MEMORANDUM

To: Water Quality Technical Advisory Group

From: Andy Bruere and Rob Donald **Date:** 20 December 2010

File Ref:

Subject: **TAG Meeting – 14 December 2010**

Attendance:

Peter Dine, David Hamilton, Warwick Silvester, Deniz Özkundakci, Paul Scholes, John McIntosh, Paul White, Janine Barber, Chris Palliser, Kit Rutherford, Piet Verburg, Nick Zamon, Max Gibbs, Simon Park, Jennifer Thorstad(GNS), Andy Bruere, Rob Donald.

1 Apologies

Clive Howard-Williams, Del Raurino, Greg Manzano

2 Actions from last meeting

Rotoehu monitoring buoy

David summarised progress – the buoy will be deployed in the New Year, sensor array includes a thermistor chain, DO and chlorophyll fluorescence. Some concern that hornwort will interfere with the operation of the buoy (though buoy has no moving parts).

Rotoehu bathymetric survey

David presented a report that documents the results of the survey, approximately 394,000 soundings collected of which 30,000 were accepted as correct (many others had interference from hornwort). Some arms of the lake difficult to cover due to dense hornwort.

Okataina sampling info

John has produced summary notes on this site.

Action: Andy to circulate notes from John to group. [Andy get these from John]

Tarawera targets reviewed

Waiting on the results of the groundwater monitoring before progressing this further.

Action: David would like to revisit the nutrient retention assumptions and report at next TAG.

Tikitapu Action Plan

Rob asked the TAG to review the nutrient budget compiled by John and Paul and provide any comments by early in the New Year. A draft action plan has been produced for the lake and it was noted that the key action (reticulation of the motor camp wastewater) has been completed.

Action – TAG members to review nutrient budget and send any comments to John

Rotoiti final water velocity report

David summarised the key findings of the report. Noted that more work is needed to understand the effects of diurnal swings in flow through the Okere gates (13-14 m3/s day versus 8-10 m3/s night) on the operation of the wall - the model uses daily average data and with residence time of 6-7 hours in Okere arm there is potential for feedback of water into Rotoiti. General discussion about the role that the wall may have played in the improvement to Okawa Bay water quality and the potential effects of diurnal Okere gate flow fluctuations on blue-green algal blooms in Okere arm.

Action – David to update report when analysis of diurnal variation completed? Consider using conductivity profiling in the lake to determine whether diurnal variation has an effect?

Monitoring buoy, health predictions

Rob noted that monthly sampling is occurring near the Rotorua buoy to allow an attempt at correlation of biovolume/cell concentration with the output from the blue-green fluorescence sensor. If successful this information could be used to improve the management of health warning.

Action – Rob to report back when data has been analysed.

Groundwater work

See memo's from Janine for update.

TLI results

Paul summarised the latest TLI report for the Rotorua Lakes. Piet summarised the results of the NIWA report on the quality of NZ lakes (commissioned by MfE).

Rotokakahi

The TAG expressed concern about the continued deterioration of Lake Rotokakahi, highlighted by the TLI report. Some discussion that there may be a link to harvesting and resulting release of nutrient laden sediment into the lake.

Action – David to get Joe Butterworth to update review of water quality info for the lake and report to next TAG. Note that the strategy group (RTALSG) has asked staff to report the findings to the Rotokakahi trust board.

3 Tarawera Groundwater Monitoring Works

Jennifer Thorstad a hydro-geologist from GNS provided a presentation on the Tarawera groundwater work where three bores have been drilled within the Lake Tarawera catchment recently. Some main points from this presentation were:

- This work builds on the 2008 groundwater flow model produced by Nicolas Gillon at the University of Waikato/GNS. This gives us an opportunity to see the effects of land use intensification on groundwater within the catchment.
- The aquifers were mostly unconfined and so therefore give no impediment to nitrogen leaching.
- The geology yields high K values (saturated hydrologic conductivity) so therefore provides a faster response to land use change in Lake Rotorua catchment.
- There were high nitrogen levels indicating the impact of farming near residential areas in two of the bores.

This work will be used to assist with determining sustainable nutrient inputs for Lake Tarawera with the upcoming Lake Tarawera Action Plan process.

4 Groundwater Rotomahana and Rerewhakaaitu

Paul White presented future work plan for the Rerewhakaaitu and Rotomahana catchments. It is planned that three bores be put in place to assist in finding groundwater flows and boundaries within the Rerewhakaaitu and Rotomahana catchments.

Paul also mentioned the work of Chris Daughney of GNS looking at groundwater travel times for Lake Rotorua. He is awaiting results of groundwater age from Uwe Morgenstern.

There was comment around Ōkataina flows into Lake Tarawera. Large groundwater foci are evident below surface waters on the north-east of Lake Tarawera, presumably arising from Ōkataina lake and catchment.

The group had some discussion around the requirements for Tarawera Action Plan and whether it would be sensible to do an Action Plan which encompassed the whole seven lake catchments as opposed to just doing individual lakes in succession. Although there is some merit in this approach, it was agreed that the Tarawera Action Plan needs to be progressed with some urgency so that actions can be formulated to reduce phosphorus inputs and that each of the contributing lakes buffer Lake Tarawera from greater nutrient inputs. A seven-lake Action Plan would delay the process of formulating actions to protect Lake Tarawera.

5 Sediment Technical Advisory Group (TAG) Update

The sediment TAG group has not met for some time as sediment capping trials on Lake Rotorua has been delayed due to resource consent issues. David commented that he had reservations around the usefulness of the Rotorua trial plots and was concerned that this would take significant resources to undertake these trials and due to the scale of the lake and potential currents within the lake it may be difficult to determine any useful outcomes from the trial work.

David made the comment that it may be better to do the hypolimnetic dosing with alum within Lake Rotorua to establish the value and impact of that activity on a large scale.

It was discussed that it may be more appropriate to go to a lake such as Rotoehu which has separate arms which could be screened off and provide better information as to the value of sediment capping agents. It was also commented that some of these arms are quite shallow and may not be the same as undertaking this activity in the deep water of Lake Rotorua. It does however have some benefit in also flocculating algae and in particular cyanobacteria.

There was significant discussion around the proposal for de-stratifcation work in Lake Rotoehu and scaling up to Lake Rotorua. Max commented that there was a large amount of information on de-stratification to keep lakes aerobic. He commented about the experience in New Zealand around the Auckland water supply lakes.

David presented results on the de-stratification algorithm. He was concerned that in Lake Rotoehu insufficient capacity of aerator leading to partial de-stratification may push buoyant algae (i.e. blue-greens) to the outer extent of the machine's reach and create a concentrated circle of biomass some distance from the aerator.

David then presented some results of DYRESM modelling on Lake Rotoehu. He was able to demonstrate that at the flow rates expected, there was little temperature gradient, however there was a need to undertake more modelling work to get some estimate of the effect on cyanobacteria. In particular the input into DYRESM needed to be aligned with operational parameters of the destratifier. Some other discussion points included:

- Possible increase in weeds due to clarity improvements in water quality. This is applicable to all lakes as we improve water quality.
- Max made the point that the supply of oxygen to sediments can reduce carbon and address anoxic issues within the lake. Decomposition of carbon material consumes dissolved oxygen, which is the reason the lake becomes anoxic and releases nutrients in the first place.
- David commented that the machinery is likely to be able to manage up to three to four degree Celsius temperature gradient in the water column.
- Some 3-D modelling may be useful to assess the horizontal extent of the reach of the destratifier (which is not explicitly included in the DYRESM modelling).

Action: Sediment TAG to assess options and direction for a number of machines and capping options.

6 Lab Equalibrium Testing capping products.

Max provided a presentation on the equilibrium tests on sediment capping agents within the lab. This testing was undertaken to assess the phosphorus uptake and the P binding capacity of these products and in particular assess their performance after their treatment to develop them into prills for application into the water column. The experiment was run at expected bottom water P concentrations for Lake Rotorua. Some of the main impacts here were:

- Of the products tested, only Phoslock™ and Aqual-P pellets removed substantial amounts of DRP from the lake water at these low concentrations.
- Phoslock™ removed 95% of the DRP but may have a minimum of 5 mg m^{-3} below which the DRP cannot be removed.
- Different Aqual-P formulations tested (Fast slow release, fast release, plus alum) had P removal efficiencies ranging of 20%, 25% and 70%, respectively.

- The binder affected Aqual-P and reduced its ability to absorb P proportional to the amount of binder added. Incorporating additional alum into the formulation enhanced to P removal efficiency of the prill.

- Under the test conditions, allophane and alum+lime prills released P, and failed to disperse rapidly in water.

- Maximum P-binding capacities (g P / kg) of the raw materials at pH 7 were re-determined and were slightly different from earlier estimates:-

Product P-binding capacity	New	Earlier
Allophane	16.1 to 19.5	13.7
Alum (46% solution)	86.4	75
Alum+lime prill	66.1	n/a
Aqual-P	11.5 to 36.5	20.5
Phoslock™	16.5	10.7

7 Settling velocity and dispersion tests, Max Gibbs

Max undertook a presentation around the settling velocity and dispersion tests for the lake capping products. The dispersion tests were undertaken in the laboratory over five days to ascertain how quickly the materials would break up into fine granules in the water column. Two grams of each product (excluding Alum solution) were added to 100 ml of natural water in a sealed container, briefly shaken and the rate of dispersion estimated. The containers were then shaken periodically over a period of 5 days and the dispersion checked. The allophane and the Alum+Lime prills did not break up and disperse during the 5 day period. Aqual-P formulations dispersed in times of <1 minute (fast release), ~4 minutes (slow release), and ~6 minutes (+alum). The Aqual-P+alum formulation settled as 2 layers with the while alum floc on top. Phoslock™ dispersed in <1 minute but was slow to settle as it developed a jelly-like floc which formed a layer several cm thick on the bottom. For dispersion and settling, the Aqual-P formulations performed best.

Then turbidity and settling tests were undertaken in a mesocosm in Lake Rotorua to determine how quickly the materials would settle out of the water column. The mesocosm settling tube was 1.6 m diameter and 15 m deep. Phoslock™ dispersed by erosion (left trails in the water) in less than 4 m but did not settle within the time frame of the tests. Aqual-P fast release prills broke up in less than 4 m in about 55 seconds and the dispersed fine granules settled through the 15 m chamber depth over the next hour. Aqual-P slow release prills broke up at a depth of 11-13 m in about 4 minutes and the dispersed material reached the 15 m depth (bottom) after 6–7 minutes. All other products fell to the bottom of the settling chamber, without breaking up, within 4 minutes. For dispersion and settling through 15 m water depth, the Aqual-P slow release prill formulation performed best.

8 Current velocity

Max Gibbs presented on the monitoring results for current velocity in Lake Rotorua. Two velocity meters were placed in Lake Rotorua for a four week period. Measurements were made with bottom mounted Acoustic Doppler Current Profilers (ADCP) in 17 m water depth in winter when the lake was fully mixed and again in late spring when the lake was thermally stratified. The main conclusions were summarised in Max's presentation, however some points are summarised below:

- The wind direction changes the water current direction. Northerly winds tend to produce a clockwise motion and southerly winds an anti-clockwise motion. When the lake was fully mixed, the flow direction and velocity from the surface appeared to be carried through to the bottom and the whole water column moved in the same direction at the same velocity. A change in surface wind stress could reverse the flow direction in about 6 hours. When the lake was thermally stratified, the bottom water often moved in the opposite direction to the surface water. Velocities increased about the depth of stratification. This flow regime appeared to cause high turbulence in the mid water column and near the lake bed. When the lake returned to calm conditions after strong winds it took about 3 days before the lake currents slowed to minimum. Under calm conditions, water column velocities were in the order of 3 cm per second. Maximum velocities recorded were < 20 cm per second, which is sufficient resuspend medium to fine sediment.
- Max commented for hypolymnetic dosing of alum we would need to be below the thermocline to prevent alum being spread right throughout the water column.
- Max commented that currents were so strong that they were moving sediments around on the bottom of the lake to such an extent that the velocity meter had been covered with sediment during its deployment. This also pointed to some difficulties in capping lake sediments. However, hypolymnetic dosing with alum may be able to cope with these currents as the alum floc would move and remain on the surface more readily.
- There was some discussion around the appropriateness of hypolymnetic dosing to lock up phosphorus.

Action: Sediment TAG to review effectiveness of hypolymnetic dosing as a strategy.

9 Ōkaro update

No report was presented here. Paul Scholes has already given the TLI update for all lakes including Lake Ōkaro. The latest monitoring shows that hypolymnetic P levels are elevated and obviously chlorophyll-a levels are elevated in the epilimnion. At the time of the meeting the lake was still in bloom with an algae bio-volume result of 28.65 mL/L. The health guideline is 1.8 mL/L.

10 Sediment Technical Advisory Group Terms of Reference

Andy presented the terms of reference which had been prepared for the sediment TAG. The main discussion points were:

- Point 3A should be confined to lake bed sediment fluxes.

Action: Andy to make this correction and circulate with meeting notes for any further comments from TAG.

- Another point which was raised that the TAG terms of reference needs to be reviewed as the group was established several years ago. At the meeting, no-one was familiar with the exact terms of reference but made the comment that the TAG was set up to review lake targets and set targets and also to provide technical advice to BOPRC on restoration of the lakes based on science.
- It was also discussed whether the TAG should have an independent chair or convenor. This is a matter which can be discussed further at later meetings, however it was agreed that the TAG was employed to assist and advise BOPRC in their lake restoration programme and that BOPRC should retain control of this group.

Action: Andy to establish or find TAG terms of reference and suggest review points back to the group at its next meeting.

11 Aeration work update

These matters were covered in previous agenda items and are not discussed further here.

Action: Aeration/de-stratification project to be reported back to the STAG to advise on science and technical matters.

12 Tikitere De-nitrification Pilot Plant update

This update was not provided as the group visited the de-nitrification plant on the following day field trip. Main comment here was that the pilot plant has been constructed. It will operate for 12-18 months to get design information for full scale plant design. In parallel a Lentikats trial was undertaken which tested the performance of specific nitrifying and denitrifying bacteria with the assistance of ethanol as a carbon source to test an alternative de-nitrification technology. This trial has been completed and the results will be reported soon by Lentikats.

13 Update on other projects being implemented

The update was provided during the field trips the following day where the group visited:

- Tikitere De-nitrification Plant
- Rotoehu Soda Springs alum dosing plant under construction
- Bio treatment application to Ōtautū Bay and Lake Rotoehu
- Boat trip across Lake Rotoehu looking at possible location of sediment trials including location of Mesocosm trials.
- Observation of proposed monitoring buoy and de-stratification machinery in Lake Rotoehu.
- Observation of weed growth in Kennedy Bay in Lake Rotoehu.
- Visit to floating wetland trial at Tautara Farm.
- Lunch at Okawa Bay and then visit to diversion wall.
- Visit to floating wetland installation at Taheke Marae.
- Visit to GNS and BOPRC infiltration lysimeters at Kaharoa.