West Wimmera Shire Council

Lake Wallace

Lake Management Observations

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Introduction

Lake Wallace is a 1.83 km2 freshwater lake located in Edenhope in the Wimmera region of Victoria, Australia. The water level in the lake fluctuates and at times has been completely dry. The Lake Pier and jetty provide access to activities such as fishing, swimming and sailing.

Recent prolific aquatic vegetation growth has been reported and after a site visit and water test sampling conducted on the 26th of November 2021, please find attached a brief evaluation of the current situation as at this date and the potential options for its management.

Aquatic Vegetation Identification & Distribution

Three aquatic plants were identified in the lake, in order of volume coverage **Vallisneria** commonly known as *Ribbonweed*, **Eleocharis shacelata** commonly known as *Tall Spikerush* and **Triglochin procerum** commonly known as *Water Ribbons*.

The bulk of the aquatic vegetation in volume percentages, more than 85-90% is Vallisneria, with the other two aquatic plants making up less than 10-15% of the volume.

Eleocharis is a slender, erect, rhizomatous Australian native perennial, emergent aquatic plant. It has erect cylindrical green stems 1-4mm in diameter, growing to heights of up to 1m and prefer growing along banks of lakes and dams and in other shallow water areas typically in less than 45 to 60cms of waters depth. Where Eleocharis is located within the greater lake, this would indicate shallower water areas.

Triglochin procerum commonly known as *Water Ribbons,* is the significant aquatic vegetation habitat noted in the 2016 Growling Grass Frog report. Triglochin is an Australian native emergent aquatic plant, with tuberous roots, with some leaves floating and others erect between 0.5 to 2 metres in length, with dense seed spikes to 30cm in length. Seeds germinate readily in autumn. In temperate areas growth as well as flowering takes place in spring and summer with fruiting in late summer or autumn. As the Triglochin is easily differentiated from the other two types of aquatic vegetation in the lake, to maintain Growling Grass Frog habitat cutting Triglochin can easily be avoided when harvesting. For a detailed assessment of potential impacts on the Growling Grass Frog and their habitat from any lake vegetation management activities a herpetologist should be consulted for an opinion.

Eleochaaris

Triglochin

Valliseneria

Vallisneria is a widespread Australian native aquatic plant. Vallisneria is the most commonly planted aquatic species in Australia. The native aquatic plant is desired by urban wetland builders for its hardy nature and large capacity to absorb high amounts of nutrients for its size and weight compared to other native aquatic species.

Vallisneria is a broad leaf perennial aquatic plant that has a wide leaf (1-5cm) that can grow up to 4m in length in ideal conditions however most typically its length is in the order of 3m or less. Growth is most vigorous in summer and the “Wet” in more tropical areas and is mildly salt tolerant and can thrive in waters with a salinity up to 1500ppm.

While I understand that the Vallisneria is currently considered by some as an issue for recreational boat usage on the lake, of the types of aquatic vegetation that could proliferate in the lake system, Vallisneria is considered high on the desirable scale than most others.

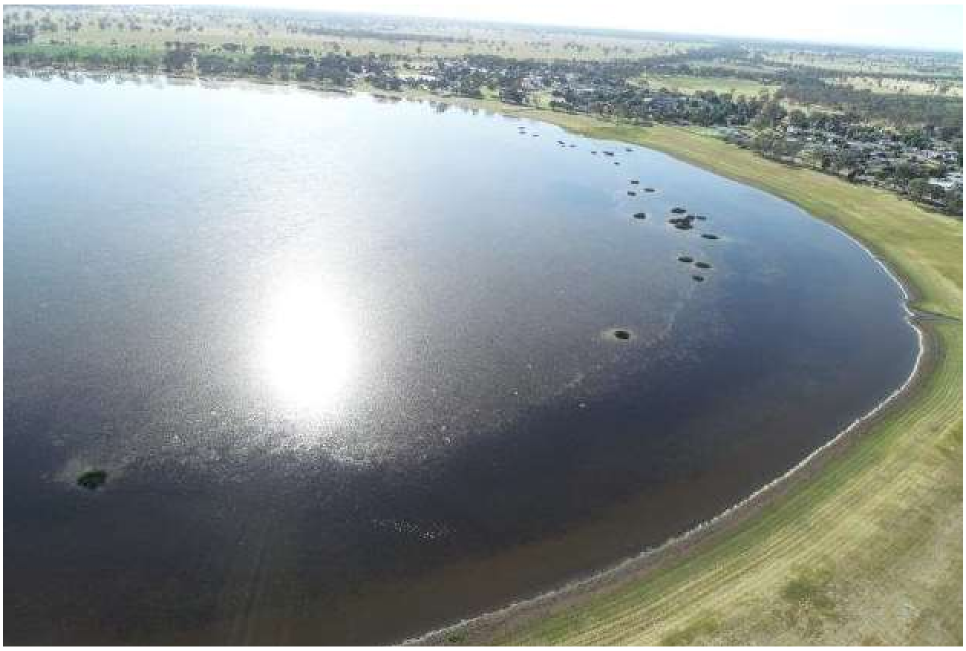


Image taken on or around the 30/11/2021
This image shows the majority of the lake vegetation is dominated by Vallisneria

Aerial drone images show that the vast majority of the lake, apart from a narrow band of clear water immediately on the edges of the lake, is densely covered with aquatic plant growth. It is estimated that 90% of the lakes surface has submerged aquatic vegetation beneath. The images also show that the vegetation coverage is fairly uniform and dense in coverage.

Coverage is considered to change as the lakes water level drops over the summer period.

The Vallisneria as it grows towards the water surface and or the water level drops to meet the Vallisneria it results in a fold over of the leaf. This then fatigues the leaf and causes parts to break off. Also, wind and wave action can whip out larger strands of the aquatic plant. These factors cause a pile of detached aquatic vegetation to gather at the downward wind edge of the lake.

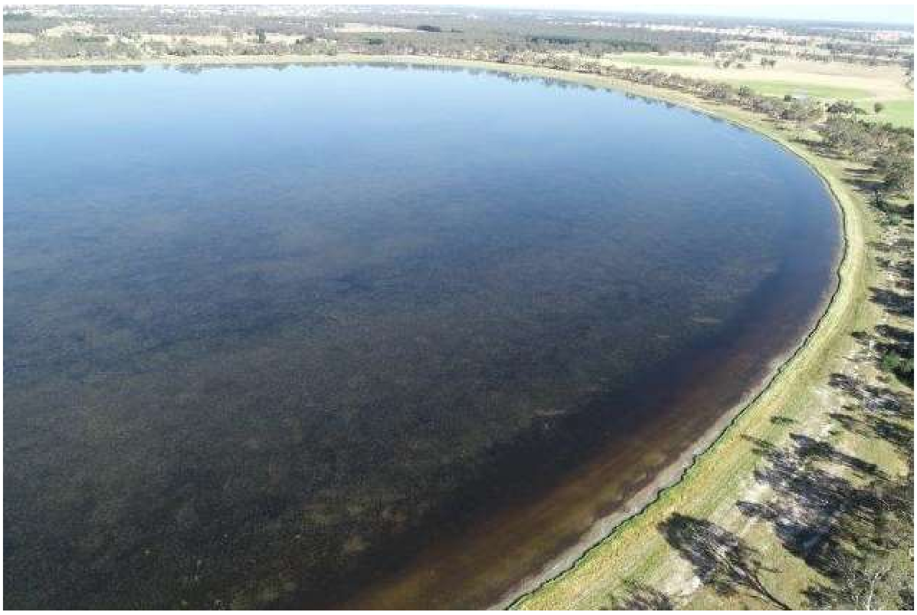


Image taken on or around the 30/11/2021

Water Quality Composition

The snap shot water test data, taken on the 26/011/21 (appendix B) shows high (above ANZECC (2000) Water Quality Guidelines target range) levels of Nitrogen (N) and Phosphorous (P) in the water. The water testing methodology was undertaken is in line with NATA accreditation. The samples were taken at 11am, 12.5m out from boat ramp at 0.790m weather depth. Dissolved Oxygen samples were taken at various locations between 11am and 12noon and averaged, all others samples taken from a single location 12.5m out from boat ramp at 0.790m weather depth.

These nutrient levels are the underlying factor driving the growth rate of the Vallisneria and other aquatic plants and algae.

The combined higher than average levels of nutrients (N&P) indicates that growth levels of aquatic vegetation and algae are more likely than less likely to also be higher than average.

This means that cut Vallisneria is more likely than less likely to grow back at faster levels than normalised growth rates.

The pH levels being high means that the overall water quality is less conducive for aquatic plant growth, as aquatic plants generally prefer less acidic water pH, therefore higher pH is more conducive to algal growth overall.

With the water quality parameters of high nitrogen, phosphorous, pH and low dissolved oxygen this would suggest that the one of the main factors that the lake is not in a Blue Green Algae bloom is based on the combination of the large spread and density of the Vallisneria, together with the currently low water temperature and the milder seasonal effects of La Niña for the 2021 and forecasted for the 2022 period. This season across Australia, overall, it appears to be dominated by aquatic plant growth, rather than an algae dominated season.

Without the Vallisneria in this volume and coverage, a Blue Green Algae bloom would be more likely than less likely.

Low dissolved oxygen levels are affected by a number of main factors including:

- Water temperatures, as water temperature increases it decreases the waters' ability to hold oxygen, thus dissolved oxygen decreases when water temperatures increase.
- Aquatic vegetation that is dying and decaying contributes to reductions in dissolved oxygen levels in the water.
- When aquatic plants photosynthesis, they take in carbon dioxide and sunlight to create energy to grow in the form of sugars, the by-product of this process is the release of oxygen into the water. At night the plant uses these sugars, through the process of respiration, taking in oxygen and combining it with the stored sugars to create energy, with the by-product being carbon dioxide. Net respiration is the difference between the oxygen produced during photosynthesis vs the oxygen used during respiration.

Of the above factors, water temperature is the major contributor to deoxygenation rather than that of the net respiration loss from aquatic plant growth or decaying vegetation.

Ongoing water quality information and testing should be undertaken and a regular water quality testing program should be established.

The ANZECC (2000) Water Quality Guidelines recommends a minimum water testing frequency of quarterly. Given the shortfall in existing data a frequency of monthly in summer, spring and bi monthly in other time is recommended to help establish baseline data. Frequency of testing should increase to weekly during any treatment or harvesting activity.

The following basic water tests should be undertaken under the following headings, as a minimum:

Biological:
Dissolved Oxygen (& or 5 Day BOD)
Total Nitrogen, as N
Total Phosphorous, as P
E.Coli (both enterococci & faecal matter)
Algae cell count, by species

Physical & Chemical
Turbidity
pH
Water Temperature
Salinity

Other recommended tests during spring and summer could include:
Chlorophyll-A
Phaeophytin a (BGA)

The ANZECC (2000) Water Quality Guidelines list a number of target ranges for various water quality parameters. The closer the water quality values are to the target range; the more aggressive aquatic vegetation treatments can be undertaken. Examples of ANZECC (2000) target ranges.

Items Tested	Target
Biological	
Dissolved Oxygen	>80
Total Nitrogen as N	< 1.6 mg/L
Total Phosphorus as P	< 0.05 mg/L
Physical & Chemical	
Turbidity ppm TDS	<500 mg/L
pH	5.0-9.0
Temperature	˚C

Aquatic Vegetation Plant Treatment Options

There are a number of aquatic vegetation treatment options available and we have been asked to consider discuss the merits of chemical treatments and mechanical harvesting.

CHEMICAL TREATMENT:

Chemical or dilution aquatic herbicide treatment is non-discriminant, meaning you cannot control what aquatic vegetation it does or does not kill.

The current water quality and turbidity would most likely be conducive and deliver effective results from the application of a dilution aquatic herbicide treatment. Aquatic Herbicides such as AQ200 have been use effectively on large scale lakes in Australia to treat this type of aquatic vegetation.

When you chemically kill aquatic vegetation using aquatic herbicides, the aquatic vegetation dyes and then falls to the bottom of the lake. Dying aquatic vegetation when it rots in mass, it takes up oxygen (thus lowering the dissolved oxygen levels in the water) and when it breaks down it deposits the nutrients held within the aquatic plant back into the water column. Therefore, it decreases dissolved oxygen levels and increases nutrient levels. This process can commonly compound already unfavourable dissolved oxygen and nutrient levels and therefore it can more likely, than less likely result in an algae bloom, water deoxygenation and fish kills.

The use of specialised aquatic herbicides, such as AQ200 and Hydrogel can be used to targe smaller patches at a time, thus lowering the impact of dilution aquatic herbicide usage. The combined cost of the product combination and the increased application time and skill can see a doubling of the cost verses a dilution aquatic herbicide approach. This would also require specialised training and equipment to apply.

CHEMICAL TREATMENT COSTS:

Estimates for a dilution aquatic herbicide treatment (product only) would be in the order of the following:

- Aquatic Herbicide treatments. Using AQ200 as an example, this would need to be applied at a rate of 5L per million litres of water in the lake. Based on an area of 164.9Ha at a max depth of 2m this would equate to (164,900m x2m)x0.4=1,319.2 Mega Litres. Therefore, would require 1,319.2 x 5L = 6,596L of AQ200 at a cost of around $90K for the herbicide product only, not including the cost to apply.
- Application can be done via aerial helicopter application or boat.

AQUATIC HARVESTING:

Aquatic vegetation harvesting is often the least impactful option available to aquatic vegetation managers. When aquatic harvesters harvest aquatic vegetation, it cuts and removes the aquatic vegetation, thus it limits the amount of rotting vegetation, limiting the impact on dissolved oxygen levels and it removes the nutrients held in the aquatic plants from the water column.

The larger the aquatic harvester the wider the cut per pass and the greater the holding capacity of the harvesting craft itself. The larger the aquatic harvester, the less down time in travel is used as a percentage of harvesting time. The example is to use the analogy is of a lawnmower with a catcher, the bigger the catcher, the less times you need to travel to unload the catcher. Therefore, the bigger the harvester the more efficient it is.

Large harvesting boats with clear access and egress are capable of harvesting around 2Ha per day and extract around 12 tonnes per day.

Of the available boat ramps on the lake, the main concreate boat ramp is the only ramp suitable for harvester access.

For harvesters to operate without limitations it requires a water depth of 600mm at 6m from the end of the concreate boat ramp. Based on the measurements undertaken during the site visit at 6m from the end of the boat ramp the water depth is only 460mm. This will limit the harvesters in water draft; thus, it will need to reduce its holding capacity by an estimated 40 to 45%, therefore reducing the area coverage to around 1.1 to 1.2Ha per day. The lower the lakes water level the less practical and efficient a harvesting boat is.

As only the main concreated boat ramp is suitable, the locations within the lake chosen to be harvested, based on the distance from the boat ramp would also affect the area coverage per day (harvest time vs travel time). As the harvesting location becomes further away from the boat ramp more time is needed traveling with a full and empty catcher and less time cutting.

AQUATIC HARVESTING COSTS

To cover 20% of the lake with an aquatic harvesting boat, based on 164.9 Ha, being 32.98Ha at 1.1Ha per day would take around 29 days. This would cost in the area of $78,000 to $85,000. Actual area coverage would diminish the further away from the boat ramp the harvesting locations are.

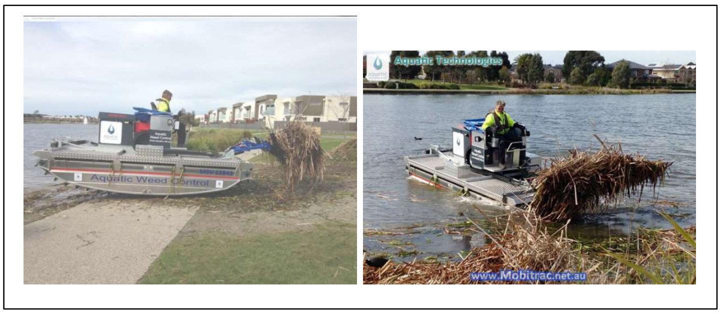
Another option would be to use an Amphibious harvester, which would not be limited by water depth. An Amphibious harvester, such as the Mobitrac would be able to cut in all depths and is the recommended method of harvesting when the water levels is below 2m.

AMPHIBIOUS HARVESTING

While the Amphibious harvester is able to harvest in all depths, it is recommended to depths as low as 0.3m, as efficiency will decrease at water levels below 0.3m.

When using the Amphibious harvester to service this lake, it should be used predominantly to cut. It would need to cut a channel (with the predominant wind direction as the factor), so that the cut vegetation can utilise the wind to push it to the lakes edge. The Amphibious harvester would also need to be utilised to push any lodged or build-up of cut vegetation to the lakes edge and an excavator or bobcat could be used to remove the vegetation for disposal, this would yield a true coverage cut of a similar area at a lower cost compared to a larger harvesting boat, by using an Amphibious harvester especially in water levels below 2m.

Image of amphibious craft cutter



Images of amphibious craft collecting & moving cut vegetation out of the water

Using a Mobitrac Amphibious harvester you could expect to save around $10K from that of a harvesting boat to cover that same area at an estimated cost of $68 to 75K. There would be the additional cost of an excavator or bobcat to remove the cut vegetation from site. The main benefit of using a Mobitrac Amphibious harvester is access in shallow water. Given that the current water levels are low and expected to drop, the Amphibious harvester guarantees access and the ability to cut regardless of the water depth, meaning it can navigate through shallow water to the deeper areas to cut without limitations.

Alternately the council could purchase a Mobitrac Amphibious harvester at a cost of around $180k.

At the time of inspection, the lakes water level was registered at 2m. For harvesting boat access this equated to a depth of 480mm at a distance of 6m from the end of the boat ramp. Therefore, at a registered lake depth of 2m a harvesting boat is able to operate, however its operation would be at a restricted capacity. A registered lake depth of less than 2m would be deemed impractical, due to boat ramp access for a harvesting boat to be used.

The ideal depth for high level efficient harvesting boat access, is a registered water depth of 2.12m or deeper, equating to a depth of 600mm at a distance of 6m from the end of the boat ramp.

At registered lake depths below 2m, an amphibious harvester is the recommended method.

AQAUATIC VEGITATION TREATMENT OPTIONS RECOMENDATIONS

Based on the observations on site and the water test data the following is to be noted:

Aquatic Herbicide Treatment:

- Dilution herbicide application would <u>not be</u> recommended due to its likely impacts on overall water quality, not discriminant nature and would be more likely than less likely to result in an algae bloom event.
- Small scaled targeted aquatic herbicide treatment can be manageable, however at a higher cost base.

Aquatic Harvesting:

Equipment Options & the operational limitations:

- A Harvesting boat can effectively be used at registered lake water depths of 2m or greater, with the ideal lake water level being greater than 2.21m. (Based on current boat ramp length and configuration). Extending or altering the boat ramp to obtain a minimum depth of 600mm at 6m from the end of the boat ramp would allow for harvester boat access at water levels less than 2m. It is estimated that at the current grade an additional 20/25m could provide an additional 300mm water depth for harvester access, therefore possibly giving effective harvesting at a depth of 1.91m and allow harvesting activities at 1.7m of waters depth.
- At registered lake depths below 2m and as low as 0.3m, an amphibious craft is the recommended method of harvesting.
- Harvesting can be undertaken at any water depths, low or high, however cutting below 0.3m of water depth, could put the aquatic plant at risk, stir up sediment & be less efficient.

- Whole lake harvesting would be costly and would be more likely than less likely to result in an algae bloom event.
- Any harvesting activity should be minimised and targeted, in a checker board harvest approach, where some minor areas are harvested and the other bulk areas are not harvested to mitigate the likelihood of resulting algae blooms.
- Any harvesting should be minimised to no more than 10% to 20% of the lake area at any one time, if being undertaken in Spring through to autumn. Larger percentages of the lake could be harvested in the cooler winter periods or the shoulder periods of autumn or spring. Harvesting more than 10% to 20% of the lake area at any one time would be more likely than less likely to result in an algae bloom event.
- Given that water temperature has a direct effect on dissolved oxygen levels, therefore it can be reasonably concluded that more favourable conditions can be found in winter for harvesting than in summer. Also, the risk of algae blooms is reduced in winter vs summer.
- Harvesting activity is beneficial in decreasing nutrient loadings, decrease vegetation fragmentation and to increase recreational access.
- Any limited harvesting activity should be targeted to obtain the best outcome for lake users and interest groups.
- Any areas harvested should have justification, a reason and plan as to why they are important for the lake users and interest groups for access or amenity.
- Interest groups and users should always prioritise the areas to be harvested.

The impact of chemically treating the whole lake would be similar to harvesting the whole lake, but much worse, as harvesting removes the cut vegetation, but chemically treating it does not.

Designing and Construction of an Aquatic Harvester in House

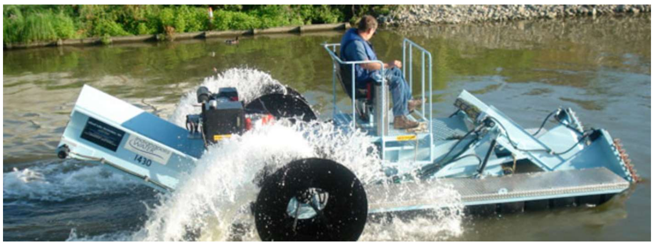
With regards to the process of designing and constructing an aquatic harvesting machine from scratch, this would be a costly exercise, compared to purchasing an off the shelf aquatic harvester, already proven over time and one that has already been certified by the Australian Maritime Safety Authority.

Purchasing an off the shelf already certified aquatic harvester will avoiding all of the red tape associated with registering a newly designed commercial vessel and the cost of research and development.

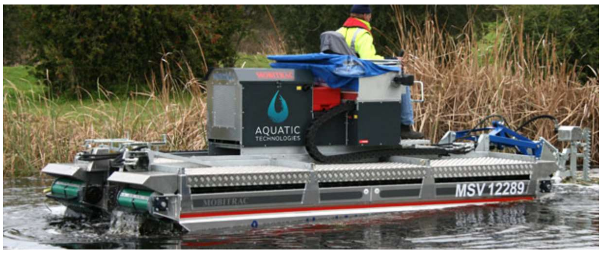
All aquatic harvesters need to be in commercial survey and registered with the Australian Maritime Safety Authority. There is weight balance, safety compliance, hull pressure tests, and floatation testing etc requirements. A maritime ship builder or naval architect would need to draw up plans and submit them to the Australian Maritime Safety Authority for approval prior to construction. I would recommend that you look for a commercially available off the shelf harvester that would suite the lake and requirements. A harvesting boat is always limited by its draft for obtaining access.

Note: Operators of commercial vessels are required to be suitably trained and hold either a Coxswain qualification or an AMSA Exemption 38 training certificate.

Suitable harvesting craft, such as a Mobitrac amphibious harvester (which is not limited to its draft) would start in cost from around $180k and boat harvesters would start in cost from $280K upwards.



Boat Harvester



Mobitrac Amphibious Harvester

Comments for Consideration in Conclusion

- A regular water testing program is recommended be established to ensure water quality information is known and so that trend data can be used for future management decision making.
- The aquatic plant growth is not the major cause of fish kills in the lake. Water temperature increase and algae are the major contributor to oxygen depletion.
- While volume of the vallisneria growth is restricting recreational usage, the off set of no aquatic plant growth would be an algae dominated lake. Without the Vallisneria in this volume and coverage, a Blue Green Algae bloom would be more likely than less likely.
- Aquatic harvesting is a more suitable option than an aquatic herbicide treatment.
- Aquatic harvesting should be limited to 10 to 20% of the lake area, as to not tip the balance to an algae dominated state. 10% in summer and up to 20% in winter periods, based on the current water quality test results.
- The closer the lake water quality actual results are to the ANZECC (2000) target ranges the greater the area that could be harvested.
- Harvesting boats can be used when water levels are above 2m. Below 2m amphibious harvesting is the recommended harvesting method.
- Any lake areas harvested, would mainly be for recreational usage and should be prioritised by the user and interest groups.
- Any lake harvesting with a harvesting boat, should be encouraged to be as close as possible to the boat ramp to increase harvester efficiencies and coverage at a lower cost per Ha harvested.
- A harvesting boat is limited by its draft and an amphibious machine can operate in all areas regardless of water depth.
- Purchasing of a harvester amphibious or boat, maybe an option if long term maintenance is considered to be needed.
- Ensure that the balance of aquatic vegetation vs algae is maintained to an aquatic vegetation dominance.

About Aquatic Technologies and the Author

Aquatic Technologies has been operating since 1998 and is an industry leader in algae control, aquatic harvesting, water testing and water quality services around Australia, New Zealand, Singapore, Malaysia, Indonesia and Vietnam.

Aquatic Technologies is a trusted knowledge source for government, mining, local councils and more, the team at Aquatic Technologies understands just how to meet the demand for exceptional waterway management.

Aquatic Technologies offers a wide range of science-backed products and expert-led services to keep your waterways healthier for longer. We understand Australian water conditions and can assist in all areas from aquatic vegetation control to waterway management solutions and consulting.

Visit the Aquatic Technologies group of websites at:
https://aquatictechnologies.com.au/
https://www.mobitrac.net.au/
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Aquatic Technologies senior consultant and CEO Terry Mealor holds a Masters of Applied Science degree, majoring in Costal and Fresh Water Management from the University of Sydney, as well as an undergraduate Bachelor of Commerce degree, majoring in Commercial Law from Deakin University, Melbourne. With over 23 years of practical on the ground aquatic plant and algae management experience. Terry is able to provide scientific advice that is science based, practical and commercially sustainable. Refer Appendices A.

Appendices

Appendix A

Appendix B

Water Testing Report Card / Lake Wallace/ Test Dated: 26th November 2021 10.00am.

Items Tested	Target	Actual Test 26th November 2021	Trend from Previous Test n/a	Report Card	Management Actions Required
Biological					
Dissolved Oxygen	>80	**69.2%**	n/a	*Refer comments*	Nil
Total Nitrogen as N	< 1.6 mg/L	**2.6 mg/L**	n/a	*Refer comments*	Nil
Nitrate + Nitrite, as N (LL)	<1.0 mg/L	**0.007 mg/L**	n/a		Nil
Total Phosphorus as P	< 0.05 mg/L	**0.068 mg/L**	n/a	*Refer comments*	Nil
Physical & Chemical					
Turbidity ppm TDS	<500 mg/L	**314 mg/L**	n/a		Nil
pH	5.0-9.0	**9.0**	n/a		Nil
Temperature	˚C	**16.76˚C**	n/a		Nil
Salinity	0-0.5 psu	**0.31 psu**	n/a		Nil
Salinity EC (dS/m)	<0.95 Very Low 0.95-1.9 Low 1.9-4.5 Medium 4.5-7.7 High 7.7-12.2 Very High >12.2 Extreme	**0.531 dS/m**	n/a	Very Low Salinity	Nil
$CaCO_3$ Hardness	60-200 mg/L	**110 mg/L**	n/a		Nil

Report card Quick Reference Key

	Results within the target range.
	Results high in the target range or just outside of target range.
	Results well outside target range.

Item	Comments	Recommended Management Actions
Dissolved Oxygen	*Low oxygen concentrations enable nuisance anaerobic microorganisms to grow, and affect taste and odour*	Note
Total Nitrogen as N	*Excess nitrogen promotes the growth of aquatic weeds and algae in water.*	Note
Total Phosphorus as P	*Excess phosphorus aids algal growth which effects water body health and promotes aquatic weed growth.*	Note
pH	*High pH can interfere with the tolerances of aquatic plant growth*	Note

Comments
The combination of low dissolved oxygen, high nutrients in the form of both Nitrogen and Phosphorus indicates that together with high pH that algae activity is more likely than less likely as water temperatures increase. An algae cell count by species is recommended.

Next Water Test to be scheduled

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

The above comments are based on the general guidelines given by the ANZECC guidelines and are applicable only to the physical and chemical analyses carried out on the water samples. This is general testing and does not include all possible factors contributing to health risks or general health. These measures are a guide. Does not include other possible contaminants including, but not limited to pesticides, radioactivity or other organic toxicants.

--End Report --