.

The existing blowers sometimes run at peak demand. The forecasted continued growth in the catchment will increase the demand on the blowers and result in prolonged periods of peak demand and there is currently no standby blower provided.

3.2 Solution

The aeration and blower system need to be upgraded for increased capacity. The basis of design for the aeration system is 70 connections per year for the next ten years. In order to predict the aeration demands for this design scenario, the flow data from 2015 was scaled up to match the predicted growth as shown in **Figure 1** below.

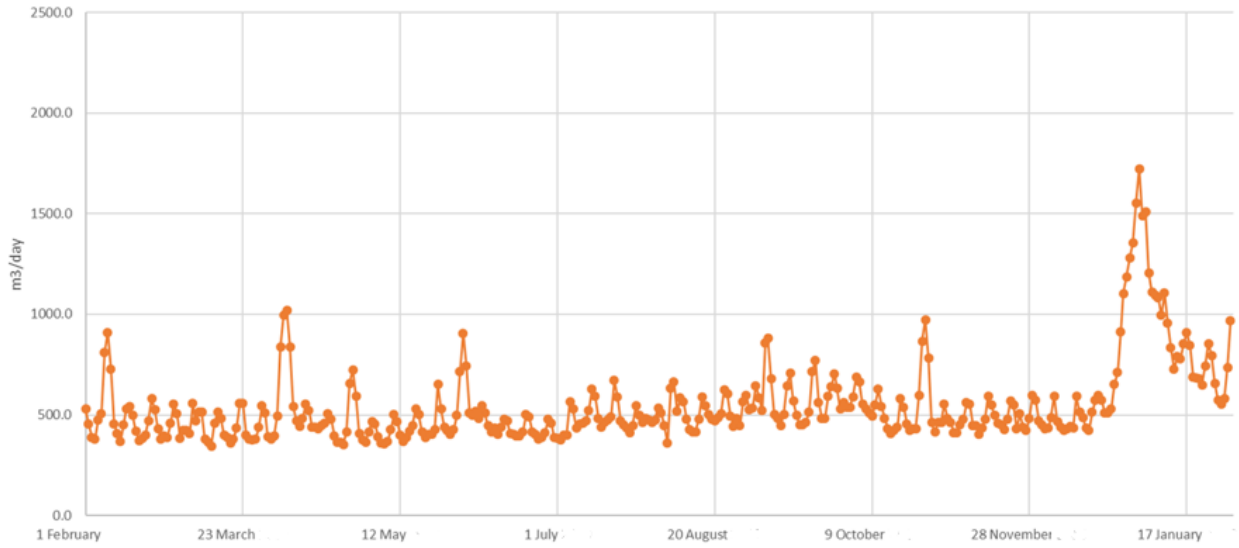


Figure 1. Predicted Flow for Design Year 2028

Recent data was used for the concentration of ammonia and BOD during the peak Christmas period as well as the concentration through the rest of the year. These concentrations along with the scaled-up flow were used to calculate the predicted aeration requirements for the peak design year.

Several options for achieving the required capacity were investigated. Each of these solutions require upgrades to the existing blower capacity. This is demonstrated in **Figure 2.**

of the predicted peak air required for year 2028 compared to the existing blower capacity. **Figure 3** shows the air required for the peak day predicted to be January 2nd, 2029.

The graphs show that in order to meet the air requirement for the peak capacity predicted, the blower capacity required is equivalent to four upgraded blowers. In the meeting on November 30th, 2018, KDC and Trility expressed preference for the air demand to be met by adding two new blowers rather than increasing the capacity of the three existing blowers. The current three blowers work (at peak) at 70% of their capacity. Consideration was given to install only one additional blower and use the spare capacity of the existing ones (i.e. 1+0.3+0.3+0,3). However, this would reduce the life span of the existing blowers and indicative costs showed similar upgrade to full replacement costs. Preference was given to maintain current blowers at 70% and install two new blowers. Trility confirmed that the room has enough space for two additional blowers.

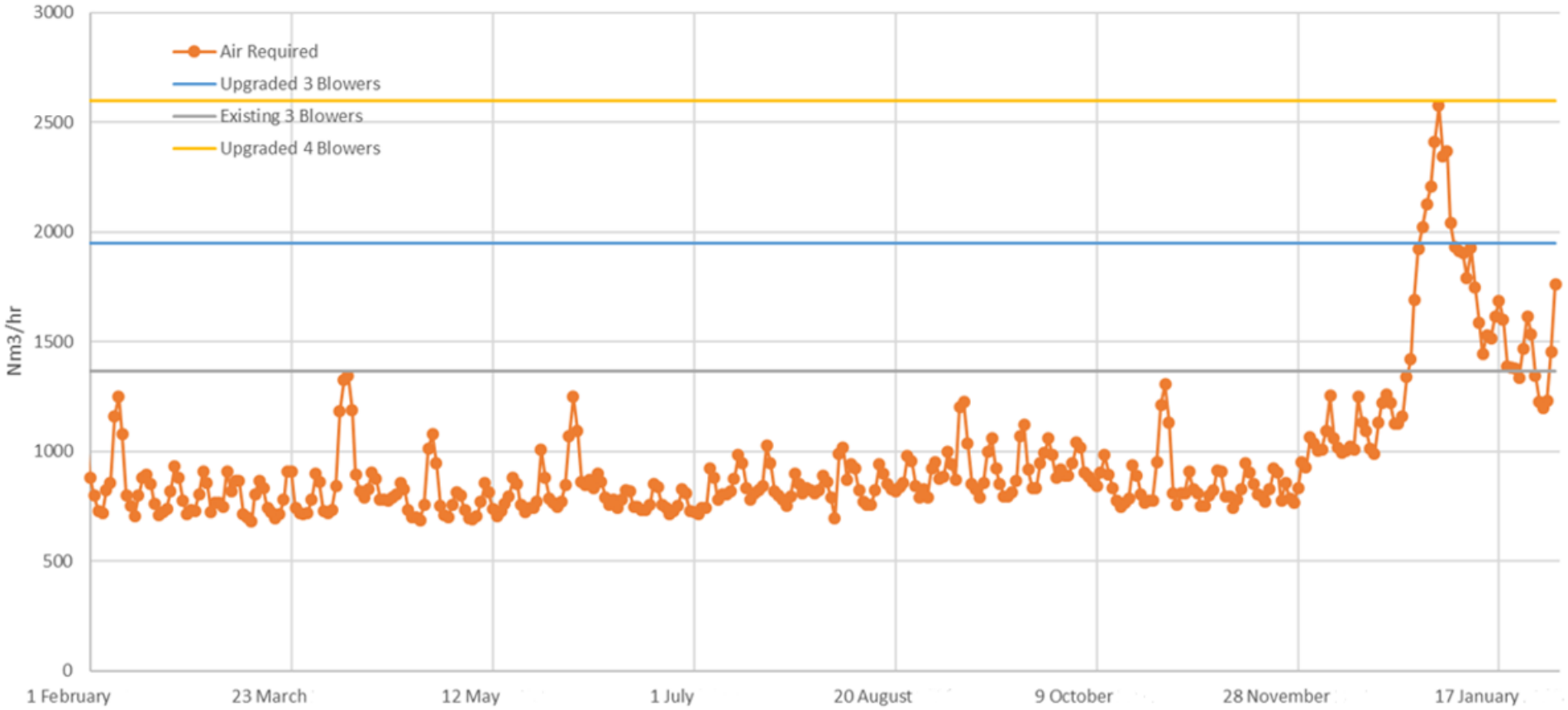


Figure 2. Air Required for Peak Design Year (Approximately 2028)

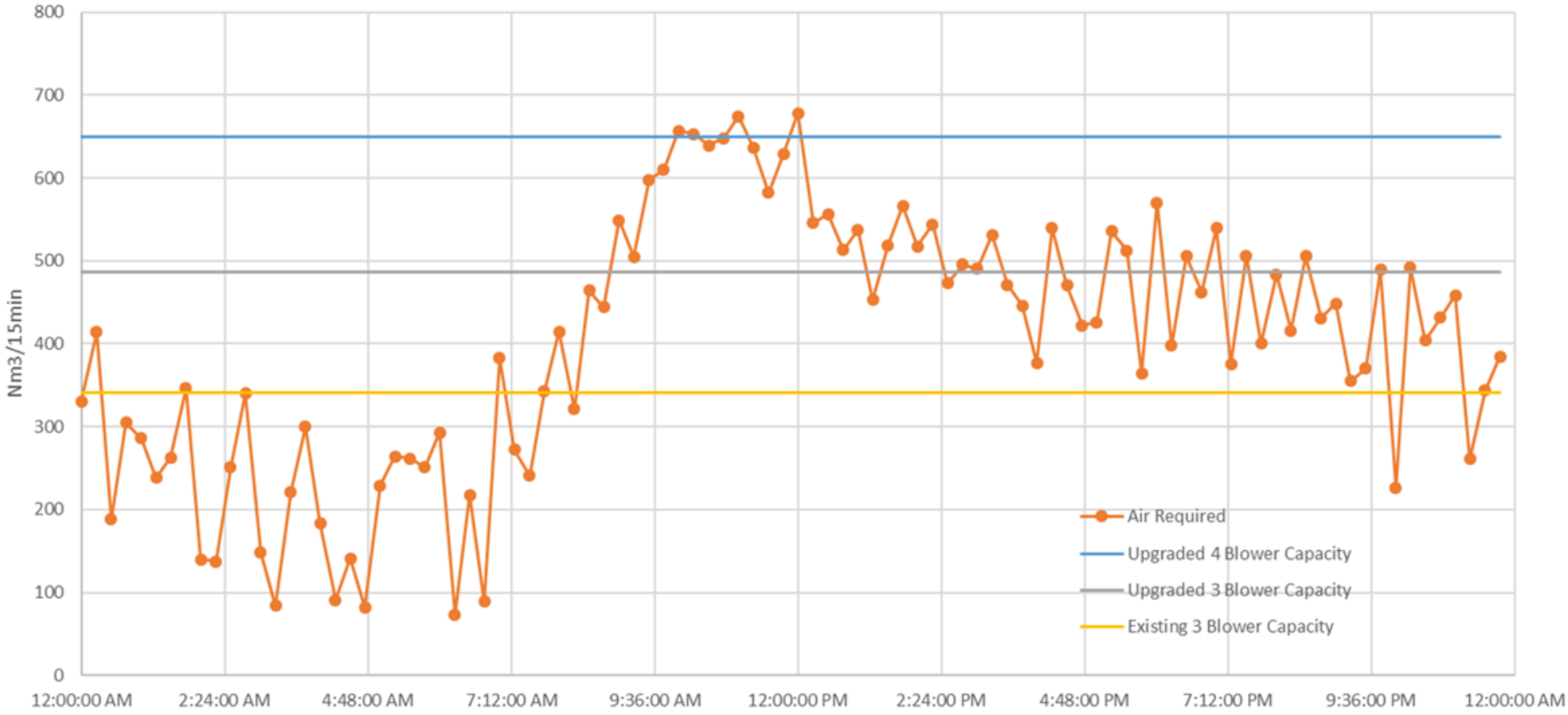


Figure 3. Air Required for Peak Design Day (Approximately 2nd January 2029)

Three different options for aeration capacity upgrades were investigated. The capital cost for each option presented below includes the cost of two new blowers. material supply, desludging, installation and operational cost associated with the installation.

a) Replace diffusers only with OTT

The existing diffusers are OTT Magnum Membrane Diffusers which were installed in 2008. We have received a proposal from OTT to use the existing air header pipework and replace the diffusers in Zone 3 with new diffusers that will meet the predicted air requirement for the design point of this upgrade as shown in **Figure 4**.

The OTT diffusers have a guaranteed lifetime of five years. The full proposal has been included in **Appendix 1**. The capital cost for this solution is $458,333.

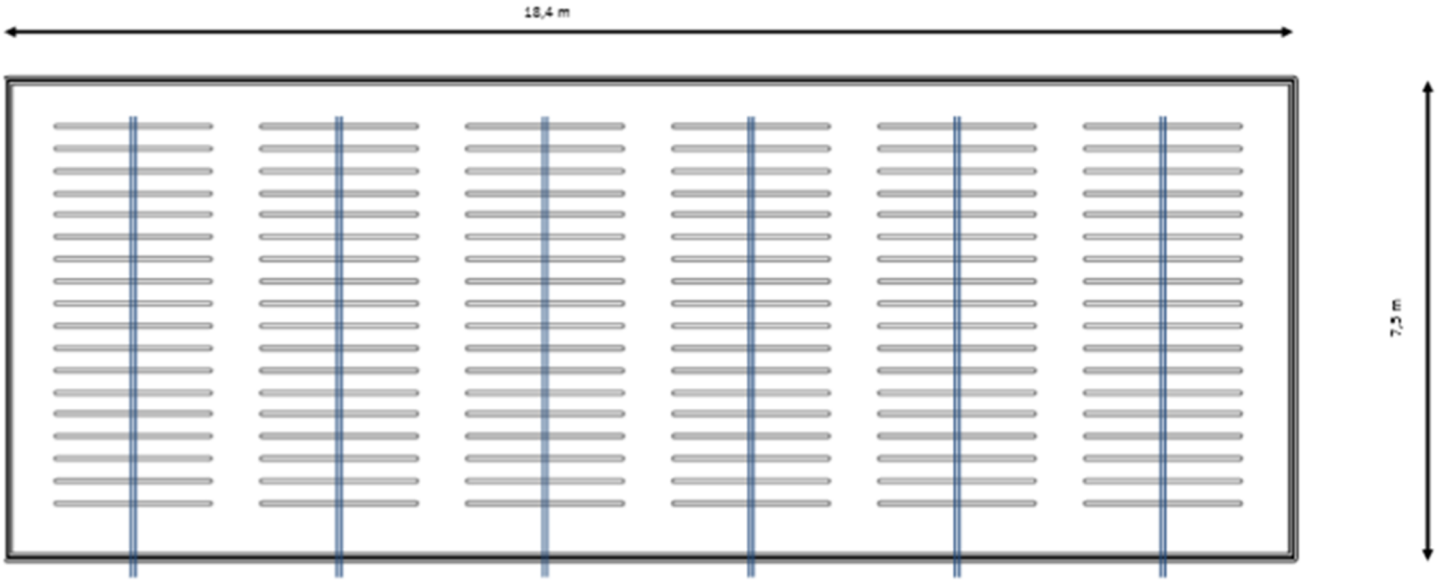


Figure 4.Proposed Diffuser Layout Provided by OTT

b) Replace diffusers and header pipework with AquaConsult system (Mason Engineering)

AquaConsult proposed a diffuser system which includes a new air header arrangement as displayed in **Figure 5 and** Figure 6. The AquaConsult diffusers are ultra-fine bubble membrane diffusers so have a reliably high transfer efficiency.

The AquaConsult diffusers have a guaranteed lifetime of ten years. The full proposal along with case studies of successful installation has been included in **Appendix 2**. The capital cost for this solution is $551,071.

In this option, the existing diffusers in Zone 1 and 2, are not changed. These are being retained as is, and are in future only used for air mixing of the zones.

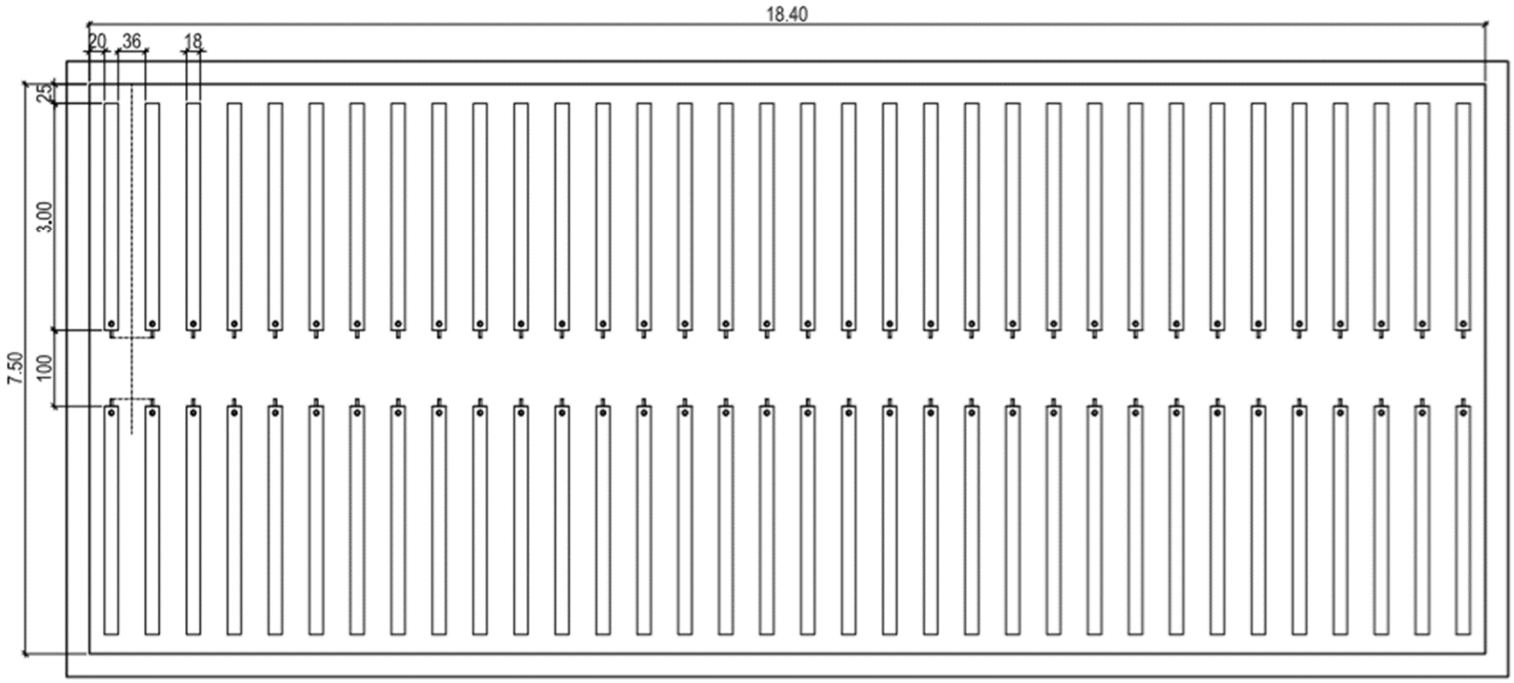


Figure 5. Proposed Diffuser Layout Provided by Masons on Behalf of AquaConsult

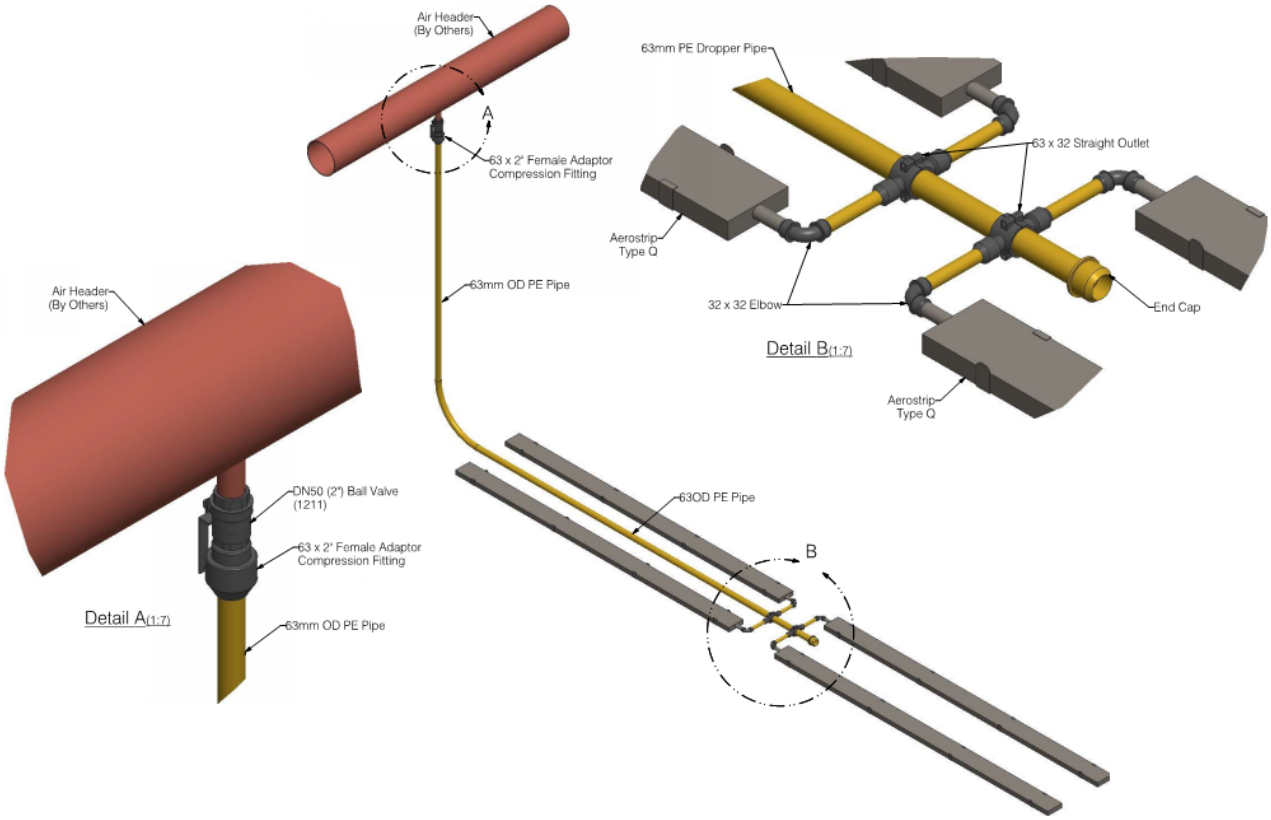


Figure 6. Air Header Arrangement for AquaConsult

c) Oxygen dosing

The third option that was investigated was to supplement the air supply through the diffuser system by using oxygen dosing. Since increased blower capacity is required for two weeks over peak season only, oxygen dosing over peak season would eliminate the need for higher aeration capacity.

WSP Opus engaged BOC Gas to develop indicative costs for this operation. The method proposed by BOC was to hire the necessary equipment (a cryogenic transportable tank, a vapouriser and a low temperature protection pressure control skid) for the required timeframe only. In addition, the required volume of oxygen would need to be purchased and delivered. Therefore, there would be minimal additional capital cost. The additional operational cost for equipment hire and oxygen purchase would be offset to some degree by the operational savings from reduced air use.

A net present value comparison of the three options (**Appendix 3**) showed that Option a) and b) are the most cost effective. These are compared below.

Efficiency: AquaConsult guarantee a higher transfer efficiency compared to OTT. This means for the same blower capacity, there is greater capacity with AquaConsult. OTT would still be deficient in oxygen in approximately five years for short periods at peak loading rates.

Asset Life: Both diffusers have a good track record of asset life. OTT guarantee five years life, but have suggested replacement by ten years. AquaConsult diffusers have several case study plants running at over 15 years on original diffusers with continued high efficiency. This is managed by a relax and expand cycle which enables self-cleaning. Normally this is six cycles per day, which will be provided by the normal operation of the IDEA reactor.

At the meeting on November 30th, 2018, Curt Martin stated that should the capital be similar, KDC were willing to pay more for the improved efficiency and longer lifespan of diffusers from AquaConsult.

Noise limits and risk mitigation for increased air use require further investigation which will be carried out as part of the detailed design phase.

4 Corroded Motor Cover

4.1 Issue

Upon a site visit by WSP Opus, it was noted that the odour motor cover was corroded. The unguarded moving machinery was a serious safety concern.

4.2 Solution

A new cover and a shelf spare were ordered and installed. This issue has therefore been resolved.

5 Balance Tank

5.1 Issue

High flow mode leads to short cycle and poor treatment. The purpose of this was to manage with wet weather flow which will be less concentrated and require less treatment. However, due to increase in the catchment, this high flow mode will sometimes activate due to high volume of full strength inflow rather than wet weather flow alone. These incidences will increase in frequency with the expected 35% growth over the next ten years. Load balancing will reduce the likelihood of high strength reduced length cycles and balancing of flow at peak loading periods will also reduce aeration demand and improve treated effluent quality.

5.2 Solution

A preliminary design for a balance tank has been sketched and costed. The primary purpose of the balance tank that has been designed is for load balancing to prevent the issue of short cycling of full strength inflow as defined in Section 5.1 above.

It has since been suggested that a balance tank also be used for the purpose of flow balancing. The hydraulic capacity of the downstream treatment system and rising main to irrigation are not sufficient for the anticipated peak instantaneous flow of 100 L/s.

Further investigation is required to determine the best way to balance hydraulic peaks across the catchment and whether this should change the original intention for the balance tank to be load balancing only. This is discussed further in Section 11.

The capital cost of the proposed load balancing tank is approximately $373,805. This does not include for management of high flows or enable transfer of Jack Boyd Drive Pump Station to the site without further peak flow storage.

The preliminary design is detailed in the following sections. Layout will be confirmed during detailed design.

5.2.1 Tank

The tank shall be 8 m internal diameter and 6 m height. It shall be covered, have a minimum working volume of 250 m^3 and a maximum water depth of 5.3 m.

It shall be made of glass coated steel or similar resilient material and be suitably corrosion resistant for contact with potentially septic wastewater. It shall have concrete poured into the base that provides benching with a 5° slope towards the pumps.

It is assumed for costing that the foundation shall consist of a 250 mm concrete slab with one layer of weld mesh, 500 mm compacted material and two layers of geotextile material.

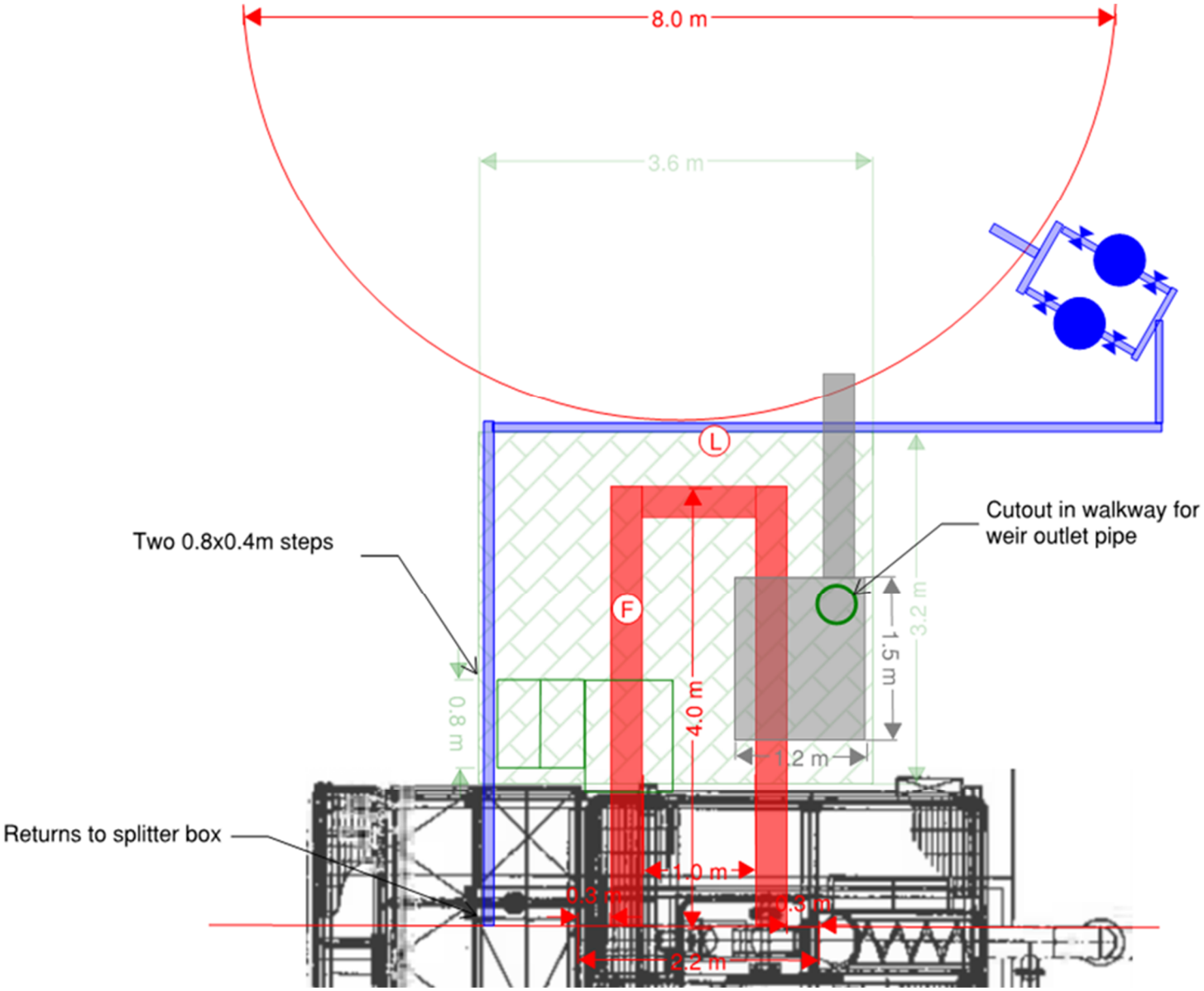


Figure 7. Balance Tank Mark Up - Plan View

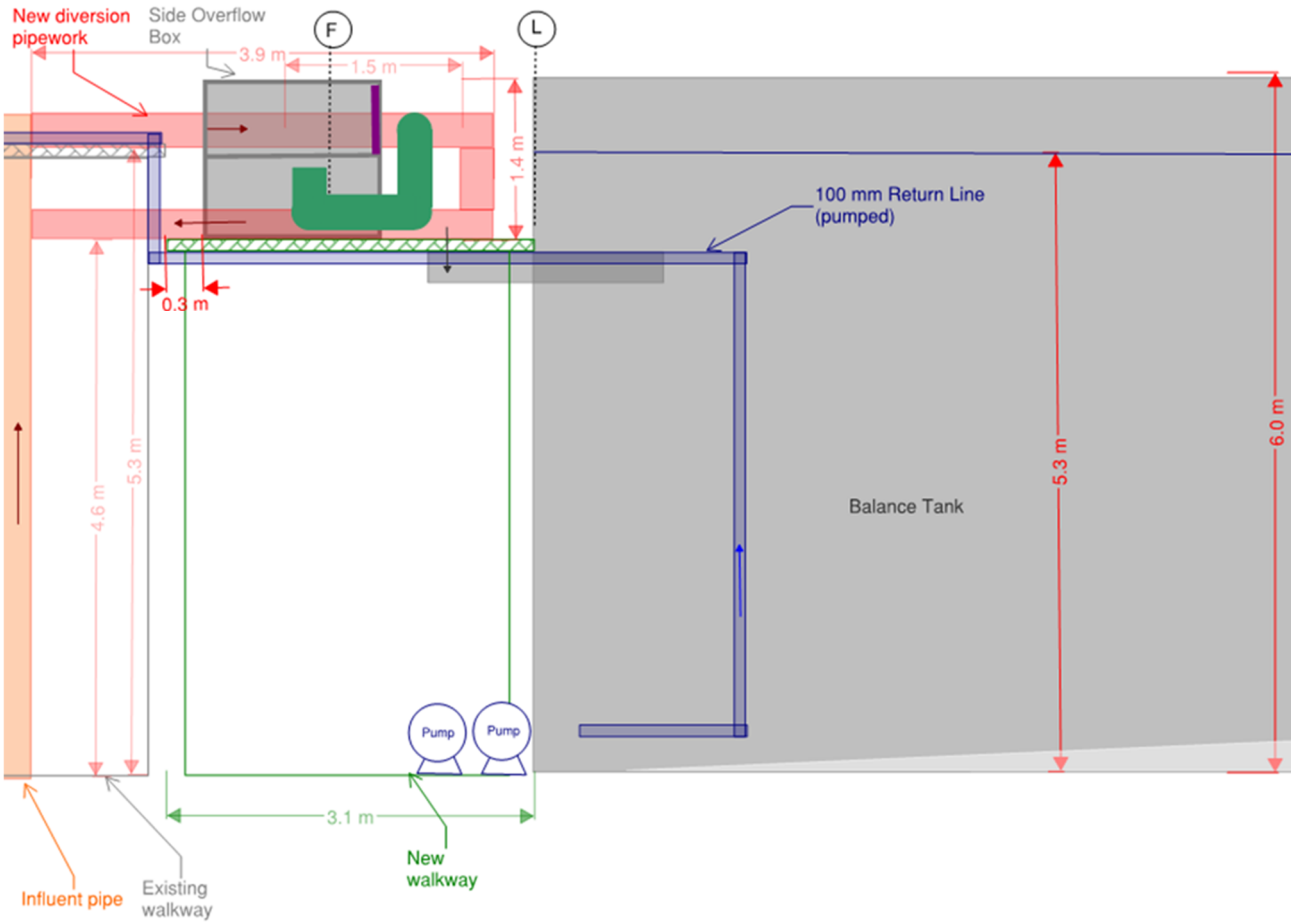


Figure 8. Balance Tank Mark Up - Side View

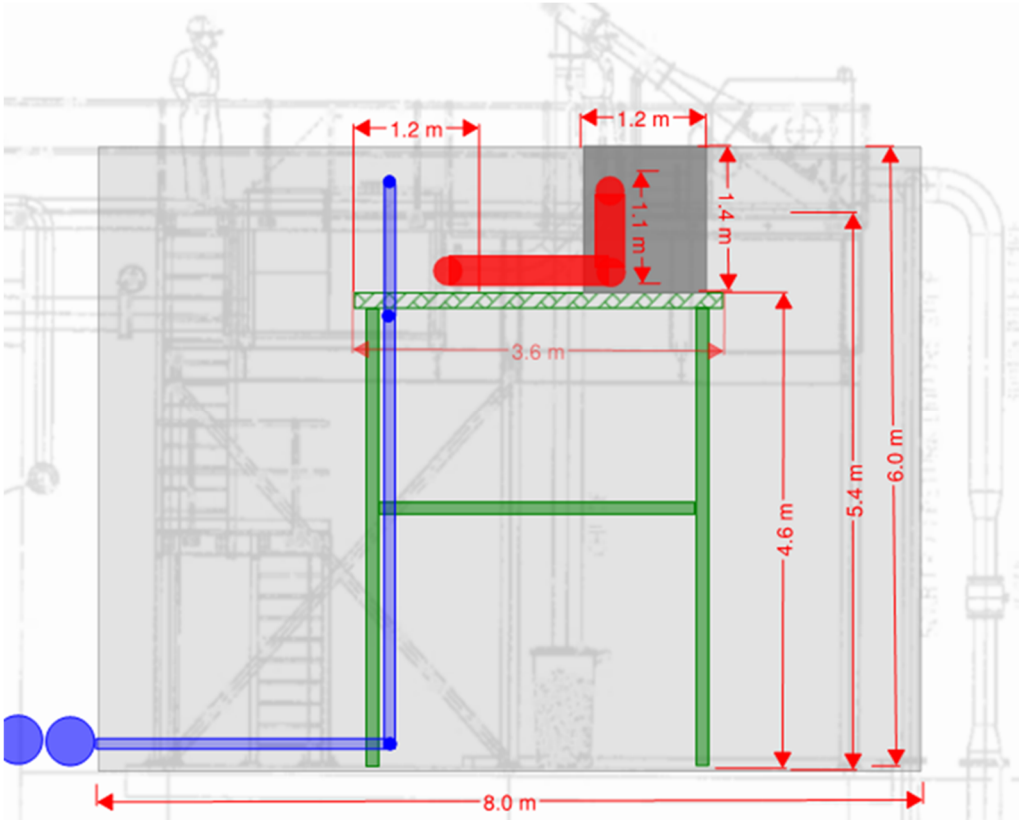


Figure 9. Balance Tank Mark Up - End View

5.2.2 Walkway Structure

The walkway structure shall be a 3.2 m by 3.6 m platform that is 5 m high. 1.1 m handrail with kicker plates to be provided. Galvanised Steel is appropriate. Open mesh Galvanised Floor

There shall be two 0.8 x 0.4 m steps and one 1.0 x 1.0 m step from the existing walkway platform. Minor modifications to existing handrail to permit access.

There shall be a 400 mm diameter cut-out in the platform for the overflow outlet pipe.

It shall be self-supporting and capable of supporting a load of 1500 kg.

The material specification are illustrated in Figure 10 and listed below:

- 47 m of 150 x 6 SHS
- 7 m of 200 PFC
- 24 m of 75x6 reinforcing bar
- 12 structural pins

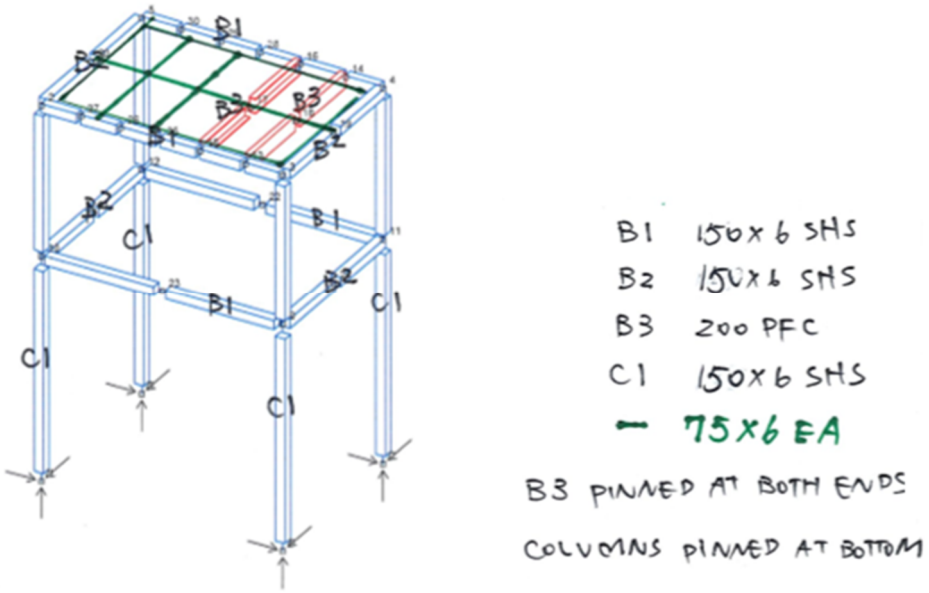


Figure 10. Material Specifications for the Walkway Structure

5.2.3 Pipework and Joints

All pipework and joints shall be stainless steel of the same specification as the existing adjoining pipework.

The diversion pipework shall be 9 m of 300 mm internal diameter.

The overflow pipework shall be 8 m of 300 mm internal diameter.

The emergency pipework shall be 4 m of 300 mm internal diameter.

The return pipework shall be 20 m of 100 mm internal diameter.

There shall be ten 90^0 300mm dia. elbows and eight 90^0 100 mm dia. elbows.

There shall be two 100 mm diameter T-joints.

Pipework may be continuous welded or flanged SS pipes. Flanged connections to be provided to flow splitter, flow control boxes and tank entry.

5.2.4 Overflow Box

The overflow box shall be 1.4 m high, 1.5 m long, 1.2 m wide and be constructed from welded 316 stainless steel.

The channel in the overflow box shall be 1.5 m long, 0.5 m wide and have one lip that is 0.4 m high, it shall be constructed from welded sheet metal.

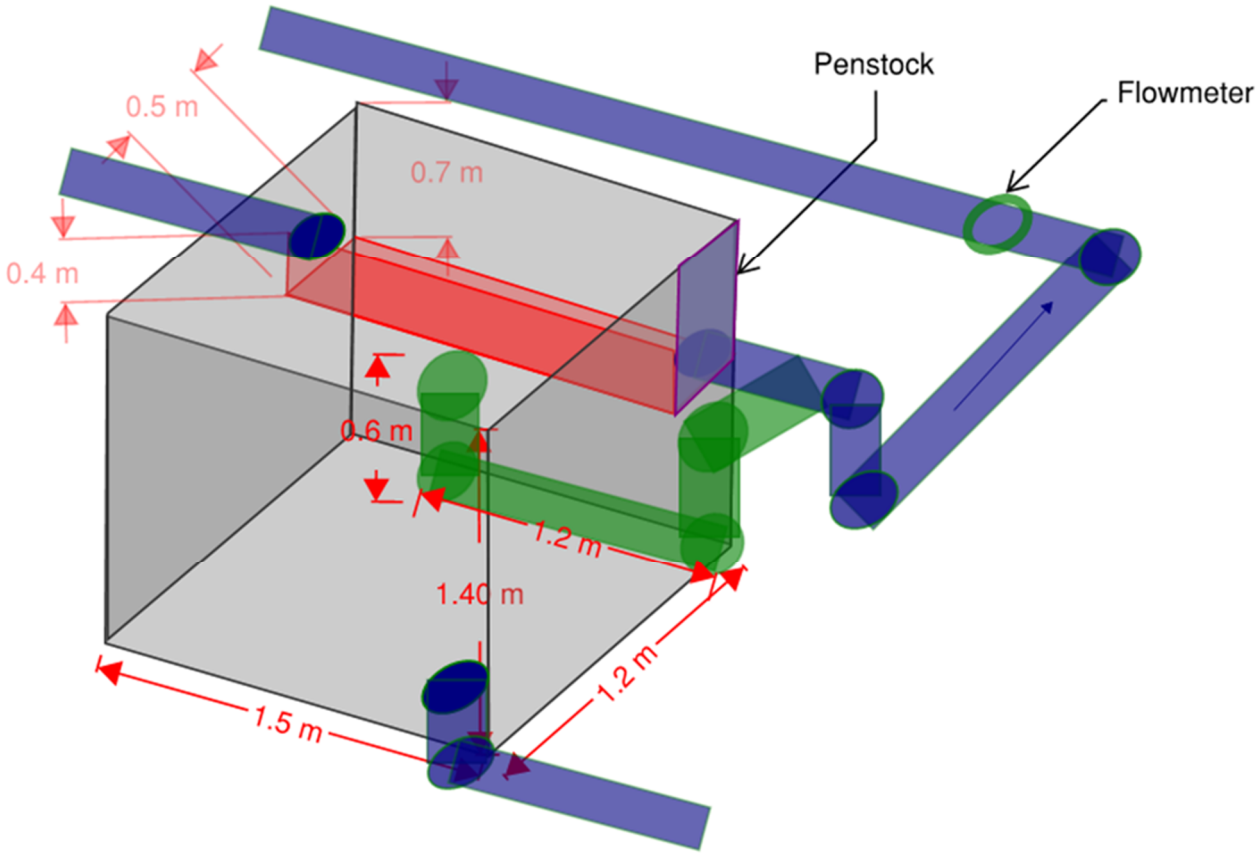


Figure 11. Overflow Box Mark Up

5.2.5 Penstock

The outlet of the overflow weir channel shall be fitted with a stainless-steel modulating penstock with no time delay. It shall have actuated control with position feedback.

5.2.6 Instrumentation

The balancing system has the following instruments:

1 Ultrasonic level sensor
2 Magflow meter

All instrumentation shall be connected to the existing PLC and include the associated cabling, programming and SCADA update.

5.2.7 Return Pump

There shall be two 10 L/s dry well submersible pumps. The pumps shall have both control from SCADA and local control. The valves and fittings shall include two non-return valves, four gate valves and pump and pipe supports as detailed in Figure 12 below.

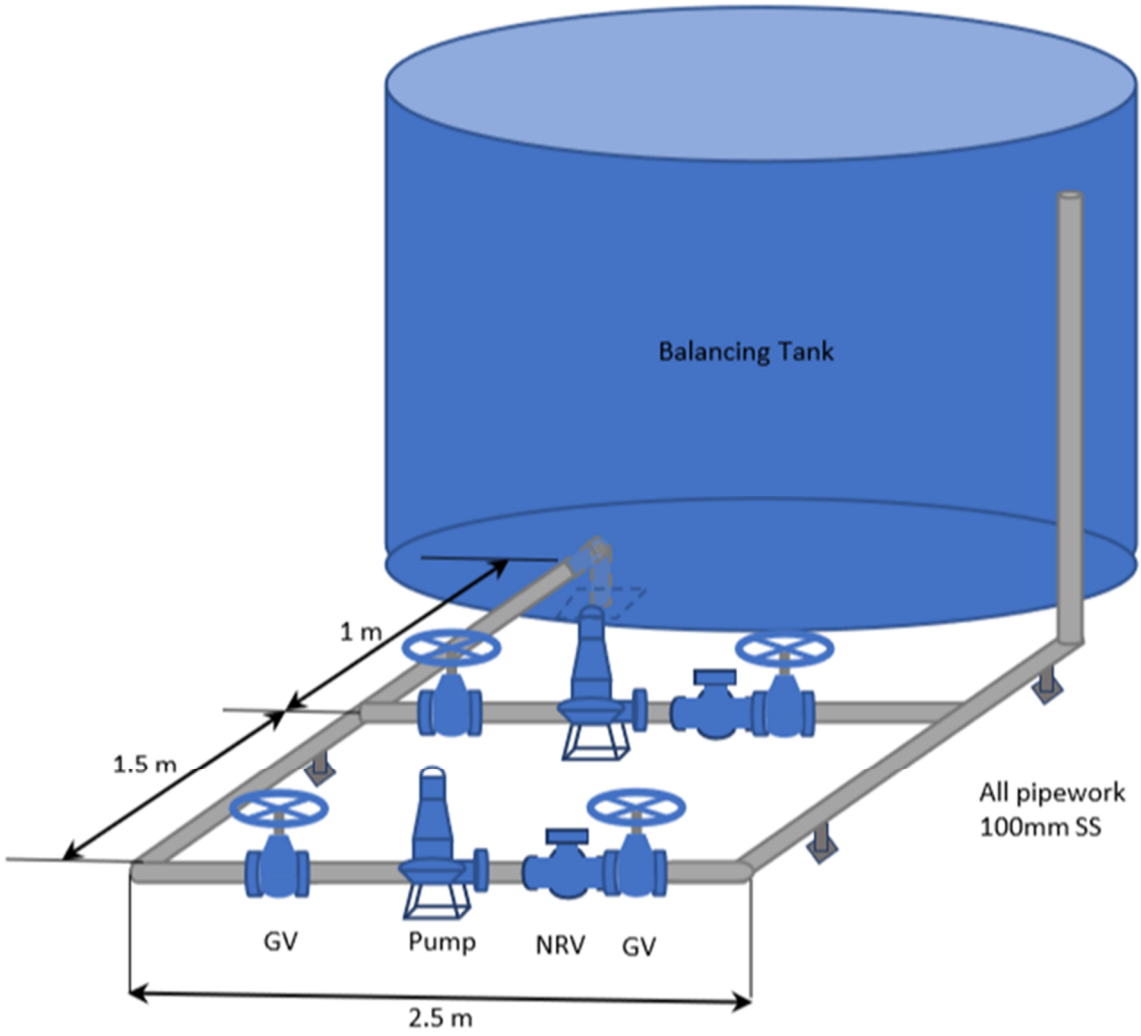


Figure 12. Mark Up of Pump Fittings and Valves Layout

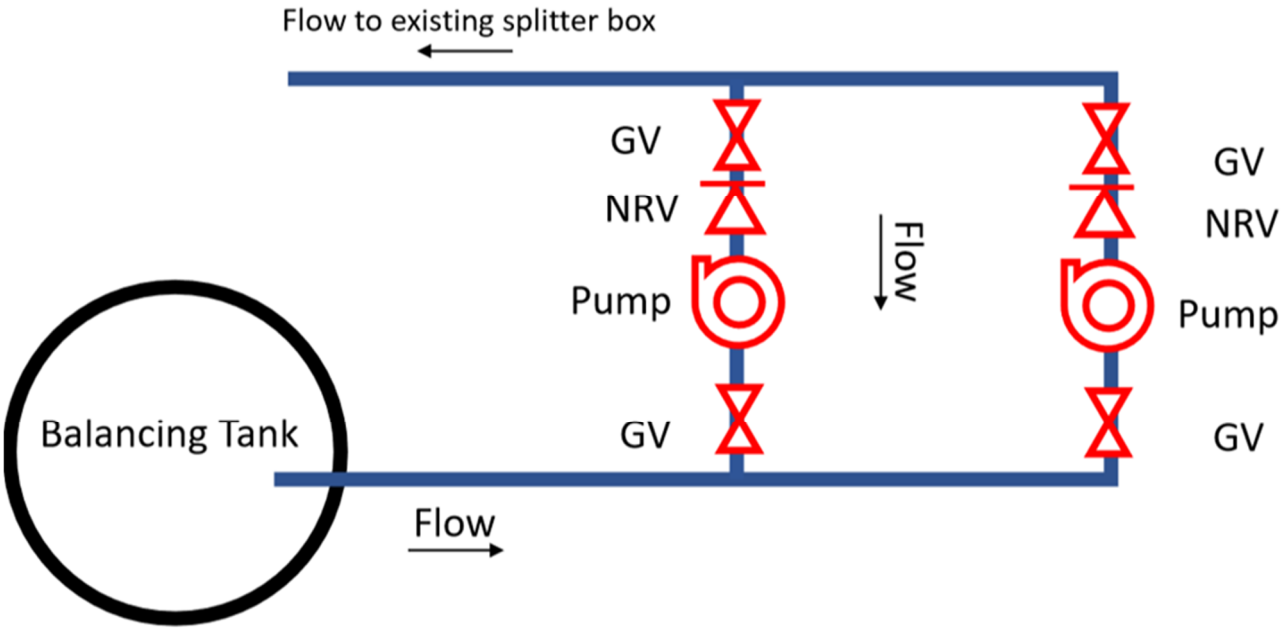


Figure 13. Mark Up of Balancing Tank Return Pump Layout

5.2.8 Cabling

Power cables to be included to the pumps and actuators. Signal cables to be included to level sensor, flow meter and high-level float switch.

5.2.9 Software

The flow to treatment and balance tank level shall both be trended on SCADA. Each pump and inlet control valve shall have available/ status/ failed signal to SCADA with remote SCADA operation and panel operation.

Digital alarms connected to telemetry for high level, pump failure (each) and penstock failure.

6 Inlet Screen

6.1 Issue

There has been an increase in flow from the pump station TPS which has resulted in more flow being pumped to the WWTP. This increase was suspected to exceed the screen capacity and result in overspill of effluent.

6.2 Solution

The existing screen is 500mm with 5mm holes and therefore has adequate capacity for up to 110 L/s as demonstrated in the supplier design chart, Figure 14, below. The combined flow from the outfall pump station and future addition of Thelma Road pump station K has a maximum instantaneous flow of 100 L/s. Therefore, an inlet screen upsize will not be required as part of these upgrades and this item has been removed from the scope.

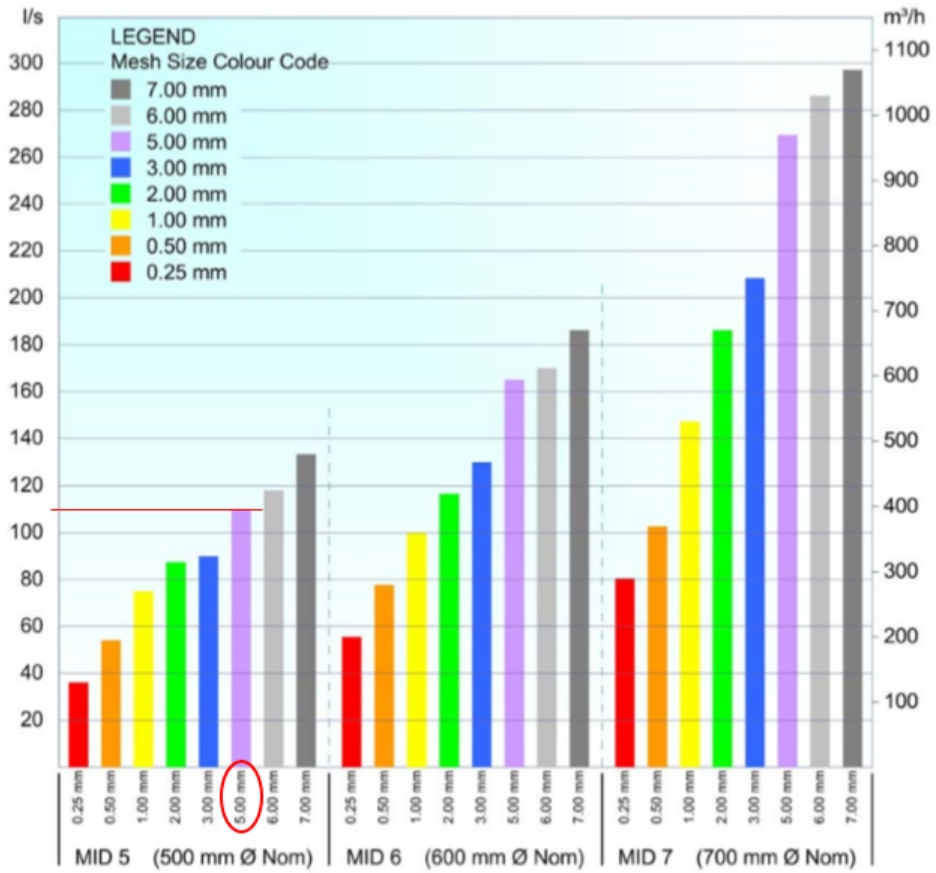


Figure 14. Inlet Screen Capacity

7 RAS Control

7.1 Issue

Seasonal settlement problems have been leading to solids loss from the reactor which results in high TSS in the effluent, particularly during high flows. The sand filters act to limit this effect. Factors that contribute to this are floc loading, variable feed, limited control on RAS and intermediate tank not buffering adequately.

There is no RAS flow meter and therefore no method to control RAS flow rates if required. This may impact on denitrification and sludge settlement

7.2 Solution

The solution proposed for the settlement issues and solids loss is to provide more control of the RAS flow rates. Figure 15 below shows the proposed layout for the addition of flow meters and valves and additional RAS pipework to provide a second dosing location. The RAS flow meters and control valves are to be linked via signal cables to the existing PLC and SCADA system. The flow trends shall be recorded on SACADA. All four flowmeters shall have display boxes that will be located on the existing walkway. The cost of this package of work will be approximately $84,524.

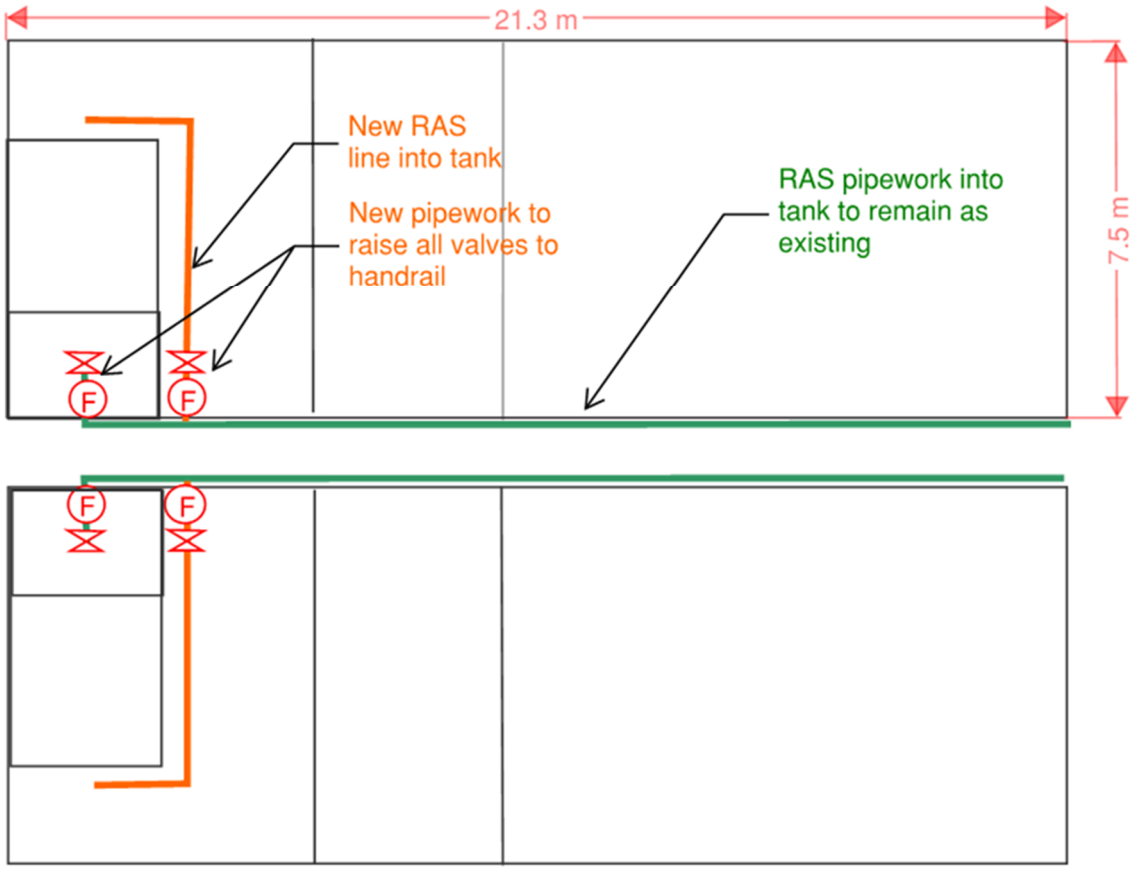


Figure 15. RAS Pipework Additions Plan View

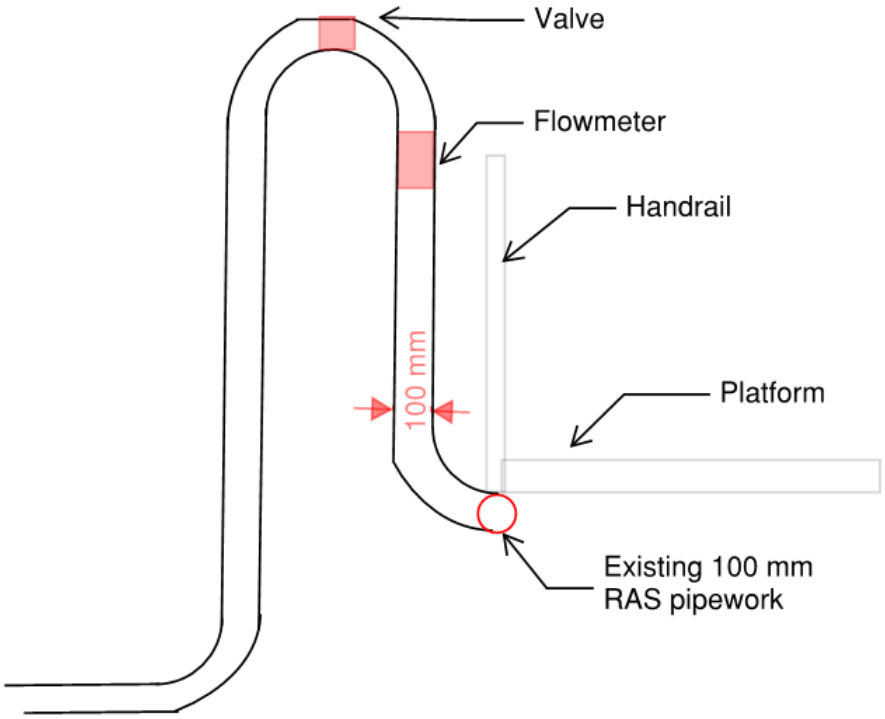


Figure 16. RAS Pipework Additions Side View

This modification enables operator control of floc loading rates and monitoring of RAS flow rates. Floc loading is calculated as:

Floc loading = BOD concentration x inflow / RASS x RAS rate.

A good settling sludge can be achieved when the floc loading is between 80 to 120 gBOD/kgRASS/day. Hence the proportion can be increased or decreased to control the floc conditions to favour floc forming bacteria.

8 Air Valve Accessibility

8.1 Issue

Currently Zone 1 and Zone 2 are aerobic continuously. This reduces the capacity to reduce nitrate and increases oxygen demand on the process. By normally running these zones anoxically, nitrate can be reduced and aeration demand is lower.

The manual air valves pose a safety risk which is currently managed by not using the valve as they cannot be reached from the walkway. This prohibits intermittent aeration of the zones to reduce solids build up.

8.2 Solution

The existing valves shall be reused and relocated to be accessible from the walkway. Additional pipework shall be added to the existing stainless-steel air main as illustrated in Figure 17 and Figure 18 below. Automation shall be added to the valves by retrofitting an actuator for open/close automation. All instrumentation shall be connected to the existing PLC and include associated cabling, programming and SCADA update. The cost of this package of work will be approximately $24,196.

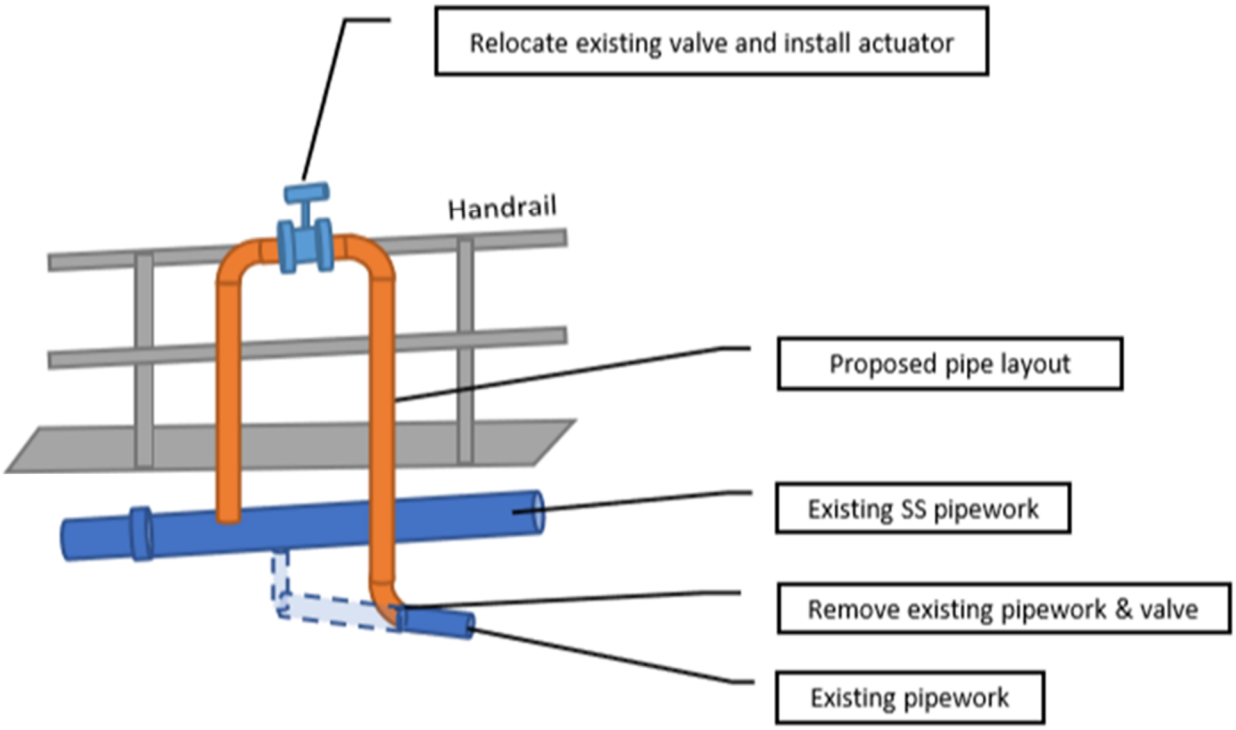


Figure 17. Sketch of Zone 1 Air Pipework Modification

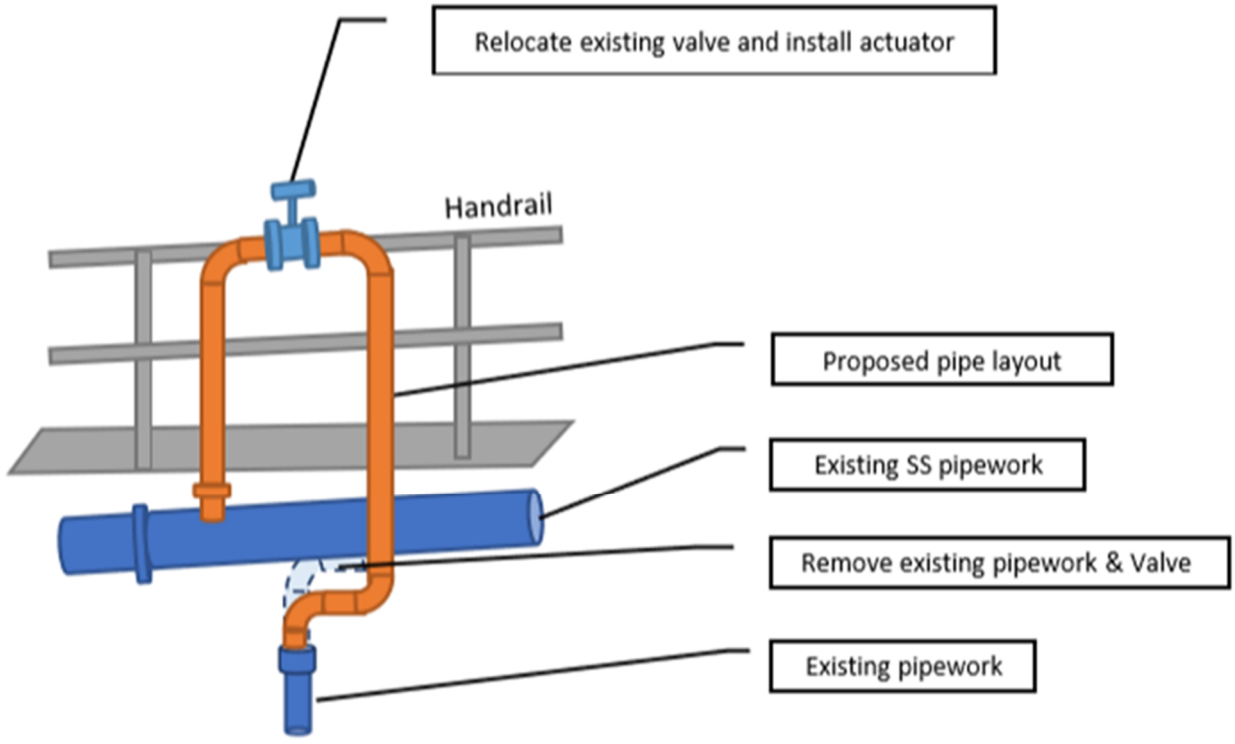


Figure 18. Sketch of Zone 2 Air Pipework Modification

9 Intermediate Tank Settlement

9.1 Issue

There is settlement occurring in the intermediate tank. This was raised as an operational issue in the Root Cause workshop.

9.2 Solution

The current method of dealing with the settlement is to use a sucker truck to remove approximately 30 m^3 of sludge of which 10 m^3 is settled and the remaining 20 m^3 is returned to the tank. The cost of this is approximately $1,000 per time and occurs two or three times a year. Upon further discussion with Trility and KDC it was determined that this was a cost-effective solution. The alternative would be to add a mixing unit to the tank which would cause solids build up in the sand filters downstream. Therefore, this item has been removed from the proposed upgrades.

10 Sand Filters

10.1 Issue

The media in the sand filters has not been inspected since installation in 2008 and therefore the condition of the media is unknown.

10.2 Solution

Trility assessed the condition of the sand filter media and found that it was in good condition. It was agreed with Trility and KDC that no further work on the existing sand filters is necessary.

However, this is a hydraulic choke point at high flows as the sand filters are capable of 7 l/s each (total 28 l/s) which typically gives only 21 l/s when a filter is in wash. This is currently managed by bypassing the sand filters in storm events. Therefore, in order to increase the hydraulic capacity of the plant and increasing the robustness for TSS compliance, it is recommended that two additional sand filter units shall be installed at a cost of approximately $212,966.

11 Jack Boyd Drive Rising Main

Future flow strategy has been added to the scope of this project post Root Cause workshop. The network in Mangawhai village has very little storage and in peak heavy rainfall, can result in demand to pass more than 70 l/s to the CWWTP.

. This has not been risk scored and ranked in order of priority. The cost for connecting the rising main from the Thelma Road pump station to the wastewater treatment plant would be approximately $248,895.80.

Before carrying out this work, KDC has requested a network assessment to look at several options in the network and upgrade to the treatment works to address this flow issue. **This work will be completed as a separate package from the current upgrade project.**

12 Irrigation

There is currently a project to increase the area under irrigation to the maximum of 65ha. This will increase the capacity of disposal to accommodate flows until approximately 2028.

An investigation has been requested to consider the maximum area possible for the irrigation on this site and the practicality of implementation (consider soils, streams and slopes).

A strategy has been requested that considers the impact of long term irrigation land requirements, rising main capacity, future treatment standards and potential alternative discharge routes to ocean or harbour.

This work will be completed as a separate package from the current upgrade project.

13 Consent

This work will be completed as a separate package from the current upgrade project.

14 Costing

Costing summary estimate			Confirmed purchase:
Consultant & KDC		$180,000	
Contingency		$180,000	
1.	Decanter	$12,000	Yes
2.	Aeration	$550,000	Yes (option to be confirmed by KDC)
3.	Balance	$373,000	Subject to flow options
4.	RAS	$85,000	Yes
5.	Air valve	$25,000	Yes
6.	Sand filters (2)	$213,000	KDC to confirm
7.	JBD connection	$250,000	Subject to flow options
		$1,868,000	

15 Procurement

In order to progress on to Stage 3, KDC shall confirm procurement. Trility will have input to several elements of each of these packages including installation, project management and coordination of contractors., so the following key elements may be procured either direct from KDC to supplier or through Trility.

- Aeration package – including blowers and diffusers
- Sand filters – if required

  Total Value: $763,000

It is proposed that the following remaining items be purchased through Trility:

- Decanter
- Balance tank package – if required
- RAS package
- Air valve package
- JBD connection – if required

  Total Value: $745,000

16 Conclusions

The solutions development (Stage 2) has been completed and has resulted in proposed solutions and evaluation of affordability. The next stage of this project is to complete detailed design and finalise procurement.

Additional questions of long term treatment, disposal and flow management have been raised and as a result of the need for further study, flow balancing, sand filters and flow diversion from Jack Boyd Drive PS are unlikely to occur in this financial year.

Appendix 1 – OTT Diffuser Proposal

OTT GROUP
OTT System GmbH & Co.

OTT System GmbH & Co. KG, Postfach 101205 30833 Langenhagen

WSP Opus
The Westhaven, 100 Beaumont St, ,
1010 AUCKLAND
NEW ZEALAND

SALES QUOTATION

Number:	10248
Date:	2018.11.01
Customer No.:	19824
Binding period:	2018.12.01
Delivery terms:	Cost Insurance Freight
your reference:	**Diffuser replacement**
Contact person:	Michael Hummel
Phone:	+49 511 78631 45
Fax:	+49 511 78631 40
Email:	hummel@ott-group.com
Ott Project No.:	18-0926
Project:	**WSP Opus 181019**
Customer Fax	
Customer Email	

Description	Quantity	Unit	Price	Discount	Total EUR
We offer based on our Assembly, Operation, Maintenance Manual and OTT warranty conditions below mentioned scope of supply:					
1112000212 MAGNUM® membrane tube diffuser: total length 2.200mm, with FLEXSIL® membrane. For installtion on 80mm square pipe. incl. 8 spares	260.00	pcs	60.00	- 10.00% = 54.0000	14,040.00
1512000212 MAGNUM® membrane tube diffuser, shortened at one side, total length 1.200mm, with FLEXSIL® membrane For 80mm square pipe incl. 2 spares	10.00	pcs	60.00	- 10.00% = 54.0000	540.00
6400000000 Transport and packing CIF to Port Auckland (seafreight)	1.00		1,500.00		1,500.00
6300000000 alternativ/optional *Supervision* Supervision / Inspection by OTT for installation and/or start-up assist. OTT will stay 4-5 days at site. Price includes travel costs, Hotel and english speaking OTT engineer.	*1.00*		*4,900.00*		*4,900.00*

Transfer
16,080.00

OTT GROUP
OTT System GmbH & Co.

OTT System GmbH & Co. KG, Postfach 101205 30833 Langenhagen

WSP Opus
The Westhaven, 100 Beaumont St, ,
1010 AUCKLAND
NEW ZEALAND

SALES QUOTATION

Number:	10248
Date:	2018.11.01
Customer No.:	19824
Binding period:	2018.12.01
Delivery terms:	Cost Insurance Freight

Net Amount	16,080.00
Total amount EUR	**16.080,00**

Payment Terms: to be agreed

Tax-free delivery

Transfer
16,080.00

Warranty Conditions

applicable to deliveries after 1st of August 2005

OTT GROUP

1. Object of delivery

1.1. Item description

- STANDARD membrane tube diffuser
- MAGNUM® membrane tube diffuser
- MAGNUM® T membrane tube diffuser
- MAGNUM® membrane tube diffuser
- D*REX*® membrane disc diffuser
- FLEX*NORM*® membranes
- FLEX*SIL*® membranes
- FLEX*LON*® membranes
- AIRREX® piping systems
- OTT aeration systems

1.2. Technical data

Dimensions and specifications of the diffusers are shown in the respective layout and data sheets for the products concerned. These are available on request.

2. Warranty case

Warranty shall be applicable when faults in material or workmanship have occurred which cause a damage to the product during the warranty period.

This product responsibility is limited to circumstances which can be influenced by the grantor of the warranty.

All functional impairments which are caused by external effects on the product from outside the sphere of influence of OTT System GmbH & Co. are excluded from the promise of guarantee. In the event that the OTT System GmbH & Co installation, operating and maintenance instructions are neglected, any and all warranty entitlements shall be void.

3. Warranty period

The warranty period shall amount to 24 months from the date of delivery.

4. Scope of warranty

Warranty shall be limited to the delivery of free replacements for justifiably rejected parts. Such free supply of replacement parts does not prolong the warranty period indicated under Item 3, not even with respect to the replacements supplied.

Otherwise, all other and additional claims, particularly claims for damages, shall be excluded, unless OTT System GmbH & Co. KG could be accused of intention or gross negligence.

5. Notice of defect

Any defects have to be notified to manufacturer immediately, within two working days after they became known. The manufacturer reserves the right to inspect the damage himself or have it inspected by a person appointed by him. If, for compelling reasons, a replacement has to be supplied prior to inspection or acknowledgement of the warranty case, such replacement shall be invoiced on a preliminary basis until clarification of liability.

6. Other contract terms

In addition to these warranty conditions, the general contract terms for the performance of services (German VOL/B), latest version, shall apply. The full text of the German VOL/B is available from OTT System GmbH & Co or may be retrieved from the internet at www.ott-system.com.

OTT System GmbH & Co.
D 30855 Langenhagen
Web: www. ott-group.com
Tel.: +49 (0)511 / 78631 0
Fax.: +49 (0)511 / 78631 40
Email: info@ott-group.com

layout results for OTT membrane tubular diffusers

project: WSP Opus (anoxic)
date: 21.11.2018
membrane type: FLEXSIL
diffuser type: MAGNUM 2000

OTT GROUP

layout criteria: *peak SOTR = 169,8 kg O2/h Zone 3 only*

applied to: *1 rectangular tank (18,4 m x 7,5 m; water level = 3,6 m)*

basin data:

water volume	**496,8**	**m³**
water surface	**138,0**	**m²**
basin area	**138,0**	**m²**
side water depth	**3,6**	**m**
submergence of diffuser	**3,40**	**m**

state of air: standard conditions in accordance to EN 12255-12:2003:

density of air @ 0°C, 1013 mbar	1,293	kg/m³
oxygen mass%	23,1	%
mass of O2 in 1 m3 of air @ 0°C, 1013 mbar	0,299	kgO_2/m^3_{air}

process data:

SOTR	**169,8**	**kg O_2/hr**

results:

resulting air flow rate:	**2837**	**m_N^3/hr (0°C, 1013 mbar)**
diffuser thoughput rate	**13,1**	**$m_N^3/hr/m_{diffuser}$**
membrane specific air flow rate	**82,1**	**$m_N^3/hr/m^2_{membrane}$**
aeration rate	**5,71**	**$m_N^3/hr/m^3$**
min. required system pressure	**460,0**	**mbar***

* add additional safety pressure capacity of the blower !

resulting number of diffusers	**108**	**MAGNUM 2000**
total diffuser length	**216,0**	**m**
membrane area	**34,6**	**m²**
diffuser density	**25,0**	**%**
diffuser head loss	**74,0**	**mbar*** **new diffuser!**

* Include safety pressure capacity choosing blower !

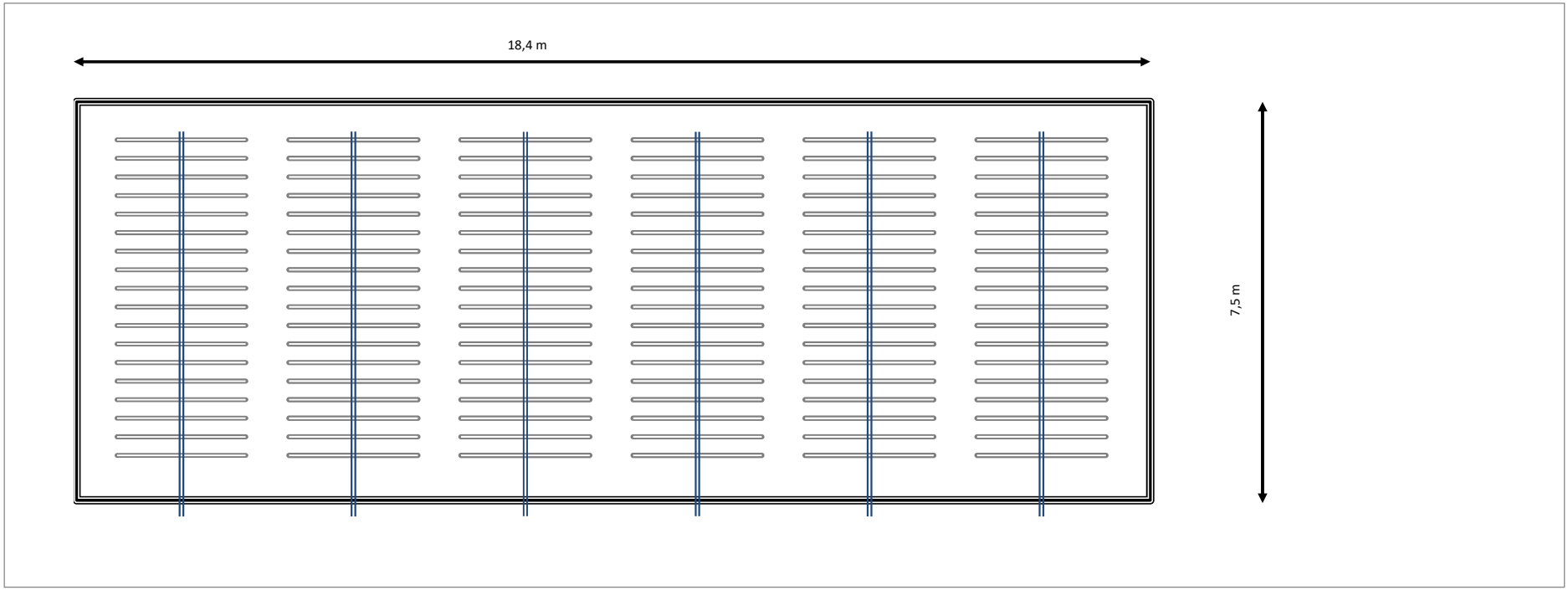
number of headers	**6**	
total header length for diffusers	**36,0**	**m**
diffusers per header	**18**	
distance between diffuser axis	**0,35**	**m**
diffuser grid aera	**79,20**	**m²**
Grid Area	**57**	**%**
theor. temperature of air @ 20°C T_{influx}	**66,0**	**°C at blower discharge**
performance in cleanwater	**4,9**	**kg O_2/hr/m²-membrane surface**
oxygen transfer in clean water	**60,9**	**g O_2/m_N^3-air**
specific SOR	**341,8**	**g $O_2/h/m_{BB}^3$**
specific mixing energy of aeration	**52,2**	**W/m³**
specific air flow rate per volume	**5,71**	**m³/h/m³**
air flow rate per covered floor area	**35,8**	**m³/h/m²**

Guaranteed values:

SOTE	**20,0**	**%**
SOTE* **	**5,9**	**%/m**
SSOTR* **	**17,6**	**g $O_2/m_N^3/m_{id}$**

***: values due to EN 12255-15 and German Standards ATV 115, ATV M209, adsorption method

ANOXIC (Zone 3 only)
SOTR = 169.8kg O^2/hr



Appendix 2 – AquaConsult Diffuser Proposal

Masons
MECHANICAL & ENVIRONMENTAL ENGINEERS

WSP Opus Limited
The Westhaven
100 Beaumont Street
Auckland 1010

Created by: Masons Sales Team
Internal Ref: 18-126
Date: 23 November 2018
Type: Firm Proposal

For the attention of: Jessica Moser

Re: Mangawhai WWTP Upgrade
Ultrafine Diffusers Equipment Supply

Dear Sirs,

Mason Engineers (NZ) Limited is pleased to submit our proposal for the above based on the information contained in your e-mail message dated 21 November 2018.

- The most efficient ultrafine membrane diffuser with the AquaConsult 'Aerostrip" diffuser providing performance that meets the specification will be provided
- All standards, protocols and safety requirements will be rigorously met. We have proposed key staff for this project who have recent experience of successfully delivering similar projects;
- Safe working is assured through use of Mason Engineers proven health, safety, quality and environmental management systems delivered by our management staff;
- Together we have the right diffuser, the right team and the right project support resources to cover all requirements including the design, supply, supervision of installation and commissioning together with after sales support
- We offer the leading Aqua Consult "Aerostrip" diffuser, a very high efficiency fine bubble diffuser with worldwide recognised operational benefits

We trust our proposal meets with your approval and look forward to reviewing this with you soon. Should you have any questions about any aspect of our offer please do not hesitate to contact Peter Pritchard or Geoff Truscott on 09 274 3143

Yours faithfully
Peter Pritchard

Business Development Environmental
Mason Engineers (NZ) Ltd

Contents

Contacts Summary

Name of Client Team

Client Name:	WSP Opus Limited
Attention:	Jessica Moser
Phone:	027 541 0573
Address	100 Beaumont Street, Auckland
Project Name:	Mangawhai WWTP Upgrade – Ultrafine Diffusers
Contract	
Date:	23 November 2018

Mason's Team

Business Development	Peter Pritchard
Email:	peter.pritchard@masons.co.nz
Phone:	+64 21 807067
Proposal Manager:	Geoff Truscott
Email:	geoff@masons.co.nz
Proposal / Tender No.	18-126

Revision

Rev	Date	Description	By
0	23/11/2018	Firm Proposal	PP / GT

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To avoid publication or other disclosure of this document or the information it contains to any third party without the prior approval of Mason Engineers, notwithstanding the potential Purchaser

To make only those copies needed for the recipient's internal review

1. Proposal Summary

This proposal is for the **supply, delivery, supervision of installation and commissioning** of AEROSTRIP® Fine Bubble Membrane Diffusers for the Mangawhai Wastewater Treatment Plant Upgrade project.

AEROSTRIP® is the world's most efficient diffuser, providing significant reductions in power and OPEX when compared to circular or disc type diffuser systems. The system has been proven in 2000+ global installations, with several now operating in Australia.

The reason for the significant energy savings is due to the *1mm bubble* size that AEROSTRIP® produces, resulting in very high oxygen transfer rates. The diffuser itself consists of tapered micro perforations that yield the small bubble size.

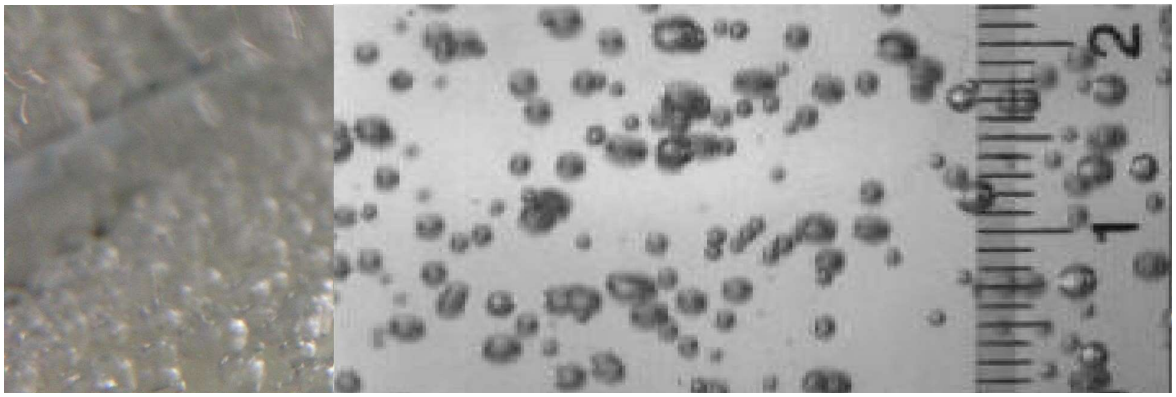


Figure 1 Aerostrip Ultrafine aeration bubbles

Retrofit installations in Europe have shown a significant payback with the use of AEROSTRIP®. Landstuhl STP in Germany ran an assessment after installing AEROSTRIP®, they achieved 23% reductions in power against the previous fine bubble diffuser system.

Another major benefit is material selection. The micro-perforated membrane diffuser is manufactured from polyurethane, which is the key to the AEROSTRIP®s long life as it contains no plasticizers or fillers which are used in EPDM or silicon diffusers. This material has high tensile strength and provides a long life of 12+ years.

This proposal has been prepared by Mason Engineers NZ Limited, the exclusive New Zealand agent for AEROSTRIP® technology. Long term support would be provided from our Auckland office.

Figure 2 Typical Installation

AEROSTRIP® FEATURES AND BENEFITS

The AEROSTRIP provides municipalities with a number of key advantages as follows:

- **High Performance** Highest oxygen transfer rate of 4 – 5.5 kg O_2/kWh, which results in significant energy savings
- **Smallest Bubble Size** The 1mm bubbles provide high surface area and highest mass transfer rate, resulting less air demand with significant power savings
- **Polyurethane Membrane** High strength, no plasticisers or fillers that can lead to brittleness. 12-year life of the polyurethane membrane
- **High turndown capability** Can operate at a number of flow ranges and fluxes (10 to 80 $Nm^3/m^2.hr$)
- **High Quality Procedures** Sophisticated manufacture procedure – each diffuser is tested for air permeability and then tested in a bath. Quality assured.
- **Proven Technology** Independently verified by leading industry and academic professional. Now there are 2000 installations around the world, including Australia

Local support – Masons **o**ffice is in Auckland and offer process, mechanical and maintenance support through customised agreements.

Technology Description

AEROSTRIP® fine bubble diffusers are submerged membrane diffusers used in aerobic biological reactors, such as SBR, MBR, continuous plants for municipal and industrial applications.

The key feature to AEROSTRIP® over other types of aeration diffusers is its energy efficiency. This is achieved through the use of a perforated polyurethane membrane that produces 1mm air bubbles. These tiny bubbles provide a high surface area for oxygen transfer and provide more oxygen into the water stream.

Basic Operation

When AEROSTRIP® diffusers are fed with air, the membrane gets inflated and stretched. Once an air cushion has been formed beneath the membrane, the perforation partly opens. The number of opened perforations increases as the airflow increases. The very fine air bubbles emerge and rise very slowly and with oscillating motion. As there are no movements caused by water rolls the bubbles have a very long life span in the basin.

The tiny diameter of bubbles (approx. 1 mm) provide large specific surface area, stable bubble formation and low rise rate which enable a very high oxygen utilization factor

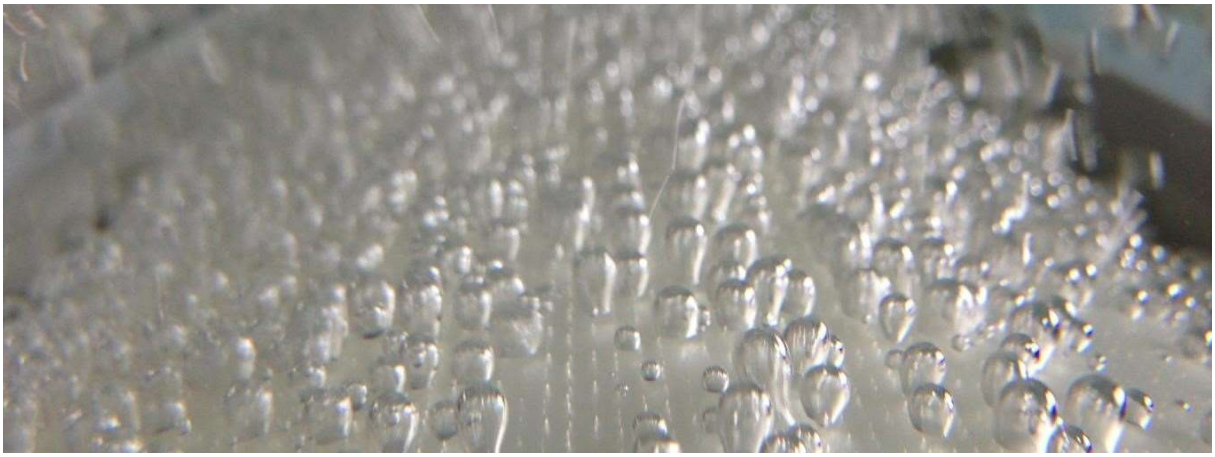


Figure 3 Start of Aeration with Aerostrip Diffusers

Material of Construction

The membrane is manufactured from polyurethane and contains no softeners or plasticisers. This provides a very robust and stable membrane, far superior to silicone based and EDPM materials in terms of life.

The standard Q Diffuser is fabricated from HDPE, the T Series in stainless steel.

Figure 4 Aerostrip Type Q Diffusers

Intermittent Operation

AEROSTRIP® diffusers can be operated continuous or intermittently. During periods of non-aeration, the membrane closes sealing off any particles and avoiding any clogging.

During operation the diffusers will go through regular 'blow down' cycles to release pressure in the header and flush the membrane. AEROSTRIP®'s polyurethane membrane remains elastic over the lifetime of the diffuser which makes the blow down step possible.

The blow down cycle consists of two phases, relax and flex. During the relax cycle, the airflow is turned off with the pores closing tight enough to prevent backflow of water into the diffuser. A valve on the surface of the diffuser allows for the air to escape and the membrane relaxes down onto the diffuser base. The pores will loosen the biofilm growth in the openings and make the flex cycle much more effective in clearing the biofilm from the pores and preventing this fouling from occurring over time.

After a short relax period, the airflow returns at a slightly elevated rate flushing the growth on the membrane which is known as the flex cycle. After which, the system resumes typical operation. This step is recommended daily and is completely automated with the duration typically 3 minutes.

If the pressure loss in the diffusers reach a maximum level of 110mbar a CIP clean will be necessary. This is a simple method to clean the diffusers with no break in the operation of the plant by dispensing acetic acid in the airflow. The injection point will be at the header pipework and the acetic acid must be injected during normal operation of the blowers with air going through to the diffusers. The pressure loss in the diffusers will drop within a couple of days.

Saving on OPEX and Payback

Due to the efficiency of the AEROSTRIP® Diffusers, the cost to treat a certain load of BOD and/or TN is less compared to other diffusers due to the fact that the less air is required and that the membrane life is triple to that of other types.

Perforations

A Perforation density of 400 000 pores per m² produces an ultrafine bubble pattern for a wide air flow range. The number of active pores, which diffuse air to water, varies with air flux. The higher the flux, the higher the number of diffusing pores. This ensures a constant small bubble size for the whole operation range of the AEROSTRIP® diffusers.

Needles perforate elastic membrane vertically allowing distribution of micro pore sizes to self-regular flux of ultra-fine bubbles for a >20:1 turndown.

Figure 5 Perforated Membrane Material

High Quality Manufacture

AEROSTRIP® is hand made in a state of the art factory located in Austria.

Each AEROSTRIP® membrane is tested for pressure loss, hole density and permeability, to ensure that strict guidelines are met prior to assembly.

Once assembled, each AEROSTRIP® is tested in a water bath prior to dispatch.

This rigorous testing procedure ensures that clients are delivered a high quality product together with the high oxygen transfer properties that distinguish AEROSTRIP® from other diffuser makes.

Figure 6 Each AEROSTRIP® is tested for permeability, hole density and pressure loss prior to dispatch

Each AEROSTRIP® is tested for permeability, hole density and pressure loss prior to dispatch

Backflow Prevention

The Polyurethane membrane acts as its own check valve (non-return valve). The contracting pores, perforated by micro needles, prevent backflow when closed and squeeze any debris whilst the polyurethane works like a water repellent inside the pores.

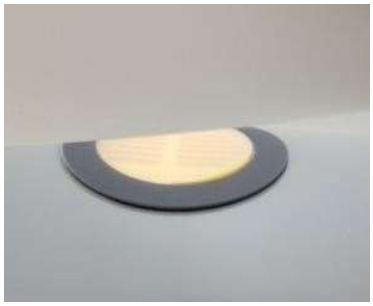


Figure 7 Check Valve - Backflow Prevention

The Q-Series diffuser also has a built-in device to prevent accidental sludge backflow into pipework in the unlikely event that the membrane is physically damaged. During the membrane inflating, the flap is free and allows air circulation, as demonstrated in the photo on the right. When the membrane deflates, the flap is pushed down by the static pressure of the water resulting in no backflow of water and/or sludge.

Research & Development

Energy efficiency and longevity of aeration technologies are two of the most important challenges in wastewater treatment today. While many aeration systems are available, they vary widely in their power usage and lifespan when operating in wastewater treatment plants.

It is generally accepted that the most efficient aeration systems are those employing fine bubbles: small and slowly ascending air bubbles offer the highest interfacial surface for oxygen transfer and offer an enormous energy-saving potential.

The secret lies in the membrane properties, perforation technology, and the design of the overall aeration system.

Intensive research activities in the areas of bubble size, oxygen-transfer rates, and oxygen-transfer efficiency are a daily routine at AQUACONSULT. The professionals are constantly improving perforation technique and are developing proprietary high productivity machines and testing facilities. Materials testing, spectrometry, and resistance to aggressive conditions are just a few key aspects of our internal research activities.

Analysis on the influence of different substances contained in wastewater on the pressure drop and bubble pattern are part of this same intensive research.

The experts from AQUACONSULT offer the end user a scientific advantage through R&D on the membranes, as well as the diffuser construction. The result is that the AEROSTRIP aeration system is the longest lasting, most efficient diffuser on the market today.

Quality and Longevity

"For conventional short sludge retention time treatment plants (SRT 1 to 6 days), this [12-year old AEROSTRIP] system performed better than all previously tested fine pore diffuser systems installed; and even better than most new ones"
Quote: Michael K. Stenstrom, Ph.D., P.E. - Distinguished Professor in the Civil and Environmental Engineering Department of UCLA (University of California, Los Angeles, USA)

Figure 8 Quality Testing

Accuracy and quality are one of the core values of AQUACONSULT. This not only applies to the high performing membranes, but also to the final AEROSTRIP® diffusers which must pass intensive tests prior to shipment. This includes the final pattern and functionality test for every single diffuser in clean water. At AQUACONSULT, developing, manufacturing and sales are DIN EN ISO 9001: 2008 certified. In addition, the products of AQUACONSULT are certified by the GWT - Gütegemeinschaft Wassertechnik für Österreich (an Austrian association) founded 1976 with the aim to promote high quality products in the field of water treatment.

"The art is not in how to build one diffuser perfectly; the secret lies in how to make thousands of diffusers with the same extraordinary properties that provide years of long-term performance. "

By employing micrometric precision of the highest accuracy, providing exceptional quality, and delivering the longest proven lifespan, AQUACONSULT has become one of the major innovation leaders in the aeration industry over the last three decades.

The longevity of AEROSTRIP® is internally tested under the most severe imaginable conditions. Recent studies are documenting how the products of AQUACONSULT behave better on site, and prove higher efficiency compared with new diffusers employing EPDM membranes.

Figure 9 Aerostrip Type Q Diffuser

2. Technical Deliverables

Process Design Information

Tank Details – Reactors 1 & 2

Zone	Water Level (m)	Blow in Depth (m)	Bottom Area (m^2)	Effective Volume (m^3)
3	3.7	3.65	138	511
3	3.7	3.65	138	511

AEROSTRIP® Data – Each Reactor

Zone	Diffuser Type	No. of Diffusers	Total diffuser area (m^2)	Floor Coverage (%)
3	Q-3.0	64	46.6	33.6
3	Q-3.0	64	22.1	33.6

Process Data

Process data is provided below. Please refer to the AQUACONSULT Aerostrip Process Data for details.

Zone 3 – Per Reactor	Current	10 year
SOTR per Tank (KgO_2/h)	149.00	197.40
Normal Air flow per zone to achieve SOTR (Nm^3/h) at 0 deg C and 1013mbarA	2087	2638
Air flow per zone to achieve SOTR (m^3/h) at 20 deg C and 1013mbarA	2239	2829
Estimated overpressure at blower (mbar)	476	516
Specific Airflow (Nm^3/ m^2h)	62.1	78.5
Oxygen Yield - SOTE (%)	23.79	24.95
Specific oxygen adsorption - SSOTE (%/m)	7.10	6.83
Specific Oxygen Yield - SSOTR ($gO_2/Nm^3.m$)	21.31	20.50

Guarantee Data

Per tank			Current	10 Year
SOTR1000 *	kg O_2/h	$\pm$ 5%	141.9	188.0
Air Flow	Nm3/h	- 0%	2090	2640

* SOTR1000 according to EN 12255-15 and DWA-M 209 after start-up period of 14 days

3. Scope of Supply Overview

Equipment

AEROSTRIP® Diffusers

	Diffuser Type	No. of Diffusers per Reactor	Total No. of Diffusers
Tank 1 & 2	Q-3.0	64	128

Set of fittings for drop leg to diffusers as follows;

Total for 2 Reactor Basins

No. Off	Description
32	2” elbows
300m	2” PE pipe PN6
100m	1” PE pipe PN6
128	316SS Snap Fastener
64 / 96	fastening elements and clamps for installation
128	Air connection on diffuser
64	Manifold

Optional Items

Please see Pricing Schedule

- In-House SOTR Test in Austria according to ASCI standard
- 5 x Q3.5 AEROSTRIP® Diffusers as installation/commissioning spares
- 1 x Standard AEROSTRIP® CIP Cleaning Portable Unit

Engineering and Documentation

- Engineering Assistance
- Operation + maintenance manual (2 hardcopies, 1 x electronic)
- General Arrangement Drawings
- Engineering Documentation
- Installation Guidance and Commissioning Assistance

Includes

- Standard Mason Engineers project management, engineering, drawings and documentation
- Delivery to site Mangawhai, New Zealand
- MEL personnel installation supervision 1 week
- MEL personnel commissioning of 1 week

Client Scope

Unless explicitly set forth in the scope of the proposal, this offer does not include the following.

General

- Blowers including VSD for blowers and air supply
- Pressure measurement (gauges and instruments)
- Baffles for Clean Water Oxygen Transfer test
- Chemicals for Clean Water Oxygen Transfer test
- Air header pipework (inclusive of manual / automatic valves)
- Control system
- Chemical Anchors & Fasteners
- Instrumentation (DO, flow etc)

Engineering, installation and other works

- Off loading
- All process design
- All civil works
- All mechanical & electrical installation works (labour and materials)
- Other upgrade works to the rest of the treatment plant
- Modifications to existing equipment or structures
- Commissioning chemical and consumables

- Any testing other than MEL standard testing and inspection.
- Performance tests other than MEL standard tests
- Piping insulation or heat tracing
- Asset hierarchy / equipment list and asset costing
- All permits and consents required for the works
- Any item not specifically mentioned

4. Commercial

Price

- Design supply & delivery $94,271.00
- CIP chemical dosing system $5,876.00
- Supervision of installation $5,850.00
- Commissioning assistance $2,750.00
- Training $1,600.00
- Documentation / factory test certs $3,500.00

Validity

Our offer is valid for 60 days from above date.

Terms & Conditions

We generally accept the contract conditions provided however some minor aspects we wish to discuss with you please.

Payment Milestones

Mason Engineers propose the following payment terms for this project and payments are due thirty (30) days from the submission of the invoice.

Mile-stone No.	% of Contract Value	Payment Milestones	Evidence for payment claims
1	20%	Advance Payment upon Contract Award	Mutually signed contact
2	70%	Site delivery of diffusers and fittings	Receipt of goods signed
3	5%	Completion of Installation	Installation Certificate
4	5%	Commissioning Complete	Commissioning Certificate

We reserve the right to claim 100% if installation and testing is not completed within 90 days of delivery

Schedule Rates for Design & Supply

For additional works outside of Mason's offer, as described, we propose the following schedule of rates.

Design & Supply Resources	Weekdays Hourly rate in NZ$
Project Manager	145.00
Project / Procurement Engineer / Expediter / QA	120.00
Foreman / Site Supervisor	120.00

Commissioning Engineer	120.00
Skilled Supervisor	85.00
Unskilled Labour	65.00
Drafter / Document Controller	85.00

- All schedules of rates are in NZ$ valid for 2018.
- Rates are exclusive of any taxes, withholding taxes and government levies.
- Rates do not include return airfares, accommodation, meals & local transports which will be reimbursed at cost plus 20%.
- Rates do not cover site services which are included in Afters Sales Services.

Foreign Exchange

Our proposal includes a portion of equipment manufactured overseas carrying Euro currency. Upon contract award within 2 Business Days, we will review the exchange rates of NZ$: Euro€, in comparison with the exchange rate we used at the time of proposal submission and make any price adjustment. Masons will then hedge the foreign exchange amount and the contract price will not be subject to further adjustment post contract award.

NZ $1.00 = Euro € 0.57

Confidentiality

This proposal contains technical and commercial information of a proprietary nature and has been submitted to you strictly commercial-in-confidence. Any data, documents and information disclosed to you as part of the tender are confidential in nature and constitute valuable and proprietary information of Mason Engineers NZ Limited. Any such data, documentation and information shall not be disclosed, used or reproduced for purposes other than the purposes described in the scope of the present tender. Mason Engineers NZ Limited shall retain ownership of all intellectual or industrial property contained in any such data, documents and information including without limitation, design, patent, software, know-how, trade secret, trade name, trade mark, copyright or any other similar right, whether registered or not and whether protected or not under the laws of any country.

Details of Providers of Bond, Guarantees and Warranties

a) Our bank is ASB Bank and they will provide all bonds that may arise from any contract

b) Extended warranty may be offered as a pro rata warranty as described in Commercial Section below.

c) We guarantee the SOTR values in the offer according to EN12255-15.

Warranty

Standard warranty is 24 months after start-up / maximum 30 months after delivery. **Extended** warranty may be offered with a pro-rata warranty as described below.

Proposal for Insurances

Mason Engineers carries comprehensive insurances. Our insurers are Aon and Zurich and we can provide copies of the Certificates of Currency if required

5. Support Information

Installation List

There are over 2000 AEROSTRIP® Diffuser installations worldwide including a number of installations in Australia. Please find attached global installations reference list in Appendix 1.

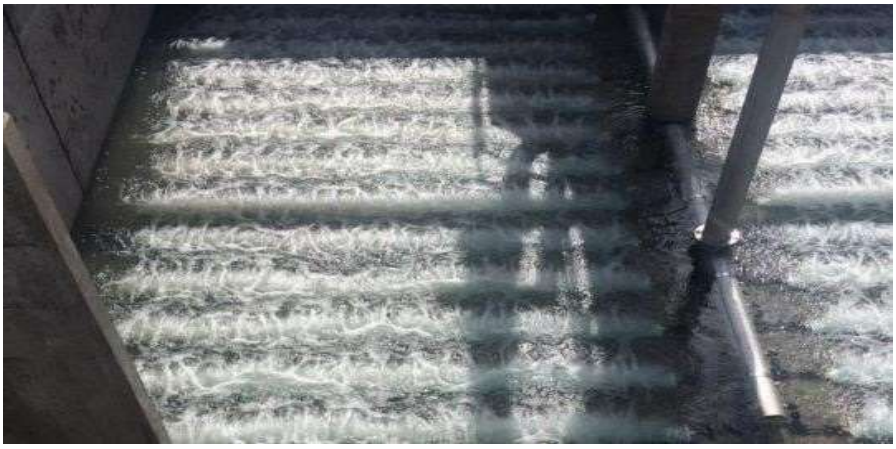
Army Bay

We have recently completed an installation for Watercare at the Army Bay Wastewater Treatment Plant

Item	Description
Client	Watercare Services Limited
Site	Army Bay WWTP – SBR 3
Process Type	SBR
Number of Diffusers	288
Diffuser Type	AEROSTRIP® Q4
Diffuser Length	4 metres
SOTR Max	353 kgO_2/h
Commissioned	July 2018

Below is an overview of the some of the major Australian installations.

South Rockhampton STP



Item	Description
Client	Rockhampton Regional Council
Site	South Rockhampton STP
Process Type	MLE
Number of Diffusers	80
Diffuser Type	AEROSTRIP® Q4
Diffuser Length	4 metres
SOTR Max	144 kgO_2/h
SAE Measured (at TWL of XXm)	4 – 4.2
Commissioned	January 2015

Oxley Creek STP

Item	Description
Client	Qld Urban Utilities
Site	Oxley Creek STP
Process Type	MLE
Number of Diffusers	128
Diffuser Type	AEROSTRIP® Q4
Diffuser Length	4 metres
SOTR Max	168 kgO_2/h
Site Guarantees	All guarantees for SOTR and SOTE met
Commissioned	January 2016

Mt St John STP

Item	Description
End User	Townsville City Council
Site	Mt St John STP
Process Type	Carousel
Number of Diffusers	336
Diffuser Type	AEROSTRIP® Q4
Diffuser Length	4 metres
SOTR Max	750 kgO_2/h
Site Guarantees	All guarantees for SOTR and SOTE met
Commissioned	June 2011

Inghams Murrarie AWTP

Item	Description
End User	Inghams Enterprises
Site	Murrarie Processing Facility
Process Type	SBR
Number of Diffusers	200
Diffuser Type	AEROSTRIP® Q4
Diffuser Length	4 metres
SOTR Max	400 kgO_2/h
Commissioned	June 2009

In addition to those above other upcoming installations in Australia are as follows;

- Woodman Pt STP (Water Corporation)
  - Installation scheduled for the beginning of 2018.
  - 180MLD upgrade using 3600 x Q4.0 AEROSTRIP® Diffusers.
- WTP Upgrade (Melbourne Water)
  - Installation scheduled for the beginning of 2018
  - 140MLD increase in additional treatment capacity using 1700 x Q4.0 AEROSTRIP® Diffusers
- Picton STP (Sydney Water)
  - AEROSTRIP® Diffusers delivered and installation scheduled for end of 2017.
  - 51 x Q4.0 AEROSTRIP® Diffusers per tank (2 tanks) for 195 kgO2/h SOTR per tank.

Drawings

Please find attached a General Arrangement drawing, Detailed drawing of the Q3.5 Aerostrip diffuser also included in the Technical Sheet.

Specific Requirements for Installation

Installation of the diffusers should be done with our guidelines Bulletins Nos. 703 and 704. We suggest that the diffusers themselves are not installed until just prior to start up to avoid possible damage, particularly from UV sun rays. Hardware such as pipework, fittings and snap fasteners can all be pre-installed. When installed we recommend that the diffusers be covered with 0.5m of water.

Our scope includes for the snap fastener and air connection to the diffuser, all in basin pipework, dropper and connection to the main air header including ball valve.

Special Tools

We recommend an acetic acid dosing station for CIP cleaning as described above. We include for this in our price.

Chemical clean-in-place (CIP) portable system

During operation the diffusers have to be relieved from pressure in regular intervals, so that the adhering sediments are removed. A blow-down cycle is recommended on a daily basis however if the differential pressure rises in spite of the blow-down cycle or if the differential pressure cannot be reduced sufficiently by the blowdown cycle, acid dosing into the air flow may be required.

The portable system offered contains;

- Injection pump for 80% acetic acid; Magdos LT3: max 1.8 L/h @ 8bar
- Suction line with level measuring device to prevent drying
- Suction filter
- Safety valve
- Pressure gage in the pressure line
- Injector with spray nozzle and ½“ fitting

Figure 10 CIP Chemical Dosing Kit

Spare Parts Support

AquaConsult has been manufacturing fine bubble membrane diffusers for over 31 years with a proven track record. They are a long term reliable supplier. Spare parts are typically available ex stock Austria and delivery period would depend on whether air or sea freight options re chosen. We advise to order some spare diffusers in case of damage during installation.

Manufacture, Testing and Delivery

Manufacture is by AquaConsult in its factory in Austria. They have a capacity to manufacture around 600 diffusers per week and we can provide a detailed manufacturing programme at the time of contract and the manufacturing is programmed into the production schedule. Your requirements are just over one week of production

- Testing is all to ISO9001 with every single diffuser tested and individually identified and marked. We will issue certified works test results sheets. This ensures that every diffuser meets the quality requirements and will meet the diffuser specifications. Diffusers that do not meet the specification are not shipped.
- Delivery ex works is typically around 8 weeks from acceptance of order. Diffusers and fittings would be placed in heat treated crates for sea freight shipment to New Zealand. Shipment is typically 6-8 weeks from Austria to New Zealand. Please refer to Bulletin 702 in Appendix 1 for correct transport and storage.

Headloss vs Flow

Please see attached document “Typical Ranges of Flux and Backpressure for Aerostrip “

Catalogues

Please find attached data sheets and catalogue information for the Aerostrip fine bubble diffusers.

Details of Sub Contractors / Identified Suppliers

The OEM supplier for the Aerostrip fine bubble diffusers we propose for the Mangawhai wastewater treatment plant upgrade is AquaConsult from Austria. Mason Engineers is the sole NZ distributor for AquaConsult.

AQUACONSULT Anlagenbau GmbH
Badener Straße 46
A-2514 Traiskirchen,
Austria

AQUACONSULT Anlagenbau GmbH was founded in 1986 as a manufacturer of fine bubble aeration systems and is concerned exclusively with the planning, development, and production of fine bubble diffuser since the mid-1990s.

The manufactured strip aerators by AQUACONSULT is called AEROSTRIP ® and can be seen today as one of the most efficient fine bubble diffusers. The production of AEROSTRIP ® is made entirely at the Austrian headquarter to the high quality requirements according to ISO 9001.

AQUACONSULT has a strong team of employees, and their longstanding experience in the field of aeration technology provides the indispensable basis for the success of the company.

Statement of Attributes

Health & Safety

Please find our Health & Safety Policy attached

Mason Engineers (NZ) Limited is committed to maintaining a safe and healthy working environment for our employees and other persons in the workplace. Health and safety is everyone's business, and everyone is expected to share in our commitment to avoid all accidents and incidents, which may cause personal injury, property damage or loss of any kind.

Our design philosophy is to make advanced design, quality and safety initiatives available to our partners and customers. To make this a reality, we have established procedures focusing on technical performance, compliance with process and environmental requirements and long-term cost effectiveness

Design is controlled to ensure outputs meet:

- Tender and project requirements
- Quality, Health, safety, environmental and legal obligations

The minimum Design Review requirements are:

- HAZID – to identify all areas of potential hazard in the project throughout its life cycle.
- 30% Design/Value Engineering Review - Carried out after major design decisions have been made (ie, equipment sized, layout developed, PIDs largely complete).

The Review's aim is to:

  - Identify potential operational or construction issues
  - Review Hazard Identification
  - Assess opportunities for cost/time savings and/or design improvements/simplifications

- Constructability Review to ensure the design allows the equipment to be constructed (both in the Workshop and at site):

  - Within capabilities of fabricators/installers
  - Within the time constraints of the project program
  - Without creating abnormal health and safety risks

- HAZOP - A formal, systematic, review of potential hazards and operating issues with the design and construction of plant.

- Go/No-Go - this review is held prior to commissioning to:
  - Confirm action items generated in the HAZID Risk Assessment, HAZOP and other reviews are complete
  - Review status of installation and identify any potential hazards

The above process contributes to the Safety in Design Register

Environmental

Mason Engineers (NZ) Limited is committed to minimising the negative impacts of our activities, products and services on the physical (built and cultural) and natural environment; and where possible by way of our core business of water treatment solutions, to improving the natural environment. Achievement of this goal is facilitated by our commitment to good Corporate Governance principles and by the application of our integrated environmental system, which is founded on our Health & Safety, Environmental management systems. Please find attached our Environmental Policy in Appendix 3.

Quality

Mason Engineers (N.Z) Ltd is committed to providing products and services, which meet high standards of quality as defined with our customers. The company bases it documentation and systems on the ISO9001 model. Please find attached our Quality Policy Statement in Appendix 3.

These systems are established in manuals, which provide the guidelines for the activities of all staff. The operation and maintenance of the quality system is the responsibility of all employees, who work to ensure customer satisfaction. The quality system is subject to continuous improvement. Mason Engineers quality objectives are to review timelines, costs and customers satisfaction with products and/or services supplies.

Proposed Methodology

Mason Engineers will programme works logically and submit detailed methodology plans, outage requests and start-up plans. Input will be provided by the Main Contractor, Suppliers, the Engineer and Client. A spirit of cooperation by all parties involved will be a key to the success of this project.

Mason Engineers will also supervise any sub-contractors and assure of performance as well as health and safety aspects as per documents.

i. Design, Fabrication, Transport and Storage

Mason Engineers and its sub-contractor Aqua-Consult will in all instances regarding design, procurement, construction, testing and commissioning utilise all available means to keep all parties involved. All communications will involve all interested parties; any decision will involve the client's representative.

Before any orders are completed and works are to begin, written approval will be sought from the client's representative. All required design information will be provided for the engineer to be properly informed and able to make a decision.

Regular updates will be provided to the engineer at pre-determined intervals. Schedule delivery and work will also be advised to the client's representative at the beginning of the month or as agreed upon intervals. For any further information, please consult the Quality Manual, a copy of which can be provided. Mason Engineers have an in-house quality management system that would be utilised to assure completion of all applicable items to the standards required.

Works co-ordination shall be arranged as follows:

a) Mason with Aqua Consult completes design in accordance with the contract.
b) Mason will forward the proposed design to the client's representative for approval.

c) Mason will accommodate any changes required by the client's representative using written instructions to do so and re-submit revised design for approval. If no design changes are required, or revised design is accepted in writing, Mason will issue final documents to WSP Opus and their contractors to use them to start the construction phase.
d) Aqua-Consult will commence manufactures and supply to the specification
e) Mason will inform the client's representative of progress based on milestone achievements or as otherwise agreed on.
f) Factory clean water testing is available to demonstrate SOTE / SOTR at costs identified above
g) Transport and storage will be arranged using current accepted best practices. On site storage may be required and we will arrange this with the contractors staff. Suitable storage shelter will be provided to ensure the goods are kept in best condition. A suitable container for small items may be employed for this purpose

ii. Site Installation and Assembly

All by others with Mason Engineers advice on installation aspects for one week

iii. Commissioning and Performance Testing

Once all work is completed to the satisfaction of all parties and the stated requirements have been fulfilled, the commissioning can be undertaken. Masons provides commissioning support services only to WSP Opus personnel

Commissioning Strategy

The plan for plant commissioning should include:

- Preliminary pre-commissioning and inspections & testing prior to completion of installation
- 5 day/week activity during the Pre-commissioning and Commissioning periods
- Testing using clean mains water (if possible)
- CIP Dosing system set-up prior to *First Product*
- Early *First Product* achievement
- An operating test period after the *First Product* (prior to Performance Testing / Tests on Completion). During this period, the diffuser air flow will be checked. Please refer to the start-up protocol bulletin 052 in Appendix 1

Pre-Commissioning Preliminary Activities

A number of Pre-commissioning activities can be carried out before wastewater is introduced to the SBR tanks. These activities will occur before the *Installation complete* milestone:

- Clear tanks of gross debris

Water Supplies and Discharges

Commissioning will require the following water supplies:

Purpose	Water quality required	Assumptions
Diffuser pipework testing	Clean mains water	Water of a suitable quality is available when required water
In situ diffuser clean water testing as detailed below *	Clean mains water	Water of a suitable quality is available when required water

* Factory clean water testing offered as an alternative

Plant Fine Tuning

A number of aspects of the plant can only be fine-tuned/process commissioned once the plant is consistently treating effluent water. These include:

- Fine tuning air flow rates
- Fine tuning automatic control valve settings
- Fine tuning number of diffusers required in operation to meet process requirements

Consistent operation will require continuous feed to the plant, and hence, the need to discharge treated water.

The tanks should be washed down prior to filling with water to eliminate the effect of contamination. The contractor is to supply potable water with the tanks filled and ready for testing upon arrival. A temporary dividing wall should be in place to divide the tank and isolate the test reactor. The tests should be performed at the operating water level. The aeration system and diffusers should be run for a minimum period of 3-4 days before the commencement of the SOTR tests (by others).

6. Relevant Experience

Mason Engineers will provide WSP Opus with leading edge membrane diffuser technology from AQUACONSULT plus construction and commissioning services. We will deliver a quality, cost effective solution which has been developed collaboratively with AquaConsult, as the sole AquaConsult distributor in New Zealand.

Mason Engineers has in house resources to deliver the Magnawhai project. We have recently completed several similar sized projects and have the resources capacity to deliver the Mangawhai project for WSP Opus.

AquaConsult as the fine bubble membrane diffuser supplier we propose, have installed over 2000 plants worldwide and it is this very extensive experience we bring to the benefit of the Mangawhai upgrade project.

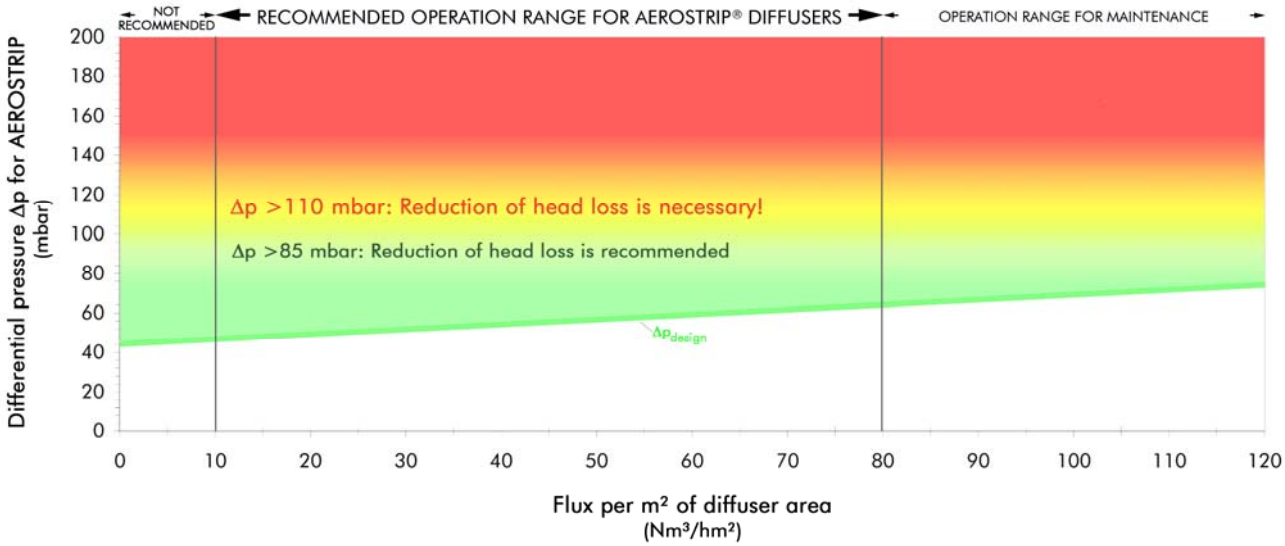
7. Appendix 1 - Aqua Consult Data

- Catalogues
- Installation List
- Flux and Backpressure
- Transport & Storage
- Installation Instructions
- Operating Instructions
- Start Up Protocol
- ISO 9001 Certificate

Typical ranges of flux and backpressure for AEROSTRIP®

The admitted flux (the airflow for surface unit of membrane) range for AEROSTRIP® lays in the interval [0 – 120 Nm³/hm²]. (Nm³ according to DIN 1343 at a temperature of 273.15K [0°C] and 1013 hPa)

Basic conditions as mentioned below have to be considered:



SPECIFIC AIRFLOW [$Nm^3/hm^2_{membrane\ surface}$]:

< 10 Nm³/m²h – Not recommended!

This may lead to improper mixing and poor oxygenation. If flux in these ranges would be desired, it will be recommended to implement intreermittent pulses having flux above 10 Nm³/h/m² which may lead to the desired average value. Even if pattern looked properly, it is highly recommended to restrict continous aeration in this range for less than 2 weeks. If such demand occurred (touristic areas, peak loads, seasonal use), it will be highly recommended to switch to intermittent operation, or restrict water treatment in less tanks.

Warning! If aeration is used for mixing purposes (no mechanical stirrers during aeration), there will be the thumb law of operating at least at a flux, which guarantees a minimum of 2 Nm³/hm² reported to the tank floor area. (For more information, kindly see our technical bulletin no. 701- operating conditions)

10 – 80 Nm³/hm² – Recommended operating range

AEROSTRIP® - fine bubble diffuser elements are designed to operate inside this range of flux, continuous or discontinuous (intermittent). There are no mechanical restrictions in designing the aeration system to operate in this range.

80 - 120 Nm³/hm² - Operation range for maintenance only

Only peak operation is allowed inside this range (during maintenance in other tanks, during peak loads). The life span of membrane may be reduced when overloaded for long time.

TYPICAL AIRFLOW FIGURES RELATED TO EACH AEROSTRIP® UNIT:

AEROSTRIP® Type	Specific airflow [Nm³/hm²membrane surface] 10 min Airflow per diffuser [Nm³/h]	80 max	120 peak
T 1,0-EU-18* / Q 1,0-EU	1,8	14,0	21,0
T 1,5-EU-18* / Q 1,5-EU	2,6	21,0	31,5
T 2,0-EU-18* / Q 2,0-EU	3,5	28,0	42,0
T 2,5-EU-18* / Q 2,5-EU	4,4	35,0	52,5
T 3,0-EU-18* / Q 3,0-EU	5,3	42,0	63,0
T 3,5-EU-18* / Q 3,5-EU	6,1	49,0	73,5
T 4,0-EU-18* / Q 4,0-EU	7,0	56,0	84,0

*) for AEROSTRIP® Type Tx,x-EU-15 the details according to the chart have to be reduced by16%.

DIFFERENTIAL PRESSURE ACROSS AEROSTRIP® (Δp or dp):

The differential pressure across membrane is the consequence of the friction of air through the pores of the membrane while passing with velocity through a tensed orifice. Additional process-related biological and mineral sedimentation may lead to the deposits on the membrane. Therefore pressure drop dp across membrane may be increasing in time, leading to possible issues. As preventive maintenance is very important for the operation of such systems, constant monitoring and logging of this pressure becomes of crucial importance.

Δp_{design}: 45 mbar + 0,25* spec. airflow [Nm³/hm²membrane surface] ; ±10% tolerance

This formula applies for new or freshly cleaned AEROSTRIP® – membranes

Δp>85 mbar: preventive maintenance required, in order to prevent and reduce pressure drop. Please consult our bulletin no. 715 - maintenance.

Δp>110 mbar: If the 110mbar limit is exceeded during operation there will be immediate actions to be taken, as instructed in our bulletin no. 715 – maintenance. Operating for extended periods of time at above 110 mbar may lead to permanent damage of membranes, and also may lead on waiving of warranty (see warranty conditions).

Δp_{max} > 200 mbar: Please note that 200 mbar is the maximum admissible differential pressure inside diffuser system. Membranes may blow and damage may occur above this upper limit

HOW TO FIND OUT ΔP?

Thumbs rule for calculation may be: Pressure in the pipe [mbar] – depth of water [cm] = $\Delta p_{AEROSTRIP®}$ [mbar]

example:	$pressure_{measured}$ @ air $pipe_{blower\ station}$:	624 mbar
	depth of water:	550 cm (= 550 mbar)
→	Δp = 624 – 550	74 mbar

This simplified calculation gives a useful estimate, of the differential pressure in the AEROSTRIP® elements. The instrumentation may use this rule for sampling of Δp. Individual pipe elements such as elbows and bushes were not considered.

Transport and storage of AEROSTRIP® DIFFUSERS

1. PACKING

Truck-transportation: The diffusers ("strip aerators") are bunched together on a stiff pallet, with a PE shrink foil. Edges are protected with wood. Piling up pallets on each other is prohibited if not a special packing has been procured.

Sea-transportation: AEROSTRIP® diffusers are packed in wooden boxes.

2. TRANSPORTATION

Bending during loading and transportation is not permitted.

Lifting of piled diffusers with a crane or a fork lift truck is only permitted if the pallet is originally packed. Otherwise the diffusers must be transported individually.

Lifting with a crane no chains or cables may be used. Admitted are nylon ropes at the designated places on the packing (see drawing).

Boxes may not be overthrown.

Transportation has to done without damage to the diffusers. Especially during loading the strip diffusers must be handled with care.

3. STORAGE

The diffusers have to be protected against weather factors, especially against heating up.

Temperature limits for storage are -5°C to +40°C. If the diffusers are to be stored outside at negative temperatures frost damages must be avoided.

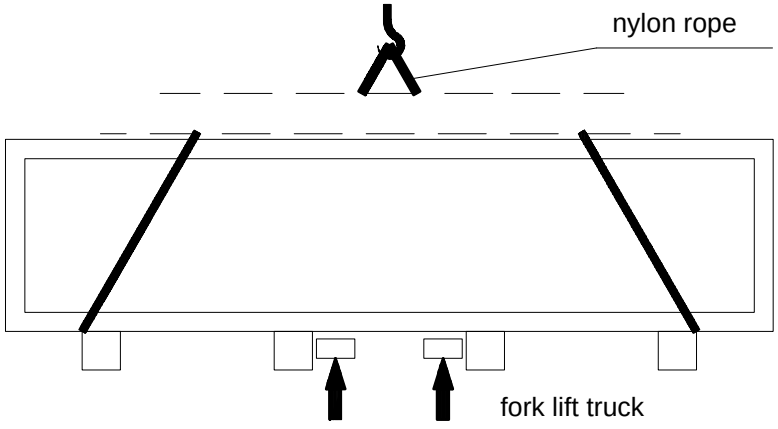
Furthermore a flat, dry and paved area should be used.

We recommend storage in closed, dry and frost-free accommodations, off of frequently used transport routes.

Do not performe any work around the storage area of these pallets.

STORAGE OF SPARE DIFFUSERS AND SPARE MEMBRANES

The spare diffusers and the spare membranes must be stored in their original package. In all situations the membrane must be protected against direct light and sunlight exposure (black PE foil)



Installation Instructions
for
AEROSTRIP® DIFFUSERS

1. PREPARATION

1.1 All non-aerator-installation work in and around the aeration tank, especially welding-, drilling-, grinding- and similar work must be completed before installing AEROSTRIP® diffusers.

1.2. The erection must be completed; tank must be ready-made and cleaned.

1.3. The air supply system including drop legs, valves and drains must be installed completely.

1.5. The air supply system must be blown out before connecting the diffusers to the drop legs.

1.4. Blowers have to be ready for operation and been tested.

1.5 Before connecting air pipes to the diffusers, the blowers must be switched on for 15 minutes to allow the pipe flushing.

2. ASSEMBLY

2.1 GENERAL (REFER TO BULL. NO. 372)
If the tank floor is even and horizontal the diffusers are put directly on the tank floor and are fastened with the fixing brackets. Level differences have to be equalized by adjusting the nuts under the fixing brackets.

2.2 SETTING OF PLUGS
It is recommended to examine details of fastening with the civil contractor of the tank. The plugs have to be designed for a force of 750 N (Type T). It is recommended to use a drilling device to drill the holes for the plugs at the designated places. If not a directly fixing of the diffusers on a flat flour is chosen, the bolts have to be fixed and equipped with a nut and a washer. The lengh of the bolts has to be accordingly to the max. level difference. The plugs for the fixing of air drop legs have to be set.

2.3 TRANSPORTATION OF AEROSTRIP® DIFFUSERS
Transportation of diffusers into the aeration tank is preferably done with a suitable device. A crane or a fork truck lift may only be used if the pile is originally packed.
Otherwise the diffusers must be transported individually. Bending of diffusers must be avoided.

2.4. DISTRIBUTION OF AEROSTRIP® DIFFUSERS
Please handle with care while placing diffusers onto the prepared bolts.

ATTENTION
Don´t step on the diffusers.
Don´t put tools on the diffusers.
Don´t damage the membrane
! EXCLUSION OF WARRANTY !

If it is yet necessary to step on the diffusers - e.g. due to high floor coverage etc. - they must be protected suitably (boards etc.).

2.5 FASTENING, LEVELLING

Levelling is done by adjusting the counter-nuts. Each individual diffuser must be exactly horizontal. The maximum difference of different diffusers must not exceed 5 cm. The diffusers should be plane and must not be twisted.

For direct fastening on a flat floor of AEROSTRIP® type T, those are fastened by bolting down the clamp.

2.6 AIR CONNECTION

After distribution and fixing of diffusers the air connection from the diffuser to the air distribution line has to be made. The connections must be tight-, kink- and tensionfree. Sufficient number of fixings shall be provided to avoid vibrations, especially for plants with mixers.

2.7 FILLING OF THE TANK

After completion of the erection filling of the tank shall commence. The incoming water shall not pour directly on the diffusers. Fill approx. 10 cm above diffusers.

2.8 TIGHTNESS CHECK

Open all ball valves to the diffusers, close drain and relief valves. Switch on the smallest blower flow and check for tightness. If there are no leaks, the filling of the tank may be continued and the plant may be started up.

If there are leaks on AEROSTRIP® diffusers contact your supplier.

3. RECORD OF ASSEMBLY

Keep a record of the assembly and start up of AEROSTRIP® diffusers.

4. IDLE PERIODS, SUN RADIATION, FROST

AEROSTRIP® diffusers have to be protected against sun radiation because of heat influence especially in summer periods resp. in hot areas. We recommend to fill water at least 1m above diffuser surface. This also reduces the danger of damages from dropped items and protects from frost.

This is also the reason that assembly of diffusers should be done speedy, uninterruptedly and after finishing all other erection work.

OPERATING INSTRUCTIONS
FOR
AEROSTRIP® DIFFUSERS

1. START UP

1.1 It is a precondition that assembly of **AEROSTRIP®** diffusers has taken place in accordance with Bull 703. If necessary remove all nails, peaky stone, broken glass etc. from the tank floor and clean the tank again. Fill the tank with clear water 10cm above **AEROSTRIP®** diffusers.
Incoming water shall not pour directly onto the aerators whenever possible.

1.2 Open all valves especially the shut off valve in the drop legs but close relief valve and drains.

1.3 Start up blowers and check the system again for tightness.
Fill the tank to the designated water level.
After approximately 7 days the typical bubble pattern for **AEROSTRIP®** diffusers will develop.
Before SOTR and SAE test will commence therefore a 14-day test run is necessary to achieve full oxygen transfer efficiency of the membrane.
For start-up a specialist is available on request.

2. OPERATION AND MAINTENANCE

2.1 We recommend to install safety devices against over-pressure. This might be:

* safety disks
* pressure relief valve on the blower (correctly adjusted)
* pressure switch with following functions:
  set point 1: initiation of a blow down cycle
  set point 2: alarm cycle , switching off

Set points will be fixed at start up according to site conditions.

2.2 Check pressure at the installed pressure gauge daily. The function of the over-pressure safety device has to be checked weekly (not with safety disks). The results have to be contantly recorded.

2.3 If the pressure differs more than 40 mbar from our initial figures, check for the cause (e.g. water level, density of the MLSS, salinity, valves closed).

2.4 At constant flow the **AEROSTRIP®** diffuser may foul. To remove deposits deflating and subsequently stretching of the membrane is necessary. If this deflating and stretching is not sufficiently done during normal operation, a membrane maintenance must be performed (blow down cycle). The intervals differ from some daily to once weekly and depend on the characteristic of the plant. Automation of this procedure is highly recommanded.

2.5 If single diffusers have to be cleaned, repeated opening and closing of the shut off valve (3 min period) may be successful.

2.6 Injection of chemicals into the air flow may only be done after approval of the diffuser supplier.

2.7 Wherever possible drain the aeration tank once a year, to check for silt or grit deposits on the diffusers or for mechanical damages.

2.8 If untypical effects occur, please contact the supplier of **AEROSTRIP®** diffusers and shut off the concerned panel. (see also Bull 709)

2.9 Maintenance agreement on request.

3. Performance of membrane maintenance cycle (blow down cycle)

3.1 Shut down blowers.

3.2 Open relief valve in the air pipe to release air till a pressure is reached which is slightly (10 to 20 mbar) lower than the pressure which corresponds to the immersion depth. (e.g. immersion depth 4,2 m, recommended air pressure 390 – 420 mbar.) As soon this pressure is reached, close air relief valve.

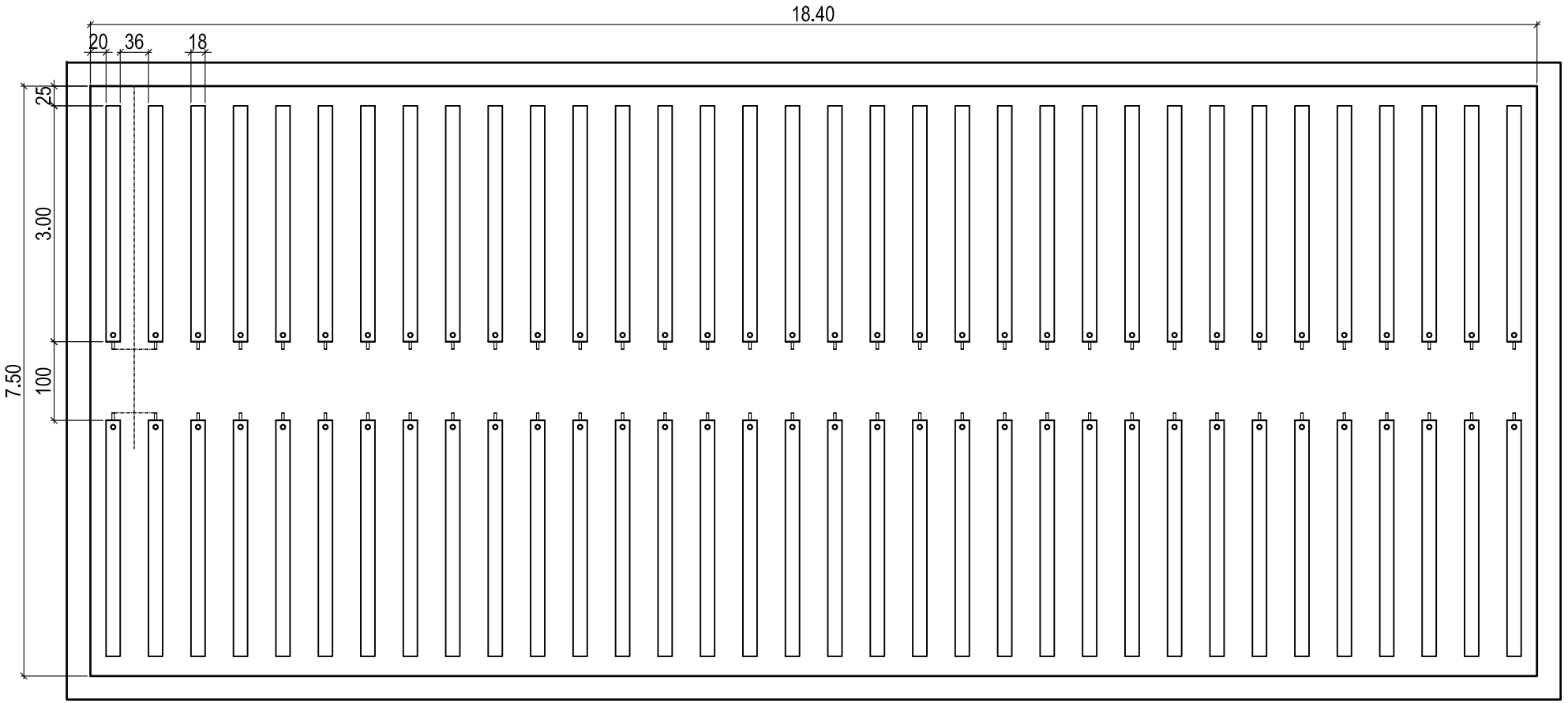
3.3 Leave membrane 2 minutes deflated.

3.4 Switch on blowers.

This procedure may be repeated immediately or after a while. Automation is a must especially with industrial waste waters.
This procedure will be performed 2 to 8 times a day for the continuous aeration processes. The time intervals should depend on the pressure loss of AEROSTRIP® diffusers (the higher the pressure, the shortest the interval).
If aeration is performed on intermittent basis, the pressure release procedure shall run at the beginning of denitrification phase - with turned-off blowers .

8. Appendix 2 – Drawings

- Drawings
    - Layout – Dwg. 17-014-ME-L-01 Rev B



basin :
64 AEROSTRIP diffusers type Q 3,0-EU

SOTR = 141,9 kgO2/h
air flow = 2090 Nm³/h

waterlevel 3,4 m

no scale

[X] zur Ausführung freigegeben			[X] Entwurf, zur Ausführung nicht freigegeben	
	Name	Datum	NZ-2560 Mangawhai WWTP layout of diffuser	AQUACONSULT
gezeichnet	Rixrath	22.11.18		
Z-Nr:	NZ-2560			
Rev.:	00			

AQUACONSULT Anlagenbau GmbH A-2514 Traiskirchen Badener Straße 46 TEL 02252/41481 FAX 02252/41480 e-mail:sales@aquaconsult.at

9. Appendix 3 – Policy Documents & Insurance

- Insurance Certificates of Currency
- HSE Policy
- Quality Policy
- Environmental Policy

AON CPF
CLIENT PLACEMENT FACILITY

CERTIFICATE OF INSURANCE

To: Geoff Truscott

Date: 26/6/2018

Client Placement Facility (CPF)
CPF Takapuna

THE SCHEDULE

Insured: Mason Engineers (NZ) Limited

Interested Parties:

In the event of mortgage or other interest, loss if any, is payable to the interested party whose receipt will be a full discharge.

Policy Number:	**Contract Type:**	**Sum Insured:**
M1199 / 3696620	Commercial Motor Vehicle	
	Third Party Liability Limit	$10,000,000

Subject of Insurance: All vehicles owned or operated by the Insured

Period of Insurance: 30/6/2018 to 30/6/2019 at 4.00pm

Endorsements / Special Clauses: As per CPF Terms & Conditions

Wording Commercial Motor Vehicle

Excesses: $500 Standard
As per the agreed CPF Terms

This certificate is issued in lieu of the Policy & it hereby grants insurance as detailed above. This insurance is subject to the terms, exceptions, conditions & warranties of the Company's standard form of policy specified as modified by the endorsements, extensions & clauses attached or specified hereon. If not attached, a copy of such policy is available at the Company's above Branch Office.

Signed by NZI as Manager of CPF

29/06/18

NZI a business division of IAG New Zealand Limited CPF

UNDERWRITTEN BY

NZI vero Allianz

Certificate of Currency

This is to certify that the under mentioned policy is current at the time of issue of this Certificate of Currency, subject always to the Insuring Clause, Exclusions, Definitions, Standard Conditions and Limits of Liability set out in the policy, its *schedule* and its endorsements.

Class of Insurance
Architects and Engineers Professional Indemnity

Policy Number
99-2787986-PIL

Named Insured
Mason Engineers (NZ) Ltd, MasonLED Ltd, Tuscan Ltd

Limit(s) of Liability
$10,000,000 any one *claim* and in the aggregate for all *claims* during the *period of insurance*

Period of Insurance
From 30 June, 2018 at 4:00pm to 30 June, 2019 at 4:00pm

Territorial Limits
As defined in the Policy

Deductible
$25,000 any one *claim*

Zurich's Proportion
100%

Issued
at Auckland on 29 June 2018

Zurich Australian Insurance Limited (incorporated in Australia) Trading as Zurich New Zealand
ABN 13 000 296 640
AFS Licence No. 232507

Level 16, 21 Queen Street
Auckland 1010
PO Box 497
Shortland Street, Auckland

Telephone +64 9 928 8000
Fax +64 9 928 8100

Zurich Australian Insurance Limited (incorporated in Australia) Trading as Zurich New Zealand
ABN 13 000 296 640
AFS Licence No: 232507

Certificate of Currency

This is to certify that the under mentioned policy is current at the time of issue of this Certificate of Currency, subject always to the Insuring Clause, Exclusions, Definitions, Standard Conditions and Limits of Liability set out in the policy, its *schedule* and its endorsements.

Class of Insurance
Combined General Liability

Policy Number
99-2787986-ZML

Named Insured
Mason Engineers (NZ) Ltd

Limit(s) of Liability
$10,000,000 any one *occurrence*, limited in respect to *products* to $10,000,000 any one *occurrence* and in the aggregate for all *occurrences* during the *period of insurance*

Period of Insurance
From 30 June, 2018 at 4:00pm to 30 June, 2019 at 4:00pm

Territorial Limits
As defined in the Policy

Deductible
$1,000 any one *occurrence*

Zurich's Proportion
100%

Issued
at Auckland on 29 June 2018

Zurich Australian Insurance Limited (incorporated in Australia) Trading as Zurich New Zealand
ABN 13 000 296 640
AFS Licence No. 232507

Level 16, 21 Queen Street
Auckland 1010
PO Box 497
Shortland Street, Auckland

Telephone +64 9 928 8000
Fax +64 9 928 8100

Zurich Australian Insurance Limited (incorporated in Australia) Trading as Zurich New Zealand
ABN 13 000 296 640
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Masons
MECHANICAL & ENVIRONMENTAL ENGINEERS

Mason Engineers (NZ) Ltd ■ 2/32 Crooks Road ■ PO Box 58873, Botany, Auckland, New Zealand
Tel: +64 9 274 3143 ■ Email: info@masons.co.nz

Health & Safety Policy Statement

Mason Engineers (NZ) Ltd are committed to providing and maintaining a safe and healthy working environment for our Employees, Contractors, sub-contractors, visitors, and all other persons using our premises as a workplace. To ensure a safe and healthy work environment, we will develop and maintain a Health and Safety Management System. Specifically, Management will:

- Set Health and Safety objectives and performance criteria for all Managers and work areas.
- Annually review Health and Safety objectives and Managers' performance against these.
- Actively encourage the accurate and timely reporting and recording of all incidents and injuries.
- Investigate all reported incidents and injuries to ensure all contributing factors are identified and, where appropriate, plans are developed to take corrective action.
- Provide and maintain safe plant and structures with safe systems of work; the safe use, handling, and storage of plant, substances, and structures.
- Provide any information, training, instruction, or supervision that is necessary to protect all persons from risks to their health and safety arising from the being work carried out.
- Identify all existing and new hazards and take all reasonably practicable steps to eliminate or minimise the exposure to hazards and risks.
- Provide workers engagement, participation and representation in all matters relating to health and safety
- Promote a system of continuous improvement – this includes reviewing policies and procedures each year
- Meet our obligations under the Health and Safety at Work Act 2015 (HSWA 2015), and all the related regulations, codes of practice, and any relevant standards or guidelines.

Every Manager, officer and worker have a responsibility to maintain Health and Safety at the workplace and is expected to share in this commitment to Health and Safety in the workplace by:

- Observing all safe work procedures, rules and instructions
- Reporting any pain or discomfort as soon as possible.
- Ensuring all incidents, injuries and hazards are reported to the appropriate person.

Signed: _____ Dated: 21-9-18

Company Director

Masons
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Quality Policy Statement

Mason Engineers (NZ) Ltd vision is to be recognised as a leading and preferred Water Treatment company, creating and providing our Customers with appropriate quality solutions to their Water Treatment challenges.

Realisation of this vision is facilitated by our commitment to good Corporate Governance principles and by the application of our Integrated Management System, which is founded on our Quality, Occupational Health & Safety and Environmental Management Systems.

Our Quality Management System which follows the principles of ISO9001, is a key component of our IMS and:

- Demonstrates our commitment to meeting the quality requirements of our Customers and the industries to which we provide products and services
- Provides a framework for establishing and reviewing quality objectives applicable to Mason Engineers and to our products, services and activities
- Is documented and accessible for use by all personnel within Mason Engineers
- Is reviewed by Management for continuing suitability and improvement

We augment our commitment to Quality in all we do by empowering our personnel to leverage their own and each other's skills and competencies to continually seek ever better solutions to the challenges presented to us by our Customers.

Signed: _____ Dated: 20-9-18
Company Director

Masons
MECHANICAL & ENVIRONMENTAL ENGINEERS

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Tel: +64 9 274 3143 ■ Email: info@masons.co.nz

Environmental Policy Statement

Mason Engineers (NZ) Ltd is committed to minimising the negative impacts of our activities, products and services on the physical (built and cultural) and natural environment and where possible by way of our core business of water treatment solutions, to improving the natural environment.

Achievement of this goal is facilitated by our commitment to good Corporate Governance principles and by the application of our integrated Management System, which is founded on our Health & Safety, Environmental Management Systems.

In particular, our Environmental Management System is a key component of our Management System and it:

- Emphasises our commitment to the prevention of pollution and harm to the environment.
- Demonstrates our commitment to comply with the applicable legislation and other requirements to which we subscribe with respect to our environmental aspects (namely those activities, products and services which interact with the environment)
- Provides a framework for establishing and reviewing environmental objectives and targets applicable to Mason Engineers (NZ) Ltd and to our activities, products and services including a "zero harm" approach.
- Is documented and accessible for use by all personnel with Mason Engineers (NZ) Ltd.
- Is reviewed by Management for continuing suitability and improvement.

In the conduct of our business we require our suppliers and subcontractors to comply with our standards and we encourage our customers to comply likewise, while at the same time our meeting or exceeding of their own standards.

By the nature of our core business of providing appropriate quality solutions to our customers' Water Treatment challenges, our commitment to and achievement of minimising negative impact on the environment, become in turn environmental achievements for our customers.

Signed: _____ Dated: 21-9-18

Company Director

Appendix 3 – Net Present Value

Base Year 2018

PROFILES:

1. **OTT diffuser like for like replacement**
2. **AquaConsult diffuser & air pipe redesign**
3. **Oxygen dosing in addition to diffusers**

*ALL INCL COST OF BLOWERS

Discount		**8%**								
		OTT Diffuser Replacement			**Aquaconsult Diffuser Replacement**			**Oxygen Dosing**		
Capital Cost		458,333.20			551,070.60			469,333.20		
NPV			**-$**	**697,970**		**-$**	**759,236**		**-$**	**836,894**
1	2018	-$ 458,333	-$	424,383	-$ 551,071	-$	510,251	-$ 469,333	-$	434,568
2	2019	-$ 23,097	-$	19,802	-$ 20,607	-$	17,667	-$ 36,642	-$	31,415
3	2020	-$ 23,720	-$	18,830	-$ 21,145	-$	16,785	-$ 37,877	-$	30,068
4	2021	-$ 24,305	-$	17,865	-$ 21,679	-$	15,934	-$ 38,396	-$	28,222
5	2022	-$ 24,958	-$	16,986	-$ 22,216	-$	15,120	-$ 38,922	-$	26,490
6	2023	-$ 50,041	-$	31,534	-$ 22,747	-$	14,334	-$ 64,286	-$	40,511
7	2024	-$ 26,205	-$	15,290	-$ 23,285	-$	13,586	-$ 40,664	-$	23,727
8	2025	-$ 26,824	-$	14,492	-$ 23,819	-$	12,868	-$ 41,183	-$	22,250
9	2026	-$ 27,450	-$	13,732	-$ 24,391	-$	12,201	-$ 42,082	-$	21,052
10	2027	-$ 28,070	-$	13,002	-$ 24,924	-$	11,545	-$ 42,940	-$	19,890
11	2028	-$ 53,229	-$	22,829	-$ 106,492	-$	45,672	-$ 67,984	-$	29,157
12	2029	-$ 28,691	-$	11,393	-$ 25,464	-$	10,112	-$ 43,604	-$	17,316
13	2030	-$ 29,312	-$	10,778	-$ 26,004	-$	9,562	-$ 44,269	-$	16,277
14	2031	-$ 29,933	-$	10,191	-$ 26,544	-$	9,037	-$ 44,933	-$	15,298
15	2032	-$ 30,554	-$	9,632	-$ 27,083	-$	8,538	-$ 45,597	-$	14,374
16	2033	-$ 55,669	-$	16,249	-$ 27,623	-$	8,063	-$ 70,756	-$	20,653
17	2034	-$ 31,175	-$	8,426	-$ 28,163	-$	7,612	-$ 46,261	-$	12,503
18	2035	-$ 31,796	-$	7,957	-$ 28,702	-$	7,183	-$ 46,925	-$	11,743
19	2036	-$ 32,417	-$	7,511	-$ 29,242	-$	6,776	-$ 47,590	-$	11,027
20	2037	-$ 33,038	-$	7,088	-$ 29,782	-$	6,390	-$ 48,254	-$	10,353

Appendix 4 – Air Use Comparison

AIR REQUIRED- OTT

		Air Rqd (calc) Nm3/h	# Blowers	Power Rqd kW	Energy Use kWh/day	Energy Cost $/day	Energy Cost $/year
	Off Peak	563	0.9	18.6	445.5	53	
2018	Peak Season	1307	2.0	43.1	1034.2	124	
	Peak Day	2396	3.7	79.0	1895.9	228	$ 22,511.83
	Off Peak	577	0.9	19.0	456.6	55	
2019	Peak Season	1346	2.1	44.4	1065.0	128	
	Peak Day	2459	3.8	81.1	1945.7	233	$ 23,096.64
	Off Peak	592	0.9	19.5	468.4	56	
2020	Peak Season	1387	2.1	45.7	1097.5	132	
	Peak Day	2522	3.9	83.1	1995.6	239	$ 23,719.81
	Off Peak	606	0.9	20.0	479.5	58	
2021	Peak Season	1426	2.2	47.0	1128.3	135	
	Peak Day	2584	4.0	85.2	2044.6	245	$ 24,304.52
	Off Peak	622	1.0	20.5	492.2	59	
2022	Peak Season	1467	2.3	48.4	1160.8	139	
	Peak Day	2646	4.1	87.2	2093.7	251	$ 24,958.35
	Off Peak	636	1.0	21.0	503.2	60	
2023	Peak Season	1507	2.3	49.7	1192.4	143	
	Peak Day	2707	4.2	89.2	2141.9	257	$ 25,546.76
	Off Peak	652	1.0	21.5	515.9	62	
2024	Peak Season	1549	2.4	51.1	1225.7	147	
	Peak Day	2772	4.3	91.4	2193.4	263	$ 26,204.68
	Off Peak	667	1.0	22.0	527.8	63	
2025	Peak Season	1589	2.4	52.4	1257.3	151	
	Peak Day	2833	4.4	93.4	2241.6	269	$ 26,823.86
	Off Peak	682	1.0	22.5	539.6	65	
2026	Peak Season	1631	2.5	53.8	1290.5	155	
	Peak Day	2892	4.4	95.3	2288.3	275	$ 27,450.45
	Off Peak	697	1.1	23.0	551.5	66	
2027	Peak Season	1671	2.6	55.1	1322.2	159	
	Peak Day	2952	4.5	97.3	2335.8	280	$ 28,069.53
	Off Peak	713	1.1	23.5	564.2	68	
2028	Peak Season	1715	2.6	56.5	1357.0	163	
	Peak Day	3011	4.6	99.3	2382.5	286	$ 28,734.47
		Total Blower Capacity Exceeded					**$ 281,420.90**

Electricity Price	0.12 $/kWh
Air per Blower	650 Nm3/hr
Power per Blower	21.43 kW

AIR REQUIRED- AQUACONSULT

		Air Rqd (calc) Nm3/h	# Blowers	Power Rqd kW	Energy Use kWh/day	Energy Cost $/day	Energy Cost $/year
	Off Peak	505	0.8	16.6	399.6	48	
2018	Peak Season	1144	1.8	37.7	905.2	109	
	Peak Day	2059	3.2	67.9	1629.2	196	$ 20,076.43
	Off Peak	518	0.8	17.1	409.9	49	
2019	Peak Season	1177	1.8	38.8	931.3	112	
	Peak Day	2112	3.2	69.6	1671.1	201	$ 20,606.73
	Off Peak	531	0.8	17.5	420.2	50	
2020	Peak Season	1212	1.9	40.0	959.0	115	
	Peak Day	2165	3.3	71.4	1713.1	206	$ 21,144.63
	Off Peak	544	0.8	17.9	430.4	52	
2021	Peak Season	1246	1.9	41.1	985.9	118	
	Peak Day	2217	3.4	73.1	1754.2	211	$ 21,678.64
	Off Peak	557	0.9	18.4	440.7	53	
2022	Peak Season	1281	2.0	42.2	1013.6	122	
	Peak Day	2269	3.5	74.8	1795.4	215	$ 22,216.44
	Off Peak	570	0.9	18.8	451.0	54	
2023	Peak Season	1314	2.0	43.3	1039.7	125	
	Peak Day	2321	3.6	76.5	1836.5	220	$ 22,746.65
	Off Peak	583	0.9	19.2	461.3	55	
2024	Peak Season	1349	2.1	44.5	1067.4	128	
	Peak Day	2375	3.7	78.3	1879.2	226	$ 23,284.64
	Off Peak	596	0.9	19.6	471.6	57	
2025	Peak Season	1383	2.1	45.6	1094.3	131	
	Peak Day	2426	3.7	80.0	1919.6	230	$ 23,818.55
	Off Peak	610	0.9	20.1	482.7	58	
2026	Peak Season	1419	2.2	46.8	1122.8	135	
	Peak Day	2476	3.8	81.6	1959.2	235	$ 24,390.73
	Off Peak	623	1.0	20.5	493.0	59	
2027	Peak Season	1453	2.2	47.9	1149.7	138	
	Peak Day	2525	3.9	83.2	1997.9	240	$ 24,924.45
	Off Peak	637	1.0	21.0	504.0	60	
2028	Peak Season	1489	2.3	49.1	1178.2	141	
	Peak Day	2575	4.0	84.9	2037.5	244	$ 25,496.63
			No Standby				**$250,384.52**

AIR REQUIRED WITH OXYGEN DOSING

		Air rqd (w O2) Nm3/h	# Blowers	Power Rqd kW	Energy Use kWh/day	Energy Cost $/day	Energy Cost $/year
	Off Peak	505	0.8	16.6	399.6	48	
2018	Peak Season	1141	1.8	37.6	902.8	108	
	Peak Day	1934	3.0	63.8	1530.3	184	$ 20,053.16
	Off Peak	518	0.8	17.1	409.9	49	
2019	Peak Season	1172	1.8	38.6	927.4	111	
	Peak Day	1936	3.0	63.8	1531.9	184	$ 20,571.03
	Off Peak	531	0.8	17.5	420.2	50	
2020	Peak Season	1204	1.9	39.7	952.7	114	
	Peak Day	1951	3.0	64.3	1543.8	185	$ 21,093.92
	Off Peak	544	0.8	17.9	430.4	52	
2021	Peak Season	1232	1.9	40.6	974.8	117	
	Peak Day	1949	3.0	64.3	1542.2	185	$ 21,600.02
	Off Peak	557	0.9	18.4	440.7	53	
2022	Peak Season	1262	1.9	41.6	998.6	120	
	Peak Day	1947	3.0	64.2	1540.6	185	$ 22,113.70
	Off Peak	570	0.9	18.8	451.0	54	
2023	Peak Season	1290	2.0	42.5	1020.7	122	
	Peak Day	1949	3.0	64.3	1542.2	185	$ 22,620.17
	Off Peak	583	0.9	19.2	461.3	55	
2024	Peak Season	1319	2.0	43.5	1043.7	125	
	Peak Day	1948	3.0	64.2	1541.4	185	$ 23,130.16
	Off Peak	596	0.9	19.6	471.6	57	
2025	Peak Season	1347	2.1	44.4	1065.8	128	
	Peak Day	1949	3.0	64.3	1542.2	185	$ 23,636.53
	Off Peak	610	0.9	20.1	482.7	58	
2026	Peak Season	1375	2.1	45.3	1088.0	131	
	Peak Day	1950	3.0	64.3	1543.0	185	$ 24,173.67
	Off Peak	623	1.0	20.5	493.0	59	
2027	Peak Season	1400	2.2	46.2	1107.8	133	
	Peak Day	1948	3.0	64.2	1541.4	185	$ 24,668.37
	Off Peak	637	1.0	21.0	504.0	60	
2028	Peak Season	1428	2.2	47.1	1129.9	136	
	Peak Day	1950	3.0	64.3	1543.0	185	$ 25,205.60
							$ 248,866.34

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