BioGill Water Treatment - Aquaculture

Assessment of a BioGill water treatment plant at Jamberoo Aquaculture

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Report commissioned by

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1 EXECUTIVE SUMMARY

Installation of two BioGill Units on the Bottom Dam is associated with improved stability in water quality as measured by diurnal changes in dissolved oxygen levels and the removal of ammonia.

Direct comparison of dissolved oxygen and ammonia, nitrite and nitrate at the inlet and outlet of the BioGill Units showed the outlet to have:

- Higher dissolved oxygen
- Lower ammonia
- Higher nitrate

This result indicates active oxidation of ammonia, a toxic by-product for silver perch and other farmed fish species.

Other indicators of good water quality for the Bottom Dam are:

- Feeding rates were able to be increased from 6 to 30 kg/day without changing the aeration schedule for the paddle wheel.
- A low percentage of harvested fish (2%) with signs of disease or stress compared to the Top Dam (10%).

1 BACKGROUND

Good water quality is one of the most important factors in achieving successful aquaculture. A key issue is to achieve high performance at low operating cost.

The BioGill Water Treatment unit is an above-ground bioreactor that supports the growth of endemic micro-organisms as a biofilm on a patented membrane (www.BioGill.com). A BioGill Water Treatment unit has been tested at Port Stephens Fisheries Institute in a recirculating aquaculture system for Mulloway and shown to reduce nitrate and nitrite levels compared to an alternative water treatment system (BioGill Report Oct 2012).

Jamberoo Aquaculture farms silver perch and is the second site within the aquaculture sector to have BioGill water treatment installed. It is the first unit to be tested in a freshwater aquaculture facility.

Silver perch aquaculture is a significant part of freshwater fish production. In 2012/12 silver perch had the highest production of all farmed freshwater fish in NSW with a total production of 189,625 kg from 25 farms from a total area of 47 ha (Livingstone 2013).

1.1 Jamberoo Aquaculture

Jamberoo Aquaculture has a commercial permit to produce silver perch from two dams (**Fig 1**). Adult fish have been sold into the Sydney market since November 2011 and have consistently achieved the top market price.

A i B i ii ii

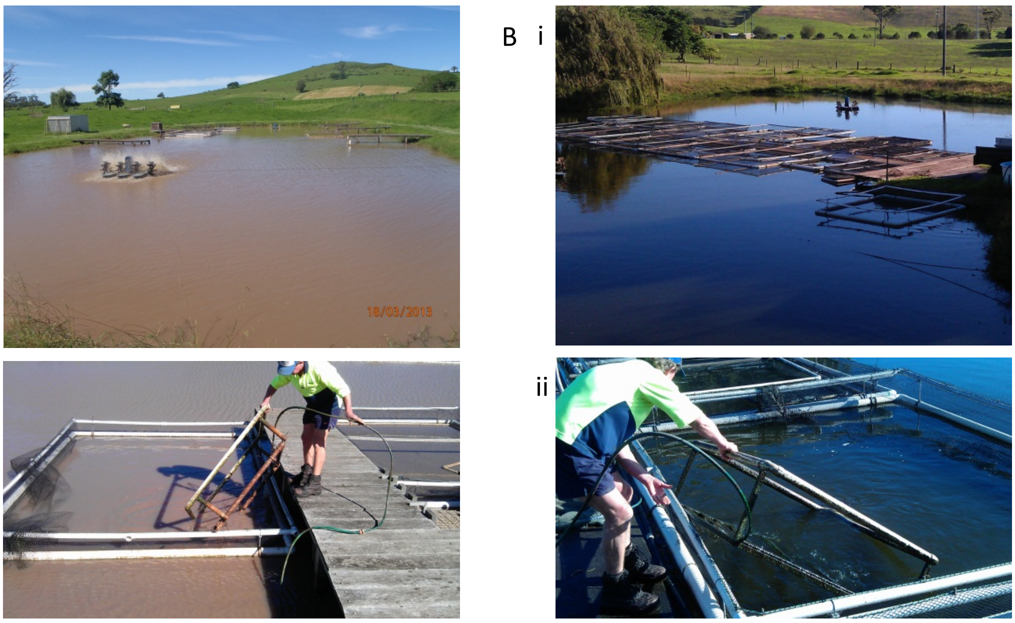

Fig 1 The two dams used for silver perch aquaculture.

A. The Top Dam with the aerator (i) and preparing a cage for harvest (ii).
B. The Bottom Dam with the cages (i) and preparing a cage for harvest (ii).

The Farm Manager considers the conditions in the "Top Dam" are not optimal for silver perch aquaculture. The water is muddy with a high level of suspended sediment and in 2012 required three applications of formalin to control fungal disease (*Saprolegniosis*). The Top Dam has a volume of 4.7 megaL (4,688 m^3) and a surface area of 0.19 hectares (**Table 1**). The fish are held in 5 cages (24 m^3/cage). The current stocking level is relatively low with 5,300 adult fish/ha. Aeration and water movement is by one 4 paddle aerator which is used for a total of 8 hrs/24 hrs (11.9 kWh/day).

Conditions in the "Bottom Dam" are considered by the Farm Manager to be more favourable for silver perch with good water clarity and only one outbreak of disease occurring over the past 3 yrs, in 2010. The Bottom Dam is larger than the Top Dam with a volume of 7.1 megaL (7100 m^3) and surface area of 0.26 ha (**Table 1**). The fish are kept in 14 cages with a total volume of 234 m^3. Current stocking levels (total fish/dam) are 3,000 kg/ha or 3 kg/m^3, which includes both adults and fingerlings. The stocking rate for the adults is 17,210 fish/ha. This is a relatively high stocking density when compared to the recommended stocking rates for grow-out ponds of 5,000 to 20,000 fish/ha (Queensland Government March 2013).

Parameter	Units	Top Dam	Bottom Dam
Dam Volume	m^3	4,688	7,105
	megaL	4.7	7.1
Dam area	m^2	1,875	2,624
	ha	0.188	0.26
Stock density			
: fingerlings (< 100 g)	#/ha	-	88,938
	kg/ha	-	514
: adult	#/ha	5,319	17,210
	kg/ha	2,340	2,494
: Total	#/ha	"	106,141
	kg/ha	"	3,007

Table 1 Dam size and stocking rates (as at 1 April 2013)

1.2 Water Quality Management

Aeration and water movement for the Bottom Dam prior to installation of the two BioGill Units was achieved primarily with one 4 paddle aerator (**Table 2**). In 2012, the Farm Manager wanted to control/prevent algal blooms and increase productivity of the Bottom Dam without reducing water quality. Two BioGill Units were installed and started operation on 7 November 2012 (24 hr/day) (**Fig 2**).

Aeration for the Top Dam is managed with a 4 paddle aerator.

Equipment	Parameter	Units		Daily Schedule
Aerator - 4 paddle	Nov 12 – 25 Mar 13	kWh/day	3.0	3-4 & 10-11 pm
	26 Mar 13 - present	"	6.0	0-1, 2-3, 4-5 am & 10-11 pm
BioGill – 2 Units	: Schedule	hhhh	0000-2400	24 hrs
	: Pump (2 Units)	kW	1.87	
		kWh/day	44.8	
	: Flow rate (2 Units)	L/hr	12,820	

Table 2 Aerator and BioGill operation (Bottom Dam)

Fig 2 Two BioGill Units were installed above the Bottom Dam (Nov 2012)
Water is pumped from the Bottom Dam to both units. From the inlet at the top of the unit the water flows down over the membranes and back to the dam under gravity.

2 AIMS

- Assess the effectiveness of the BioGill water treatment unit on the Bottom Dam.
- Establish baseline data for the Top Dam prior to installation of a BioGill unit.
- Establish methods to improve assessment of the BioGill water treatment unit in the future at Jamberoo Aquaculture.

3 RESULTS

The impact of the BioGill Units is most directly assessed by water quality measurements taken from farm records and a field assessment in March 2013. In addition fish health and purging prior to market were also investigated for batches of silver perch harvested during the field assessment.

3.1 Bottom Dam

3.1.1 Water quality

Feeding rates and water quality parameters were monitored from 30 Oct 2012 (**Fig 3**).

After installation of the BioGill units (7 Nov 2012) the feeding rate was increased from 6 kg/day to 10 kg/day (**Fig 3**). At the time of installation the Farm Manager noted high levels of algae as indicated by intense green colour of the water.

Dissolved Oxygen is a critical parameter with the minimum recommended concentration for silver perch of 3.0 ppm (Rowland 2007). The lowest DO concentration occurred on the 28 Nov 2012, 2 weeks after installation of the BioGill Unit (**Fig 3**). Just prior to this event the Farm Manager noted that the algae was dispersing. The aerator was run throughout the following night and since then the minimum DO level has not dropped below 3.0 ppm despite the daily feeding rate being increased from 6 kg/day to 30 kg/day.

pH levels have been maintained within the optimum range for silver perch of 7.0 to 9.0 (**Fig 3**). The cluster of measurements below pH 7 in early March 2013 was likely due to a faulty probe. Throughout the Trial water temperature has remained relatively constant within the range 20 to 25 °C, also within the optimal range for silver perch aquaculture (Rowland 2007).

The instability in DO levels during the first two months of the trial is also evident from comparison of the morning and afternoon DO concentrations (**Fig 4**). Throughout November and December 2012 the diurnal range was irregular and only a small increase or decrease in DO concentration occurred throughout the day for three out of the four samples. By March 2013 however there is a consistent increase in DO concentration from morning to the late afternoon. The effect of doubling aeration time from 2 to 4 hrs (26 Mar 2013) can be observed in the increase in the daily minimum and maximum DO levels from 28 Mar onwards.

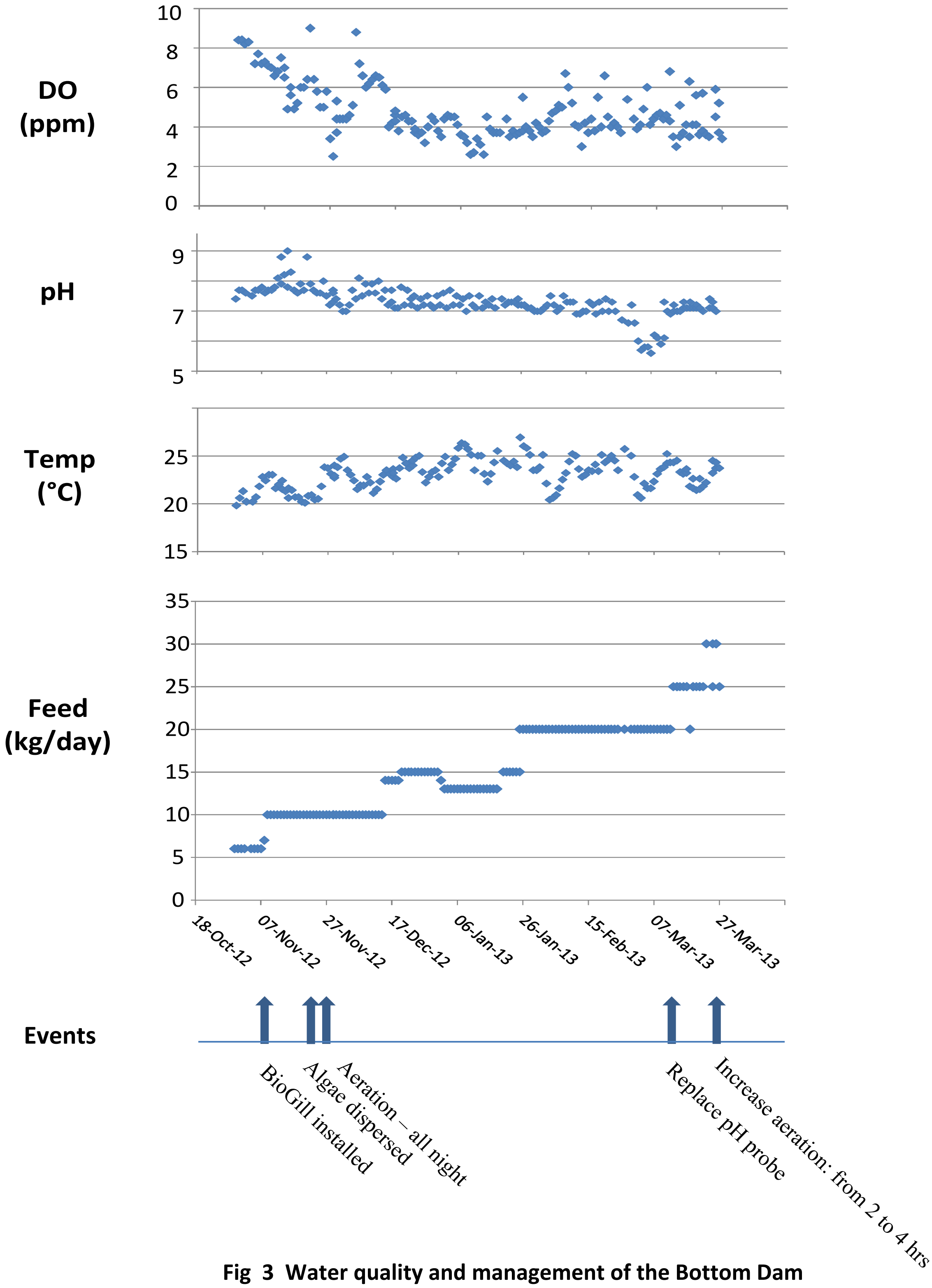

Fig 3 Water quality and management of the Bottom Dam
(Nov 2012 – Mar 2013)

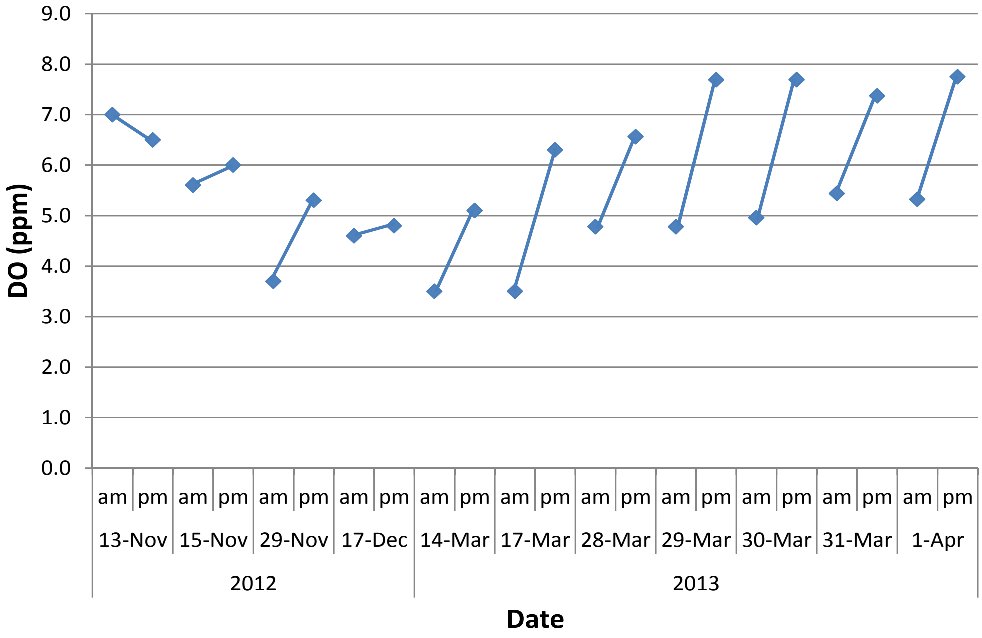

Fig 4 Dissolved oxygen (ppm) in the Bottom Dam
Measurements were taken in the morning (< 9 am) and in the evening (5-6 pm)

Alga are an important source of feed for fish, drive the diurnal changes in dissolved oxygen and have the potential to wipeout production by a sudden die-off or dominance of toxic species. For the Bottom Dam the Total Algae count was 63,000±3,000 cells/ml. Of these two toxigenic species of blue-green algae were detected, *Anabaena* (15,500±4,000 cells/ml) and *Microcystis* (5,500±2,000 cells/ml) (**Table 3**). The analyst reported "a diverse community with toxigenic Microcystis and potentially toxic coiled Anabaena present in notable levels. Other blue-green algae detected were not from toxigenic taxa". The complete list of species detected at Appendix **A2**.

Yeast and mould are members of the Fungi kingdom. Many pathogenic fungi in animals have both mould and yeast forms dependent upon environmental conditions (Prescott 1996).

	Algae :Total	**:Blue-Green** *Anabaena*	*Microcystis*	**Fungi Yeast**	**Mould**
Mean	62,948	15,385	5,442	42,500	400
SD	3,196	3885	2,223	10,607	141

Table 3 Total algae, blue-green algae and fungi counts (cells/ml) for the Bottom Dam
SD - Standard deviation. Two replicate samples collected 2 April 2013. Analysis by a NATA registered laboratory (Appendix A2).

3.1.2 BioGill Inlet and Outlet

The effect of the BioGill unit on water quality was measured directly by sampling both the inlet and outlet in the morning and late afternoon over 7 days (27 Mar - 2 Apr 2013). Dissolved oxygen, temperature, pH, oxygen reduction potential, total dissolved solids and turbidity were measured in the morning (0700-0730) and late afternoon (1700-1800) (**Fig 5**). Ammonia, nitrite, nitrate and alkalinity were measured on the last day of this sampling period.

The DO minimums for the BioGill outlet are consistently higher than those for the inlet in the morning. In the afternoon for the majority of the samples (4 out of 6) the reverse was observed with the inlet levels being higher than the outlet levels. DO levels are at their lowest point in the early morning just prior to phytoplankton starting photosynthesis and the production of oxygen. As the outlet values are higher than the inlet values the BioGill process results in a net increase in oxygen. Photosynthesis is unlikely to occur in the BioGill because it is closed to light however the trickling of water over the membrane may allow diffusion of oxygen into the water from the atmosphere.

In the afternoon DO is at maximum levels due to photosynthesis by phytoplankton in the Dam. An overall net reduction in DO levels in the afternoon maybe due to respiration reactions within the biofilm on the BioGill membranes. That these reactions do not cause a reduction in DO levels in the morning indicates that the diffusion of oxygen into the biofilm is sufficient to overcome this oxygen demand. Given that the volume pumped by the BioGill in 5 hrs. is $\frac{1}{100}$ the volume of the Dam it is unlikely that the higher DO levels make a significant impact on overall dissolved levels for the Dam. This effect may however be significant where the BioGill is used on smaller volume dams or additional BioGill Units are installed.

Turbidity is a measure of suspended particles and on two of the sampling days turbidity at the inlet was higher than the outlet, which is consistent with BioGill acting as a physical filter. Differences in in total dissolved substance levels between to the inlet and outlet were minimal until the last two sampling times, the afternoon of Day 6 and the morning of Day 7. TDS was higher for the inlet than the outlet in the first sample whereas the situation was reversed the following morning when TDS was higher for the outlet than the inlet. This suggests that BioGill was having a buffering effect on the Total Dissolved Substances levels in the water passing over the membranes and maybe beneficial for aquaculture by limiting rapid changes in this parameter.

The levels for pH and temperature are within the recommended ranges for silver perch (pH 7.0 - 9.5 and 10 - 30 °C; Rowland 2007) and there was little difference between the inlet and outlet values.

Oxidation reduction potential is a measure of whether oxidation reactions or reduction reactions are favoured. For pond aquaculture values between 100 and 300 mV are recommended (Lekang 2013). There was little difference between the values for the inlet and outlet ORP values. Overall the values are lower than recommended. It is not possible from this data to determine the direct impact of BioGill on overall pond ORP; however the oxidation of ammonia as noted below indicates that BioGill is contributing to an oxidation process. ORP values remained relatively constant throughout the sample period and within the recommended range at most time. The most dramatic change occurred on the morning of Day 5 with a drop down to 40 mV. This may simply have been due to operator error because there is no change in the other parameters to indicate a rapid change and recovery of environmental conditions.

Ammonia is a key parameter for silver perch health with the maximum recommended long term limit < 0.1 mg/L and the level of concern being > 1.0 mg/L. Nitrifying bacteria are important biological agents in the oxidation of ammonia to the less harmful nitrate via nitrite and are likely to be present in the BioGill biofilm given the following result. The values measured for the inlet and outlet are consistent with the BioGill oxidising ammonia to nitrate (**Fig 6**). For ammonia the inlet concentration (0.4 mg/L) is twice as high as the outlet (0.2 mg/L) while for nitrate the outlet concentration (1.2 mg/L) is higher than the inlet (1.0 mg/L). Over the longer term the ammonia concentration is too high for optimum health and additional control measures may need to be considered if the levels do not drop below 0.1 mg/L.

Alkalinity provides buffering against changes in pH and the recommended minimum value for pond aquaculture is 20 mg/L with the optimum range being 75 - 200 mg/L (Wurtus 1992). There was little difference between the inlet and outlet values (82 and 80 mg/L, respectively) and the level is within the optimum range.

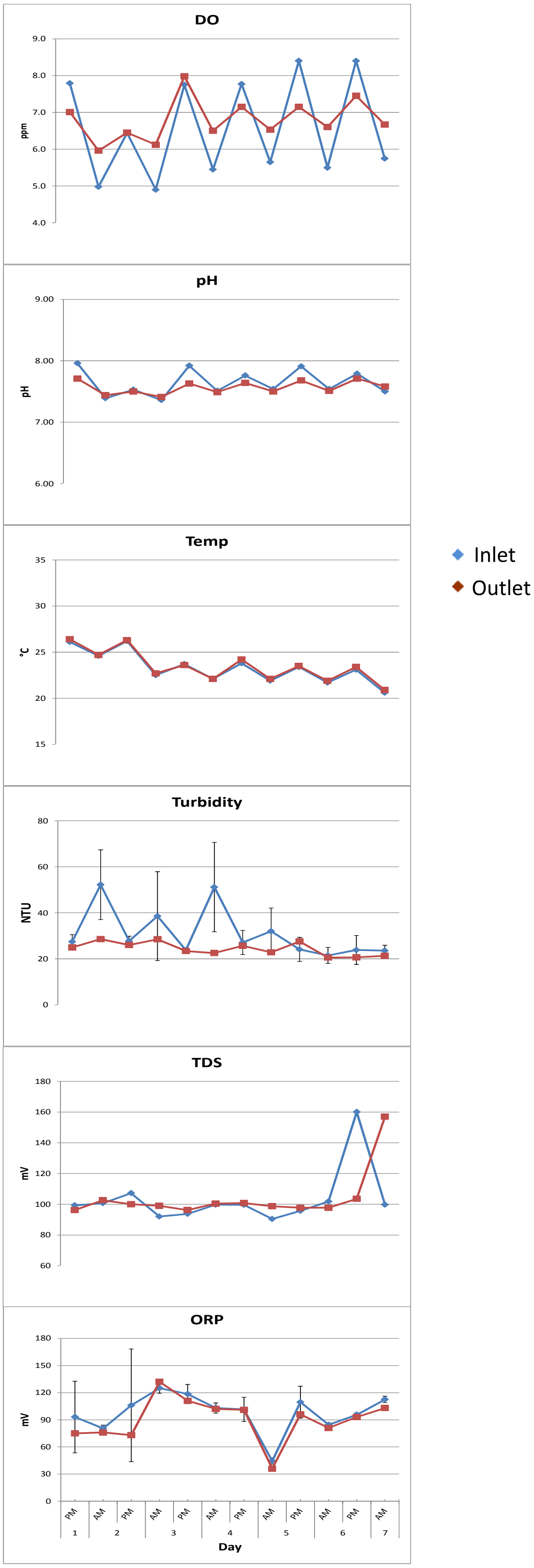

Fig 5 BioGill inlet (●) and outlet (◆) water quality sampled over 7 days.

Measurements taken from 27.3 to 2.4 2013 in the AM (0700 - 0730) and PM (1700 - 1800).
DO (dissolved oxygen); TDS (Total Dissolved Substances); ORP (Oxidation-Reduction Potential)

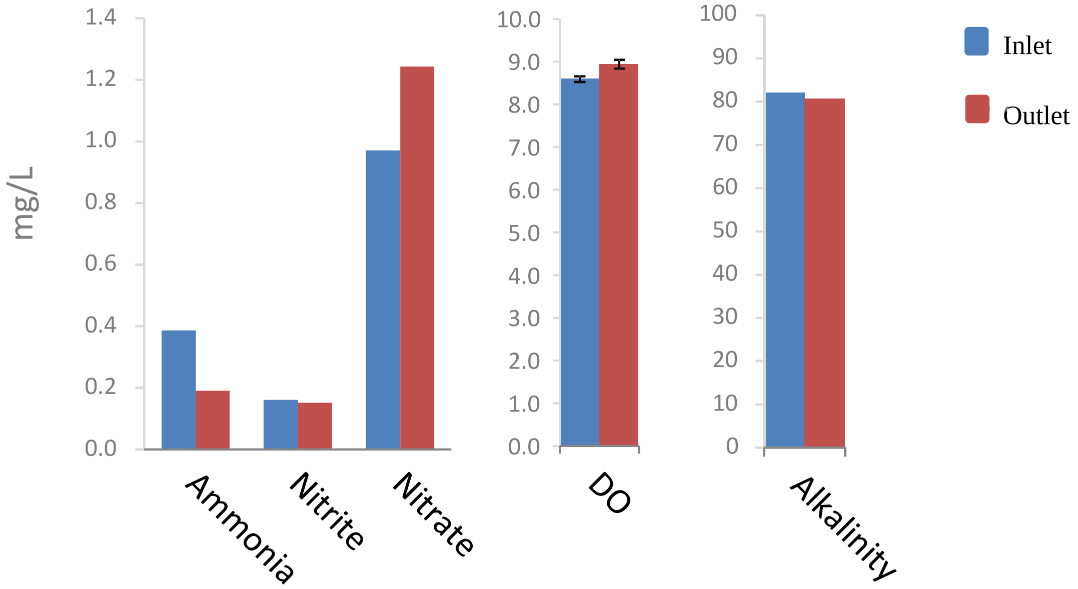

Fig 6 BioGill inlet (◆) and outlet (◆) for Ammonia, Nitrite, Nitrate, DO and Alkalinity
Samples were collected at 7 - 7:30 am on 2 April 2013, stored on ice and analysed by a NATA registered laboratory.

3.2 Top Dam Water Quality

Water quality for the Top Dam was monitored in the morning and the late afternoon over 7 days (27 Mar - 2 Apr 2013) (**Fig 7**).

Turbidity is a dominating parameter being 10-fold higher (528 ± 17 NTU) than the levels measured in the Bottom Dam (26 ± 6 NTU). The effect of the high turbidity can be seen on the lack of diurnal change in dissolved oxygen and pH.

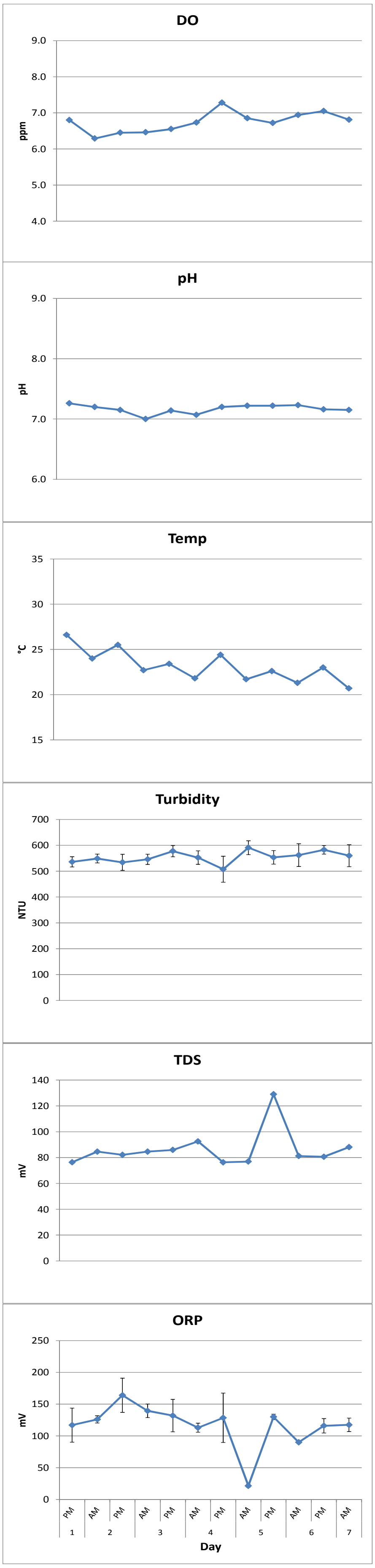

Fig 7 Top Dam water quality sampled over 7 days.

Measurements taken from 27.3 to 2.4 2013 in the AM (0700 - 0730) and PM (1700 - 1800).
DO (dissolved oxygen); TDS (Total Dissolved Substances); ORP (Oxidation-Reduction Potential)

The low light levels in the Top Dam also limited algal density (3,500 ± 1,500 cells/ml) while promoting yeast growth (88,500 ± 2,000 organisms/100 ml) (**Table 4**). A low level of a blue-green algae (541 cells/ml) was detected in one sample but it is non-toxigenic. Compared to the Bottom Dam the Top Dam has 20-fold less alga and 2-fold higher yeast while mould counts were equivalent. The complete analysts report is at **Appendix A3**

	Algae		**Fungi**	
	:Total	**:Blue-Green**[1] *(non-toxigenic)*	**Yeast**	**Mould**
Mean	3,462	*541*	88,500	450
SD	1570	-	2,121	212

1. Density detected for one sample. Not detected in the other replicate sample.

Table 4 Total algae, blue-green algae and fungi counts (organisms/100 ml) for the Top Dam
SD - Standard deviation. Two replicate samples collected 2 April 2013. Analysis by a NATA registered laboratory (Appendix A2).

3.3 Fish health

To assess the health of the existing stock of fish one cage from each dam was harvested and the adult fish were examined for obvious signs of disease or stress during transfer to the purging tanks (**Table 5**).

Two fish (2%) of 102 from the Bottom Dam were not healthy. The fish with black coloration and swimming slowly on its side may have been stressed from physical injury because no other fish had similar symptoms.

Ten fish (11%) of 87 harvested from the Top Dam were not healthy with all these fish displaying a red rash around the gills and across the mid-ventral belly (**Fig 8**) . No further diagnosis of was undertaken however given a significant proportion this population displayed the same symptoms a common disease agent or environmental stress is possible.

Bottom Dam	
Healthy	99
Stressed/diseased	
• Black colouration & slow swimming on side	1
• Mild inflammation around gills	1
TOTAL	102

Top Dam	
Healthy	77
Stressed/diseased	
• Red rash on gills & ventral area	10
TOTAL	87

Table 5 Health of harvested fish

Fig 8 Red rash on a fish taken from the Top Dam.
10 % of the fish harvested from the Top
Dam had this condition

3.4 Purge time

Silver perch are purged in clean well-aerated water prior to market to remove off-flavours. Purging requires 5 to 10 days and can induce stress or disease in the fish (Rowland 2007; Queensland Government 2013). Jamberoo Aquaculture purges in a recirculating system with fibre mat, sand and bio-ball filters. During purging solid waste from the fish build up on the fibre mats. The Jamberoo Aquaculture Standard Operating Procedure (SOP) specifies that the mats are changed when the water flow becomes restricted. When the mats stop clogging the purge is considered complete.

A batch of adult fish of equivalent biomass from each dam were harvested and purged separately. The fish from the Bottom Dam required 19 hrs of purging before the mat filters stopped clogging and the batch from the Top Dam required 42 hrs (**Table 6**). The mat filters were replaced three times for the Bottom Dam and four times for the Top Dam (**Fig 9**).

There were no mortalities or signs of stress among either batch.   Algae is a key factor in determining purge time however the high turbidity in the Top Dam compared to the Bottom Dam maybe the reason for the higher purge time required for the fish harvested from the Top Dam.

Parameter		Bottom Dam	Top Dam
Fish			
: Number		98	156
: Weight	(kg)	62.5	72
Purge time	(hrs)	19	42

Table 6 Time required for purging harvested fish

A

B

Fig 9 Mat filters used during purging.
A) Bottom Dam B) Top Dam

4 CONCLUSIONS

In November 2012 there were high levels of algae in the Bottom Dam due to a build-up of nutrients from the farmed fish. Within 2 weeks of the BioGill starting operation the nutrients had been reduced to such an extent that the algae could not maintain growth and started to die off. The drop in dissolved oxygen resulting from decomposition of the algae was overcome with a temporary increase in aeration. Water quality for the Bottom Dam has stabilised since the BioGill Units were installed.

The BioGill Unit on the Bottom Dam actively reduces ammonia levels in the water. The coincident increase in nitrate concentration indicates that the biofilm in the BioGill Unit is actively nitrifying the inlet water. It is likely that the BioGill has been able to prevent any significant algal bloom since installation in early November 2012. This is despite a 5-fold increase in feeding rate.

The rate of feed is determined by the Farm Manager's daily observation of water quality (DO, pH and water colour), fish feeding behaviour (speed of feeding and time for feed to be consumed). Although specific stock levels in the Bottom Dam were not recorded over this time the increase in feed consumption is consistent with an increase in growth rate and or an increase in stocking density.

Purge times for harvested fish from the Bottom Dam are significantly lower than reported industry periods with the Jamberoo Aquaculture requiring only overnight purging. Fish from the Top Dam also required a longer purge time despite lower levels of algae in this dam. Additional trials will be required to determine the extent to which the BioGill water treatment system is a causal agent.

Fish harvested from the Bottom Dam were healthier than those harvested from the Top Dam. The higher levels of fungi in the Top Dam may have stressed the fish. The extent to which the BioGill Unit can be associated with the high health status of the fish harvested from the Bottom Dam would require additional trials however it is reasonable to assume that the reduced nutrient load in the water and the subsequent control of algal blooms and improved water quality are contributing factors.

It should be noted that two species of toxigenic blue-green algae have been detected in the Bottom Dam. It is unlikely that this is due to the use of BioGill water treatment because this process excludes light from the Unit and thus would not support photosynthetic micro-organisms.

The results from the two Dams are not directly comparable because of significant differences in the environment of each Dam. The high levels of turbidity in the Top Dam are limiting algal growth and promoting yeasts. The water quality data for the Top Dam will provide a baseline to determine the effect of installation of a BioGill Unit.

5 REFERENCES

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Wurtus W and Durborow R. Interactions of pH, carbon dioxide alkalinity and hardness in fish ponds. SRAC Publication No. 464, Southern Regional Aquaculture Centre, December 1992 (https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/112 ; downloaded 15 Jan 2013).

APPENDICES

A 1 METHODS

Water quality

Nov 2012 – April 2013

Water quality parameter and feeding rate for the Bottom Dam were measured by the Farm Manager just prior to installation of the BioGill Units and then daily. The Farm Manager adjusted feeding rate based upon the fish feeding habits and daily water quality measurements, particularly of dissolved oxygen.

Field assessment – March 2013

A field assessment was performed by Aqua Firma Solutions in conjunction with Jamberoo Aquaculture to further assess the impact of the BioGill Unit on water quality and provide additional baseline information for the Top Dam prior to moving one of the BioGill Units from the Bottom Dam to the Top Dam.

Locations

Top Dam (inside a stocked cage)

BioGill Inlet (beside a stocked cage)

BioGill Outlet

Field

Field measurements were taken in the morning (0700 -30) and the late afternoon (1700-1800) with a TPS 90FL Series Multi-parameter meter with probes for DO, pH, temperature, turbidity, total dissolved solids TDS) and oxidation reduction potential (ORP).

Laboratory

Parameters measured by laboratory analysis (ALS Environmental Division, Sydney) were dissolved oxygen, alkalinity, ammonia, nitrite and nitrate. Total algae (in-house method) and yeast and mould (Method: AS5013.29-2009) were also measured.

Location	Equipment	Schedule	Time on :Schedule	:Time (hr)	Power (HP)	(kW[1])	(kWh/day)
Bottom Dam	2HP/4 paddles	1	1500-1600	1			
			2200-2300	1			
				2	2	1.492	3.0
	"	2	0000-0100	1			
			0200-0300	1			
			0400-0500	1			
			2200-2300	1			
				4	2	1.492	6.0
	BioGill		24 hrs	24	2.5	1.865	44.8
							50.7
Top Dam	2HP/4 paddles	-	0000 - 0600	6			
			1000-1100	1			
			1600-1700	1			
				8	2	1.492	11.9

Note: 1 HP = 0.746 kW

Table A1.1 Power consumption of aerators and the BioGill Units

Location	Dimensions :Length				Vol		Surface Area	
		(m)			(m^3)	(megaL)	(m^2)	(ha)
Top Dam	Side 1							
		75						
	Side 2	25						
	Depth	2.5			4688	4.7	1875	0.188
Bottom Dam	Side1	60	Square	44				
	Side 2	60		47				
		48		3	6204			
		45	Triangle 1	0.5				
	Depth sides	2.5		7				
	Middle	3.5		47				
				2	329			
			Triangle 2	0.5				
				13				
				44				
				2	572			
					7105	7.1	2624	0.262
Total								0.450

Table A1.2 Dam Length, Volume and Surface Area

Dam dimensions supplied by Jamberoo Aquaculture.

Harvest and Fish Health Assessment

Existing farm records were collated and the Farm Manager interviewed.

Adult fish for harvest were collected from one cage in each Dam (2 April 2013). They were checked visually for signs of stress or disease using as a guide the NSW DPI manual on silver perch diseases of the silver perch (Read 2007). Indicators checked by the Farm Manager were: fin condition, skin colour (black filaments, redness), skin lesions, eye clarity and swimming behaviour in the purging tank.

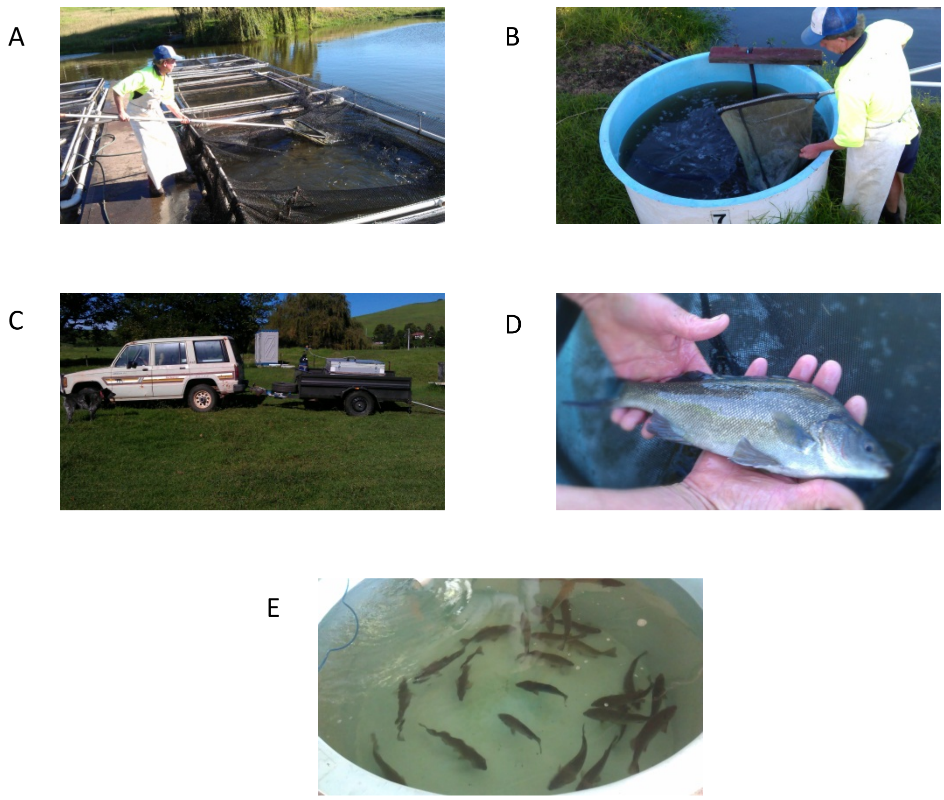

Fig A1.1 Harvesting silver perch for market
A) Netting B) Selecting the larger fish C) Transporting the fish from the Dam to the Purge facility D) Health assessment E) Purging

A 2 ALGAL REPORTS - BOTTOM DAM

Environmental Division (Water Resources Group)
22 Dalmore Drive Scoresby 3179
Tel. 03 8756 8183   Fax. 03 9763 1862

NATA Accredited Laboratory No. 992
Accredited for compliance with ISO/IEC 17025
WORLD RECOGNISED ACCREDITATION

ALGAL REPORT

CLIENT :	ALS	
LABORATORY NO./BATCH NO. :	3426669	13-17114
LOCALITY :	EW1300958	
SITE :	013-AA	
SAMPLE :	13 Bot	
DATE SAMPLED :	02/04/2013	
SAMPLED BY :	Sample analysed as received	

COMMENTS: + A diverse algal community was observed with toxigenic Microcystis and potentially toxic coiled Anabaena present in noteable levels.

Sedgewick-Rafter Vol.(ml) 1.0207 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
BACILLARIOPHYCEAE			
Aulacoseira distans	19	0	931
Aulacoseira granulata	2	0	98
Centrales	59	0	2890
Pennales	6	0	294
CHLOROPHYCEAE			
Actinastrum	6	0	294
Ankistrodesmus	5	0	245
Ankyra	1	0	49
Botryococcus (colonies)	1	0	49
Chlamydomonads	21	0	1029
Chlorococcoids	54	0	2645
Closteriopsis	14	0	686
Closterium	23	0	1127
Coelastrum	68	0	3331
Crucigenia	376	0	18419
Dictyosphaerium	0	102	200
Didymocystis	28	0	1372
Oocystis	4	0	196
Pediastrum	112	0	5486
Scenedesmus	52	0	2547
Selenastrum	11	0	539
Sphaerocystis	24	0	1176
Staurastrum	8	0	392
CRYPTOPHYCEAE			
Cryptomonads	34	0	1666
CYANOPHYCEAE			
Anabaena (coiled)	258	0	12638
Microcystis	79	0	3870

ANALYST: *Louise Leyden* **Biologist**   VERIFIED: *Kumar Eliezer* **Biologist**   DATE: **09/04/2013**

METHOD NO.: BM010

Environmental Division (Water Resources Group)
22 Dalmore Drive Scoresby 3179
Tel. 03 8756 8183 Fax. 03 9763 1862

NATA Accredited Laboratory No. 992
Accredited for compliance with ISO/IEC 17025
WORLD RECOGNISED ACCREDITATION

ALGAL REPORT

CLIENT :	ALS	
LABORATORY NO./BATCH NO. :	3426669	13-17114
LOCALITY :	EW1300958	
SITE :	013-AA	
SAMPLE :	13 Bot	
DATE SAMPLED :	02/04/2013	
SAMPLED BY :	Sample analysed as received	

COMMENTS: + A diverse algal community was observed with toxigenic Microcystis and potentially toxic coiled Anabaena present in noteable levels.

Sedgewick-Rafter Vol.(ml) 1.0207 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
Planktolyngbya (short filaments)	24	0	1176
Pseudanabaena	2	0	98
Synechocystis	36	0	1763
EUGLENOPHYCEAE			
Euglena	0	1	2
TOTAL			65208

+ The comments are discretionary and are for the purpose of helping to understand WQ implications.The comments are not accredited by NATA.

ANALYST: *Louise Leyden* VERIFIED: *Kumar Eliezer* DATE: **09/04/2013**

Biologist **Biologist**

METHOD NO.: BM010

Environmental Division (Water Resources Group)
22 Dalmore Drive Scoresby 3179
Tel. 03 8756 8183 Fax. 03 9763 1862

NATA Accredited Laboratory No. 992
Accredited for compliance with ISO/IEC 17025
WORLD RECOGNISED ACCREDITATION

ALGAL REPORT

CLIENT :	ALS
LABORATORY NO./BATCH NO. :	3426670 13-17114
LOCALITY :	EW1300958
SITE :	014-AA
SAMPLE :	14 Bot
DATE SAMPLED :	02/04/2013
SAMPLED BY :	Sample analysed as received

COMMENTS: + A diverse algal community present with potentially toxic Anabaena and toxigenic Microcystis present. The other BGA are non-toxigenic taxa.

Sedgewick-Rafter Vol.(ml) 1.0479 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
BACILLARIOPHYCEAE			
Aulacoseira distans	10	0	477
Aulacoseira granulata	4	0	191
Centrales	43	0	2052
Pennales	4	0	191
CHLOROPHYCEAE			
Actinastrum	7	0	334
Ankistrodesmus	5	0	239
Ankyra	1	0	48
Chlamydomonads	25	0	1193
Chlorococcoids	79	0	3769
Closteriopsis	27	0	1288
Closterium	20	0	954
Coelastrum	32	0	1527
Crucigenia	252	0	12024
Didymocystis	20	0	954
Oocystis	4	0	191
Pediastrum	60	0	2863
Scenedesmus	36	0	1718
Selenastrum	7	0	334
Sphaerocystis	32	0	1527
Staurastrum	6	0	286
CHRYSOPHYCEAE			
c.f. Uroglena	0	147	281
CRYPTOPHYCEAE			
Cryptomonads	26	0	1241
CYANOPHYCEAE			
Anabaena (coiled)	380	0	18132
Microcystis	147	0	7014

ANALYST: *Louise Leyden* **Biologist** VERIFIED: *Kumar Eliezer* **Biologist** DATE: **09/04/2013**

METHOD NO.: BM010

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ALGAL REPORT

CLIENT :	ALS	
LABORATORY NO./BATCH NO. :	3426670	13-17114
LOCALITY :	EW1300958	
SITE :	014-AA	
SAMPLE :	14 Bot	
DATE SAMPLED :	02/04/2013	
SAMPLED BY :	Sample analysed as received	

COMMENTS: + A diverse algal community present with potentially toxic Anabaena and toxigenic Microcystis present. The other BGA are non-toxigenic taxa.

Sedgewick-Rafter Vol.(ml) 1.0479 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
Planktolyngbya (short filaments)	9	0	429
Pseudanabaena	10	0	477
Synechocystis	20	0	954
TOTAL			60688

+ The comments are discretionary and are for the purpose of helping to understand WQ implications.The comments are not accredited by NATA.

ANALYST: *Louise Leyden*
Biologist

VERIFIED: *Kumar Eliezer*
Biologist

DATE: **09/04/2013**

METHOD NO.: BM010

A 3 ALGAL REPORTS - TOP DAM

Environmental Division (Water Resources Group)
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ALGAL REPORT

CLIENT :	ALS	
LABORATORY NO./BATCH NO. :	3426671	13-17114
LOCALITY :	EW1300958	
SITE :	017-AA	
SAMPLE :	17 Top	
DATE SAMPLED :	02/04/2013	
SAMPLED BY :	Sample analysed as received	

COMMENTS: + A moderately diverse algal community present with unicellular greens dominating. No BGA were detected. It is to be noted that there was a lot of fine sediment/debris present throughout, influencing water quality and clarity.

Sedgewick-Rafter Vol.(ml) 1.0207 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
BACILLARIOPHYCEAE			
Centrales	1	0	49
Pennales	7	0	343
CHLOROPHYCEAE			
Ankistrodesmus	1	0	49
Ankyra	1	0	49
Chlamydomonads	8	0	392
Chlorococcoids	15	0	735
Crucigenia	4	0	196
Monoraphidium	3	0	147
CRYPTOPHYCEAE			
Cryptomonads	8	0	392
TOTAL			2352

+ The comments are discretionary and are for the purpose of helping to understand WQ implications.The comments are not accredited by NATA.

ANALYST: *Louise Leyden* **Biologist**

VERIFIED: *Kumar Eliezer* **Biologist**

DATE: 09/04/2013

METHOD NO.: BM010

Environmental Division (Water Resources Group)
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WORLD RECOGNISED ACCREDITATION

ALGAL REPORT

CLIENT :	ALS
LABORATORY NO./BATCH NO. :	3426672 13-17114
LOCALITY :	EW1300958
SITE :	018-AA
SAMPLE :	18 Top
DATE SAMPLED :	02/04/2013
SAMPLED BY :	Sample analysed as received

COMMENTS: + A moderately diverse algal community present with unicellular greens dominating. The BGA present are non-toxigenic taxa. It is to be noted that there was a lot of fine sediment/debris present throughout, affecting clarity and water quality.

Sedgewick-Rafter Vol.(ml) 1.0171 **Concentration** 1 : 1 **Magnification** **Fields**	- 200x 20	- 100x 500	**Total Count (cells or units/ml)**
BACILLARIOPHYCEAE			
Centrales	5	0	246
Pennales	8	0	393
CHLOROPHYCEAE			
Chlamydomonads	13	0	639
Chlorococcoids	36	0	1770
Crucigenia	4	0	197
Monoraphidium	2	0	98
CRYPTOPHYCEAE			
Cryptomonads	13	0	639
CYANOPHYCEAE			
Aphanocapsa (small cells)	11	0	541
DINOPHYCEAE			
Peridinium	1	0	49
TOTAL			4572

+ The comments are discretionary and are for the purpose of helping to understand WQ implications.The comments are not accredited by NATA.

ANALYST: *Louise Leyden* VERIFIED: *Kumar Eliezer* DATE: 09/04/2013

Biologist **Biologist**

METHOD NO.: BM010