



A Bay of Plenty Regional Council, Rotorua District Council and Te Arawa Lakes Trust joint project

Te kaupapa mo ngā taonga o Rotorua

Draft Lake Ōkātina Action Plan

- for better water quality

Ko te wai te ora o ngā mea katoa
Water is the life giver of all things

This is a non-statutory document to improve water quality in Lake Ōkātina.

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The lake of laughter - Te moana-i-kataina-ā-Te Rangitakaroro

Lake Ōkātaina is one of the 12 Rotorua Te Arawa Lakes. It is remote, deep and surrounded by native bush. Its name comes from Māori chief Te Rangitakaroro (son of Tarāwhai), who laughed when he heard one of his warriors call the lake an ocean¹.

Lake Ōkātaina was formed 7,000 years ago by volcanic activity. It is 1,080 hectares in size and has a catchment area of 62.9 square kilometres. Nearly 81 percent of the catchment is in the surrounding scenic reserve. In 1921, the Chief of Ngāti Tarāwhai gifted the lake shore to be protected as reserve. Outside this reserve area, about 10 percent of the catchment is pasture, eight percent is in exotic forest and the remainder is wetland, buildings and bare ground.

Lake Ōkātaina is 79 metres at its deepest point, with an average depth of 39 metres. While the lake level rises and falls, Lake Ōkātaina has no surface outlets. Subsurface flow is thought to drain towards Lake Tarawera – a nearby larger lake that is about 13 metres lower than Lake Ōkātaina in elevation.

The steep inclines along the lake edge and the pumice soils in the catchment cause fast run-off of rainwater into the lake, increasing the risk of erosion. Occasionally, landslides leave scars on the landscape.

Lake Ōkātaina's water quality is good and reasonably stable compared to some of the other 12 Rotorua Te Arawa Lakes². The lake is also safe for swimming. However, its trophic level (the indicator that measures overall lake health) is not quite as good as we would like it to be.



Figure 1 *Waharia o Te Koutū Pā*

¹ Gosling (2002) Lake Ōkātaina Scenic Reserve, Super Site Resource 4, Department of Conservation.

² Scholes, P, Bay of Plenty Regional Council (2009) Rotorua Lakes Water Quality Report.

1.1 Purpose of a lake action plan

A lake action plan describes what we know and don't know about a particular lake, and what we need to do to improve lake water quality. The intention of developing actions is to meet the lake health target or trophic level index (TLI) target. Lake Ōkātina's trophic level is set at the 1994 level of 2.6.

Trophic Level Index

The trophic level index (TLI) is a number used to indicate the overall health of lakes. The number is calculated using four separate water quality measurements: total nitrogen, total phosphorous, water clarity and chlorophyll-a. The worse the water quality, the higher the number.

Nitrogen and phosphorous are nutrients that plants thrive on. Large amounts of these nutrients in lakes encourage the growth of algae, which can lead to poor water quality. Water clarity is how clear the water in the lake is. Clear water usually means better water quality. Chlorophyll-a is the green colour in plants. Knowing how much chlorophyll-a is in a lake gives us a good idea of how much algae the lake has. More algae means poorer water quality.

These four measurements are combined into one number – the Trophic Level Index.

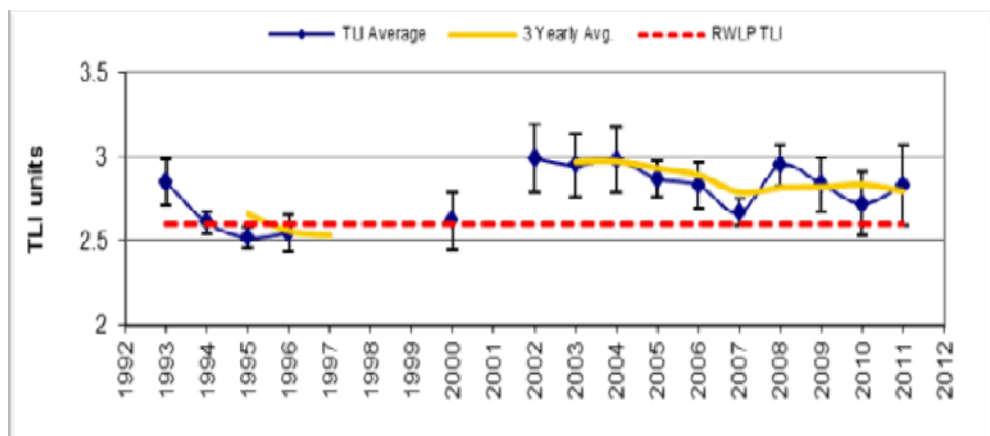
1.2 Why do we develop a lake action plan?

In order to improve lake water quality, one of the tasks in the Rotorua Lakes Protection and Restoration Action Programme is to develop action plans for the Rotorua Te Arawa lakes.

The Regional Water and Land Plan further stipulates that an action plan is required if the water quality (defined by the three-year average TLI) of a lake is higher than its target TLI by 0.2 or more for two years in a row.

Lake Ōkātina has a Trophic Level Index target of 2.6 that has been set in the Bay of Plenty Regional Water and Land Plan. The lake's current three year average TLI is 2.9.

As a key partner of the Rotorua Lakes Protection and Restoration Action Programme, the Bay of Plenty Regional Council has led the task of developing an action plan for Lake



Ōkātina.

Figure 2 Lake Ōkātina's water quality trend measured by the TLI

In developing this draft action plan, we have:

- Examined what we know about the lake, its characteristics and its surroundings
- Researched lake water quality trends
- Talked with the local community and iwi about the water quality trend of the lake
- Asked the local community and iwi what they want for the lake
- Considered potential actions.

This process has helped us understand what is happening at Lake Ōkātina, what the community's expectations are, and how we can improve water quality.

For more details and information about the research behind the draft Lake Ōkātina Action Plan, please see the background document "*Lake Ōkātina Water Quality Background Information 2012*".



Figure 3 Lake Ōkātina at Ngahaua Bay

1.3 What does the community want for Lake Ōkātina?

Lake Ōkātina is a unique, tranquil and unspoilt wilderness. This lake is highly valued for its historical and cultural significance, as well as its prized fishing opportunities.

Almost 10 years ago, stakeholders said they wanted the lake water quality to be at the level it was in 1994, which was a TLI of 2.6, and so this has been our target.

In workshops held during March and April 2012, the Lake Ōkātina community expressed their ideal future for Lake Ōkātina:

- Unspoilt wilderness, deep clear water reflecting natural bush, tranquillity
- Drinkable water and edible kōura (freshwater crayfish)
- Keeping the lake unique
- Historic and cultural sites protected.

The community also told us that they would like to see:

- The lake as clean as possible, with good water quality
- The environment and current good water quality maintained
- Lake Ōkātina as a showcase for New Zealand flora and fauna, with a healthy ecosystem that is free of pests
- Lake Ōkātina as a fishing destination
- Boat-users check and clean boats for weed before entering the lake
- The effect that visitors have on the lake managed, monitored and reported – with enough toilets available for any events held at the lake
- Local iwi playing a main role in looking after the lake and land
- A programme in place to look after the lake
- Updated, easy-to-understand science information available.

1.4 **Water quality in the lake**

Lake Ōkātina has good water quality - but not as good as it was in 1994 (the target level).

The current overall TLI at Lake Ōkātina is around 2.9. The trend over the last 10 years shows this lake's TLI is steady compared with other lakes, and more detailed analysis shows that nitrogen has been declining and phosphorus has been increasing.

While phosphorus and nitrogen are the key nutrients we focus on for improving water quality, scientists are also concerned about low oxygen levels in the deep water in autumn. This could lead to higher levels of nitrogen and phosphorus in the winter and prompt algal blooms.

There is also some concern that the underwater ecology is threatened by invasive aquatic weeds, such as hornwort. The hornwort infestation discovered in the lake several years ago continues to be managed.

For more details about water quality in Lake Ōkātina, please see the background document "*Lake Ōkātina Water Quality Background Information 2012*".



Figure 4 Lake Ōkātina at Tauranganui Bay with weed cordon

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1.5 What is causing the drop in water quality?

Lake Ōkātina is a unique case. There have not been any obvious changes in the catchment which would have led to higher nutrient levels.

Lake Ōkātina has many characteristics that would normally ensure good water quality:

- It is a deep lake surrounded by native bush
- It is reasonably isolated
- Most of its surface catchment is covered by native bush
- Little wastewater is released in the catchment.

Further, the Lake Ōkātina catchment has not significantly changed since the TLI was first recorded. It is mostly covered in native bush, farming remains stable and while visitors numbers have varied over the years, the scale is still small.

What we do know is that this catchment has natural characteristics that make it vulnerable to water pollution. The steep surroundings and loose volcanic soils make it sensitive to erosion. It is important for Lake Ōkātina that we keep nutrients on land and in the soil as much as possible.



Figure 5 Lake Ōkātina around Tikitiki

Scientists estimate the levels of nutrients entering the lake annually are:

- Nitrogen: 27,112 kilograms per year
- Phosphorous: 2,079 kilograms per year

The amount of nutrients going into the lake has resulted in the lake trophic level of around 2.8 and 2.9. Work has been done to identify where the nutrients are coming from³:

³ McIntosh (2011) nutrient budget for Lake Ōkātina

Table 1 Where nutrients are coming from

Land Use	% area (including lake)	% Nitrogen entering lake	% Phosphorus entering lake
Native bush	67%	47%	57%
Grassland (pasture)	9%	30%	26%
Rainfall on lake	17%	16%	8%
Exotic forest	7%	6%	8%
Stormwater	0%	0.3%	0%
Septic tanks	-	0.4%	0.5%

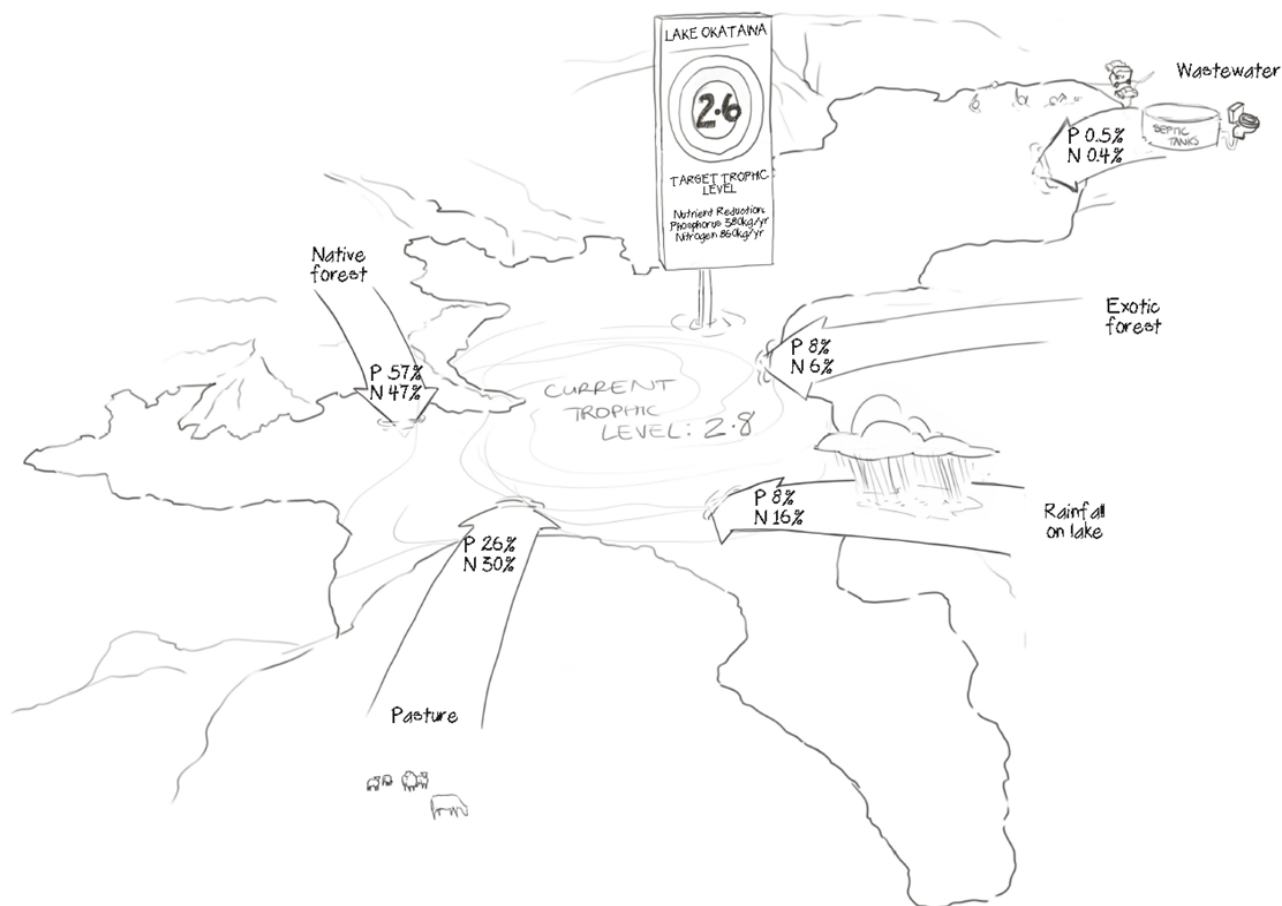


Figure 6 Where nutrients are coming from

In order to achieve a TLI of 2.6, the amount of nitrogen and phosphorus going into Lake Ōkātina needs to be reduced by 860 kg of nitrogen and 380 kg of phosphorus each year. While it is important to reduce both nutrients going into the lake, it appears that removing a higher proportion of phosphorus will help us meet the desired water quality.

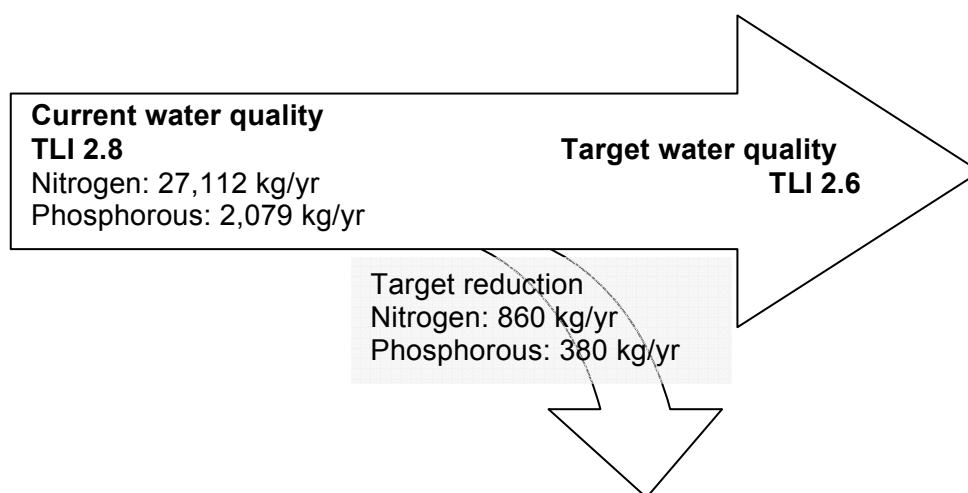


Figure 7 Required reductions to achieving the target water quality

1.6 What other factors could be affecting water quality?

The community identified⁴ other factors that could be causing a drop in the water quality in Lake Ōkātina:

- Animal pests damaging the native bush could cause higher levels of nutrients going into the lake
- Aquatic pests could upset the balance of the lake
- A need for more facilities (toilets) for visitors and events around the lake.

We don't know to what degree the water quality is affected by pest animals degrading the native bush. Because the community has observed a significant impact on the native bush, scientists recognise that it is an area that requires further investigation.

The community is also concerned about having enough public toilets available, particularly during events. The presence of *E. coli*⁵ usually means that faeces has entered the water. The good news is that the Lake Ōkātina swimming area has consistently low levels of *E. coli* in the water, and it is safe for swimming.

⁴ Bay of Plenty Regional Council, Te Arawa Lakes Trust, Rotorua District Council and key lake stakeholders (2012) Lake Ōkātina Water Quality Workshop

⁵ *Escherichia coli*, a type of human and animal gut bacteria.



Figure 8 *Differences in native bush when animal pests are excluded*

The community is concerned about damage to native bush from pests. Understory vegetation is important for the forest ecosystem. The photos show the difference 10 years after the animal pest exclusion area (near Oruaruoa) was installed – the left photo shows outside of the pest animal excluding area, and the right photo shows inside of the pest animal excluding area.

1.7 **What would happen if we did nothing?**

If no action was taken, it is likely that Lake Ōkātina's water quality would remain steady (because of little change is expected in the catchment). As has been seen over the past seven years, the nutrient levels would vary with the amount of rainfall and the lake level.

There is a risk around the high oxygen depletion rates, where the amount of oxygen diminishes more quickly in the deep parts of the lake.

Once oxygen levels drop to a certain point, nutrients would start to be released from the bottom of the lake. Once this process has started, it is very difficult to reverse. Nutrients from lakebed sediments would have a significant effect on the lake water quality, leading to rapid growth of unwanted algae and a reduction in the clarity and visibility of the lake water. Low oxygen levels also increase the risk to the health of fish in the lake. The oxygen levels are currently being monitored monthly by the Bay of Plenty Regional Council.

1.8 **What are our assumptions?**

Scientists have had to make certain assumptions in order to undertake the difficult task of estimating the nutrient budget for Lake Ōkātina⁶. These assumptions include:

- The lake level will remain stable
- The water flow of the Lake Ōkātina catchment is similar to other Rotorua lake catchments
- Nutrients entering the lake as a result of land use occurs at a similar rate as recorded in other Rotorua lakes
- No significant land use change has occurred in the last ten years.

⁶ McIntosh prepared a Lake Ōkātina Nutrient Budget in 2011.

Scientists also make estimates around the nutrient budget. These estimates include:

- The amount of nutrient that stays in the lake
- The amount of nutrients coming from sewage and stormwater.

The accuracy of the nutrient budget is affected by data availability.

1.9 **Actions to improve water quality**

Lake Ōkātina is a unique situation – a lake with good water quality, where the activities in its catchment suggest the lake should have good water quality.

However, we need to reduce the nutrients entering the lake by 860 kg of nitrogen and 380 kg of phosphorus every year for Lake Ōkātina to achieve its water quality target.

We are reasonably confident of achieving the nitrogen target by voluntary change from agriculture land use to forestry. However, this can only happen with the support of favourable market conditions.

At this stage, we do not have enough information about how the phosphorus target can be achieved. Approximately 57% of the phosphorus entering the lake comes from native bush. As yet, we know very little about how to reduce nutrients entering the lake from native bush.

One of the key proposed actions in this plan is to investigate how the water quality is affected by the state of the native bush, and whether animal pest control will significantly reduce the nutrient input.

As new evidence becomes available, we will take an adaptive approach – that is to act (and consult) on the most effective, efficient and appropriate options available for improving water quality in Lake Ōkātina.

In the meantime, there are still actions that can be taken to protect and restore this sensitive and vulnerable lake catchment.

While many of the on-going actions are funded through current work programmes (for example, the Sustainable Land Use Programme), no specific funding is allocated to the Lake Ōkātina catchment.

The table below outlines what work is being done and can be done to help protect the water quality of Lake Ōkātina.

Actions for reducing nutrient input and improving water quality:

Actions we can take	Timeframe	Led by	Effectiveness in reducing nitrogen and phosphorus
Reducing nutrient input			
Voluntary change to less nutrient-leaching land use	Ongoing	Landowners, if supported by market conditions	A recent voluntary change has estimated to meet 78 % (671 kg per year) of the nitrogen, and nearly 10 % (37 kg per year) of the phosphorus reduction target. Further changes could remove 2,009kg of nitrogen and 110kg of phosphorus per year.
Looking into pest control options in the catchment	Initiated, and will continue if funding is available	Department of Conservation, assisted by local iwi and lake community	The effectiveness is being investigated. If new evidence suggests this action is highly effective it will become a priority area.
Voluntary land and farm management practice that reduces the potential for erosion, sediment loss or nutrient loss into waterways (stewardship management approach)	Ongoing	Landowners, assisted by Bay of Plenty Regional Council (advice and possible subsidy)	Relatively effective depending on farm conditions.
An effluent treatment rule: septic tanks within 200m of lakes are required to meet a nitrogen concentration standard of 15g/m ³ from December 2012	Rule is enforceable from December 2012	Bay of Plenty Regional Council	Effect will be minor, due to the small population around the lake.
A policy that sets nutrient discharge limits in the Regional Water and Land Plan for all Rotorua Te Arawa Lakes	Proposed Regional Policy Statement requirement	Bay of Plenty Regional Council	Yet to be determined.
Review regulatory interventions for all Rotorua Te Arawa Lake catchments	Ongoing	Bay of Plenty Regional Council and Rotorua District Council	Yet to be determined.

Other actions:

Actions	Timeframe	Led by
Building awareness and knowledge about nutrient sources		
Investigate and measure the flow-on effects of native bush understorey health to lake water quality	To be scoped	University of Waikato, led by Chair in Lakes Management and Restoration
Update community on Lake Ōkātina's water quality trends, including Lake Ōkātina Scenic Reserve Board, Ngāti Tarāwhai Iwi Trust	To be scoped	Bay of Plenty Regional Council
Invite interested Lake Ōkātina stakeholders to forums presenting lake science	Ongoing	Bay of Plenty Regional Council
Monitor Trophic Level Index and de-oxygenation rates	Ongoing, monthly	Bay of Plenty Regional Council
Report to the Lake Ōkātina community on water quality	Ongoing, annually	Bay of Plenty Regional Council
Provide sustainable land-use information through workshops, field days and discussion groups Workshops have been held with the forestry sector about earthworks and harvest practices	Ongoing	Bay of Plenty Regional Council and partners
On-farm benchmarking	On-going	Farmers across border between Lake Ōkātina and Lake Rotorua catchments, supported by Bay of Plenty Regional Council
Ensuring the amenity of the lake		
A rule to ban jet-skis and water-skiing on the lake. Other boats must travel 5 knots within 200m of the shore	Completed	Rotorua District Council / Bay of Plenty Regional Council
Control aquatic weed. A hornwort incursion response plan was formulated in response to a 2010 hornwort incursion	Completed with on-going observation	Bay of Plenty Regional Council

1.10 **Action plan review: What will we do if circumstances change?**

An action plan is developed based on our current knowledge. In the case of Lake Ōkātina, there are things we know, and some things we are yet to learn. For example, we don't know what specifically caused the water quality to change, and to what degree restoring the native bush will help improve the lake's water quality.

Sometimes new information or evidence becomes available, and this provides us with more opportunities for action. We will be alert to the possibility of new information and will review our options if and when new evidence emerges. In this way, we will focus our efforts on the most effective and suitable actions to protect and improve the water quality of Lake Ōkātina.

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