

MEMORANDUM

To: Water Quality TAG

From: Andy Bruere
Lake Operations Manager

Date: 3 May 2010

File Ref: 336 501

Subject: **Notes from Water Quality TAG Meeting – 28 April 2010**

In Attendance: Rob Donald, Eddie Grogan (Environment Bay of Plenty); Chris Palliser, Max Gibbs, Clive Howard Williams (NIWA); Warwick Silvester, David Hamilton (University of Waikato); John McIntosh, (Consultants); Dell Raerino, Hera Smith (Te Arawa Lakes Trust); Paul White (GNS); Peter Brown (Enviromex); Simon Park (Headway Ltd)

Apologies: Kit Rutherford, Paul Scholes, Pete Verburg and Peter Dine.

1 Karakia

The meeting was opened with a karakia from Dell.

2 Matters arising from last meeting

- (a) Update on monitoring buoys. A discussion around future monitoring buoys for lakes and funding is required between David, Andy and Rob.

Action: Andy to initiate this discussion in particular looking at the need for a monitoring buoy on Lake Rotoehu.

David showed the Environment Bay of Plenty live links for lakes and discussed the need for the Rotoehu buoy.

- (b) David presented Terry Beckett monitoring information around Lake Tarawera. Terry collects regular stream flow and nutrient information. It has also been reported that there is an underwater flow coming in around Humphries Bay and there is a need to look at the possible inputs at this point.

Sixty percent of the lake inflow comes through groundwater. CBER report 94 shows expected future nitrogen loads to Lake Tarawera.

The sampling is undertaken quarterly. Environment Bay of Plenty to consider whether it should be supporting Terry Beckett with this useful work which he is undertaking.

Action: Andy to consider possible support for Terry Beckett for this work.

(c) Hera Smith raised whether there was any connection between the information provided by the monitoring buoys and predicting when health warnings may come into place. TAG agreed that this was a sensible initiative.

Action: Rob Donald is to refer this matter to Matt Bloxham to see whether there are any correlations which could lead to the monitoring buoy information being used in predicting when algae concentrations may be approaching health warning levels.

(d) Warwick Silvester asked how the DNZ meetings had progressed. Eddie Grogan outlined that there was a meeting on Monday night with dairy farmers around the dairy club proposal and that further work needed to take place before any indication of advances could be reported on. Andy also reported that as a result of the last TAG meeting and discussion on DNZ representation, it was agreed that DNZ would not be invited to join the TAG group. This matter has to be conveyed to DNZ.

Action: Andy to ensure that DNZ is aware of our position and has notes available from the meetings.

3 Sediment group report

(a) David updated the group on the last sediment group meeting. He explained that it was an open forum for ideas on controlling nutrient releases. Items that were covered were as follows:

- The costings work on the various alternative products was presented to the group by Peter Brown.
- Design of the trial pots for Lake Rotorua later in 2010.
- Max presented the Okaro update. David also commented that there were no health warnings on Lake Okaro this season which was unusual.
- Kelly Hughes presented the potential wave aerator to the group.
- Sediment harrowing was discussed by the sediment TAG group. Max indicated significant risk with oxygen demand created by re-suspended sediments (see 3f below also).
- Sediment capping agents. Some particle size estimates being undertaken for Z2G1 material in Lake Okaro.

Action: It was agreed that the sediment working group should formalise its terms of reference and the people involved within the working group so that TAG understands exactly what they're required to achieve as well as providing the professional image required when referring to the group.

(b) Rotorua current measurements. Max presented information on currents in Lake Rotorua. He commented that previous monitoring had shown

flow-in the near surface waters was generally clockwise and about 3 cm per second around the northern end. It would mean a particle dropped in 15 metres depth would drift about 1.7 km before it reached the bottom. This supported the need for pelletisation of the products.

His proposal is that we should have two current meters in place over one month near Hamurana. The ADCPs would be bottom-mounted. One would be near the monitoring buoy and one at the probable trial site. It would also be useful to do a month when the lake was stratified and a month when the lake was not stratified. Two monitoring sites would be sufficient. David indicated he could use the Elcom model to identify flows around other parts of the lake from this monitoring.

It was commented that flows in the bottom waters are generally counter-clockwise.

Action: Max and David to identify sites and set up monitoring for winter and compare results with Elcom models.

Action: David and Max to undertake the same work for Lake Rotoehu in preparation for sediment capping or aeration work in Rotoehu.

Action: David to circulate remote sensing images to TAG.

- (c) David reported on 3D model for Rotorua and indicated that the current monitoring could be used to validate the 3D models for Rotorua and Rotoehu.

David also outlined the work which Jonathan Abell a PhD student was starting. This study will examine the effect of storm flows and sediment deposition into Lake Rotorua. This is looking at where sediment might end up from flows down streams into Lake Rotorua and whether phosphorus depositing to the sediment is likely to become available within the lake. This will involve some specific Biofish runs around stream outlet areas and sediment traps located in these areas.

- (d) Peter Brown presented the findings of his sediment capping evaluation report. He pointed out that there would need to be some verification of the aluminium/lime and the Virophos application rates. He also discussed the gel cap versus particulate cap type of application and that the effect of current would need to be considered in that situation as there is a risk of that being moved.

There was a discussion around potential effect of dual coat changing the anoxia in the sediment layer. Max explained about P release and the aim of the cap is to block in the first 2 to 4 cm of P release. He explained that the capping layer would bind any P that's rising through that layer. The particle size and density of the capping layer would need to be considered carefully in terms of sedimentation and transport rates as well as potential for reuspension from the bottom via lake currents.

Main danger is getting capping material transported into a high-erosion shallow water layer. Other points made during the discussion were:

- Possible liquid application of materials at depth could be considered.

- The allophane option included an allowance for processing costs.
- The aluminium/lime product needs further development work.

There was some discussion around particle size and density which relates to the ability to fill an aircraft during the application cycle and then is likely to impact spreading uniformity through the air and through the water column. This needs to be considered in developing techniques for application.

Max pointed out that the allophane sample from Landcare Research was only 30% active ingredient. The material used in the lab trials was extracted allophane. So the calculations for the costings on allophane need to be re-done to take that into consideration. It is likely three times the material will be required as calculated in the report. The actual application in the core test was 720 grams per square metre.

Action: Max will email Peter the application information.

- (e) Ōkaro sediment capping update. Max presented sediment capping update on Lake Ōkaro. This relates to the application that was undertaken in August 2009. The main points made by Max were:

- There was a more even coverage in the 2009 application compared with 2007.
- However there was still significant variation and some of the material had 'escaped' into littoral zone.
- Significantly, the fine material had flocculated P and also some of the organic material.
- The material had absorbed ammonium out of the water column.
- The most notable difference is the phosphorus concentrations in the water column between 2008-2009 and 2009-2010. Phosphorus levels had significantly reduced in the water column between these summer periods.

John commented that the Z2 added in 2009 was equivalent to about three times the alum dose which was undertaken in 2005.

There was also some discussion around how much of the absorption capacity of the first application had been used. Max commented that this was about 20% of the adsorption capacity used up. Now the material is settled down to a depth in the sediment where it is not useful to prevent P releases.

- (f) Harrowing update. John gave a very brief update on the findings of possible harrowing works. He referred mostly to the report from Max Gibbs on Lake Horowhenua. The indications are that harrowing is not likely to have significant benefits for our lakes' programme, unless it was done fairly regularly. It does not appear to be particularly practical at this stage.

He mentioned the possibility of a small scale experiment sometime down the track.

- (g) TAG was concerned that alum had potential for toxicity in low-alkalinity Lake Rotorua. Future considerations would need to consider whether there was a need for buffering if alum was used.

The product specifications for Virophos were questioned. No information was available.

Action: The specifications of Virophos need to be established and presented to the sediment working group. Andy via Peter Browne.

Action: The sediment working group will take a look at aluminium/lime mix and decide whether to pursue this further and trials.

- (h) There was also some discussion around allophane and possible removal of pumice to refine the allophane percentage. This could have some benefits of transportation and application. It was also raised that there could continue to be new products appearing for some time. The question was how much effort should the group put into investigating every possible alternative material.

Action: It was recommended that the sediment working group should set some criteria on what products it may test into the future. This would include things such as it had already been tested or trialled to some extent in the natural environment and whether there were any other risks associated with toxic components.

- (i) It was also discussed whether we have the dose rates for application correct in the capping evaluation report. Max Gibbs raised that he thought the recommended dose rates were appropriate but we need to consider the water column use of the product during the application. It appeared from the discussion that this could be quite low, 3% to 5%, but in other circumstances it could be significant up to 50%.

Action: The sediment working group was requested to work on a risk matrix for the various products and formulations.

- (j) It was also recommended that we await the Landcare Research report before finalising the allophane percentage to correct the costings.

4 Update on land use change and lake intervention modelling

- (a) Simon updated the group on the progress with the Lake Rotorua scenario modelling. Chris Palliser circulated a report on the ROTAN work for the meeting.

Action: Need to undertake modelling at a higher level, up to 300 tonnes p.a. of nitrogen as this appears to be where the regional special projects committee wants to be.

John McIntosh raised is it possible to undertake horticulture as an alternative as it has a relatively low nitrogen leaching footprint? He pointed to the Hort Research modelling that was done recently for Environment Bay of Plenty as assistance to this project.

- (b) Discussion on aeration within the lake DC models was deferred until the aeration item – number 5.
- (c) Discussion on internal sub catchment boundaries took place. Paul and Andy agree that although the internal sub catchment boundaries between the groundwater model and ROTAN model were not in

agreement, the ROTAN model could be used for advice on high level decisions such as how much land use change is required within the catchment and the groundwater model would be used during the implementation phase to refine where the boundaries between rapid and less-rapid groundwater movement may be. It was discussed also that the Puarenga and Waipa discrepancies between the model and actual data could be due to catchment boundary issues.

David presented information on the lake DC simulations. His presentation covered water quality impact on nutrient concentrations. This will be converted to TLI values at a later date. Internal loads are still a main contributor to in-lake nutrients. So far he has removed 10 tonnes of phosphorus and 30 tonnes of nitrogen.

There was discussion about further lake DC modelling. This is around timing of interventions.

Action: It was agreed that the timing of intervention should remain as detailed in the Ten Year Plan. Andy can provide that information if it is not already available.

- (d) There was a need to continue to model in a way that was rigorous enough to support any planning direction we make through the Environment Court. However there was also a need to present our information in a relatively straight forward way for lay people including our councillors to understand and make decisions as to the impact of those changes.

Discussion on effects of climate change; it was concluded that future scenarios include 1) no change, b) a likely change from one of the climate change models and c) an integrated assessment based on several models. There was a need for alignment of DC and ROTAN models for climate change simulations.

Catchment P modelling. David and Chris both have experience working with the CLUES model. Chris explained that the CLUES model now has mitigation and land use change capabilities but not any groundwater impacts. It was agreed that we could get some numbers from CLUES for P inputs to put into the lake model.

Action: Chris to update the CLUES model for Lake Rotorua to include the new land use used for the ROTAN model. Simon to follow up with David and Chris.

It was also discussed that total P was the only species modelled.

Simon Park questioned whether CLUES could handle more minor land use change and land management changes. Chris responded that there was a need to put in model percentage mitigation first (see Simon).

- (e) P mitigation project. Simon updated the group on the P mitigation project. This is something that Environment Bay of Plenty and DNZ initiated about 18 months ago but had not been supported. There is now support of this project from Council and Environment Bay of Plenty are re-initiating it. It's basically trying to target obvious physical sources of P around some of the catchments where P storm loads are high to prevent it reaching the lakes.

It was commented by the group that this was a positive step and that we also need to be considering the nitrogen mitigation that may be occurring as a result of doing this work.

5 Lake aeration

(a) Hans Burggraaf presented information on the lake aeration technologies that Environment Bay of Plenty are investigating with him. Some of the main points that he made were:

- Within Lake Rotorua the temperature difference between upper epilimnion and hypolimnion during stratification events is relatively low (1 to 2 degrees). By looking at information from the lake buoy stratification does not occur when the thermal difference is only half a degree; this should be the aim of lake aeration methods.
- The system he is proposing for Lake Rotorua and possibly applicable to Rotoehu is an air driven system, driven by compressed air hose and has an air capture system to improve efficiency.

Jason Ewert, the engineer who has assessed the engineering aspects and costings of this proposal also made the following comments:

- Need to target lake low points to minimise units and maximise de-stratification.
- The engineering principles of the device are very predictable.
- Some innovations Hans has put in include bubble harvesting and mixing of high pressure air.
- The horizontal collection and distribution system provides some innovation.
- It appears it would be pertinent to turn these things on early as stratification occurs to prevent a large thermal difference and this would consume less energy.
- There was also some discussion around thermocline depth to ensure that the water being picked up is taken out of the hypolimnion across the thermocline and is not simply going to sink back down.

It was decided by the group that the technology has potential within our sediment treatment research and that the next two steps should be to undertake modelling of the machine in one of our lakes and take it to the next step of designing a machine which could be constructed for implementation.

Action: David to undertake model performance evaluation with DC using information provided by Hans on flow rates etc.

(b) There was a discussion around how much P is released in a year due to oxygen depletion compared with normal P release from bottom sediments cycling. David pointed out that the ratio was about three to one. This indicates aeration would still have a very significant impact in reducing phosphorus (as well as nitrogen) release from bottom sediments.

Warwick made the comment that to support the quantity of algae growth in the Rotorua lakes we need much more nutrient release than the catchment inputs. He suggested a figure of about 10 times, indicating that nutrient releases from bottom sediments may be significantly more than some of the estimates we have.

- (c) It was also discussed that we need to go forward with the design for Lake Rotoehu. Andy to discuss with Hans the next step in getting the work of the design underway for possible implementation into Lake Rotoehu.

Action: Andy to work with Hans to get design for Rotoehu machine.

Some other points made by the group during the discussion were as follows:

- NIWA has experience with aeration work within the Hunua dams.
- Need to ensure that the stratification is not below the point of draw off so finding the deepest hole to ensure you're within the stratified area.
- There was some discussion around what parameters would need to be measured and any trial of aeration work. Hans commented that we would be measuring the power, flow, area of influence on stratification. David suggested a bio-fish transect could be used to assist with some of this.

6 Wave pump

- (a) The wave pump which had been designed by Kelly Hughes as a small water circulation/aeration technique has been modelled by David. He set it up on Lake Ōkaro. To get any impact he had to put 40 wave pumps on the lake for three years. His graph showed that it deepens the epilimnion but not enough to prevent stratification.

The TAG recommendation is that no further research is required on this technology.

7 Okere control gates

- (a) David Hamilton has been working with Environment Bay of Plenty engineers to model the impact of a change in Okere control gates on Lake Rotoiti hydrodynamics. Typically Rotoiti had been controlled within about a 30 cm range until 1996 when the range was brought into plus or minus 75 mm. The advantage of the modelling was David was able to use Nina Von Westernhagen's 3D simulations to make predictions about changes in water quality.

The main conclusion from David's presentation is that increasing lake level range and fluctuations has an advantage of reducing flow from the Ohau Channel around the diversion wall and into Lake Rotoiti. David pointed out that he has more modelling work to do because of some incorrect water level data presented prior to the modelling runs.

8 Water velocity monitoring Ohau Channel

- (a) David reported on the water monitoring work for Ōhau Channel. The second run of monitoring has been undertaken and the second report is nearly complete.

The monitoring was undertaken initially in May and that has been reported and more latterly in November. The November monitoring was to consider whether there is any overflow rather than underflow coming around into Lake Rotoiti. David's conclusion is that some flow is occurring around the wall. This seems to coincide with the simulated model and is not of sufficient volume to raise any particular concerns that would indicate a compromise to the integrity of the wall.

Action: David will complete the second water velocity report and circulate.

9 Rotoehu 3D model simulations

- (a) David explained the work undertaken by Mat Allen and that the 3D model is available for projects such as the aeration modelling work.

One of the issues raised by David is that the bathymetry is dated and relates to some work by Irwin which would be important to update if we're going to go into aeration or sediment capping in Lake Rotoehu.

Action: David and Andy to discuss process to get side scan bathymetry work done for Lake Rotoehu.

10 Tikitere pilot plant update

- (a) Andy updated the group on the Tikitere pilot plant project. The contract has been let for this project and works will start soon. The pilot plant is planned to operate for about 18 months running two parallel small plants. One plant is the bark/corn cob bed system as a carbon source and the other one is using methanol and proprietary encapsulated bacteria to provide de-nitrification.

11 Update on other projects being implemented

- (a) Andy provided an update on the following projects:
- Puarenga P locking plant is now commissioned and operational.
 - Soda Springs P locking plant construction is due to start on 10 May.
 - The bio-treatment project for Lake Rotoehu using bacterial cultures in Otautu Bay is going through the consent process and is expected to start during late 2010.
 - Weed harvesting project for Lake Rotoehu is continuing its seasonal harvest. It is expected that two to two and a half months of weed harvesting would take place. Weed harvesting also took place in Okawa Bay of Rotoiti this year for the second time.
 - Staff have a project to address conversion of gorse to pine trees within the catchment and appear to have traction on getting out 18

hectares of gorse with a Māori trust. This project will start in the near future.

- The floating wetland project is gaining traction and is looking at putting in two small floating wetlands in Lake Rotoiti in the near future and others are likely to follow as community interest in floating wetlands continues.
- The Awahou P locking and discussions around possible P locking on an alternate stream are not progressing well as there is poor engagement with iwi; EBOP staff are working on this.
- The algae harvesting equipment is in place and the predictions are that we will be removing about 0.250 kg of algae per day. This is from a flow of about 25 cubic meters an hour. This is simply a proof of concept trial and has funding from New Zealand Trade and Enterprise.

12 Mesocosm work

- (a) David presented the findings of the Rotorua mesocosm work. This is a project where mesocosms were placed in Lake Rotomā, Lake Tarawera and Lake Rotorua. The findings of the work particularly for Lake Rotorua is, that there was very little response from the addition of nitrogen or phosphorus independently, however, there was a significant improvement in algae production with both nutrients added. David explained this is more support for our programme of addressing both nitrogen and phosphorus inputs.

Action: Andy to circulate mesocosm graphs to TAG group.

13 Additional item

- (a) Warwick Sylvester wanted to make an announcement that Max Gibbs had been given an honorary doctorate from the University of Waikato for his work around water research over the years. This award is going to be conferred at the University on Monday. The group congratulated Max and was obviously pleased that he had gained this recognition from years of work within the area.

14 Other business

- (a) Max gave a short presentation on the mesocosm study within Lake Hayes. Some of the notable things Max pointed out during his presentation were:
 - The work is being done in conjunction with ORC and he showed some particularly informative signage onsite about the project.
 - The mesocosms were set in 10 metres of water and by anchoring them and aligning them with the wind and currents it was possible to get them more stable set in place.

- They also installed benthic chambers in the tubes.

Unfortunately the trial did not provide good results for the season as the lake did not have an algae bloom as it usually does. However, Max's comments were with respect to running mesocosm work trials they learned a significant amount of information which will be applied in future works.

Max also stated that they would like to continue with mesocosm work for Lake Rotoehu. Andy agreed that we could support their consultation with iwi and the community.

Action: Max to provide Andy with the summary of their proposal for Lake Rotoehu and Andy to discuss how this may be communicated with iwi to gain support.