

FILE NOTE



File Note From: Andy Bruere
Lake Operations Manager

File Reference: **Date:** 19 February 2013

Subject: **Water Quality TAG meeting - 18 February 2013**
Bay of Plenty Regional Council Rotorua Office

1 **Attendance**

Those in attendance were:

John McIntosh, Warwick Silvester, Marie Dennis, Alison Lowe, Paul White, Andy Bruere, Chris Palliser, Jonathan Abell, David Hamilton, Piet Verburg, Paul Scholes, Max Gibbs and also Michelle Lee part of the time and Mark Buckley.

2 **Apologies**

Apologies received from Kit Rutherford, Deniz Özkundakci, Victoria Jollens, Peter Dine, Clive Howard-William and Trevor Stuthridge.

2.1 **TLI reporting**

Paul Scholes updated the Group on the TLI error bars. He outlined that they had been re-calculated with monthly data which resulted in much reduced error bars.

Paul also suggested undertaking a TLI on the epilimnion rather than the full water depth. David commented that Ministry for the Environment is considering this matter. He commented that, where a lake is fully mixed the whole water column could be used to calculate the TLI but where the lake is stratified, then best use then epilimnion values.

Action

- **Paul to circulate new TLI error compared with the old calculation.**
- **Andy to prepare letter for TAG to Ministry for the Environment to outline the issue and suggest they undertake a mini-project to refine the TLI protocol to provide consistent results throughout councils in New Zealand. Paul Scholes also to present to SWIM Group in May an outline of the issue.**

2.2 **Rotomahana overflow**

Andy outlined that the Rotomahana overflow had been gauged and provided the results (attached to this memo) for water quality and flow.

Action

- **Andy to circulate results to the Group.**

2.3 Update on Rotoehu and Lake Hayes projects

Max provided an update of the Rotoehu and Lake Hayes projects. Main points are that they are going through a renewal of a resource consent process at the moment with Andy Woolhouse. The old mesocosms will be removed and replaced with new dark sided mesocosms. They will ensure that periphyton is kept out of the water column. They are applying for treatment levels at a higher rate as only alum and Aqual-P bound phosphorus worked properly at the optimal dose rates. The trial work at Lake Hayes has just been completed. The purpose of the black wall is to simulate a deep lake environment by cutting out light.

2.4 Ōkaro wetland performance differences

Clive was not present at the meeting so this item was held over until the next meeting.

2.5 Ōkaro Wetland detainment bund (presentation from John Paterson)

John circulated a memorandum explaining the detainment bund project. This is the second time this has been brought to the TAG for consideration. The proposal is to install a sediment bund which will detain around about 16,000 cubic metres of water to contain the majority of flow which bypasses the wetland. The bund would operate through a 100 mm outlet and then the whole flow could be accommodated in the wetland.

Council management was now requiring consideration of alternatives on a proposal such as this because it is relatively high cost, in the vicinity of about \$80-100,000 to design, construct and commission. The alternative would be to plant around about 30-40 hectares of pine trees within the catchment.

David Hamilton made the following comment:

- The 80 tonnes of sediment accumulation in the wetland could be reduced by this bund and it would have a beneficial effect on the life of the wetland.
- David questioned the longevity of these types of bunds in the catchment and how often would they need to be cleaned out. John said experience in the Rotorua catchment with similar bunds had shown no evidence of significant sediment accumulation requiring cleaning out. However, the weir upstream of the wetland had been cleared out once and the sediment spread back on land.

The Group listed out a number of advantages of this sort of bunding system for Ōkaro:

- 1 Protect the investment in the wetland and reduce sediment load to the wetland.
- 2 Better treatment through the wetland by reducing the flow rate into the wetland. The comment was made that Chris Tanner could provide some advice on this matter.
- 3 There could be some monitoring in and out of the bund to test performance in terms of reducing sediment and other contaminants.
- 4 The bund option appeared to have less uncertainty than the forest option.
- 5 The soils in the area have high phosphate concentrations and so a change in land use may not have a significant improvement in sediment phosphorus concentrations discharged during storm events.
- 6 This could be a possible monitoring project and allow confirmation of what has been achieved compared with the difficulty of monitoring a land use change from agricultural to forestry.

- 7 More likely to be feasible to assess impact on water quality from putting in a new dam compared with forestry.

Paul White asked what return period storm event would be contained by the bund

Action

Consider the value of pine plantation versus bunding on the environment.

David Hamilton made the comment that we need to be very careful about using aerial based nitrogen and phosphorus yields for soils like Rotomahana mud. He was also concerned about nutrient leaching from forestry during various stages of the forest operation.

Warwick Silvester questioned whether we could consider three low level bunds in series to achieve the same thing at lower cost. John said they had looked at options but there were not many areas above the selected site which would be suitable for ponding.

Action

- **It was suggested that the option of forest planting compared with the bund application could be added to the lake model which was currently being run with David and Deniz.**

David Hamilton quoted some results from Purukohukohu catchment where production forest leaching rates were compared with native forest and pasture leaching rates.

The main points highlighted were:

- At the time of canopy closure (9 to 12 years after planting) nitrogen exports from a pine subcatchment were lower than those from a native forest subcatchment, but the pine subcatchment was less retentive of total phosphorus (4-fold difference).
- At the pine plantation approached maturity yields were higher than from the native forest; nitrate c. 2-fold, total Kjeldahl nitrogen (TKN) c. 6-fold and total phosphorus c. 14-fold.

Total phosphorus yields were 24-fold higher in the pine subcatchment in the year following harvesting and then decreased to 3-fold higher four years after harvest. Comparable figures for nitrate and TKN were c. 4-fold and 26-fold higher, respectively, one year after logging, followed three years later by nitrate yields less than one-fifth and TKN c. 2-fold higher than the native forest control. Marie Dennis made the comment that Trevor Stuthridge is in charge of the team undertaking modelling land use work at SICON. Information would be available from Trevor Stuthridge on nutrient leaching from various forest operations.

Action

- **It was agreed that further information would be brought back to the next TAG meeting so they could make a recommendation on the value of the Ōkaro bund.**

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3 Sediment TAG update

3.1 Rotoehu progress

- (i) Andy gave a brief update on the physical components of the project. The machines had been re-anchored after moving earlier in the project. There was some issue with weed blockage of the machines and a diver has been sent down to clear that. However, it appears they quickly draw weed back into the intake screens and create further blockage. The recommendation from Hans and the diver is that we remove the screens and allow the weed to go through. This may create some other issues but we will deal with those at the time. Andy commented that Hans was considering building some structures or fences around the intake to prevent weed blockage. However he was concerned that this could affect where water was drawn from and not properly picking up the cool water in the bottom of the lake.
- (ii) David provided an update on the monitoring for the project. The Group linked into the temperature for the monitoring buoy on the website and showed stratification over the summer period. DO dropped about 6 February and then a wind event mixed the lake again. The Group was interested in the times when the destratification machines were operating.

Action

- **Andy to get plot of when machine has been operating and when the weed was cleared for the Group.**
- **Check wind events of similar magnitude to determine lake mixing effect.**

David then went on to explain monitoring had been monthly for the last year. Over the last three weeks Kohji had been monitoring twice per week.

There is a need for at least two days of low wind for the trials. The model being used is the AECOM-CAEDYM.

Hiroshi Yajima is in New Zealand to assist in calibrating and validating the model for this project.

Action

- **Need to consider calibration of buoy data with occurrence of blue/green shoreline algal blooms.**
- **Invite Alistair Suren to the next TAG meeting to present on blue/green statistics for Bay of Plenty.**
- **David to link with Alistair to investigate DNA techniques compared with cell count.**

Warwick Silvester was questioning whether we were getting an effect from destratification. David commented that at this stage he could not confirm that. Warwick was also interested that the bottom water temperature was dropping by about one to two degrees quickly as the lake re-stratified after being mixed. It appeared at this stage there was no satisfactory answer as to why water temperature would drop so quickly.

3.2 Lake Ōkaro modelling and sediment capping

David gave a brief overview of the status of the Lake Ōkaro modelling and the report on sediment capping during December 2011 and July-August 2012. In the near future a full report on these sediment capping exercises will be available.

David noted that the timing of alum dosing may be critical to its success. He was commenting, if buoyant cells hold excess phosphorus and they are not flocculated and sedimented out by the alum or Aqual-P and it may only be clarifying the water column and allows a bloom of the less desirable algae.

Max suggested that this happened on each application and a small bloom has occurred after the application.

John McIntosh commented that for Ōkaro we have had two years with no application of alum or Aqual-P (prior to the Dec 2011 application) and we have had two years of high catchment runoff which would contribute to conditions more likely to cause an algal bloom.

Action

- **TAG to discuss and advise on the need for ongoing alum dosing on Lake Ōkaro.**

Max made the comment, is there sub-optimal dose, that below which, there is no impact or effect on algae.

3.3 Groundwater investigations in Whakarewarewa and part Rotokakahi Catchment (Paul White)

Paul White provided an update of these investigations and also provided the report prepared for Bay of Plenty Regional Council. Paul outlined where the study area was, part of the Whakarewarewa Forest and the area of effluent irrigation for Rotorua sewage and it was also extended out towards the shores of Lake Rotokakahi from that area. The report from GNS is 2012/246.

In summary the findings were:

- The groundwater catchment boundary between Whakarewarewa Forest and Lakes Rotokakahi and Tikitapu is probably similar to the surface catchment boundary as indicated by catchment water budgets, measured groundwater elevations and a groundwater flow model.
- Therefore, a groundwater divide consistent with topography probably prevents groundwater flow between Whakarewarewa Forest and Lakes Rotokakahi and Tikitapu.
- The vast majority of spray irrigation in the Whakarewarewa Forest occurs in spray blocks below the 394 m topographic contour, which is the surface water elevation of Lake Rotokakahi. Groundwater elevation at the 394 m topographic contour in Whakarewarewa Forest will be below the elevation of Lake Rotokakahi because the water table in wells is always below the ground surface.
- As a result, it is highly unlikely that the treated wastewater flows through the groundwater system from the Whakarewarewa Forest spray irrigation field into Lake Rotokakahi.

This work had been done in preparation for engagement with the Board of Control for Lake Rotokakahi to ensure any impact from sewage irrigation had been identified. Engagement with the owners of Lake Rotokakahi has not progressed so far to date.

3.4 Jonathon Abell PhD presentation

Jonathan Abell presented some of the results of his PhD particularly in the area of storm flow inflows to Lake Rotorua, phosphorus bio-availability and some lake modelling work around the wind effect on stream outflow from Ngongotaha.

Stream inflows were studied for the Ngongotaha and Puarenga streams. These two catchments have contrasting land use with larger or smaller areas of forestry and agricultural production. Some of the main conclusions coming from this work are that:

- Load calculations that do not reflect \uparrow TN and in particular TP concentrations with \uparrow discharge will significantly underestimate loads to the lake
- Particulate P concentrations can increase **a lot** when it rains
- DIN is fairly invariant to discharge **but** some evidence of pulses in the Puarenga Stream after heavy rain
- DON and DOP were minor
- A large data set has been collected
- Phosphorus bio-availability is complex!
- Sediments can remove as well as release P to water
- 100% of PP measured in two streams after moderate rainfall was potentially bioavailable in the longer term
- Abiotic processes (sorption kinetics) have a major role in regulating bioavailability of P in stream inflows
- Consistency of particulate phosphorus speciation within source areas shown by Jamie Steer suggests that further work could aid general understanding of phosphorus availability

John McIntosh commented that more latterly we don't seem to be seeing an increase in phosphorus in water as a result of storm events. A pulse of dissolved phosphorus is not creating a big impact on lake water phosphorus levels. There was discussion around this point and consideration that sediment phosphorus coming into the lake may not result in a noticeable change in water quality as a result of recent storm events. However, it would be moving towards the deeper parts of the lake in time and then have potential to release phosphorus.

David commented that the project has demonstrated the value of detainment bunds in stopping phosphorus flow to lake over time. This may have more long term impacts as the train of sediment reaching the lake is reduced.

Jonathan then commented on his lake modelling work. He's undertaken 3D modelling for Lake Rotorua. He modelled a 2011 storm and showed the wind effect on the Lake and the Ngongotaha Stream outflow. The direction of flow within the Lake during the storm event seemed to coincide with the monitoring work which had been undertaken by NIWA in 2011. It showed the effect on the Ngongotaha Stream outflow as pushing the flow to the south of the Stream. His conclusions were summarised as:

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- A 3-D model successfully simulated field data during a dynamic 5-day period
- Phytoplankton distribution and nutrient limitation varied temporally and spatially as a result of horizontal transport processes
- 3-D modelling can potentially help to answer **lots** of questions about phosphorus distribution and availability, as well as changes between N and P limitation in the Lake.

Piet Verburg commented that calcium is low in New Zealand lakes and this can have an effect on phosphorus availability, in North American lakes, calcium levels are higher and can tend to hold phosphorus in a form that is less bioavailable than some other metal cation bound forms.

3.5 Model updates

Model updates was put on hold until next TAG meeting as Deniz was away and more progress will be available at the next reporting time.

3.6 Tarawera modelling progress

A new item from Paul White, updated us on the Tarawera modelling progress. Paul commented that:

- A geological model will be completed by March 2013.
- The flow model for groundwater will be started at that time.
- The land use model will be underway by October 2013.

3.7 Alum dosing protocol (John McIntosh)

John McIntosh provided a presentation on the alum dosing and phosphorus levels within Lake Rotorua. He was advocating that the TAG should have a position on what it is trying to achieve with the alum dosing and also have a protocol on how it manages the alum dosing. See his PowerPoint for TAG position. Warwick Silvester asked what's the outflow of aluminium at Puarenga. John commented about half a part per million of aluminium from natural sources and about half part per million from alum dosing. The plant had been turned down to a low rate of about half a part per million aluminium in response to low phosphate levels in the lake (less than 0.020 ppm). Max suggested that we repeat the benthic experiments undertaken by David Burger to determine the level of nutrient release from sediments under the current regime. Discussion around this indicated there was support for this, however there was no urgency to undertake these experiments.

Action

- **TAG agreed to accept John's wording with a six-month review and await the results of the Rotorua modelling to determine any change to the purpose and protocol of alum dosing for Lake Rotorua**
- **TAG accepted dosing strategy as written by John.**

Max Gibbs suggested that as P is reduced in the catchment load then the alum dosing could reduce, ideally to zero.

3.8 Rototua sediment sampling

David presented the results of sediment sampling which has been undertaken in the last year. These were undertaken to check for accumulation of aluminium on lake sediments. The monitoring was designed to mimic the same sites monitored by Lisa Pearson and Dennis Trolle in 2007. David commented that sediment accumulation was as high as 1 cm/year in the deep parts of the lake.

The results provided by David showed in Zone 1 (closest to the Utuhina and Puarenga streams) there is only a hint that aluminium is increasing. Further communication with Denniz will be made to check this.

Aluminium to P ratio to check, this might be greater than 5:1.

David's conclusions on this monitoring :

- Sediment survey data do not support the hypothesis that Al accumulated in the main basin of Lake Rotorua.
- It is suggested here, that long- to medium-term catchment and in-lake dynamics had more influence on the net change in sediment P concentrations than alum. (See PPT attached).
- The alum mass balance corroborates these findings: There is a compelling probability that very little alum was deposited into the main basin.
- The mass balance approach indicates, however, that alum may have reduced water column P and internal loading to some extent, but this reduction alone cannot explain the recent substantial improvement in water quality.

Action

- **Andy to provide aluminium concentrations coming from the dosing plants so Deniz can check possible application rate to the bottom of the lake.**
- **David and Deniz to complete modelling with updated ROTAN inputs to get better estimate of alum impact.**
- **Paul Scholes to arrange for in-lake sampling of phosphorus at the buoy if stratification events large enough to release P.**

There is a need to get updated farm and other changes that would affect nutrients from land use as soon as possible so that this modelling work can be undertaken.

Action

- **Update sediment survey again in three years' time. Start littoral survey around Utuhina to see if any impact there (David suggested about six cores).**

3.9 Ōkātina Action Plan and research

Michelle Lee, one of our regional planners, presented on the Ōkātina Action Plan and the status of the draft Action Plan for Lake Ōkātina. She commented on the main actions which include:

- Land use change in the short-term for about 70 hectares of land to achieve the nitrogen target for the Lake,

- A longer term objective of research to establish the impact of animal pests affecting the understory and forest harvesting within the catchment, and
- A longer term objective in the next Ten Year Plan getting funding for further land use change to try and achieve a greater part of the phosphorus target.

Michelle explained however, that even if all the land use in the catchment was converted to forestry we would still fall short on the phosphorus target for the Lake and so therefore further investigations were necessary to understand why that phosphorus target could not easily be achieved by land use change. David then outlined the PhD study which we are awaiting the university to enrol a student from Ghana.

David made the comment that not all forests are equal in terms of nitrogen leaching and some situations they are capable of leaching up to 10 kg of nitrogen per hectare. See: <http://researchcommons.waikato.ac.nz/bitstream/handle/10289/5181/Nutrients%20%26%20land%20use%20in%20NZ%20lakes.pdf?sequence=3> (Relationships between land use and water quality in New Zealand lakes).

He also stated that there could be significant influence from animal pests within the area.

He also raised the issue of the potential for a predator proof fence around the complete catchment. Other than island reserves around New Zealand, this could be a full catchment project where a fence was located around a catchment boundary. This could have all sorts of advantages such as easier to control pests because there is less opportunity for them to come through weak areas such as stream crossings within the fence.

Paul Scholes commented that for part of the work we need more stream inflow data. David agreed and suggested that there would be significant amount of work getting around the catchment to identify stream inflows at the outset of the project.

John commented that there is some evidence that an up-flow at Humphrey's Bay in Lake Tarawera may be the outflow from Ōkataina. However this had not been confirmed.

3.10 Tikitere zeolite adsorption works

Andy Woolhouse presented on the trial being undertaken at Tikitere to test zeolite for absorbing ammonia from the geothermal flows. He provided a PowerPoint presentation and graphs of the results of this trial to date.

The main points were that this is a repeat of the trial undertaken in 2006 however, it is testing for zeolite at different size fractions and in series tanks to ensure that when one cell of zeolite becomes saturated with ammonia, then there are two further cells which can sop up and adsorb any ammonia coming through.

At the outset, it was considered that we could load the ammonia up until the outflow from each tank reached about 30 milligrams per litre of ammoniacal nitrogen.

Andy commented that stream values can be variable and showed levels getting up between 30 and 45 milligrams per litre of nitrogen.

Particle size tests seem to show the medium particle size operating best. The fine particles seem to have a problem and possibly due to preferential flow through the bed. It was commented that if we could get a fluidised bed situation then that would resolve that issue.

Arsenic levels monitored were about 6 milligrams per kilogram. David commented that this was not too high.

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Action

- **David commented that we should also be checking for cadmium since this could affect potential land use of the product for fertiliser.**

It was also discussed that this trial was reinitiated because there are now some potential end uses for the zeolite with ammonia adsorbed from the stream flow. We would potentially generate about 5,000 tonnes of zeolite per year and so far we can find a disposal source for about 2,000 tonnes and there are other enquiries around this.

David commented about calcium silicate being capable of taking up about 18% of its weight as dissolved phosphorus. He provided a contact person, Jim Johnston from Victoria University who is a chemist undertaking research in this area.

Further trial work for the Tikitere zeolite is continuing particularly looking at optimum flow rates and pH adjustment to enhance absorption on the exchange sites.

3.11 NIWA internal load report

This was put on hold until next meeting due to shortage of time to discuss it fully.

3.12 Rotorua sewage update

Mark Buckley provided an update on the main sewage projects for the Rotorua District Council:

- For Rotorua sewerage, Mark commented that they are close to meeting the nutrient limit over the last 12 months from the treatment plant. They have had a total of about 32 tonne N/year which is 2 tonnes over the consent limit.
- They are investigating options for meeting the 30 tonne N/year limit and will present that to the Te Arawa Rotorua Lakes Strategy Group in May.
- For Lake Rotomā, investigations into the satellite plant there have been stopped due to various political and iwi considerations. They are now looking at two options of either reticulating Rotomā and eastern Rotoiti to Kawerau or reticulating both areas back to the Lake Rotorua Scheme. This matter is on hold until a decision on the long-term Rotorua Scheme has been made by the council.
- Lake Tarawera sewerage feasibility has been undertaken and is about \$3.4 million dollars. This will remove about 1 tonne of phosphorus and about 4.4 tonnes of nitrogen from the catchment which is around about half of the nitrogen target for the lake. They have made an application to the Regional Council for funding of this project.

3.13 Trend Analysis Report on Lake Rotorua

David presented on the Trend Analysis Report for Lake Rotorua. This was a report required through the mediation process between Federated Farmers and Bay of Plenty Regional Council for the Regional Policy Statement.

The Report is a combined Waikato University, DNZ report and the first step of that, was to ensure that both parties were working with the same data set.

The main comments David made on this were:

- Total nitrogen is consistent and lower.
- Total phosphorus: there is effect (reduction) over 2011/2012.
- Chlorophyll-a is consistent and lower.
- Seechi disk is increasing.

David commented this highlighted that the magnitude of change was significant.

Warwick Silvester made the comment that we can't artificially alum dose Lake Rotorua forever. Over time after alum dosing ceases, if nothing else is done it will revert to an N and P limited lake. Need to consider long-term environmental response.

David made the comment that he is not certain that it is P limited as total nitrogen has reduced also according to the bioassay results of Jonathan Abell in 2011. The results of Lake Rotorua modelling with respect to alum and the recent land use changes will be necessary to assist in answering that question.

3.14 Programme progress on action plans and achievements

Andy did not present any detail on this because the meeting was close to finish time. He suggested that as there is significant detail this be sent to TAG members so that they can comment on whether we have appropriate numbers for nutrient reduction from actions undertaken on the various lakes.

Action

- **Andy to circulate some estimates on this for the TAG to comment on. TAG comment is required for the results to be presented to the Ministry for the Environment as part of our Deed Funding programme.**

3.15 DNZ representative on TAG

This matter was not discussed. However through the process of mediation between the farming fraternity and Bay of Plenty Regional Council for the Regional Policy Statement, there was an agreement made that a suitably qualified scientist representing DNZ would be invited to future TAG meetings. It is expected that this will be a position allocated to a professional scientist and that they will participate constructively within the meetings.

The meeting finished at 5:00 pm