Revised Version September 2010

Resource Consent Application
and Assessment of Environmental Effects for the

Okere Gates and Ohau Channel Weir Structures

Bay of Plenty
REGIONAL COUNCIL

OPUS

Bay of Plenty Regional Council
Rivers and Drainage Group

Okere Gates and Ohau Channel Weir Structures
Application for Resource Consents

Assessment of Environmental Effects
Revised Version September 2010

Prepared By: Clive Tozer
Environmental Project Manager

Claire Abbiss
Senior Planner

Reviewed By: Peter Askey
Principal Engineer

Approved for Release By: Peter Askey
Principal Engineer

Opus International Consultants Limited
Whakatane
Concordia House, Pyne Street
PO Box 800
Whakatane, New Zealand

Telephone: +64 7 308 0139
Facsimile: +64 7 308 4757

Date September 2010

Reference: 289030.07

Report #

Status: Final Version 3

Contents

APPENDIX 19 BOPRC Publication 'Guide to Lake Structures'

Executive Summary

The levels of Lakes Rotorua and Lake Rotoiti are controlled by means of the Ohau Channel Weir and Okere Gates respectively. The gates also control flows from Lake Rotoiti to the headwaters of the Kaituna River. The purpose of the Okere Gates is to increase the outflows from Lake Rotoiti to permit floodwater to be discharged when required, and to reduce outflows to prevent undesirable low lake levels.

Existing consents for the structures and for damming the lakes' waters were granted under the Resource Management Act (RMA) in 1996. Bay of Plenty Regional Council (BOPRC) Rivers and Drainage Group is the current consent holder. The existing lake level regimes are achieved by means of conditions of these consents, developed through consultation with the local community at the time.

Since the consents were granted, the ownership of the lake beds has been transferred from the Crown to Te Arawa Lakes Trust (TALT) under the Deed of Settlement of the Te Arawa Lakes Historical Claims and Remaining Annuity Claims 2004 and Te Arawa Lakes Settlement Act 2006. Under the Settlement, BOPRC is required to engage with and involve Te Arawa on Rotorua Lakes issues.

New resource consents for the Okere Gates and Ohau Weir Structure are sought to replace the existing consents which expired on 30 June 2010. An application for the new consents by the Rivers and Drainage Group was lodged on 21 December 2009 (six months before the existing consents expired). This has enabled the consent holder to continue to operate the structures under the existing consents past the expiry date until new consents are issued, in accordance with s124 of the RMA.

The Rivers and Drainage Group, as consent holder, has involved TALT representatives by including them on the team to develop a robust and transparent programme and strategy for consent renewal. The same parties have worked towards determining a Proposed Operational Strategy for Lakes Rotorua and Rotoiti levels controlled by these structures. Input to the team has also been provided by consultants for specific services including Opus International Consultants retained to file the consent renewal, modelling of various options by Aurecon and optimisation of operational alternatives by Hydrologics Inc. At the request of Ngati Pikiao and endorsed by TALT, independent consultant Dr Morgan was retained to undertake technical evaluation to ensure that a Maori perspective was included. His role was also to ensure consideration of the cultural wellbeing alongside other well beings in the development of Proposed Operational Strategy. The team was guided by Dr Morgan's Mauri Model that weights equally each of the wellbeings (social, cultural, economic, and environmental) in the initial evaluation of operational options.

The timeline to renew the consents has been set up in three stages.

Stage 1 ended in December 2009 with the lodgement of a consent application following considerable community engagement and consultation. Modelling of several different options was considered during this stage and it was decided to request the status quo operational strategy for the Ohau Weir that controls levels in Lake Rotorua. A wide starting point range was specified for Lake Rotoiti to allow for further consultation, modelling and refinement of these operations during Stage 2.

Stage 2 will end upon notification of the revised application. This stage has involved further consultation and water quality modelling on Lake Rotoiti operations. A Proposed Option (D7) has been determined for Lake Rotoiti. This Assessment of Effects (AEE) is a revision of the AEE lodged in December 2009, and has been revised on the basis of the Proposed Optional Strategy.

Stage 3 will commence upon public notification of the consent and will include receiving submissions, a Council Hearing (using a Commissioner) or Environment Court hearing and deliberations ending with a consent decision. Based on submissions the applicant may request direct referral of the final consent application to the Environment Court. It is anticipated that Stage 3 will be completed before the end of 2010.

Modelling

Experience in operating the Okere Gates has shown that while this structure mitigates to a small degree flood peaks in the Lower Kaituna, uncontrolled Mangorewa River flows dominate downstream flood peaks. Given that the Okere Gates provide minimal downstream flood control and that there have been calls by some local iwi for the removal of that structure, modelling was initiated to determine the positive and negative impacts of the current structures and how they are operated. The modelling also looked at what impacts there would be if the Okere Gates were removed and replaced with alternative control structures. This modelling information was used to define an initial operational range with TALT.

As part of the process, the consent holder invited Aurecon consultants to gather background information on the current Okere Gate operations and investigate and model alternative Okere Gate control structures. This work included inviting feedback from a number of stakeholders, identifying the benefits and disadvantages of the current and alternative structures and simulating operations with different structural alternatives (Aurecon, 2009). The modelling has since been peer reviewed by Opus and as a result of the peer review some modelling refinements have been completed.

Modelling of different options indicated that Lake Rotorua levels changed very little for a wide range of changes to operations in Lake Rotoiti.

In other words the hydraulic link between the two lakes is quite limited.

Lake Rotorua

Lake Rotorua levels, controlled by the Ohau Weir structure, have a relatively natural fluctuation within the currently consented range of 610 mm between 279.50 and 280.11 m (RL Moturiki Datum). Operations consist of the removal and re-insertion of stoplogs in the weir structure allowing some level control. For the most part levels fluctuate naturally with the stoplogs only removed occasionally – typically once or twice a year during significant flood rainfall events. Trigger levels determine when the stoplogs are removed or reinserted. Consultation has indicated that in general lake users and the lakeside community are satisfied with the current control structure and lake levels. Considerable infrastructural investment has been made on and around the Lake Rotorua foreshore by Rotorua District Council (RDC) and private enterprise based on the current Lake Rotorua operational strategy.

Given this fact and that there has not been a strong community or stakeholder demand to change the Lake Rotorua operating levels (via the Ohau Weir), the Rivers and Drainage Group propose to keep operating Lake Rotorua in the range of its current consent i.e. keeping levels similar to their current levels, i.e. between RL 279.5m and RL 280.11m. (610mm range).

As a result, no operational or structural changes were considered for the Ohau Weir and Lake Rotorua operations. Some operational flexibility of the guidelines for installation and removal of the stoplogs will be sought, to allow for more flexibility in maintaining downstream Lake Rotoiti levels without significantly impacting Lake Rotorua levels.

Lake Rotoiti

Investigations of alternate operational strategies for Lake Rotoiti have been extensive. Hydrologic modelling has included simulation from current operations to removal of the gates and replacement with various weir structures. Modelling has also shown that the gates can be retained and the effect of any of these options achieved through gate operations. The gates do not compromise options – rather they provide more flexibility of operation.

Optimisation modelling determined that a wider operating range than the current target range could maximise wider benefits according to the draft performance measures developed through the Mauri model process. Anecdotal recollection however indicated that historical lake levels may have been lower than those indicated by historical data. To recognise different options a wide initial lake level range was selected for the December 2009 application. This wide range provided flexibility for investigation and refinement of the operating range.

Options Considered

As part of the work to identify the proposed operations for the Okere Gates a number of options have been considered, modelled and discussed with the community. The following four options were identified as representing the wide spectrum of options considered. A consistent 10 year period from 1998 to 2007 with the same measured rainfall and inflows to both Lake Rotorua and Rotoiti was used in the different model simulations.

- Status quo. Measured Rotoiti levels resulting from current consented operations.
- Low Weir (Option 4). Simulated Rotoiti levels with the Okere gates replaced with a low stepped weir without restoring the original rock ledge (removed during construction).
- Natural Levels (Option 1). Simulated Rotoiti levels by installing a stoplog structure that replicates the pre-structure Rotoiti outlet morphology (i.e. gates removed and rock ledge reinstated) and the current 10 year rainfall and inflow.
- Proposed Option (D7). Model simulated operations to best meet the varied community goals for Rotoiti levels.

The lake level ranges for the different options are compared in Figure (i) below.

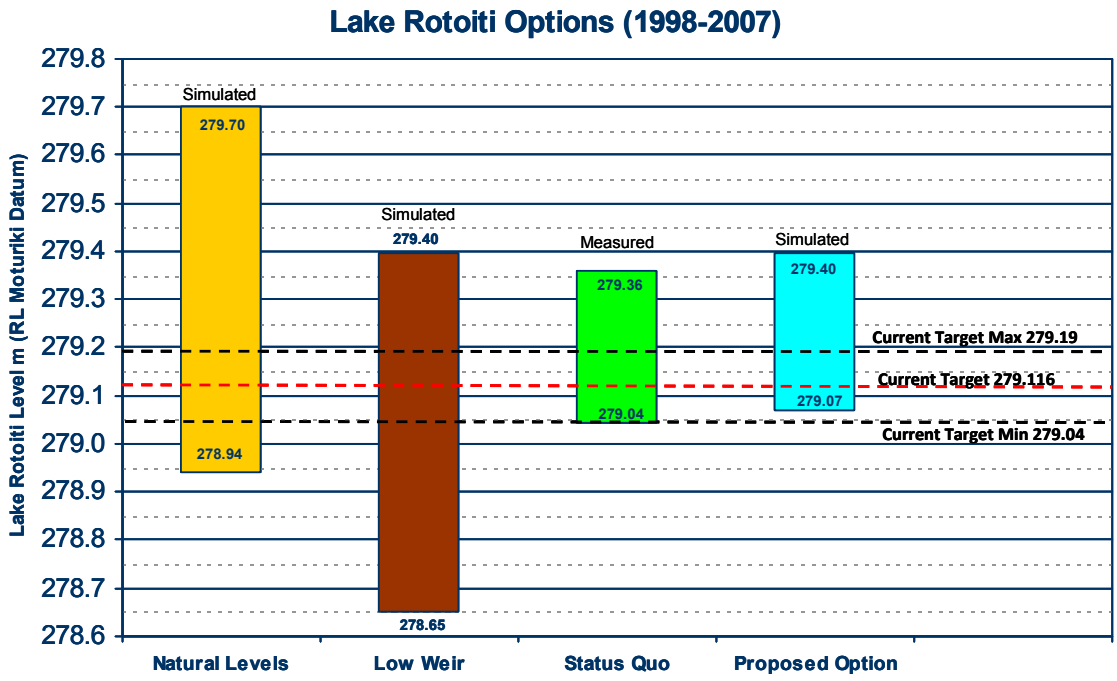

Figure (i): Comparison of simulated lake level ranges for different Lake Rotoiti operational options compared with measured data from 1998 – 2007.

To maximise benefits to the wider community, indicators that considered cultural, environmental, social and economic well beings were identified using the Mauri model. Performance measures were derived from these indicators to quantify differences between options. Between February and May 2010, a simplified subset of the performance measures was used together with best professional judgement, modelling, feedback from public meetings and stakeholder consultation to select the Proposed Option.

In general there was support for a wider operational range than the status quo, however concerns were expressed during the 9 and 11 April 2010 Public Open Days about lower than current target Lake Rotoiti levels proposed, particularly in the summer months. In an effort to address these community concerns further modelling and consultation with a cross section of the community (using small representative groups – such as TALT, Ngati Pikiao and Lake Rotoiti Community Association) was undertaken to refine the preferred option.

Proposed Option

Through the consultation and feedback received between February and May 2010 and modelling efforts, the Proposed Option has been developed and refined. The range of the Proposed Option is shown in Figure (i) above and daily Lake Rotoiti levels over the 10 year period (1998-2007) for each option are shown in Figure (ii) (below). The Proposed Option has a slightly wider and slightly more natural range than the status quo. The Proposed Option does not have the variability of low weir or natural levels options but better meets other performance criteria.

Key benefits of the Proposed Option are as follows:

- A slightly more natural range (with a target range rather than fixed target level as in the status quo) with some associated cultural and environmental benefits.
- Potentially better water quality in Lake Rotoiti and down Kaituna River.
- Jetties and navigation largely unaffected by level range.
- Fewer flows greater 40 cumecs down Kaituna River thus reduced river bank erosion and flood risk.
- Slight improvement in number of raftable days.
- Gentler rate of lake level rises conducive to Dabchick breeding.

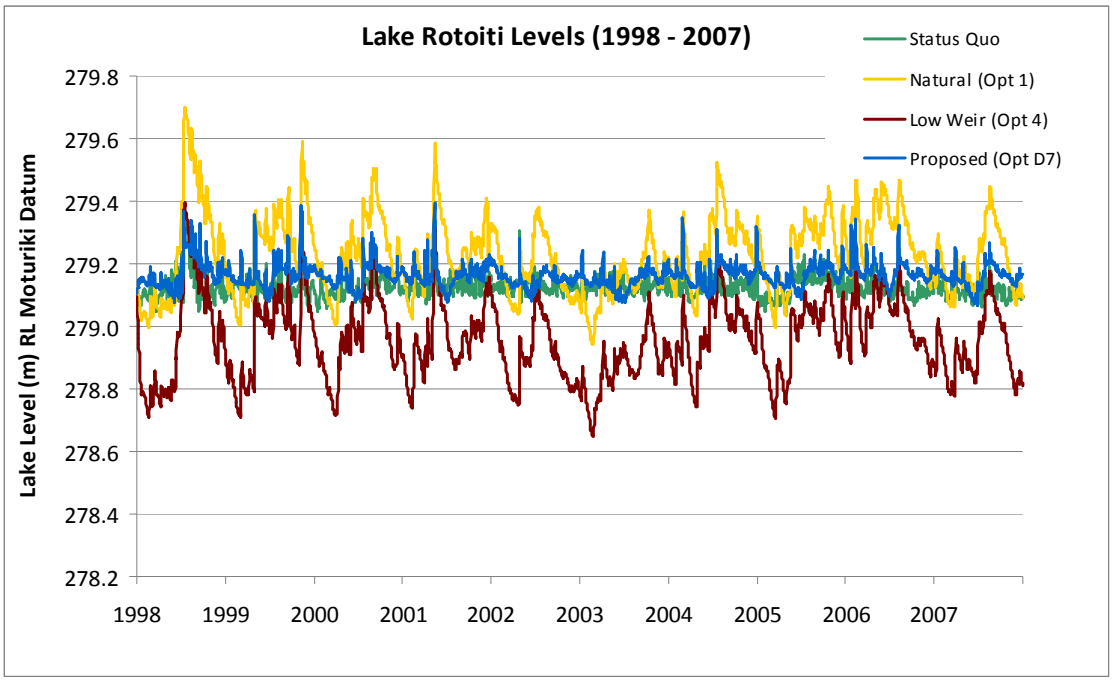

Figure (ii): Daily Lake Rotoiti levels over 10 years with different operational options

Proposed Operational Strategy

Based on the Proposed Option (D7), the Proposed Operational Strategy for Lake Rotoiti controlled by the Okere Gates is proposed as follows:

Principle: Improve environmental and cultural outcomes while not adversely affecting social and economic values. This is achieved by allowing for some seasonal fluctuation within specified target ranges. This differs from the current consented operations which have a static target level with tight variance around the target level.

Proposed Maximum and Minimum Levels and Range (all levels in m RL Moturiki Datum)

- Maximum level of 279.40

- Minimum level of 279.00
- 400 mm maximum range

(Note that 90% of the simulated Natural Levels are between the proposed maximum and minimum).

Proposed Operational Levels and Range (all levels in m RL Moturiki Datum)

- Allow operational levels to rise above 279.25 for a maximum of 5% of each year in significant flood/rainfall events.
- Target operational range of 200 mm between 279.05 and 279.25 with the following target distribution.
    - 5 -10% of year between 279.20 and 279.25
    - At least 80% of year between 279.10 and 279.20
    - 5 -10% of year between 279.05 and 279.10 in the months of May to July

Review and Operational Flexibility

It is proposed that a regular (every three years) review of this operational strategy is undertaken to allow operational flexibility within the above targets.

Operational flexibility within these targets could include initiatives such as rapid drawdown (flushing) to provide short term benefits for water quality if requested and approved by the Te Arawa Rotorua Lakes programme.

A schematic of the Proposed Operational Strategy compared with the current operational strategy is shown in Figure (iii) below.

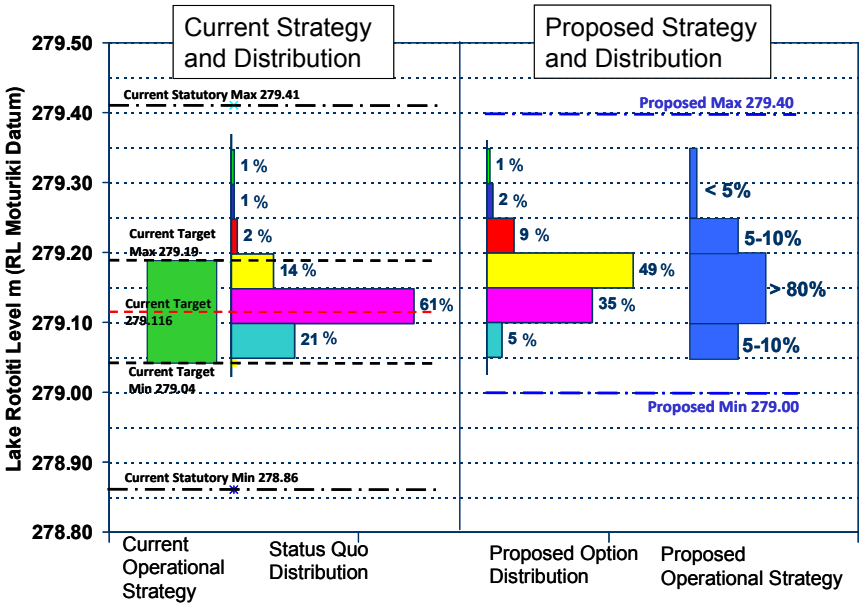

Figure (iii): Comparison of current operational strategy and distribution with Proposed Option (D7) distribution and Proposed Operational Strategy.

The green measured range of the current operational strategy and the associated distribution to the right of that shows 61% in the narrow 50mm range between 279.10 and 279.15. The Proposed Option shows the modelled distribution. However this could vary slightly depending on climate conditions (catchment rainfall). So a more generic distribution with target ranges is recommended for the Proposed Operational Strategy.

Consultation has identified that all stakeholders agree that maintaining and enhancing the water quality is of great importance and that operation of the structures and resulting levels and flows is to place a priority on this. While some differences exist between affected parties, the Rivers and Drainage Group has attempted to address the interests and concerns of as wide a range of stakeholders as possible. The Proposed Option reflects that which most stakeholders can live with.

The December 2009 AEE focused principally on Lake Rotoiti and was based upon the wide starting point range and upon performance indicators discussed with key stakeholders at that time. This limited specificity of that initial assessment summary.

This updated AEE (expected to be notified) is based around the Proposed Option and the Proposed Operational Strategy derived from it. The baseline for effects has been taken as the existing situation.

Based on the Proposed Operational Strategy lake level range, for Lake Rotoiti:

- Adverse effects on cultural values are marginally less compared to the status quo.
- Adverse effects on the ecological indicators are marginally less compared to the status quo.
- Adverse effects on water quality are marginally less compared to the status quo.
- Effects on the environment as a whole are generally slightly positive.
- Adverse effects on social and amenity values are not changed compared to the status quo.
- Adverse effects on economic factors effects are generally not changed compared to the status quo.

The AEE raised several matters that show that some community aspirations (performance criteria) cannot realistically be met as part of the Proposed Operational Strategy. For example the sub standard Hinehopu stormwater drainage and high groundwater levels which have been an ongoing issue (pre gates) and are (post gates and currently) affected by tectonic movement and settlement. The future of Hinehopu (Tamatea Street) baches/dwellings is uncertain irrespective of the Proposed Option lake levels. RDC has been considering planning instruments to dissuade further building development and to promote possible retreat/relocation away from low lying areas.

The magnitude of this issue is reinforced in the simplified representation of settlement around Lakes Rotorua and Rotoiti as shown in Figure (iv) below. Note that Hinehopu has settled by approximately 67mm relative to Okawa Bay since 1953.

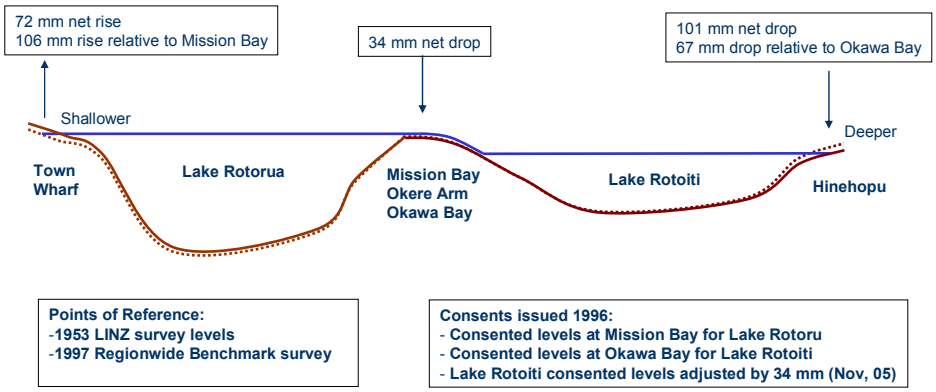

Figure (iv): Simplified schematic showing relative tectonic movement at Lake Rotorua and Rotoiti.

The existing sub standard drainage at Hinehopu (specifically Tamatea Street properties) is untenable and cannot be realistically rectified. However the potential minor additional effects of slightly increasing the maximum lake level from the Status Quo 279.361m RL to the Proposed Option 279.397m RL (36mm difference) and slightly raising the median lake level from the Status Quo 279.121m RL to the Proposed Option 279.160m RL (39mm difference), are difficult to predict and quantify. At this point the Rivers and Drainage Group are not able to provide any specific mitigation. However if ongoing seasonal groundwater monitoring demonstrates that the Proposed Operational Strategy would result in minor additional adverse effects on groundwater levels at the Tamatea Street bach properties, then the applicant is prepared to investigate commensurate mitigation to ensure there is no net loss of amenity relative to Status Quo.

The AEE also showed that it is not realistic to be able expose wider Lake Rotoiti beaches (up to 3m wide) on the majority of sites raised by Ngati Pikiao. Significant beaches could only be obtained at the sites discussed by adopting a wide lake level range. This would have very significant social and economic repercussions for many lake margin property and structure owners. Under the Proposed Operational Strategy there is negligible improvement in beach width and even potential for an initial slight loss of beach exposure. By way of mitigation for this potential slight initial loss of width, it is proposed that BOPRC undertake judicious herbicide application to encroaching exotic weeds and grasses on the landward edge, at Tamatea St (Hinehopu) and Ruato Bay beaches to enhance beach width

In some areas existing beaches have been and are being very successfully enhanced by community groups removing lake edge vegetation such as gorse and willows. Rivers and Drainage Group would work with community groups to restore the beaches described above.

Other issues that are /can be potentially addressed outside this consent include:

- Wider Lakes Water Quality matters – via Lakes Water Quality Programme.
- Rotorua Town Wharf shallowing – via localised sediment dredging (note separate resource consent including consent of lake bed owners (TALT) is required for dredging).
- Hinehopu waste water reticulation (septic tanks) – via RDC reticulation plans.
- Ohau Channel and Okere Arm siltation – via Kaituna Catchment Control Scheme maintenance programme (possibly including dredging).

1 Introduction

1.1 Purpose of the Project

The purpose of this project is to apply for new resource consents to replace existing ones, to use the Ohau Channel Weir and Okere Gates, and to dam water at the outlet of Lake Rotorua and Lake Rotoiti. The existing consents are currently held by Bay of Plenty Regional Council (BOPRC) Rivers and Drainage Group. Rivers and Drainage Group are, in accordance with s124 of the Resource Management Act 1991 (RMA), operating the weir and gates under the existing consents, which expired in June 2010.

Rivers and Drainage Group, the Applicant, has reviewed current and alternative gate and weir operations and investigated potential operations that will optimise benefits of numerous performance measures.

These investigations included speaking with a number of interested groups, key stakeholders and the wider community.

A working partnership has been established comprising the Applicant and Te Arawa Lakes Trust (TALT). The working party identified performance indicators, measures and options for further discussion and refinement to balance benefits to the Cultural, Environmental, Social and Economic well beings of the Rotorua and Rotoiti communities. Provision for these well beings is included for in both the Resource Management Act 1991 (RMA) and the Local Government Act 2002 (LGA).

Section 5 of the RMA requires the management of natural and physical resources to enable people and communities to provide for their social, economic, and cultural wellbeing, while avoiding, remedying or mitigating adverse effect on the environment.

Using the information obtained during the investigations, and through the consultation process, the Applicant has developed operational strategies for the gates and weir that will maximise benefits to a wider community than previously.

1.2 Timeline to Obtain New Consents

The timeline to obtain new resource consents for the Okere Gates and Ohau Weir Structures has been set up in three stages.

Stage 1 ended in December 2009 with the lodgement of a consent application following considerable community engagement and consultation. Modelling of several different options was considered during this stage and it was decided to request the status quo operational strategy for the Ohau Weir that controls levels in Lake Rotorua. A wide starting point range was specified for Lake Rotoiti to allow for further consultation, modelling and refinement of these operations during Stage 2.

Stage 2 will end upon notification of the revised application. This stage has involved further consultation and water quality modelling on Lake Rotoiti operations. A Proposed Operational Strategy has been determined for Lake Rotoiti. This AEE is a revision of the AEE lodged in December 2009, and has been revised on the basis of a Proposed Operational Strategy.

Stage 3 will commence upon public notification of the consent and will include receiving submissions, a Council Hearing (using a Commissioner) or Environment Court hearing and deliberations ending with a consent decision. Based on submissions the applicant may request direct referral of the final consent application to the Environment Court. It is anticipated that Stage 3 will be completed before the end of 2010.

1.3 Background

Lake Rotoiti and Lake Rotorua levels are controlled by the operation of the Okere radial gates and the Ohau Channel Weir respectively. The gates also regulate the rate of discharge from Lake Rotoiti to the Kaituna River.

The Okere radial gates and Ohau weir are currently owned by the Kaituna Catchment Control Scheme and operated by Rivers and Drainage Group, in accordance with their existing resource consents.

The purpose of the Okere Gates is to increase the outflows from Lake Rotoiti to permit floodwater to be discharged when required, and to reduce outflows to prevent undesirable low lake levels. The impacts of Okere Gates operation on Lake Rotorua levels are generally minor.

The purpose of the Ohau Weir is to control the level of Lake Rotorua, predominantly to prevent undesirable low levels.

The Ohau Channel Weir was constructed in 1989 as a simple weir structure with stop logs. The Okere Gates structure, constructed in 1982, is a substantial radial triple gate structure.

Prior to the construction of the Okere Gates in 1982, there was a natural rock ledge (at approx RL 278.5m) about 35m downstream of the existing gates, which set a minimum level for Lake Rotoiti.

Both control structures were put in place as part of the Upper Kaituna Catchment Control Scheme. Pre-scheme, there was no lake level control on either Lake Rotoiti or Lake Rotorua (apart from the natural rock ledge), with the result that lake levels fluctuated considerably, determined by climatic effects. The structures were designed so that the lake level ranges could be managed within the range set by the old National Water and Soil Conservation Authority (NWSCA), in 1975. These levels were included in BOPRC's Transitional Regional Plan, and are referred to in the existing consents granted for damming the outlets of both lakes.

The Ohau Weir and Okere Gates are operated and maintained as part of the Rivers and Drainage Asset Management Plan (AMP). The AMP outlines what regular inspections and maintenance are carried out on the structures over their expected life cycle. The AMP also provides details of related costs including provision for the renewal of assets as required under the LGA.

1.4 Resource Consents Sought

1.4.1 Resource Management Act

Resource Consents are sought to continue operating the existing Ohau Channel Weir and Okere Gates structures placed in the beds of the Ohau Channel and Kaituna River

respectively. Table 1 summarises the activities and relevant resource consent triggers in the Operative Regional Water and Land Plan.

Rivers and Drainage Group considered the potential for discharge of incidental quantities of hydrocarbons during operation and maintenance of the two structures. Such discharge is not known to have occurred in the past and effects are considered less than minor. No application to Rotorua District Council for consent to undertake this activity is proposed.

Spraying of herbicide (to control exotic weeds and grasses encroaching on beach margins) is a permitted activity in the Regional Water and Land Plan (Rule 21) subject to permitted activity conditions. It has been assumed that the conditions will be complied with and Rivers and Drainage do not propose to apply for consent to undertake this activity.

Table 1: Summary of Consent Triggers in Operative Regional Water and Land Plan

Activity	Regional Plan Rule	Status	Key Parameters
Place, Use and Maintain the Lake Rotoiti Level Control Structure	Rule 71– Activity in the Beds of Streams, Rivers and Lakes	Discretionary Activity	Use, erection, reconstruction, placement, alteration, extension, removal, or demolition of any structure or part of any structure in, on, under, or over the bed of a stream, river or lake, is a discretionary activity.
Place, Use and Maintain the Lake Rotorua Level Control Structure	Rule 71– Activity in the Beds of Streams, Rivers and Lakes	Discretionary Activity	Use, erection, reconstruction, placement, alteration, extension, removal, or demolition of any structure or part of any structure in, on, under, or over the bed of a stream, river or lake, is a discretionary activity.
To dam the Ohau channel at the outlet from Lake Rotorua for the purpose of controlling the level of Lake Rotorua	Rule 48 – Damming or Diversion of Water	Discretionary Activity	
To dam the outlet of Lake Rotoiti by means of the Okere Gates Structure	Rule 48 – Damming or Diversion of Water	Discretionary Activity	
To artificially control the water levels in Lake Rotorua	Rule 50 – Artificial Control of Water Levels in Natural Lakes	Discretionary	The artificial control of water levels in natural lakes, including any associated activities, is a discretionary activity. The intent of the rule is to restrict the artificial control of water levels in natural lakes, and allow BOPRC to assess the adverse environmental effects of the proposed activity through a resource consent application. Specific conditions can be used to avoid, remedy or mitigate those effects
To artificially control the water levels in Lake Rotoiti	Rule 50 – Artificial Control of Water Levels in Natural Lakes	Discretionary	The artificial control of water levels in natural lakes, including any associated activities, is a discretionary activity. The intent of the rule is to restrict the artificial control of water levels in natural lakes, and allow BOPRC to assess the adverse environmental effects of the proposed activity through a resource consent application. Specific conditions can be used to avoid, remedy or mitigate those effects.
Discharge water from Lake Rotoiti to the Kaituna River through the Okere Control Gates structure. Discharge water from Lake Rotorua to	Rule 37 – Discharge of Water to Water	Discretionary	Any discharge of water to water that is not permitted by a rule in the Plan is a discretionary activity.

Activity	Regional Plan Rule	Status	Key Parameters
Ohau Channel over the Ohau Channel Weir.	Rule 37 – Discharge of Water to Water	Discretionary	Any discharge of water to water that is not permitted by a rule in the Plan is a discretionary activity.

1.4.2 Bay of Plenty Regional Council Floodway and Drainage Bylaw 2002

For certain activities on a section of a river within a River Scheme (as defined in Schedule 5 of the Regional Water and Land Plan), the approval of Rivers and Drainage Group is required with regard to their functions under the Soil Conservation and Rivers Control Act 1941, and the BOPRC Floodway and Drainage Bylaw 2002.

Both the Ohau Channel and Okere Gates are within the (Upper) Kaituna Catchment Control Scheme.

However, as there are no current proposals to alter the structures or carry out any works to the surrounding areas and so no consent is required under this bylaw.

1.5 Project Objectives

The main objectives of the resource consent applications project were identified by the Rivers and Drainage Group early in the process and are as follows:

- To review the operating regime of the Ohau Channel Weir and Okere Gates and define appropriate operational strategies that maximise benefits to the wider community, balancing the benefits to the cultural, environmental, social and economic well beings.
- To actively engage the community, particularly the new lake bed owner, Te Arawa Lakes Trust, to assist in identifying the preferred operational regimes for the weir and gates.
- To prepare and apply for new consents from BOPRC by the end of 2009 to ensure that the existing activities can be continued under the existing consents in accordance with section 124 of the RMA.
- To review the applications lodged in December 2009 based upon further modelling and consultation for notification in September 2010.

1.6 Processes Followed to Date

The consent application process followed by the Applicant to date has been to:

- Carry out hydraulic modelling of alternative Okere Gate operational options and use this information to inform the consent application process. The model included hydraulic modelling of Lake Rotorua and Rotoiti (linked through the Ohau Weir and Ohau Channel) and outflow through the Okere Gates to the Kaituna River.
- Consult first with partners, TALT, and discuss potential operational regimes for lake level control. Attend various hui facilitated by TALT to present proposals to iwi.
- Work with independent consultant Dr Morgan of Mahi Maioro Consultants and use Dr Morgan's Mauri Model to develop performance measures to assist in the development of the preferred operational regimes.
- Perform optimisation modelling of the lake level control system using performance measures and develop optimised operational scenario.

- Present the starting point operational range to stakeholders and interested parties at a Public Open Day in October 2009.
- Workshop with TALT, other stakeholders, and interested parties to refine performance measures in November 2009.
- Receive feedback and comments from hui, public open day, workshops and other sources.
- Peer review of hydraulic modelling in November 2009. Subsequent improvements were made to the hydraulic model.
- Prepare an AEE based on proposed starting point operational range or envelope. Lodged 21 December 2009.
- Ongoing development of performance measures initiated at workshop in November 2009.
- Conduct a Web Survey (Mauri Model – Dr Morgan) February/March 2010.
- Carry out Water Quality modelling – David Hamilton Waikato University.
- Ongoing Optimisation modelling.
- Run Public Open Days at Rotorua – 9 and 11 April 2010.
- Conduct numerous consultation meetings – TALT, numerous iwi , Lake Rotoiti Community Association (LRCA), RDC, River Scheme.
- Maintain awareness and information flow via 6 Newsletters and numerous newspaper articles.
- Revise AEE based on Proposed Option (D7) – in anticipation of notification.

2 Existing Situation

2.1 Explanation of Relative Levels in Existing Resource Consents for Lake Rotoiti

The existing resource consent to dam the outlet of Lake Rotoiti by means of the Okere Gates includes reference to levels relative to Moturiki Datum.

This AEE also refers to relative levels. However, there is a 34mm difference between the existing consent levels and those discussed throughout this AEE.

In mid-2005 Rivers and Drainage Group decided to use a more reliable survey benchmark for Lake Rotoiti level management following evidence of local settlement. Prior to mid 2005, Rivers and Drainage Group had used a local Okere and Okawa Bay benchmark. However after mid-2005, it adopted the "Rotorua Fundamental Benchmark" which was 34mm lower than the Okere and Okawa Bay benchmark. Since the existing Okere Gate consents were issued on 19 November 1996 and thus pegged to the original Okere and Okawa Bay benchmark, this means that the consented levels needed to be adjusted by a reduction of 34mm, and this conversion took effect from 30 November 2005.

Therefore, throughout this AEE, the relative levels discussed for Lake Rotoiti are based on the corrected levels, shown in the Table 2.

Table 2: Corrected Consent Levels for Lake Rotoiti Referred to throughout this Report

Lake Rotoiti		
	Levels Stated in Consent m RL Moturiki Datum	Corrected Levels Referred to in this Assessment m RL Moturiki Datum
Statutory Maximum	279.44	279.406
Statutory Minimum	278.89	278.856
Target Maximum	279.225	279.191
Target Minimum	279.075	279.041
Target Level	279.150	279.116

Refer to memo titled “Lakes Rotoiti and Rotorua Survey Data and Datums”, dated 22 April 2010 by Robbin Britton and an attached letter from Flaherty Survey and Mapping (9 Sept 2002), contained in **Appendix 4**, BOPRC Rivers and Drainage Group, July 2010 “Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application”.

Reference level data for Lake Rotorua, used for consented operations at the Ohau Weir is based on readings taken from Mission Bay level recorder (based on 1953 survey). Re-survey in 1997 revealed that the Town Wharf level recorder had risen 72mm relative to the regional benchmark and the Mission Bay level recorder had settled 34mm relative to the regional benchmark. Hence for the same water level, readings taken at the Town Wharf are 106mm higher than those at the Mission Bay level recorder and must be corrected for true comparison.

Hinehopu appears to have settled by approximately 67mm relative to Okawa Bay but this has not affected data used in modelling. Since Okawa Bay has settled 34mm relative to the regional benchmark Hinehopu has settled an overall net drop of 101mm relative to the regional benchmark.

A simplified representation of settlement around Lakes Rotorua and Rotoiti is shown in **Figure 1** below.

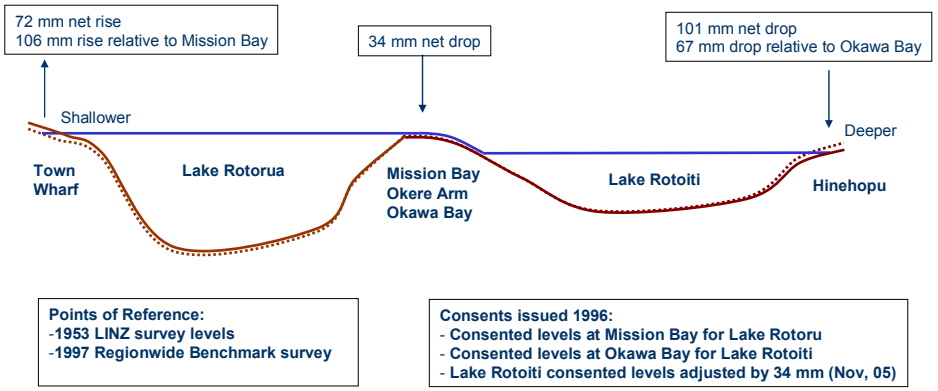

Figure 1: Simplified schematic showing relative tectonic movement at Lakes Rotorua and Rotoiti.

2.2 Description and Location of Structures

2.2.1 Location

The Ohau Channel Weir is located at the outlet of Lake Rotorua at the entrance to the Ohau Channel.

The Okere Gates are located at the outlet of Lake Rotoiti, above the Kaituna River. Refer **Figure 2** for location plan.

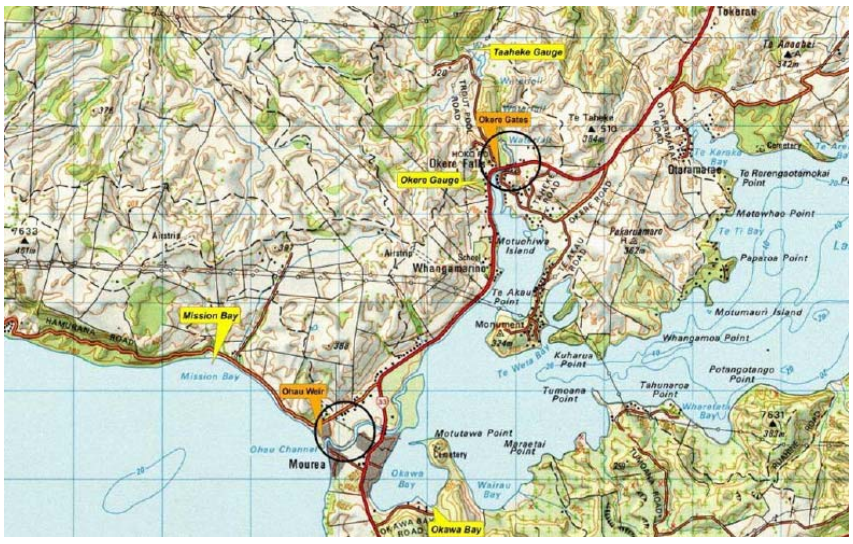

Figure 2: Location of Okere Gates and Ohau Channel Weir.

2.2.2 Ownership of the Lake Beds and Land beneath the Weir and Gates

Lake Beds – Te Arawa Lakes Settlement Act 2006

On 18 December 2004, the Crown and Te Arawa Iwi and Hapu signed a Deed of Settlement for Te Arawa Historical Treaty Claims over 14 lakes. The Deed of Settlement was given legal effect by legislation passed through parliament in 2006. This resulted in the transfer of titles to 13 lake beds including those of Lake Rotorua and Lake Rotoiti to Te Arawa.

The water column (space occupied by water) and airspace remains in Crown ownership and is administered by Land Information New Zealand (LINZ).

The Te Arawa Lakes Trust (TALT) web site, October 2009, states, *"Public access for recreational purposes, rights of navigation, existing structures and existing types of commercial activities are protected. However individuals or businesses that wish to build new structures or modify existing structures on the lakebeds will need the consent of both Te Arawa and the Crown (Land Information New Zealand). Te Arawa and LINZ will jointly consider applications*".

The Deed of Settlement provides for the transfer of the lakebeds under the Rotorua Te Arawa Lakes Settlement. However the Deed does not include any transfer to Te Arawa of the existing structures on the lakebeds licensed before the Treaty Settlement.

TALT owns and manages the lake beds and is a partner with BOPRC and Rotorua District Council (RDC) under the Rotorua Te Arawa Lakes Strategy Group. The Rotorua Te Arawa Lakes Strategy Group is established under the Settlement Act "*to contribute to the promotion of sustainable management of the Rotorua Lakes and their catchments, for the use and enjoyment of present and future generations, while recognising and providing for the traditional relationship of Te Arawa with their ancestral lakes*". The settlement entered into by the Crown and Te Arawa recognises the association of Te Arawa with their ancestral lakes and provides for ownership of the lakebeds by Te Arawa and for the involvement of Te Arawa in management decisions that affect the Te Arawa Lakes.

Kaituna River

Iwi and hapu of the Kaituna River, such as Tapuika and Waitaha to name just two, have a significant association and relationship with the river.

Ngati Pikiao claim continuous occupation and jurisdiction over the bed of the Kaituna River. This claim is before the Crown.

Under Weir and Gates

A Status Report has been completed to determine who owns the lake beds beneath the Ohau Weir and Okere Gate structures. It concluded that the Crown owns the land which is administered by LINZ. The findings of the Status Report were approved by the Commissioner of Crown Lands in 2010. Ngati Pikiao disputes this and has a claim before the Crown in this respect.

A copy of the report is included in **Appendix 1.**

2.2.3 Ohau Channel Weir

The Ohau Channel weir is described in engineering terms as a two stage broad crested weir. It has provision for the installation of stop logs in the central portion to help maintain Lake Rotorua levels during dry spells. The stop logs are laid across the central portion of the weir in three groups. Hydraulically they form a false floor which gives a partial damming effect.

The hydraulic design of the lower weir allows for the passage of typical runabout boats.

The weir includes special features to allow fish passage. These include gabion baskets and rock on both the upstream and downstream sides of the structure, and specifically placed rocks to provide an acceptable riffle area. Refer **Figure 3** for picture of weir.

Figure 3: Ohau Channel Weir (August 2008).

2.2.4 Okere Radial Gates

The Okere Gates structure is a substantial radial triple gate structure. Lake level data is transmitted via telemetry from the Okawa Bay recorder to BOPRC's Whakatane office. The gates are adjusted daily by an operator who uses a computer based in Whakatane, who remotely monitors lake levels and gate settings. Okawa Bay levels are used as the primary Lake Rotoiti water level monitor. If for some reason the Okawa Bay site fails secondary data may be obtained from the Okere Falls recorder that is owned and operated by NIWA. Refer **Figure 4** for picture of gates.

Figure 4: Okere Radial Gates (August 2008).

2.3 Existing Resource Consents

The existing consents for the placement and use of the structures and the damming of Lakes Rotorua and Rotoiti are summarised in Table 3 below. Copies of the consents are included in **Appendix 2.**

Table 3: Summary of Existing Consents for Ohau Channel Weir and Okere Gates Structures.

Consent Number	Consent Purpose	Expiry Date
05 0661	To place and use the Lake Rotoiti Level control structure	30 June 2010
05 0663	To place and use the Lake Rotorua Level control Structure and to alter the associated fish passage mechanisms and undertake channel bank protection works	30 June 2010
02 4505	To dam the Ohau Channel at the outlet from Lake Rotorua for the purpose of controlling the level of Lake Rotorua	30 June 2010
02 4504	To dam the outlet of Lake Rotoiti by means of the Okere Falls Gate structure	30 June 2010

2.4 Description of Existing Lake Operating Regimes

2.4.1 Lake Rotorua

The resource consent for the Ohau Channel Weir structure sets conditions for the operating regime to control lake levels of Lake Rotorua.

The Ohau Channel weir structure is operated currently to ensure, as far as practicable, the level of Lake Rotorua is maintained between the following maximum and minimum levels above Moturiki Datum:

Maximum: RL 280.11m

Minimum: RL 279.50m

The lake levels are managed by installing and removing the stop logs according to the following procedure;

(i) The three stop logs shall be installed when the lake is at or just above the lake level of RL 279.810m if the lake water level has been falling rapidly in the previous weeks.

(ii) The three stop logs shall be removed if the lake level reaches RL 280.00m.

2.4.2 Lake Rotoiti

The resource consent for the Okere Gates structure sets conditions for the operating regime to control lake levels of Lake Rotoiti and flows to the Kaituna River.

The lake level is controlled according to the following procedure:

(i) The gates are operated with the objective of maintaining the level of Lake Rotoiti to a target level of RL 279.116m (corrected to allow for the change in recording station per section 2.1 above) +/- 0.075m above Moturiki Datum. If the lake level departs from this range, the gates must be adjusted to return the lake levels to this range as soon as possible.

In situations when the target level cannot be achieved, the lake shall be controlled between the following maximum and minimum levels (current 'statutory' range) above Moturiki Datum (corrected to allow for the change in recording station per section 2.1 above):

Maximum: RL 279.406m

Minimum: RL 278.856m

Further, the gates are currently operated to ensure that certain maximum and minimum flow rates and changes in flow rates to the Kaituna River are not exceeded. The operation of the gates recognises the requirements of rafting operators on the Kaituna, but the achievement of the target levels takes precedence over the recreational use of the Kaituna River.

The gates are currently operated within the consent conditions in accordance with BOPRC "Operating Guidelines for Okere Gates between Lake Rotoiti and the Kaituna River". The most recent version of these guidelines, dated 30 November 2005, is included in **Appendix 3.** These operating guidelines provide more detail about the lake levels at which the gates are opened or closed, and the degree that the gates should be opened or closed.

2.5 Ohau Diversion Wall

The Ohau Diversion Wall is designed to stop water flowing from Lake Rotorua and the Ohau Channel into the main body of Lake Rotoiti, instead diverting the discharge from the Ohau Channel directly to the Okere Arm and down the Kaituna River. The wall was constructed over 2007/2008. It is a sheet pile wall 1275m long attached to the lake bed

with king piles up to 70m deep in places. It has been designed with a low profile which extends 500 mm above the water surface so it is not visually intrusive.

The purpose of the diversion wall is to divert nutrient laden water directly down the Kaituna River rather than impacting the water quality of Lake Rotoiti.

The wall was designed to operate at the range of lake levels permitted by the existing resource consent for the Okere Gates. Refer **Figure 5** for location of diversion wall.

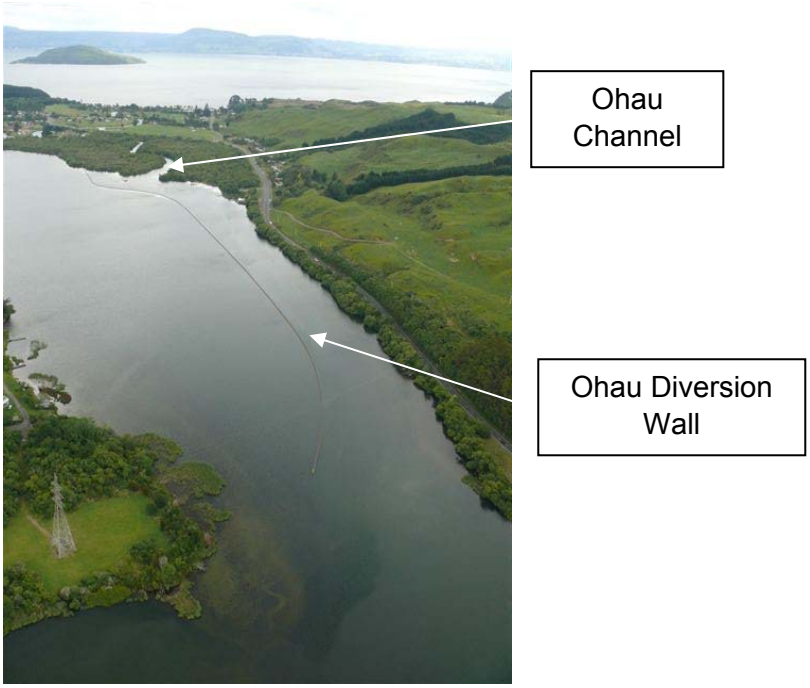

Figure 5: View of Ohau Diversion Wall taken from above Okere Arm looking south west towards the mouth of the Ohau Channel with Lake Rotorua in the background.

2.6 Existing Resource Consent Compliance

2.6.1 Operation of Ohau Channel Weir

Based upon the data collected by BOPRC, the weir has been operated such that Lake Rotorua levels have been within the consented range for nearly 100% of the time, except during an extreme high in 1998.

BOPRC consent compliance monitoring database advises that there have been no **formal** complaints recorded about the operation of the stop logs.

2.6.2 Operation of Okere Gates

Based upon data collected by BOPRC since the current consents have been operating, the gates have been operated such that Lake Rotoiti levels have been within the consented range 100% of the time and the minimum and maximum flows to the Kaituna River have also been within the consent limits for 100% of the time.

Since January 2000, there have been six official complaints made to BOPRC regarding the operation of the Okere Gates. Of these, one was regarding flow rates on the Kaituna River, and the remainder were regarding the lake levels.

Rivers and Drainage maintain a log of all complaints received regarding operation of the Okere Gates and Ohau Weir structures. No enforcement orders or abatement notices have been served on Rivers and Drainage since the existing Okere Gates and Ohau Weir consents were issued in 1996.

A limited number of complaints over the last 10 years have been received from individual lakeside residents and commercial river rafters. Often the complainant believed that lake levels or Okere Gate flows were either too high or too low. These complaints often arose during storms or dry periods and were rectified as soon as catchment conditions permitted (i.e. storm passes or drought broke).

2.7 Summary of Key Existing Issues

The levels of both lakes Rotorua and Rotoiti are controlled by Rivers and Drainage Group by means of the Ohau Channel Weir and Okere Gates, respectively.

The existing lake level operating regimes were developed through consultation with the local community during 1995 and 1996, and the resource consents for the placement and use of both structures, and the damming of Lakes Rotorua and Rotoiti were granted in 1996.

Since that time, the ownership of the Lake Beds has been transferred to TALT, by way of a Deed of Settlement between the Crown and Te Arawa Iwi and Hapu, on 18 December 2004.

The Applicant has partnered with TALT, as lake bed owners, to develop an operating regime for both lakes that will consider broad Te Arawa Iwi and Hapu and community issues.

The Applicant has equally considered the four well beings of the community, identified in the Resource Management Act and the Local Government Act, namely environmental, social, cultural and economic.

There are a number of stakeholders within the community, whose interests range widely regarding the weighting they consider should be given to the four well beings. Conflicts inevitably exist between the different interests and the desired operating regime, and it has been the Applicant's aim to try to address the interests of as wide a range of stakeholders as possible.

The performance and ongoing effectiveness of the Ohau Diversion Wall was a key consideration in the development of an operating regime for Lake Rotoiti.

Compliance with the existing consent conditions is high, and there have been few reported official complaints since the consents were granted in 1996.

3 Description of the Existing Environment

3.1 Recreational and Commercial Tourism

3.1.1 General

Currently lakes Rotorua and Rotoiti are utilised by many for recreation and tourism, including boating, sailing, kayaking, windsurfing, kite surfing, water skiing, cultural practices, food gathering, fishing (both shore based and boat based), swimming, picnicking and sightseeing. The Kaituna River (Okere Falls and rapids) is used by a number of white water rafting/kayaking commercial operators. Further downstream on the Kaituna, commercial and recreational jet boat operators use the river, and the river is utilised for cultural practices by local iwi and hapu.

There are many private landowners of waterfront property who utilise the Lakes' margins for their recreational pursuits (i.e. boating and swimming). Many lakefront owners also own or lease lakefront structures such as jetties, ramps or boatsheds.

Please refer to Section 3.3 for tangata whenua context and cultural values.

3.1.2 Lake Rotorua

Recreational Use

Lake Rotorua is the largest lake in the region with a surface area of 81km^2 and is valued by locals and tourists alike. It is a relatively shallow lake with a maximum depth of 45m and a mean depth of 11m. There are high levels of nutrients in the water and lakebed sediments resulting in poor water quality. However The Rotorua Lakes Protection and Restoration Action Programme aims at improving the long term water quality of the Rotorua lakes.

Despite the seasonal water quality issues, Lake Rotorua is very popular for recreation and in particular for boating and trout fishing pursuits. The rainbow and brown trout fishery is well regarded due in large part to the significant spring fed spawning streams and rivers which discharge to the lake and ensure a self sustaining population. Sightseeing and picnicking are also popular.

Tourism

Rotorua is an iconic international tourist destination. Total visits by travellers to Rotorua are forecast to rise from 3.04 million in 2008 to 3.31 million in 2015 (Ministry of Tourism).

Lake Rotorua attracts many national and international visitors who enjoy the activities in and around the waterfront.

The RDC has invested and continues to invest in lakefront development infrastructure. In its 10 year plan RDC has budgeted a further $8M for a lakefront development including a 200m jetty. This development relies on relatively stable lake levels (similar to the current operating range).

Examples of commercial, tourist focused water based activities that take place from the lakefront include cruises on the Lakeland Queen a 35m long stern driven paddle vessel

catering for up to 300 guests; Rotorua Duck Tours (a WWII landing craft); Wai Ora Experiences including trips to Mokoia Island, Floatplane operations and Kawarau Jet tours across Lake Rotorua to Hamurana Springs or through Ohau Channel to Lake Rotoiti and the Manupirua hot pools.

A number of trout fishing guides are also based out of Lake Rotorua.

Various sources (refer to References) provide the following data for Rotorua:

"Rotorua is one of the key tourist attraction areas in New Zealand. Tourism has been one of the major economic bases in Rotorua from the 1800s until the present day. As well as the geothermal features, the Rotorua lakes, Maori culture, fishing, farm and wildlife exhibits and outdoor pursuits all add to the area's attraction to tourists."

"Total visits by travellers to Rotorua are forecast to rise from 3.04m in 2008 to 3.31m in 2015. International visitors comprised 43.9% of visitors in 2008 (1.44m visitor nights), and expected to rise to 46.7% by 2015 (1.65m visitor nights). Domestic visits are expected to increase from 2.19m in 2008 to 2.29m in 2015. Actual expenditure by tourists in 2006 was $470 m, and this is forecast to rise to $698m by 2013."

"Tourism provides an estimated 7000+ full-time equivalent jobs in the Rotorua district, which is equivalent to 25% of Rotorua's total workforce and ranks the tourism industry as Rotorua's largest employer. Direct employment in the tourism industry accounts for approximately 20% of Rotorua's total workforce and a further 5% of Rotorua's total workforce are indirectly employed in the tourism industry by virtue of having jobs that are dependent on the tourism industry e.g. a percentage of jobs in businesses servicing the tourism industry, such as food wholesalers".

Boating

As noted previously, Lake Rotorua is relatively shallow. Low lake levels have the potential to significantly affect lake front access for commercial craft.

Commercial boating activity that takes place includes guided trout fishing, lake cruises, trips from Rotorua to Manupirua (lake side hot pools on lake Rotoiti via Ohau Channel), and trips to view Mokoia Island. Other lake based commercial tour operators conducting trout fishing, kayaking, and lake boating operations can also be similarly affected.

Private recreational boating is very significant particularly to Rotorua city residents. RDC provides seven public boat ramps. These and the many private lake edge structures (such as jetties) are well used.

Fishing

Fishing in Lake Rotorua is a long established activity. Trout fishing, in particular for rainbow trout by private fishers and those guided by professionals, is well recognised nationally and internationally. Many small operators make their living from hosting trout fishing expeditions. Fishing is by trolling or harling/jigging from boats, or fly fishing from the lakeside.

Geothermal

Of further interest from a commercial (tourism) point of view is that groundwater level (which may be affected by lake levels), has been observed to have an effect on geothermal activity, on which the city of Rotorua relies heavily. The level of water in the geothermal aquifer is known to have an effect on localised surface geothermal activity. Exchanges of activity have been observed in the Rotorua area between Kuirau Park springs and Tarewa Road springs, as far back as 1896 (refer www.envbop.govt.nz/Environment/Problems.aspx). What is not known with any certainty is the link between geothermal groundwater levels and normal groundwater levels, although Titchmarsh, 1995, comments;

[geothermal] "*Aquifer pressure beneath much of Rotorua city is controlled by the lake level, and is uniform due to high permeability in the rhyolitic host rock. Also in view of the large outflow from the Rotorua geothermal field, the lake level is probably the main cold water pressure control for much of the field. Rising lake levels may cause increased temperatures and flow rates in the immediate vicinity of the lake, but if water levels were allowed to continue to rise, thermal sites would be flooded and visible activity would cease. Restricting the maximum level to the status quo means that there will be no detrimental effect to the geothermal activity. Whilst raising the minimum level to reflect what has been the management status quo since the structure [stop logs at entrance to Ohau Channel] was installed, means there will be no change caused to geothermal activity.*"

3.1.3 Lake Rotoiti

Recreational Use

Lake Rotoiti east of Rotorua is a relatively large lake of 35km^2 with an average depth of 31m and a deepest point of 93.5m. The Ohau Diversion Wall built in 2008 diverts water from Lake Rotorua directly down the Kaituna River, preventing it mixing with the main body of Lake Rotoiti. As a result, the water quality in Rotoiti is improving markedly. Given the lake's attractive geographical and natural setting it is highly regarded recreationally.

Recreational boating and the quality rainbow trout fishery are the big drawcards for recreation on Lake Rotoiti.

Public access to bays and onto the lake (via five public boat ramps) is good.

Lake Rotoiti connects via the Ohau Channel to Lake Rotorua.

There are a significant number of permanent and seasonal lake margin bach and permanent home owners.

Tourism

Commercial tourist businesses are increasingly focused on the attractive attributes of Lake Rotoiti. For example the 'Pure Cruise' yacht charters a 16m catamaran which operates out of Okawa Bay and works in conjunction with the Duxton Hotel.

Some kayak companies are offering services. Some commercial craft are also using the Lake Rotorua/Lake Rotoiti link via the Ohau Channel.

A number of trout fishing guides are also operating on Lake Rotoiti.

Boating

Boating on Lake Rotoiti is very popular. The western part of Lake Rotoiti (and Okawa Bay, Te Weta Bay and Otaramarae in particular) is heavily used for a range of recreational activity and particularly boating. Similarly the southern bays between Hauparu and Gisborne Point/Rotoiti are also favoured. RDC have a number of public facilities including jetties and/or boat ramps on Lake Rotoiti; at Okawa Bay, Gisborne Point, Otaramarae, Ohau Delta (adjacent to SH33) and Hinehopu. The Otaramarae and Delta ramps are especially popular.

Fishing

Trout fishing in Lake Rotoiti is considered world class. Eastern Fish & Game support the Rotoiti fishery by releasing hatchery raised rainbow trout juveniles to this lake as there are only limited spawning streams in the Lake Rotoiti catchment.

Popular shore based trout fishing locations include the Ohau Channel and Ohau Delta. The NZ fishing website recommends "fishing the mouth of any small stream as it enters the lake, particularly in winter when large trout are searching for places to spawn" (refer www.nzfishing.com/FishingWaters/Eastern/ERFishingWaters/ERRotoiti.htm).

Beaches are significant to shore based anglers at popular winter spots such as Ruato Bay and Hinehopu. Edge water needs ideally to be clear with depth and without weed.

The trout fishing season is generally October – June, but specific areas are subject to regulations.

There is also a history of cultural-mahinga kai/fishing (seeking traditional seasonal food sources that were commonly served at local marae in the past) by Ngati Pikiao, with a long established smelt ('inanga') fishery. Ngati Pikiao also fish for Koura (fresh water cray) and collect Kakahi (fresh water mussels).

Geothermal

The Tikitere Thermal Area includes a number of hot springs (used for bathing) within the area between Okawa Bay and Hauparu Bay. They are notable natural features and of much cultural and recreational importance. Some of the lake edge springs are only accessible by boat.

Beaches

The diminished number and size of sandy exposed beaches may have curbed some recreational activity such as walking, swimming and picnicking due to reduced accessibility, particularly since the 1996 consent conditions became operational.

For Ngati Pikiao, some beaches have been a traditional pathway and Dr Morgan requested approximately 3m wide beaches at nine key Lake Rotoiti locations on behalf of Ngāti Pikiao (refer Beach Profile Location Map contained in Appendix 9 of BOPRC Rivers and Drainage Group, September 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application", which is included as **Appendix 4** to this report). Ngati Pikiao in particular contend that the lake levels have been artificially raised by the

operation of the Okere Gates since their installation, removing beaches and covering significant land marks. Ngati Pikiao want to see a return to more natural fluctuating lake levels which they suggest will lead to a return to wider beaches.

There is still some uncertainty as to why beaches have diminished in number and size.

One theory is that alleged higher lake levels than in the past have inundated them. However historical lake level data suggests that the lake today is on average a little lower than it has been naturally (status quo/current median is 279.121m RL vs 1906-1946 median of 279.127m RL and 1906-1981 median level of 279.159m RL). Another theory is that because the lake level has been artificially maintained within a narrow range since 1996, the beaches are not seasonally inundated during higher levels or exposed at lower levels as much as they would have been in the past, allowing vegetation to encroach and to cover sandy beach areas. It also appears that there may have been some reclamation or encroachment of beaches by some landowners which could add to the impression that the beaches have been inundated.

To ascertain the true reason for beach losses, there have been investigations to locate and use old photographs to validate anecdotal recollection. Initial analysis of some photos indicates that beaches may have been wider due more to a greater range of water level fluctuation than lower lake levels (refer to Gisborne Point aerial photographs 1974/2006 in **Appendix 5**).

Structures

There are approximately 480 consented structures (slipways, ramps, jetties and boat sheds) around Lakes Rotoiti and Rotorua, and an estimated 140 additional structures that are not consented, summarised in Table 4 below.

Table 4: Summary of Consented Structures around Lakes Rotorua and Rotoiti.

Lake	Type of structure	Number consented
Rotorua	Boat Ramp	16
Rotoiti	Boat Ramp	28
Rotorua	Boat Shed	3
Rotoiti	Boat Shed	69
Rotorua	Jetty	79
Rotoiti	Jetty	270
Rotorua	Slipway	4
Rotoiti	Slipway	10

Refer to map – Lake Rotoiti lake structure consents - in **Appendix 6** showing the general location and density of these structures around Lake Rotoiti and where they are concentrated and a physical depth survey data base of 270 jetties completed in April/May 2010 **(Appendix 17).** Note that there are numerous structures (particularly jetties) adjacent to private properties on the southern and western and north-western shores of Lake Rotoiti.

Many of the existing private jetties, boatsheds and other structures were built 40 to 60 years ago when lake levels were dictated by the seasonal rainfall patterns. Lake levels were variable with an approximate 400-500mm range. Structure owners in the pre Okere Gates era accommodated this natural variation and accepted that in some years or at some critical times of low or high lake level, their structures were either not usable or there were limitations to their use (for example only one boat could tie alongside a jetty due to shallow depth rather than two or three boats which could tie up at other times of the year).

Since 1996 the existing consent conditions have lead to a narrow operating range and a very stable lake level. This has resulted in some larger private and commercial vessels being stationed on or seasonally brought to the lake. It is accepted that adjacent landowners and structure owners have an expectation of this strict operating range being maintained in line with the existing resource consent definitions. Furthermore some adjacent landowners/structure owners have maintained or modified existing or built new structures on the basis of the post 1996 lake level regime. Existing structure consent holders have an expectation that their jetties, boatsheds and ramps are available and effective 365 days a year.

TALT and LINZ have a formal relationship and a joint process for considering applications to erect new structures, modify existing structures, or attach a structure in or on a Te Arawa lakebed. New commercial activities also require the written consent of TALT and LINZ.

3.1.4 Kaituna River

Recreational Use and Tourism including Rafting

White water rafting and kayaking on the upper Kaituna River is world renowned. The Kaituna Cascades and falls are considered to be one of the region's top adventure attractions.

While seven commercial operators are active, there are many freelance kayakers who enjoy the Tutea Falls. The Tutea Falls, part of the Kaituna Cascades, downstream of the Okere Gates are a "Grade 5" falls, and are the highest commercially rafted waterfall in the world with a 7m drop.

Many visitors enjoy the walkways beside the upper river and falls which provides opportunity to view the river and rafters.

The rafters are reliant upon the discharge of Lake Rotoiti from Okere Arm through the Okere Gates. Flows between 13.6m³/s and 26m³/s are required to be able to operate safely. Rivers and Drainage Group has managed river flow to recognise the operational needs of this sector while not compromising the lake level targets under the resource consent.

Further downstream some commercial and private jet boat operations exist.

3.2 Lake Navigation

3.2.1 General

BOPRC has responsibility for navigation on the lakes, and provides a number of services. These include provision and maintenance of navigational structures, marker buoys and

moorings, Harbour Wardens and enforcement of various international boating regulations, NZ Maritime rules and BOPRC bylaws. BOPRC also provides lakes advice and information on navigation and safety matters related to boating.

Various vessels use both lakes, including a range of recreational motor boats, jet skis, kayaks, and small sailing vessels including the BOP Trailer yacht squadron (120 vessels based out of Okawa Bay) and historic wooden boats/motor launches. Lake Rotorua is also utilised by the 'Lakeland Queen', along with the Rotorua Duck Tours WWII landing craft. Lake Rotoiti is used by a 16m commercial catamaran (draught of 2m) with a 14m mast out of Okawa Bay. Boats with limited draught and width can ply between Lake Rotorua and Lake Rotoiti via the Ohau Channel.

The various boats generally draw between 250mm and 400mm (powerboats – the majority of vessels on the lake), 750-900mm for approx 30-40 larger launches (a number having arrived at the lake post 1996) and 1.2m or more for a small number of keeled vessels.

3.2.2 Lake Rotorua

The lake is relatively shallow, notably with a shelf of just 1m depth, which extends up to 600m out into the lake in some places. Commercial boat operators sometimes struggle to avoid grounding in dry summer low lake level conditions and have requested (via the consultation process) a narrower summer operating range.

3.2.3 Lake Rotoiti including the Ohau Channel

Historically shallow draughted vessels (including a number of the historic wooden motor launches) were common on Lake Rotoiti. The controlled and defined lake range introduced in the 1996 resource consent conditions has enabled larger vessels with deeper draught to operate on the lake.

Some current areas of boating interest in Lake Rotoiti, for navigational purposes are shown in Table 5 below (all depths are approximate).

Table 5: Current Approximate Water Depths in areas of known marginal navigation Lake Rotoiti at Status Quo target depth (279.116m RL).

Area, Feature or Hazard	Current Approximate depth (m)
End of the Ohau Diversion Wall	0.76
Te Akau Bay – Between Motuohiwa Island and Te Akau Point	Uniformly Shallow
Ohau Delta – in some places has grass growing on it.	Varies – but very shallow – less than 300mm at times
Te Akau Bay Marina	0.76
The Okere Arm – Jetties	1.20
Reef at 'Cemetery Point'	0.46
Te Weta Bay – Rocks in the channel, not clear how far they extend	0.91
Otaramarae – many boatsheds	0.91
Cherry Bay Ski lane – very stony	0.30
Okawa Bay entrance	Varies – but very shallow at times
Power lines at 'narrows'	Gap between water surface & power lines
Ohau channel shallow in places at the outside of the 'first bend'.	As little as 0.30
Tumoana Point – Tumoana Road	0.30

The Ohau Channel can currently be navigated by 7m vessels, drawing up to 600mm, so long as they can negotiate the shallow delta and stay in the boating channel, but is not suitable for keeled vessels.

3.3 Tangata Whenua Context and Cultural Values

3.3.1 Context

The context for Maori, for mana whenua and tangata whenua of Lake Rotoiti, Okere Arm, and the Ohau Channel is embraced in the following words '*Te Rotoiti i kitea an Ihenga te moana*", which means "*the precious small lake sighted and claimed by Ihenga".*

The naming of the lake is credited to the Maori explorer Ihenga, who is also said to have discovered Lake Rotorua. Legend says that the lake was named as such because when Ihenga first saw it, he was only able to see a small part of it and so thought the lake was smaller than it actually is.

Te Arawa Lakes Trust (TALT) was established under the Te Arawa Lakes Settlement Act 2006 and Deed of Settlement 2004. TALT receives and manages assets on behalf of and for the benefit of the present and future generations of Te Arawa having regard for their traditional, historical, spiritual and cultural relationship with Te Arawa Lakes and acknowledging their customary values and practices.

With the leadership of Te Arawa Lakes Trust governance to coordinate meetings with the key representatives, the following groups were identified as having a key interest in the application for new resource consents for the Okere Gates and Ohau Channel Weir structures:

(i) Te Arawa

(ii) Ngati Pikiao

(iii) Ngati Hinerangi

(iv) Ngati Takinga

(v) Te Runanga o Ngati Pikiao

(vi) Te Pae Tawhiti a Ngati Pikao

(vii) Ngati Pikiao Affiliate Iwi Trust

(viii) Te Arawa Standing Committee

(ix) Taheke Marae Trust

(x) Te Takinga Marae Trust

Te Arawa have a very special relationship with the Te Arawa lakes. They view the lakes as a taonga that has been handed down to them by their ancestor and as kaitiaki. Te Arawa have a strong cultural, spiritual and traditional connection to the lakes. The lakes' existence is a major life force for Te Arawa and the history of the lakes is deeply entrenched in their genealogy. Maintaining the health of the lakes has a key link to maintaining the health of Te Arawa whanau, hapu and iwi.

Te Arawa lakes are also an economic source for the local tangata whenua. Te Arawa have utilised the beauty and uniqueness of the lakes for tourism and the economic growth of their people. The degradation of the health of the lakes in more recent years has meant that Te Arawa's ability to promote the lakes as an unspoiled, natural environment has become increasingly difficult.

As such, the use of the Mauri Model (refer Section 5.4 for an explanation of the model and how it has been used in this project) is considered an important tool by Te Arawa to assist Te Arawa people analyse and assess the relative importance of particular indicators of the four well beings, especially cultural well being.

Interest in Lake Rotorua and Lake Rotoiti stretches across a wide landscape, and includes tangata whenua who reside on the Lower Kaituna and Maketu Estuary. Their interest primarily results from concerns that any changes to the operation of the lakes may cause degradation to the water quality of the Kaituna River and Maketu Estuary. These groups have been identified as:

- Tapuika Iwi
- Ngati Whakaue ki Maketu.

Other tangata whenua identified to consult with are:

- Ngati Parua
- Waitaha.

Other mandated representatives to be kept informed are

- Te Arawa Lakes Trust
- Te Runanga o Ngati Whakaue ki Maketu
- Tapuika Resource Management Group
- Waitaha Resource Management Group.

3.3.2 Cultural Values

There is a need for tangata whenua to protect the mauri of their lakes. Mauri can be defined as 'the binding force between the physical and the spiritual, and it is the basis of kaitiakitanga as this is the ethic of working to enhance the mauri of all things'. Mauri can be used as a measure of sustainability for:

- spiritual connection
- life force
- rangatiratanga
- kaitiakitanga
- mana
- customary rights
- ownership
- resource management.

These are key values to tangata whenua. Understanding them will assist in understanding the tangata whenua world view, connection, relationship and perspective of mauri.

The hui to date with Te Arawa and Ngati Pikiao have identified a number of cultural values associated with the Lakes and the Ohau Channel, including:

- The presence of beaches - For Ngati Pikiao, some beaches have been a traditional pathway and Dr Morgan has sought approximately 3m wide beaches at nine key Lake Rotoiti locations.
- The health and wellbeing of the Lakes.
- Environmental sustainability.

- Source of food - there is also a history of cultural-mahinga kai/recreational fishing (seeking traditional seasonal food sources that were commonly served at local marae in the past) by Ngati Pikiao, with a long established smelt ('inanga') fishery. Ngati Pikiao also fish for Koura (fresh water cray) and collect Kakahi (fresh water mussels).

- Access to waahi tapu sites along the Kaituna River and margins of Lake Rotoiti.

3.4 Archaeology

Opus's archaeologist prepared a report investigating the archaeological issues associated with this proposal in November 2009. This report was subsequently updated in September 2010. A copy of the report can be found in **Appendix 7.**

The report has not investigated the existing recorded archaeological sites around Lake Rotorua, as this proposal is to not change the operating levels for Lake Rotorua.

The report finds that there are at least thirty-nine recorded archaeological sites around the immediate periphery of Lake Rotoiti. These recorded archaeological sites are predominantly pa, which are located on high spots overlooking Lake Rotoiti. Refer **Figure 6** for location of recorded archaeological sites around Lake Rotoiti.

Figure 6: Location of recorded archaeological sites around Lake Rotoiti. Each star symbol represents a recorded archaeological site. Image captured from ArcSite on the 23rd November 2009

Given the intensive occupation around Lake Rotoiti, activities such as fishing and fowling will have taken place. There is the potential that some structures and artefacts associated with these events are currently underwater.

3.5 Property Ownership

Refer to Section 2.2.2 for a discussion of the ownership of the lake beds and the beds beneath the two structures.

The appended "Lake Rotoiti – Map of Land Ownership Types", **Appendix 8** provides an outline of Maori land, Maori reserves, public reserves (primarily RDC), Department of Conservation (DOC) reserves and freehold land associated with Lake Rotoiti. Maori land parcels are dominant immediately north and northwest of Lake Rotoiti and to the south and south east of the lake especially east of Ruato Bay. It is estimated that approx 50% of the lake margin directly adjoins Maori land. DOC reserves include the Okere Falls Scenic Reserve, Hinehopu (Hongi's Track) Scenic Reserve and Lake Rotoiti Scenic Reserve around parts of the lake margin.

3.5.1 Jetty, boatshed and boat ramps

Consented structures are owned by the consent holder, unconsented structures are owned by the Crown, until such time as the occupier obtains consent. Associated air space and water column are owned by the Crown (administered by LINZ) and the Lake beds are owned by TALT (Refer to map – Lake Rotoiti lake structure consents in **Appendix 6**).

3.6 Local Stormwater Drainage and Utility Services

3.6.1 Lake Rotorua

The city of Rotorua's stormwater is collected, reticulated and discharged either indirectly or directly to the Lake. Sewage from the City of Rotorua and settlements around Rotorua is reticulated to a central plant for treatment. Treated waste water is spray irrigated in Whakarewarewa Forest to the south of the city.

There have been some residential developments in recent years on the western shores of Lake Rotorua at Ngongataha, at the south west of the lake in the suburb of Koutu and in the south east at Hannahs Bay, that have been impacted by lake level related drainage issues. These areas are low lying and frequently experience flooding (by elevated groundwater and/or stormwater) of sewage pump stations. Several of these areas are below extreme high lake levels (100 year levels), and some areas which have been developed are identified as hazards for flooding. A few areas experience flooding of sections in 20 year events and can experience localised flooding as frequently as every three to four months e.g. Preston Road and Waikuta Road, Ngongataha.

The currently consented mean (target) operating level for Lake Rotorua is RL 279.805m. When the lake is near the top of its operating range (consented maximum of RL 280.11m) there are recognised drainage issues in lower lying lake margin areas due to elevated groundwater. The village of Mourea at the north eastern margin of the lake is a case in point.

A paper by RH Wilson (1972) clearly illustrates and flooding has long been an issue for communities around Lake Rotorua.

On the basis of stormwater and drainage issues becoming more prevalent at lake levels near or certainly beyond the consented maximum of RL 280.11m, there is a good case for not increasing the Lake level for Rotorua.

RDC would not favour an increase in the current maximum level of Lake Rotorua because of the negative impact on stormwater and drainage.

That said, an increase in the level of Lake Rotorua by say 100mm would not compromise the design flood levels of the Upper Kaituna Catchment Scheme streams that flow into Lake Rotorua i.e. current maximum lake level is below the average design service levels (typically 100 year level) at stream mouths being maintained by the scheme (e.g. Utuhina, Ngongotahā, Waititi, Puarenga etc) (West, 2009).

3.6.2 Lake Rotoiti

Lake settlement properties generally discharge stormwater to ground soakage or to water courses and thereafter to the lake. Several lakeside settlements have a portion of their stormwater collected into stormwater systems and discharged to the Lake.

In some areas septic tanks are still used to currently treat household effluent on site. RDC are planning staged reticulation of sewage/waste water for the Lake Rotoiti communities currently relying on septic tanks. Any septic tank sewage issues are therefore only relevant until the installation of reticulation. This is still in the planning stages for many areas, and not scheduled to be completed until 2012.

Higher lake water levels at Hinehopu at the eastern end of the lake may possibly slow or stop stormwater draining in that area. Stormwater can be temporarily retained in drains by the combination of higher water levels and wave action (due to substantial fetch) experienced at this end of the lake. According to discussions with staff from RDC, the current operating maximum level causes no real long term damage or issue for roading or drainage systems abutting the Lake. Peter Dine (Engineer) of the RDC supports a more natural lake level range, between the current consented maximum and minimum limits (refer BOPRC Meeting Minutes, 7 May 2010 in **Appendix 13** of this AEE).

During consultation meetings, residents of the Hinehopu area have advised that stormwater is '*held up'* by high water in the lake causing localised flooding. The NZ Transport Agency (NZTA) confirm *"that we have not had any highway pavement faults or failures as a direct result of current Lake Rotoiti levels. Indeed, we may have problems if the control gate or its operating regime changed - and lake levels rose. The only issue is the lake level can make discharge of under highway culverts problematic in the Hinehopu area, lake levels sometimes being the same as ground water levels on the other side of the road. However, this has not caused the highway a problem, rather complaints are received from upstream owners who feel the highway is responsible for holding water back*" (from email message from Kevin Thompson, Highway and Road Safety Manager, RDC, to Robbin Britton – contract engineer to BOPRC).

The golf course owners at Hinehopu are of the opinion that high lake levels cause drainage issues on the 7th and 8th holes in particular nearest the lake. It should be noted that the golf course borders a wetland at the boundary near Tamatea Street. It has been noted by a long time Hinehopu bach owner that the 7th and 8th holes were swampy in the early 1990's when the course was developed. A further factor to be noted is the Institute of Geological

and Nuclear Sciences (GNS) and BOPRC data which indicates that the area at the eastern end of Lake Rotoiti is geologically unique. GNS observations suggest that the lava tongue upon which the locality sits, is tilting and sinking. The provisional results of the Region Wide Bench Mark Survey (using the Rotorua Fundamental BM as origin) show that the local Hinehopu benchmark, namely AC 71/1 has settled approximately 101mm since 1953 relative to the Rotorua Fundamental BM (refer also Section 2.1). This lower level also affects a number of private baches and residences, which currently experience drainage issues (both stormwater and septic tank field efficiency). At a hui held with representatives from Ngati Pikiao in October 2009, they recognised that there may be health impacts arising from these drainage issues. Unfortunately the requirements of the Building Act cannot currently be met by a number of Hinehopu (Tamatea Street) baches/residences due to drainage/soakage and surface flooding problems even at current lake levels (refer BOPRC Meeting Minutes to CEO's of RDC, BOPRC and TALT on 7 May 2010 in **Appendix 13** of this AEE).

Ruato Bay is another area sometimes affected by the combination of high lake levels, high stormwater flows and wave action which can impede culvert flows under the state highway.

Drainage issues have also been raised by Ngati Pikiao in and around the Ohau Channel – particularly adjacent to the Te Takinga Marae where residents contend the Channel water levels are elevated by up to 500mm compared to historic levels. Residents also point out that local drainage to the Channel is impeded by the elevated Ohau Channel waters (refer TALT Hui Meeting Minutes on 9 October 2010 in Appendix 13 of this AEE).

Rivers and Drainage Group recently carried out a survey of the Ohau Channel in June 2010 and compared results with previous surveys carried out in 1980, 1988, 2002 and 2009. The purpose of the survey was to determine whether sedimentation was occurring in the channel and thus responsible for rising water levels. In the period 1980 to 2002, some cross-sections showed definite reduction in area which suggests sedimentation had occurred over that period (Barnett and MacMurray (2005) determined that the aggradation had occurred in the 1980–1988 inter-survey period and degradation in the 1988-2002 inter-survey period but overall there had been a net aggradational trend over the 1980-2002 period). However between the 2002 and 2009 surveys very little change in channel cross-sectional area appeared to have occurred. The most recent cross section survey of the Ohau Channel was carried out after the trial flushing from 14-20 June 2010. Comparison of the 2009 and 2010 channel cross-sections shows that:

- A net aggradation had occurred upstream of the Te Kouru Wetland.
- A net degradation had occurred along the meandering channel through the wetland.

However the aggradational and degradational changes were very small relative to those that occurred in the 1980-2002 period. Rivers and Drainage Group are undertaking a thorough analysis to determine the actual quantitative aggradation and degradation volumes over the 1980-2010 period.

The most recent cross section survey data suggests either that an annual flush may not be sufficient to move sediment and degrade the bed to mitigate the potential flood risk or that it needs to be much longer than the recent seven day flush in June 2010 to be effective. Dredging is an alternative option to maintain (or increase) the channel capacity.

The survey showed that the Ohau channel can be flushed and water levels in the channel reduced evenly along its length, except at the Ohau Weir structure. During flushing algae fragments were observed floating downstream in the channel, and in the Okere arm. The flush test confirmed that it is possible to lower lake levels during autumn, as modelled in the Proposed Option (D7) model.

Historic pre gates information supports the assertion that elevated lake levels impact on drainage (RH Wilson 1972). From this information, and lake level records we know that lake levels have periodically been higher in the past, and caused flooding at that time.

3.7 Catchment Description, Hydrology and Hydraulic Behaviour of Lakes System

3.7.1 Physical Environment

Lakes Rotorua and Rotoiti are the largest (~81km^2) and third largest (~35km^2) of twelve major lakes in the Rotorua region, collectively known as the Rotorua Lakes (refer to map in **Appendix 9**). Both lakes are of volcanic origin and were formed thousands of years ago. They are the only two lakes draining directly into the Kaituna River.

The Kaituna River flows northwards from the Lake Rotoiti outlet over a distance of about 50 km. It meanders through the Western Bay of Plenty and out to the sea at Maketu. The natural outlet for the river is Maketu Estuary, however in 1957 the river was diverted through the Te Tumu Cut directly out to sea. Upstream of Okere Falls its catchment size is 634km^2. Downstream of Okere Falls the river drops 260m as it passes through a deep gorge, where springs (groundwater) add to the flow. Other rivers and streams join the Kaituna River downstream of Okere Falls, e.g. the Mangorewa River, the Parawhenuamea Stream, the Waiari Stream, the Ohineangaanga Stream, the Atuaroa Stream, the Raparapahoe Canal and the Kopuroa Canal, altogether adding an additional catchment area of approximately 320km^2 at Te Matai gauging station.

The catchments of Lakes Rotoiti and Rotorua are heavily populated, with extensive urban (Rotorua City) and recreational development along the lake shorelines.

Lake Rotorua was formed about 140,000 years ago. It is a relatively shallow lake with a maximum depth of 45m and a mean depth of 11m. The catchment area covers 508km^2. The lake is 11.2km across from north to south and 9.6km from east to west. The catchment is predominantly pasture (52%), with indigenous forest/scrub (25%), exotic forest (14%), urban (8%) and less than 1% wetlands (Beca, 2005).

Lake Rotorua's water level is controlled, to a limited degree, by the Ohau Channel weir. The weir initially maintained by the Catchment Board from 1974 and finally altered and completed as a permanent structure in September 1989, is located directly at the outflow of Lake Rotorua into the Ohau Channel (Refer to **Figure 7**). The predominant control on lake outflows is the hydraulic capacity of the Ohau Channel itself.

Figure 7: Boat passing the central section of the Ohau Channel Weir (photo taken on 26.9.2009).

The Ohau Channel meanders from Lake Rotorua into Lake Rotoiti in a north-easterly direction north of Mourea township (**Figure 8**). The channel is a natural watercourse with surrounding wetland and is about 1.5km in length.

Figure 8: Aerial view of the Ohau Channel (© GoogleEarth, 2009).

Lake Rotoiti is located east of Lake Rotorua. Lake Rotorua itself provides inflow to Lake Rotoiti through the Ohau Channel of about 17m^3/s on average.

Lake Rotoiti lies within the Haroharo caldera and was formed following an eruption about 8,500 years ago. The Lake is dammed by lava from that eruption. The Lake occupies two distinct basins, the deep Central Basin and the shallower Western Basin. The maximum

depth of the lake is 93.5m with a mean depth of 31m. The lake is about 15km long and up to 3.5km wide.

The catchment of Lake Rotoiti is about 124.6km^2 with 44% in indigenous forest/scrub, 30% in exotic forest, 24% in pasture and 1% urban. Less than one percent of the catchment is covered in wetland (Beca, 2005).

The outflow of Lake Rotoiti is the Kaituna River which commences at the northwest end of Lake Rotoiti downstream of the Okere Gates structure, situated at the end of the so-called Okere Arm/Channel (**Figure 9**).

Figure 9: Aerial view of the Okere Arm / Channel (© GoogleEarth, 2009).

The Okere Gates structure is located in the Okere Falls township next to SH33 (**Figure 9**). With this structure, the Rivers and Drainage Group controls the lake level of Lake Rotoiti and the outflow, i.e. rate of discharge, from Lake Rotoiti into the Kaituna River. The structure consists of three 6.7m wide radial gates (**Figure 10**). The bottom sill sits at RL 277.55m and the road/operation deck at RL 280.75m.

Figure 10: Okere control structure's three radial gates (photo taken on 26.9.2009).

3.7.2 Lakes Hydrology

In principle Lakes Rotorua and Rotoiti effectively behave as two giant interconnected bath tubs with the lake levels rising and falling depending on the balance of inflows and outflows. Lake levels rise when the net volume of inflows exceeds the volume of outflows (as determined by the hydraulic capacity of the outlet channels in each case) and vice-versa.

Lake Rotorua is fed by a number of spring-fed streams, which maintain a relatively constant inflow to the lake. The Lake responds to rainfall averages over a period of weeks to months either above or below a long-term mean. The Lake level has been measured since 1934. In high rainfall years, e.g. 1938, 1954, 1956, 1962, 1971 and 1998 lake levels reach high levels, whereas in extremely dry years very low levels occur. There is a natural annual fluctuation of between 500 and 600mm. **Figure 11** shows the mean monthly lake levels for Lake Rotorua from 1934 to 2002 (Beca, 2005).

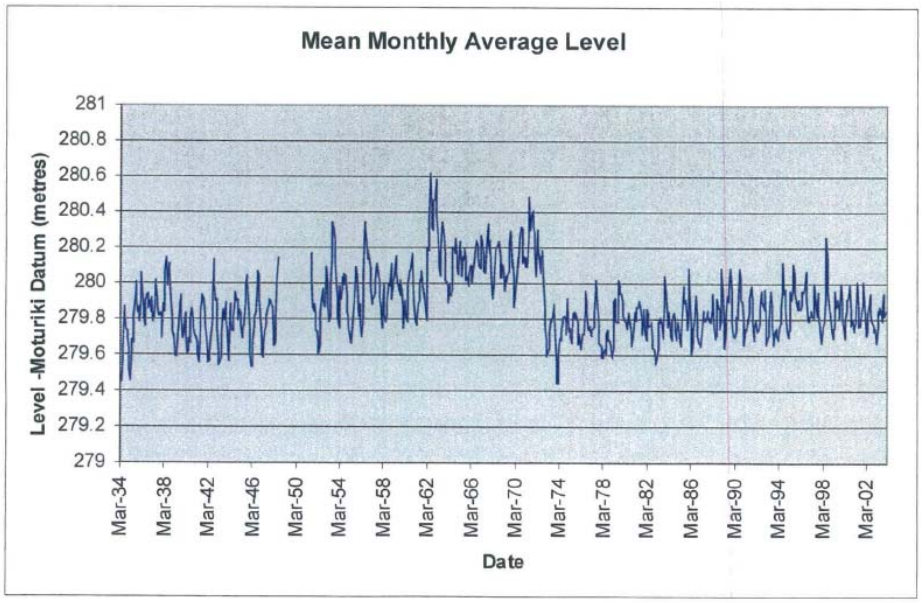

Figure 11: Mean monthly level of Lake Rotorua (Beca, 2005)

The discharge into the Ohau Channel is controlled by the lake level in Lake Rotorua and the hydraulic capacity of the channel itself. The Ohau Channel was dredged in 1972 in response to very high Lake Rotorua levels in the 1960's and early 1970's resulting from the prior extremely wet period of some 15 to 20 years. The dredging resulted in an immediate reduction in the average of Lake Rotorua of some 400mm (**Figure 11**). Following the dredging, the opposite problem of low lake levels occurred partly due to climate variations.

The permanent Ohau Channel weir was built in 1989. The structure controls flows during low lake levels, but does not influence high lake levels, as high flows are still controlled by the hydraulic capacity of the channel. The structure limits how far lake levels can fall below median levels, thus preventing the lake reaching extreme lows. Since installation, the Rotorua Lake has remained within the control range (min. level = RL 279.50m; max. level = RL 280.11m) except for an extreme high in 1998.

The water balance (incl. lake level) of Lake Rotoiti is governed by:

- precipitation (rainfall) on the Lake
- evapotranspiration
- inflow from Lake Rotorua via the Ohau Channel
- local catchment inflows (e.g. streams)
- groundwater inflow.

Spigel (1989) identified "*the transport of Lake Rotorua water to Lake Rotoiti during storms is negligible … and lake level rises during storms are a response more to rainfall on the lake than to inflows from Lake Rotorua. The residual term in the water balance reflects groundwater input, resulting in a net westward flow through the lake. In the absence of density currents this flow reinforces the tendency of Lake Rotorua water to short-circuit (i.e.*

to flow directly to the outlet of Lake Rotoiti without mixing with the main body of the lake) because of the proximity of the lake inlet and outlet at the western end of the lake."

Lake Rotoiti's water levels have been continuously gauged at the lake outlet into the Kaituna River since 1906. **Figure 12** illustrates the lake level record from 1906 to 2007 and the 12 month moving average.

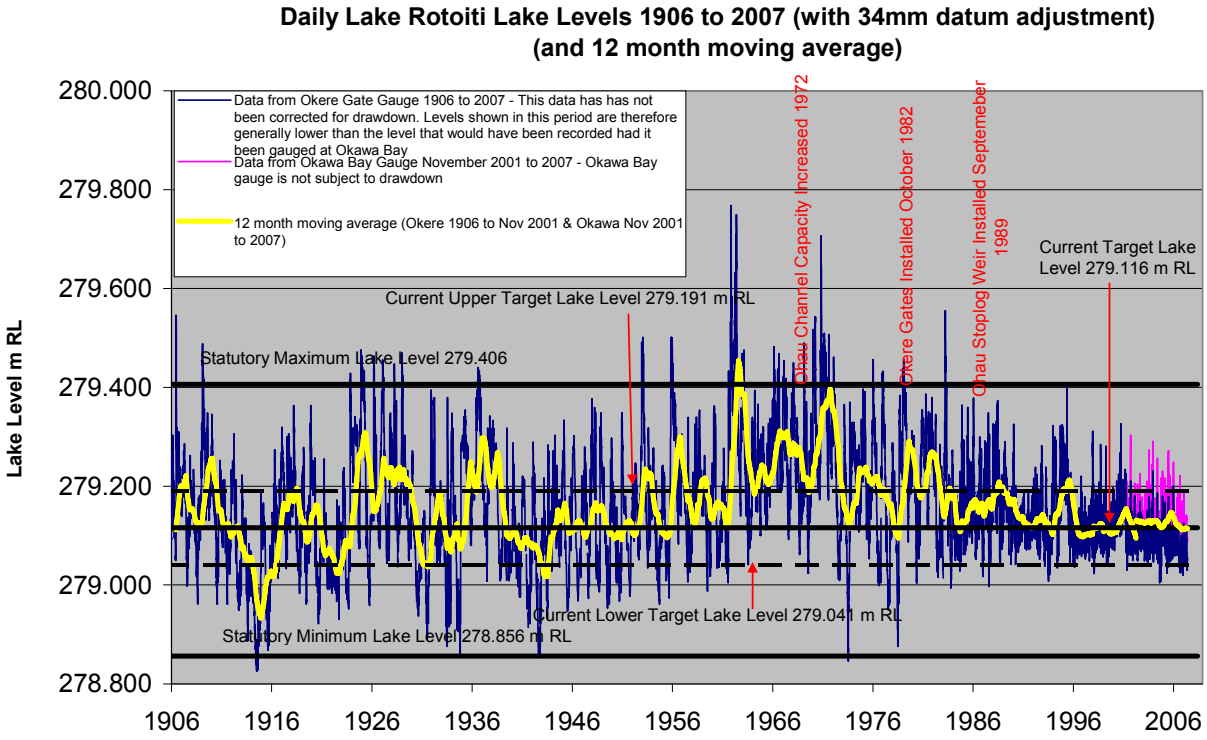

Figure 12 Lake Rotoiti level hydrograph since 1906 showing data adjustments made.

Prior to 1972 the water level in Lake Rotoiti was uncontrolled. The level was high during years of high precipitation and natural inflows and low during years of relative drought. This situation was changed in 1972 with the installation of a limited degree of control on the outflow from Lake Rotorua (preliminary Ohau Channel weir) primarily under low flow conditions and further in 1982 with completion of the control structure on the outflow of Lake Rotoiti at Okere Falls (Okere Gates).

Comparison of the mean daily lake levels for the twenty years pre and post control indicate that there has been a noticeable change in regime (**Figure 12**). The conspicuous feature is the reduction in variability over month/year/decade timescales in recent years.

It is also perceptible that from 1982 to 1997 the Okere Gates were operated with a comparatively wide operating regime (**Figure 13**). Early 1998 the operating regime was narrowed down to a target level of RL 279.116m above Moturiki Datum ± 75mm (BOPRC, 2005) (**Figure 14**).

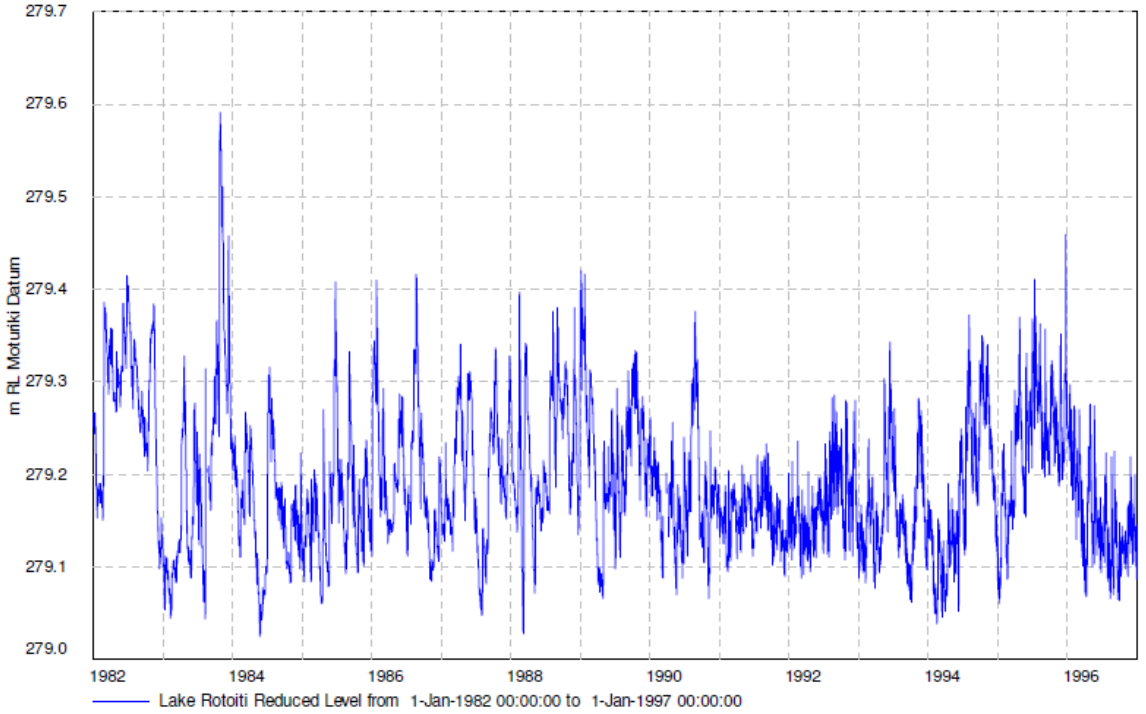

Figure 13: Lake Rotoiti daily level record 1982 to 1997.

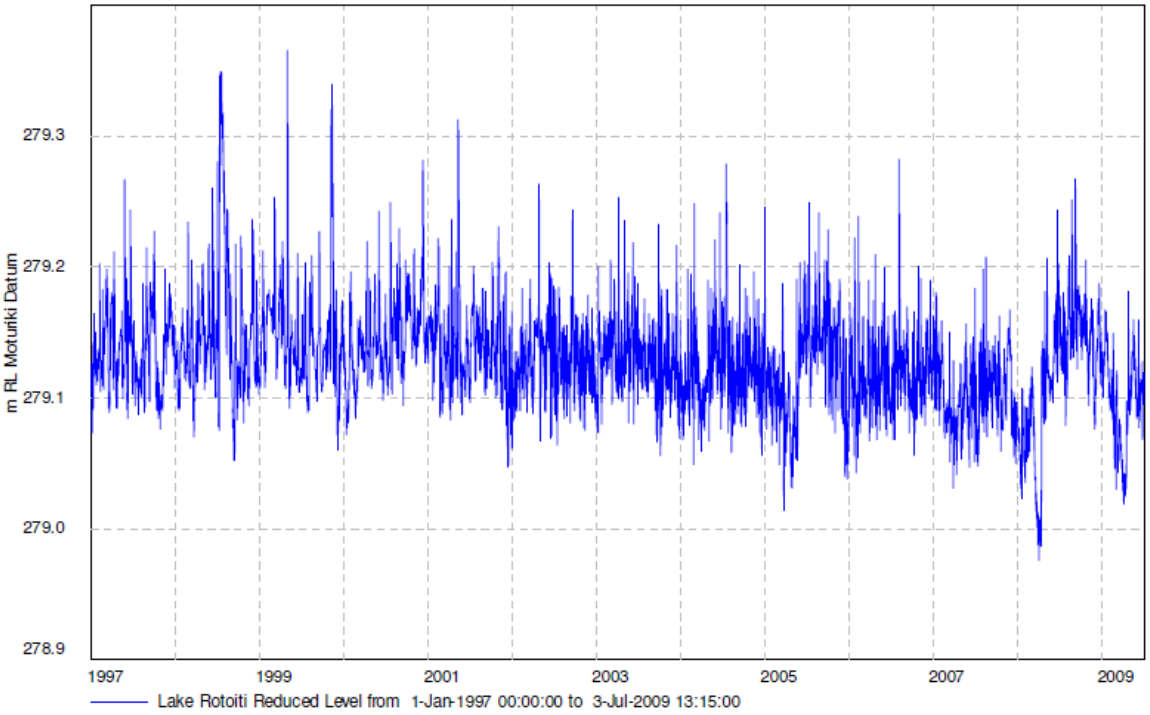

Figure 14: Lake Rotoiti daily level record 1997 to 2009.

Long term patterns of average level and variance about this level (**Figure 12**), and evaluation of variation in water levels (**Figure 15**) show this control effect more clearly, and indicate how management has largely succeeded in attaining the target level of RL 279.116m ± 75mm measured by BOPRC's latest lake level recorder at Okawa Bay Marina. **Figure 12** also indicates how the uncontrolled level of Lake Rotoiti varied over short and long time scales. There was a period of near decadal cycles in the early part of the 20th Century, followed by gradually accumulating water level from 1945 to 1965 and sustained high levels in the 60's and early 70's (following a period of heavy rainfall). The current level has stabilised just below the average pre-1950 median level (RL 279.17m), but this is towards the low end of the range seen in the decade prior to regulation.

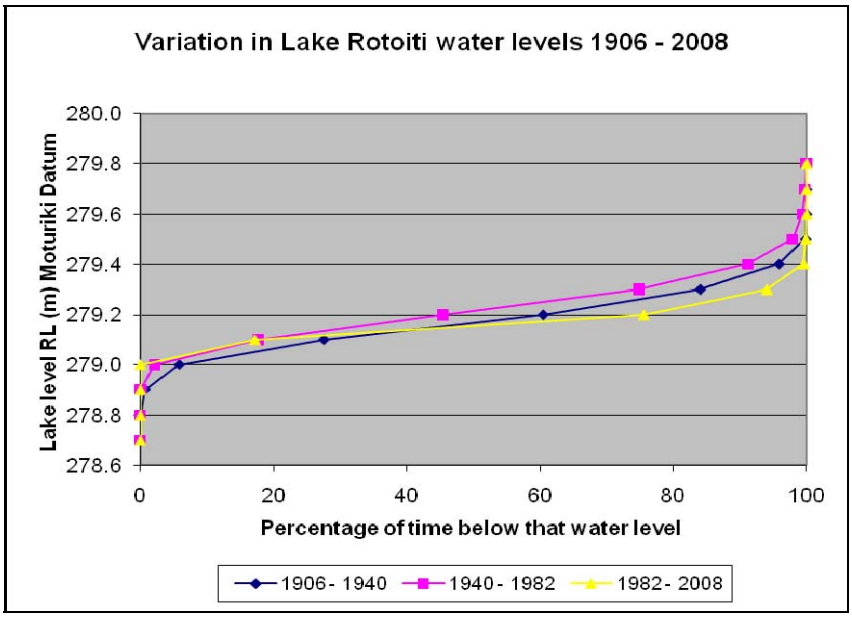

Figure 15: Variation in Lake Rotoiti levels 1906 to 2008.

In summary, prior to outflow control, water level changes of 20-50cm range occurred between years in Lake Rotoiti, sometimes as part of near decadal cycles and sometimes as a steady directional change, and a seasonal pattern of approximately 20cm average range was overlaid on these long term fluctuations. These patterns have disappeared since regulation. The short term (within month) variability of 5-10cm is, however, only slightly less than that that seen without regulation, (NIWA, 2003).

3.7.3 Kaituna River Hydrology

The Kaituna River drains Lakes Rotorua and Rotoiti with little additional tributary inflow through the Kaituna Gorge downstream. Below the gorge, the lower river has one major tributary, the Mangorewa River, and several other smaller tributaries, the Parawhenuamea, Waiari, Ohineangaanga and Raparapahoe Streams, and the Kopuroa Canal.

Lakes Rotorua and Rotoiti act in series to significantly suppress flood flows through the Kaituna Gorge due to their retention effect. As a consequence the range of monthly average outflows for Lake Rotoiti since lake control was first implemented in 1982 is relatively low, varying from 14-31m^3/s for a typical average year (1991), from 20-35m^3/s for a typical wet year (1996), and from 12-25m^3/s for a typical dry year (1993). The suppression of flood flows by Lakes Rotorua and Rotoiti means that the normal (low) flow

hydrology of the Lower Kaituna River is dominated by the flow contribution of these lakes. The contribution of the primary downstream tributary, the Mangorewa River, and other smaller tributaries under normal flow conditions is only a small fraction of that sourced from the two lakes.

In contrast, the flood hydrology of the Lower Kaituna River is dominated by the influence of the Mangorewa River and, to a lesser extent, the other smaller tributaries. The contribution of the outflow from the two lakes forms only a small fraction of the overall peak flood discharge in the lower river compared to the contribution from the Mangorewa and other smaller tributaries. For example, in the very large December 1995 flood, the flood peaked at the Te Matai gauging station (below the confluence of the Kaituna River with the Mangorewa River and just above the State Highway 2 bridge) on 24th December with a discharge of about 230m^3/s while the outflow from Lake Rotoiti (measured at the Taaheke gauging station) was still rising to a peak value of 46m^3/s late on 25th December. The peak flow recorded in the Mangorewa River for the same event was approximately 220m^3/s on 24th December.

Currently the Okere Gates controlling the outflow from Lake Rotoiti are operated to hold the lake level in a relatively narrow band. This is manifested in very distinct changes in lake outflow. The step changes in lake outflow transmit through the downstream gorge with no significant attenuation at all. They are reflected in sharp changes in level in the lower river which can be detected in measured water levels downstream.

Instream Minimum Flows as Identified in Regional Water and Land Plan (RWLP)

Method 179 of the Regional Water and Land Plan establishes how the Instream Minimum Flow for the Kaituna River is to be calculated, namely it is 90% of the Q_5 seven day low flow.

Information taken from BOPRC's EDS Report, 2005 for Taaheke Flow data, the seven day low flow (five yr return period) is 10.936m^3/sec.

Therefore, by applying Method 179 of the RWLP, the Instream Minimum Flow for the Kaituna River is 9.842m^3/sec.

The Rivers and Drainage Group assessed the number of days flow less than 9.842m^3/s for the proposed D7 option occurred, over the period 1 January 1998 to 31 December 2007. There were eight days out of 3621 days when flow through the Okere Gates dropped below 9.842m^3/sec (0.22% of the time). These periods were 11 and 18 February 1998 and then over six days in February 2003 (11, 15, 16, 19, 22 and 23rd). Rivers and Drainage Group concluded that low flows we rare and tended to happen during the summer. The number of days where flow for the Proposed Option is less than 9.842m^3/s based on a seven day rolling average, is zero.

In addition, comparison of low flows shown in Figure 28 indicate the Proposed Option (D7) does not cause any more extreme low flows than that produced under the status quo.

3.7.4 Hydraulic Aspects

Lake Rotorua outflows are controlled, to a limited degree, by the Ohau Channel weir. **Figure 16** illustrates the weir rating curves stated by Titchmarsh, 1995. The ratings are

maintained by NIWA who regularly gauge the flows at the site. In practice, the rating of the structure is influenced by a number of factors, including the sediment bar build-up between Lake Rotorua and weir, wind effects (wind setup) in Lake Rotorua, the geometry and frictional characteristics of the Ohau Channel, weed growth and sedimentation in the Ohau Channel, Lake Rotoiti water level and stop log installation/operation.

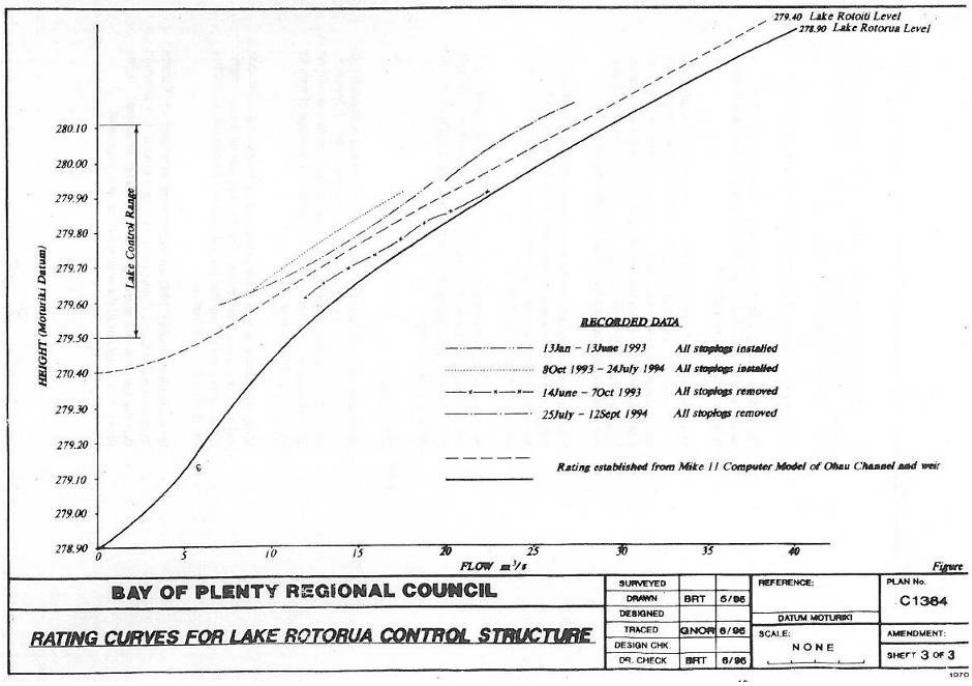

Figure 16: Ohau Channel weir rating curves (Titchmarsh, 1995).

The design discharges of the Ohau Channel weir are (Titchmarsh, 1995):

- Q_{100} = 45m^3/s
- Q_{200} = 48m^3/s
- Q_{1000} = 54m^3/s

The average flow in the Ohau Channel is approximately 17m^3/s, with a recorded high of 35m^3/s and lows around 12m^3/s (Beca, 2005).

In an effort to improve Lake Rotoiti water quality, a solid sheet pile diversion, the Ohau Diversion Wall, was completed in 2008, at an approximate cost of $10Million. The diversion wall begins on the southern end of the Ohau Channel and skirts the lakebed shelf at the delta, extending into the Okere Arm. It runs 75m offshore parallel to SH33 and extends to Te Akau Point (1275 metres). The location and design of this structure effectively diverts all of the Ohau Channel flow down the Okere Arm into the Kaituna River. The top level of the diversion wall is approximately RL279.55m which compares with the current target level of RL279.116m.

Before the Okere Gates were installed, a rock ledge at the lake outlet to the Okere Falls naturally set the minimum level and controlled the outflow from Lake Rotoiti. The Gates were put in place in 1982

- to allow increased outflows to limit the incidence of high lake levels in both lakes, and
- to allow reduced outflows to prevent undesirable low lake levels.

Since the commissioning of the Gates, the water level of Lake Rotoiti (**Figures 13 and 14**) and the downstream flows in the Kaituna River (refer Section 3.7.3) have been predominantly controlled by the structure. The current objective based on consents obtained in 1996 is to aim for a target lake level of RL 279.116m above Moturiki Datum and to remain within 75mm of this level as far as practicable. The consented levels range reaches from RL 278.856m to RL 279.406m, i.e. 550mm.

In order to maintain the aforementioned lake level range, the openings of the three gates are reviewed daily and adjusted as needed, to either increase or reduce the lake outflow and therewith balance the lake inflows. The lake outflow, i.e. discharge in the Kaituna River, has been measured at Taaheke gauging station (NIWA's recording site no. 1114609) downstream of the Okere Gates since 21st October 1981 (**Figure 17**).

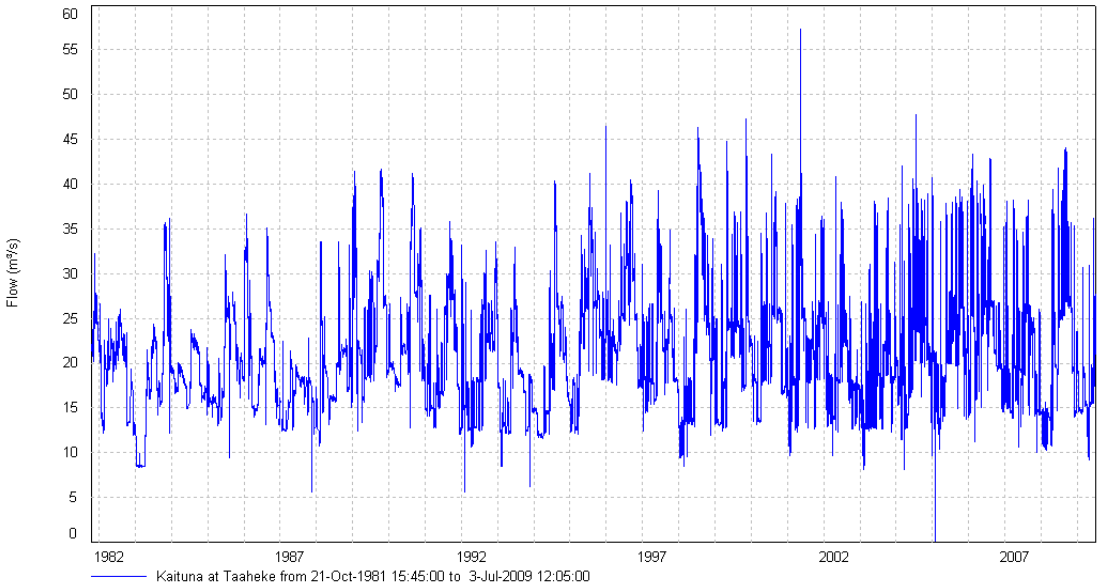

Figure 17: Kaituna River @ Taaheke daily flow record (1981 to present).

Besides the Okere Gates structure, a recent review of some computational hydraulic modelling of the lake system has identified that the frictional characteristics of the Okere Arm/Channel up and downstream of the Okere Gates also plays a significant part in controlling the lake outflows, particularly in high flows (Opus, 2009). This is demonstrated by the fact that the control gates operate in a partially drowned mode as opposed to a free discharge mode (i.e. water levels downstream of the gates are above the bottom lip of the gate). A narrow channel section downstream of the gate structure chokes the river flow, creating a backwater effect and increasing the tailwater level at the gate structure, causing a partially drowned gate outflow (**Figure 10**) and thereby reducing the hydraulic capacity of the Okere Gates.

3.7.5 Wave Climate

Both Lake Rotorua and Lake Rotoiti are exposed to wind-generated waves.

Lake Rotorua is exposed to wind-generated waves from the southwest. These wind-generated waves stir up lake bed sediment material in the vicinity of the entrance to the Ohau Channel. This is the primary mechanism for the transport of sediment past the outlet control weir into the Ohau Channel.

Lake Rotoiti is exposed to wind-generated waves from the east. Near the Ohau Channel the effective wind fetch is 2.7km while nearer the Okere Arm the fetch is reduced to 1.9km (Beca, 2005).

Wave heights have been estimated by Beca (2005) using hindcasting techniques with wind data from Rotorua airport. The data indicates that the predominant winds are from southwest and north-east, although the most extreme sustained winds (40 knots) were recorded from an easterly direction. Significant wave heights are shown in Table 6.

Table 6: Significant wave heights on Lake Rotoiti (Beca, 2005)

Location	Wind Fetch (km)	1 year return period		50 year return period	
		Wind (knots)	Hs (m)	Wind (knots)	Hs (m)
Ohau Channel	2.7	30	0.55	40	0.76
Okere Arm	1.9	32	0.50	42	0.70

During storm conditions, waves generated from the easterly quarter are dissipated on well-vegetated banks with little wave reflection. In extreme events some localised bank erosion can be expected.

Wakes generated from boats could have significant wave height of up to 0.4m and would also be dissipated on the existing lake banks (Beca, 2005).

3.7.6 Sedimentation Effects in the Ohau Channel

As mentioned above, the Ohau Channel carries the outflow from Lake Rotorua into Lake Rotoiti. The recent history of the Ohau Channel indicates a tendency to gradual aggradation, reducing the flow cross-sectional area and increasing the level of Lake Rotorua. Investigations and computational hydraulic modelling by Barnett & MacMurray (2005) identified the following.

- There is a wide shallow shelf with a bed of pumice and sand in Lake Rotorua, immediately west of the Ohau Channel weir. This shelf allows suspension of sand by wave action during south-westerly wind conditions, and is the main source of sediment input to the Ohau Channel.
- The sediment that forms the bed of the Ohau Channel is mostly sand, tending to be coarser at the upstream end.

- The sediment transported through the Ohau Channel is deposited on a small delta at the outlet into Lake Rotoiti.

- The Ohau Channel aggraded overall by about 4,900m^3 between 1980 and 2002. Aggradation of about 8,000m^3 between 1980 and 1988 was reduced by degradation of 3,000m^3 between 1988 and 2002. The main features of the change between 1980 and 2002 are degradation immediately downstream of the Lake Rotorua outlet, aggradation in the upper reach (extending to about the marae downstream of the SH bridge), and approximately equilibrium in the lower reach.

- The hydraulic modelling simulations showed that the diversion wall below the Ohau channel outlet in Lake Rotoiti will have little effect on the rate of sedimentation in the channel and on the delta. It also has minimal effect on the water levels in Lake Rotorua.

- Lake Rotoiti lakebed contours and the relatively small delta suggest that the Ohau Channel does not carry a large wash load of fine inorganic material, and indicates that the rate of deposition of wash load in the channel contained by the diversion wall will be relatively low.

- Measurements of the suspended sediment in the Ohau Channel showed that most of the suspended load is organic material. The lakebed sediment cores showed that organic material does not contribute significantly to sedimentation of Lake Rotoiti.

- In order to maintain Lake Rotorua levels within the desired range, dredging of the Ohau Channel may be necessary during the life of the diversion wall. However the wall will not significantly accelerate the sedimentation of the channel.

Due to recent high lake levels in Lakes Rotorua and Rotoiti, the Rivers and Drainage Group implemented a test flush of the Ohau Channel within the range of the current consent. This trial was agreed following discussions with Ngati Pikiao.

The stop logs on the Ohau Weir had previously been taken out on 26 May 2010. The Okere Gates were to be opened until Lake Rotoiti reached its lower target level. This weir and gate operating strategy maximised the outflow from Lake Rotorua into Lake Rotoiti through the Ohau Channel and the outflow from Lake Rotoiti into the Kaituna River through the Okere Gates. The bed shear stresses generated by the gradient on the water surface profile along the Ohau Channel appear to have mobilised and flushed some sediment material from the bed of the channel (refer Section 3.6) .

Preliminary analysis of the channel cross-section survey data by the BOPRC Rivers and Drainage Group (**refer to Appendix 4**) indicates that bed aggradational and degradational changes over the period from 2002 to 2010 have been minor relative to the changes that occurred over the period 1980 to 2002. Comparison of the surveyed cross-sections between 2009 and 2010 indicate that the short duration sediment flushing trial in June 2010 may have resulted in some degradation of the channel bed through the wetland area at the downstream end of the channel. Rivers and Drainage are undertaking a detailed analysis of the aggradation and degradation volumes along the Ohau Channel over the period 1980-2010.

3.7.7 Mixing Characteristics of Ohau Channel Outflow into Lake Rotoiti and Ohau Diversion Wall

Deterioration of the water quality in Lake Rotorua is due to the discharge of nutrients (primarily nitrogen and phosphorus) from various sources (including erosion, agriculture, septic tanks, storm water and direct inputs of wastewater until 1991) beyond the assimilative capacity of the lake, which has promoted algal growth. Subsequent sedimentation and deposition of algae leads to oxygen depletion near the lakebed, which promotes further nutrient release and thus perpetuates this undesirable situation.

Lake Rotoiti receives a substantial load of nutrients from Lake Rotorua via the Ohau Channel. The channel enters the lake a relatively short distance from the Okere Arm, its only outlet channel. Investigations identified that if the Ohau Channel inflow plume entering Lake Rotoiti is warmer than water where it enters the lake, it became buoyant and "overflowed" to become part of the upper water column (epilimnion) in the lake. Under these circumstances nutrient inputs from Lake Rotorua were mostly diverted down the Okere Arm/channel towards the lake outlet and into the Kaituna River, with very little contribution to the eastern basin of Rotoiti. However, if the inflow was cooler than Lake Rotoiti water, it initially "underflowed" and became either an interflow, whereby it intruded horizontally at some intermediate depth, or was maintained as an underflow at the bottom of the water column. Underflow or interflow produced little if any direct outflow of Ohau Channel water down the Okere Arm/the Kaituna River (Hamilton et al., 2005; NIWA, 2004).

To remove the large nutrient source from Lake Rotoiti and improve lake water quality a diversion wall was built in 2007/2008 and completed in July 2008 to redirect the Ohau Channel plume towards the Okere Arm/Channel.

Today, the diversion wall prevents 180 tonnes of nitrogen and 15 tonnes of phosphorus entering the main body of Lake Rotoiti from Lake Rotorua each year through the Ohau Channel. The diversion is expected to improve Lake Rotoiti's water quality in short-term and reduce harmful algal blooms in the lake by 40% within five years (BOPRC 2008, Ohau Diversion Wall Information Sheet).

NIWA's (2004) modelling efforts predicted that the diversion wall could cause a 2.5 cm water level increase at the downstream end of the Ohau Channel, which may be transmitted upstream to Lake Rotorua via the hydraulic gradient in the channel. Minor increases in water velocity in the vicinity of the Ohau Channel entrance were predicted.

In the investigation process it was demonstrated that the diversion wall would have very little impact on Kaituna River quality. BOPRC undertook studies that found while the wall increases the amount of nutrients that enter the Kaituna River, this would not adversely affect fish, water birds and downstream water quality. This is because algae growth in the Kaituna River is limited by the speed of the flowing water - not nutrients. BOPRC developed the Kaituna River and Ongatoro/Maketu Estuary Strategy (BOPRC August 2009) in conjunction with Tauranga City Council, Western Bay of Plenty District Council, local hapu and affected groups. The Strategy identifies the issues and priorities for the river and estuary system.

3.8 Ecological Health and Habitat Values

Opus's Ecologist has prepared a report titled "Ecological effects of proposed change in Lake Rotoiti water level and range of fluctuation". A copy of the full report is included in **Appendix 10**.

3.8.1 General Ecology

As discussed earlier in this report, Lake Rotoiti is about 15km long, up to 3.5km wide and up to 93.5m deep. It has an area of about 3500ha and a catchment area of about 124.6km^2. Prior to the diversion wall the main inflow was from Lake Rotorua via the 1.5km long Ohau Channel (contributing about 60% of the water to the lake). The main outflow is the Kaituna River, which is controlled at the lake outlet by the Okere gate structure.

Lake Rotoiti and its associated wetlands are ranked as an "outstanding" "Site of Special Wildlife Interest" (SSWI) (Rasch, 1989). This is the top official ranking for wildlife habitats and reflects the high diversity of waterfowl occurring at the lake (17 species recorded), the high botanical value of the surrounding wetlands, the presence of two globally threatened bird species - Weweia /NZ Dabchick (*Poliocephalus rufopectus*) and North Island Fernbird (*Bowdleria punctata vealeae*), and that it supports about 15% of the world population of Weweia and 8% of the world population of Papango/NZ Scaup (*Aythya novaeseelandiae*) (Cromarty and Scott 1995; Heather and Robertson 1996).

3.8.2 Water Quality

Lake Rotoiti first showed signs of deteriorating water quality in the 1970's as increasing rates of oxygen consumption from the bottom waters in summer. This has occurred at an increasing rate over the period 1956 to 1984 (Vincent *et al*. 1984). Throughout the 1990's Lake Rotoiti would have been classified as mesotrophic (moderate productivity) and in a relatively stable state. It had moderate water clarity and few phytoplankton blooms despite the loss of oxygen from the bottom waters causing the release of high levels of nutrients from the bottom sediments. In about 2002/03 there was a significant deterioration in water quality and more frequent blooms of cyanobacteria causing the lake to be classified as eutrophic (Scholes and Bloxham 2005; Hamill 2006). However water quality has improved in recent years and Lake Rotoiti is now classified as mesotrophic (Scholes 2009).

Prior to the construction of the Ohau Channel diversion wall, water from Lake Rotorua was the major source of nutrients to Lake Rotoiti. In addition to adding nutrients, the water from Lake Rotorua was thought to seed cyanobacteria blooms in Lake Rotoiti. Recent monitoring indicated an improvement in the water quality of Lake Rotoiti since the construction of the diversion wall (Scholes 2009; David Hamilton pers. comm. 2009).

4 Options Considered

A number of scenarios for the structures have been considered during the development of this proposal.

4.1 Description of Options

4.1.1 Lake Rotorua

The proposal is to retain the existing stop log weir structure, the existing maximum and minimum lake levels and the current lake level range (610mm). Some operational flexibility is sought with respect to more timely removal and replacement of the stoplogs to improve management of the lake levels. However this operational flexibility will have negligible effect on Lake Rotorua levels compared to the current/status quo.

4.1.2 Lake Rotoiti

Various options for Lake Rotoiti operations have been developed and modelled. The report written for BOPRC by Aurecon in March 2009, assessed the impacts of the following options on Lake Rotorua and Lake Rotoiti levels and outflows in to the Kaituna River:

1) **Status Quo** - Retain the Okere Gates and operate as per the existing resource consent.

2) **Option 1** – 'Natural' – install a stop log structure at Okere gates that approximately replicates the natural rock ledge that existed prior to the construction of the gates.

3) **Option 2** – replace the Okere Gates with a stepped weir structure that broadly aims to maintain current target levels.

4) **Option 3** – retain the Okere Gates but keep the radial gates permanently fully open.

On 28 August 2009, Rivers and Drainage Group instructed Aurecon to model a further option at the request of Dr Morgan. Based on anecdotal evidence, Dr Morgan asserts that Option 4 better represents Lake Rotoiti water levels prior to the gates installation in 1982. Average water levels produced by the Option 4 model are lower than historically recorded water levels:

5) **Option 4** – Low Weir – replace the Okere Gates with a low stepped weir at the location of the existing Okere Gates. The lowest invert in Option 4 is lower than that modelled in the original stepped weir (Option 2 above).

On 10 September 2009, Rivers and Drainage Group asked Aurecon to model an additional option:

6) **Option 5** – Option 5 modelled the pre-gate scenario using the original cross-sections i.e. prior to any channel excavation (prior to 1981). However a subsequent peer review of the modelling found that it underestimated the lake level of Lake Rotoiti. A more accurate technique for modelling pre-gate scenarios was identified taking account of the control of lake outflows by channel friction under low flow conditions.

During September and October 2009, Hydrologics Inc undertook optimisation modelling of gate operations (refer also to Section 4.4 below) using early draft performance indicators and measures, and provided a further option for consideration:

7) **Option 6** - Hydrologics Version 6 - This comprised the latest optimisation modelling up to October 2009 and was included in the December 2009 AEE.

Given the inconclusive results from the Mauri Model web survey a simplified subset of approximately 10 performance measures and 26 performance indicators (refer **Appendix 4**) was developed by Rivers and Drainage in association with TALT in March 2010. These were subsequently used for option comparison and during ongoing public consultation.

In April 2010, Option 1 replicating the natural pre-lake control situation was peer reviewed. The lake level/outflow rating curve developed for Option 1 following this peer review was used to derive revised lake level and outflow records for the period 1998 to 2007.

Over the past four months Rivers and Drainage Group has carried out numerous model runs to develop its final optimised solution and many of these were used in consultation.

All the above options are outlined in more detail in the companion BOPRC Rivers and Drainage Group, July 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application", **Appendix 4.**

During May 2010, Hydrologics Inc. and Rivers and Drainage Group developed a further operating strategy proposal. This operating strategy for the Okere Gates is referred to as Proposed Option (D7).

8) **Option 7 –** Proposed Option (D7) utilises the existing gates to control lake levels, and was developed by manual adjustment of a set of monthly discharge rules (expressed in the form of a lake level/discharge curve).

The adjustment process took account of environmental, technical and operational constraints, in particular, the physical inability of the control gates to control the lake outflow as the gates are opened wider and wider and the flow regime changes from an orifice flow to a free discharge. This change in flow regime does not occur as a sharp change, rather there is a gradual transition which is marked by unstable flow conditions with the lake outflow hunting continuously between the two flow regimes until the free discharge regime with the gates clear of the water surface profile is firmly established. Proposed Option D7 is described more fully in Sections 6 and 9.3 of this report.

4.2 Key Finding of the Aurecon Report 2009

A key finding of the Aurecon Report, 2009, was that the gates appeared to be underutilised and all the options investigated could be simulated by implementing a different operating regime for the control gates than currently allowed or consented.

4.3 Review of Aurecon Modelling

Rivers and Drainage Group initiated an independent peer review of the Aurecon modelling on 9 September 2009, by Opus Principal Hydraulic Engineer Dr Grant Webby.

4.3.1 Summary of Additional Work Undertaken

The original Aurecon Report 2009 included many assumptions and uncertainties as listed on that reports' p11 and elsewhere. The purpose of the initial study and the report by Aurecon was to compare different options and provide a qualitative discussion on the possible pros and cons that these options would have on different stakeholders. The aim was therefore to assess the broad trends and relative differences between options.

4.3.2 Broad Trends Reported in the Original Aurecon Report

It was found that replacing the gates with a weir:

- Increased the range of fluctuation in Lake Rotoiti lake levels markedly.
- Decreased the range of fluctuation of outflows to the Kaituna River (both high flows and low flow event numbers were reduced).
- Impacted lake levels for Lake Rotorua to a very minor degree.

It was found that the level of the weir:

- Impacted significantly on the level of Lake Rotoiti.
- Did not have much impact on the range of fluctuation of Lake Rotoiti levels. To provide a narrower range of lake level fluctuation it was discussed in the report that a much longer weir length would be required.

The report stated that if an alternative structure to the current gate operation is preferred, accurate survey of the Okere Channel and the Ohau Diversion Wall within Lake Rotoiti will be required to refine the modelling and calibration.

4.3.3 Further Work Undertaken for Options 1 and 4

The independent review of the modelling investigations undertaken for the Aurecon report identified that the channel downstream of the Okere gates could be exerting a degree of control on the outflow from Lake Rotoiti that had not been previously recognised. The review concluded that if this were true, then the simulated lake level record for Lake Rotoiti for each alternative option for the Okere gates would be higher than reported by Aurecon in their March 2009 report.

The Rivers and Drainage Group asked Aurecon to investigate these findings with the assistance of the peer reviewer, concentrating specifically on Option 4 based on Dr Morgan's view that this option best reflects the hydraulic characteristics of the pre-lake control outlet from Lake Rotoiti. A detailed hydraulic model of the Okere Channel downstream of the NIWA water level recorder was constructed and calibrated for the existing channel geometry against water level profiles measured on 3rd November 2009 by Graeme O'Rourke of BOPRC for two different flows, 19.6m^3/s and 35.3m^3/s. The calibrated

model was then applied to Option 4 for the Okere Gates and used to determine an effective lake level/discharge rating equivalent to the pre-lake control natural outlet rating curves for the Okere Channel. These additional investigations confirmed the opinion of the peer reviewer that the frictional characteristics of the lake outlet were influencing lake outflows from Lake Rotoiti and hence the lake level regime.

Subsequently Option 1 for the Okere Gates was evaluated using the same calibrated model of the Okere Channel.

A revised set of simulated lake level and outflow records for Lakes Rotorua and Rotoiti for the 10 year period 1998 to 2009 for both Options 1 and 4 were obtained using the results of the detailed hydraulic analysis of the Okere Channel.

4.3.4 Results

While all the broad trends discussed above were still observed, the results for Low Weir Option 4 showed that the simulated levels of Lake Rotoiti were 210mm higher than previously modelled. This was due to the following:

- Backwater effect upstream of the downstream channel being more pronounced than previously assumed and partially drowning the gate outflow, i.e. reducing its hydraulic capacity especially during higher flows.
- Greater head losses upstream of the weir due to use of pre-existing rather than post construction cross-sections at chainages 179.22 and 185.33.
- Incorporation of additional section at chainage 229.27. The frictional characteristics of the Okere Channel influencing lake outflows and hence the lake level regime.

4.4 Optimisation Modelling

In May 2009 Rivers and Drainage Group asked US based firm Hydrologics Inc to carry out optimisation modelling of the existing Okere Gates structure. Hydrologics specialise in optimisation modelling which is used to determine the best operational regime in situations where there are numerous and competing performance requirements and which are individually weighted.

Hydrologics Inc modelled an operational regime in October 2009 (V6) based on draft performance indicators and measures proposed by the Rivers and Drainage Group and Dr Morgan using the Mauri Model (refer **Appendix 11** and **Appendix 4** of this AEE for further explanation of the Mauri Model). The draft performance indicators and measures attempted to balance benefits to the cultural, environmental, social and economic well beings. An effort was made by Dr Morgan with stakeholders to use the Mauri Model to refine the draft performance measures and associated weightings so that agreed performance measures could be used in optimisation modelling.

Application of the Mauri model through a public open day and workshop (both held in late 2009) and an on line survey (in early 2010) was not able to produce conclusive weightings for the 35 draft performance measures developed through that process. To proceed, the Rivers and Drainage Group subsequently simplified measures, condensing them down into 10 simpler measures and three rules. The Mauri Model was not used past this point of

performance measure identification. Optimisation modelling was forced to always satisfy the three rules which are:

(i) that Kaituna River flows never drop below 7.9 cumecs

(ii) that Lake Rotoiti water quality must not deteriorate as a result of a proposed option

(iii) that outflow from Okere Gates must always be greater or equal to Ohau Channel flows (this is important for maintaining and improving water quality in Lake Rotoiti and preventing nutrient leakage around the nutrient diversion wall).

Rivers and Drainage Group undertook significant further consultation with representative stakeholder groups to determine what they could live with and applied best professional judgement in selection of a preferred option that had the widest community benefit and which balanced environmental, cultural, social and economic well beings. The condensed performance measures and three rules were built into the Hydrologics model. The results of the final optimisation modelling carried out by Hydrologics are presented as the Proposed Option (D7).

Results of the Proposed Option (D7) modelling show levels in Lake Rotoiti range between RL279.07m and RL279.40m which is close to current consented (operational) target minimum (RL 279.041m) and maximum consented level (RL 279.41m).

5 Development of the Proposed Options (as at June 2010) for Lake Levels for Lake Rotoiti and Lake Rotorua

This section summarises the steps taken to develop and reach the proposed operational strategies for both lakes and records how the Lake Rotoiti modelling results, combined with wider stakeholder consultation and small group consultation (particularly with TALT, Ngati Pikiao and Lake Rotoiti Community Association (LRCA)), has resulted in the proposed operational level ranges for Lake Rotoiti.

5.1 Lake Rotorua

Modelling has included a range of possible structural configurations and operations for the Okere Gates. All of these options have indicated very little effect on Lake Rotorua (there is only a weak hydraulic link between Lakes Rotorua and Rotoiti). Consultation has indicated that in general lake users and the lakeside community are satisfied with the current Ohau Weir control structure and Lake Rotorua levels. Considerable infrastructural investment (for example jetties) has been made on and around the Lake Rotorua foreshore by RDC and private enterprise based on the current Lake Rotorua operational strategy.

As a result **it is proposed to keep operating Lake Rotorua in the range of its current consent** keeping levels similar to their current levels.

5.2 Lake Rotoiti

In chronological order, the steps taken to develop the starting point operating range (December 2009) and then the Proposed Operational Strategy represented by the Proposed Option (D7) for Lake Rotoiti lake levels are detailed in Tables 7(a) and 7(b) below:

Table 7(a): Steps Taken to Develop Starting Point Operating Range for Lake Rotoiti Lake Levels (Stage 1 of the stages described in Section 1.2 above)

Date	Action
Early 2009	BOPRC Rivers and Drainage Group as holders of the existing consents and TALT as owners of the beds of Lakes Rotorua and Rotoiti entered into a working relationship to jointly develop the operational regime for the Ohau Channel Weir and the Okere Gates to be used as the basis for the new resource consent applications.
4 March 2009	Initial briefing to Te Arawa Lakes Trust Management, TALT Rotorua. Purpose was to brief TALT management on work underway to update consents including review of current operation.
13 March 2009	Completion of a review of benefits report on the Okere Gates and Ohau Weir Control Structures. This review was undertaken by Aurecon Consultants over the period January – March 2009. The review modelled the current operating regime over the period 1997 to 2008. Using the same hydrological input data it examined the effect of 3 alternative operating scenarios including historical simulation using a weir to simulate water levels prior to 1982 when Okere gates were installed (Option 1), a stepped weir (Option 2) and Okere gates fully open (Option 3). The review indicated that the gates were underutilised and all options could be simulated by implementing a wider operating range than currently allowed (or consented). The scope of the report included consulting with numerous stakeholders, and responses are recorded in the report.
28 April 2009	Presentation of Okere Gates/Ohau Weir Control Structures Consent process to BOPRC Maori Committee.
4 May 2009	Presentation of Okere Gates/Ohau Structures review results to Te Arawa Lakes Trust, Environmental Committee. Rivers and Drainage Group provided a Power Point. Results of the Aurecon review were presented to the environmental committee. Presentation included summary of modelling results of Options 1 – 3, benefits and challenges, the proposed programme and process to gain new consents. PowerPoint presentation is available.
May 2009	Engagement of Hydrologics Inc. Hydrologics is a US consulting firm that specializes in computer based optimization. Hydrologics has taken Aurecon results, combined these with numerous performance measures identified by Rivers and Drainage and simulated alternative operating scenarios that optimize benefits to as many stakeholders as possible. It is noted that optimization initially requires weightings in order to generate optimized solution(s).
11 June 2009	Presentation of Okere Gates/Ohau Weir Control Structures Consent process to BOPRC Regulation, Monitoring & Operations (RMO) Committee.
29 June 2009	Meeting with Te Arawa Lakes Trust Management, TALT Rotorua Offices. At this meeting it was discovered that TALT did not own the river/lake bed beneath the Okere Gate and Ohau Weir control structures. Ownership of these river/bed areas is vested in BOPRC's Rivers and Drainage Group. Since TALT own the lake beds, Rivers and Drainage Group decided to continue to work in partnership with the Trust to identify an operating regime acceptable to both parties before taking an initial proposed operating range to other stakeholders.
7 July 2009	TALT Hui, Nukuteapiapi Whare Tupuna. TALT management presented results of Aurecon Review to trustees and received feedback. A hui was called by TALT inviting

Date	Action
	those Te Arawa Hapu, organisations including land trusts that would be affected by the application to update them on the Okere Gates process. It was agreed by those in attendance to support the establishment of a working party to work with Roku Mihinui and Hera Smith of TALT and consist of Joe Tahana, Pakitai Raharuhi, Dr Morgan. It was agreed to progress the consent process in conjunction with BOPRC Rivers and Drainage.
14 July 2009	Hui with Ngati Pikiao at Tupuaeharuru Marae, Rotoiti, on Te Pai Tawhitia Ngati Pikiao and Okere Flood Gates, attended by Bill Bayfield (BOPRC Chief Executive) and Ken Tarboton of Rivers and Drainage Group. It was requested by Ngati Pikiao that Dr Morgan, of Mahi Maioro Professionals Engineering Consultancy, join the working party. Dr Morgan was later engaged and contracted to BOPRC to assist in the consents renewals process.
28 August 2009	Modelling of "Option 4" by Aurecon. At the request of Dr Morgan, Aurecon modelled a 4th Option comprising a low stepped weir at the location of the existing Okere Gates. The lowest invert in Option 4 is lower than that modelled in the original stepped weir (Option 2 of the Aurecon March 2009 Report).
31 August 2009	Professional Services Contract awarded to Opus, to prepare AEE and consent applications on behalf of Rivers and Drainage Group.
1 September 2009	1 September 2009 – Power point presentation by Dr Morgan on the Mauri Model. The meeting was attended by Ken Tarboton, Robbin Britton, Colin Meadowcroft, Mangala Wickramanayake for BOPRC; Hera Smith (Exec Officer) for Te Arawa Lakes Trust, Clive Tozer of Opus. There was a live link to US with Hydrologics team of Dan Sheer, Sam Lebherz and Dean Randall. The outcome of this meeting was that BOPRC, TALT, Dr Morgan and Opus would work up objectives/options/performance measures which reflect the Mauri Model input to an operating regime that has so far been modelled by Hydrologics. Discussion concluded in the development of a process/timeline that would result in the two models working together and revision of Performance Measures that were initially developed by BOPRC, to account for a wider set of Performance Measures that took account of the four well-beings associated with Mauri Model.
7 September 2009	Workshop with Rivers and Drainage Group, Opus and facilitated by Dr Morgan - TALT were unable to attend due to other engagements. At the workshop draft performance indicators, measures and weightings were developed using the Mauri Model, based on the inputs of those present, drawing on knowledge and a technical understanding of some of the issues. It was also agreed that the option to be used as the starting point for the process was retention of the Okere Gates, with the gates operated to produce a more natural lake level regime, and maximise wider benefits to the initial performance measures for the four well-beings. The workshop concluded in the development of a revised draft set of Performance Indicators and Performance Measures.
9-10 September 2009	Aurecon were requested by Rivers and Drainage Group to model a 5th Option comprising "no Okere Gates and adoption of original cross-sections" in Okere Arm. Aurecon Modelling was sent to Opus's Dr Grant Webby for independent peer review. Scope of the peer review comprised examination of hydrological data, checking datums and modelling assumptions for all 5 Options modelled plus an assessment of the reason for discrepancies between historical recollection of lake levels (by Ngati Pikiao) and actual hydrological data (since 1906).
11	The revised draft Performance Measures and outputs of the Aurecon modelling of the 5th Option were emailed to Hydrologics for them to optimize. Model outputs were

Date	Action
September 2009	sent to Hydrologics for optimization in conjunction with revised set of draft Performance Measures.
11 September 2009	Meeting with Rivers and Drainage Group and TALT to update TALT and obtain their general acceptance in principle of the revised performance indicators and associated Performance Measures to be applied to the Okere Gates & Ohau Channel re-consenting process. The team identified dates for two hui in October 2009 plus a Public Open Day. Following discussion of the revised draft Performance Measures it was agreed that: (i) They provided a sound first basis for presentation to the two hui scheduled for October 2009 (ii) The outcome of the hui, particularly the first meeting (expected to be Te Arawa/Pikiao trustees), could change Performance Measures (iii) They are to be forwarded onto Hydrologics for optimisation. Any subsequent changes to Performance Measures resulting from the hui will 'fine tune' the optimisation results. (iv) Results of optimisation could be used as the basis of the AEE that Opus need to get underway in order to meet the consent lodgement deadline of end of 2009 (v) The Okere gates would probably be retained since a more variable operating range (approaching a more natural regime) could have more positive environmental effects.
Mid September 2009	Robbin Britton reported that Hydrologics would be re-configuring their optimisation model to reflect the draft Performance Measures presented at the meeting of 11 September 2009. Hopefully results will be ready 14/15 September 2009 for Opus to pick up and commence its AEE.
14 September 2009	*A*urecon completed modelling of an additional Option 5 and results were emailed to Hydrologics. This run models the pre-gate scenario using the original cross-sections i.e. prior to any channel excavation (prior to 1981).
2 October 2009	Hui at Taheke Marae, Okere Falls Road, Okere for Ngati Pikiao – as result of feedback, the proposed lake level range was further refined.
7 October 2009	Meeting with RDC staff, Peter Guerin, Tracey May and Peter Dine to update RDC on process.
9 October 2009	Hui at Te Runanga Tea House , Government Gardens Rotorua for TALT – as a result of feedback, the proposed operating regime was further refined.
13 October	Hydrologics undertook another modelling run based on draft Performance Measures sent to them by BOPRC on 13 October 2009.

Date	Action
2009	
18 October 2009	Revised Hydrologics modelling results received at BOPRC, known as "Version 6".
19 October 2009	Presentation to Te Arawa Lakes Standing Committee of RDC – this presentation was based upon the Hydrologics Model developed 18 October 2009.
27 October 2009	Dr Morgan indicated that the Hydrologics optimised range ("Version 6") did not adequately represent anecdotal evidence of local iwi in the performance measures used to come up with optimised scenario. He requested that a wider, lower range than the Hydrologics optimised range ("Version 6") be presented at the Open Day. It was recognised there were differences between measured data and anecdotal recollection that had not yet been resolved. Out of respect to anecdotal recollection, the initial starting lake level range for Lake Rotoiti to be presented at the Open Day, was increased to 600mm, with a lower minimum and median level.
28 October 2009	Public Open Day: Morning Stakeholder meetings – presented the regime as proposed on 27 October 2009.
28 October 2009	Public Open Day: Afternoon/evening Open Day in Rotorua -presented the regime as proposed on 27 October 2009.
29 October 2009	Rotorua Lakes Community Board – Rivers and Drainage Group presented a summary of material presented at the Open Day.
1 November 2009	Aurecon revised and updated the Option 4 (no structure option) in response to peer review recommendations. As a result the average lake levels produced by Option 4, was found to increase by some 200mm (when compared to the original Option 4 model results presented at the Public Open Day on 28th October 2009).
9 November 2009	Mauri Model workshop in Rotorua to develop performance criteria with a full range of key stakeholders present. Time constraints unfortunately meant that performance criteria were not completed.
16 November 2009	BOPRC Project Team instructed Opus to prepare the AEE based upon the same operating regime for Lake Rotorua as is currently consented, and a wide operating regime for Lake Rotoiti, described in this report as "starting point" operating range of lake levels. The Lake Rotoiti starting point operating range to be an 800mm range, from RL 279.406m to RL 278.60m. This approach was chosen to allow for flexibility over the coming months whilst consultation and option refinement continues.
18 -21 Dec 2009	Resource Consent Application and AEE (with wide 'starting point' range for Lake Rotoiti) was forwarded and subsequently lodged with the consent authority on 21 December. The wide 800mm starting point range gave Rivers and Drainage Group flexibility to investigate changing the operating range within this band between lodgement and notification.

Table 7(b): Steps taken post lodgement of the AEE in December 2009 to refine Lake Rotoiti Starting Point Operating Range and Develop a Proposed Option (Stage 2 of the stages described in Section 1.2 above)

Date	Action
Late Dec 2009/Jan/ early Feb 2010	Since performance criteria could not be confirmed during the 9 November 2009 Mauri Model workshop, Dr Morgan (Maihi Maioro Consultants) developed a web based Mauri Model survey tool to allow stakeholders to provide input via the internet to help Rivers and Drainage Group finalise performance criteria (indicators, measures and weightings). These performance criteria were to be used in optimisation modelling to help refine preferred Lake Rotoiti operational levels.
18 January 2010	Rivers and Drainage Group met with Todd Energy and outlined the status of its consent application as detailed in the December 2009 AEE. Todd Energy indicated they planned to lodge a consent application for a 13MW hydropower scheme that would be located downstream of Okere gates. Todd Energy said it would assess the impact of Rivers and Drainage Group Preferred Option once notified.
9 February 2010	Rivers and Drainage Group updated the RMO Committee on the content of the December 2009 AEE and indicated the likely outcome of refinement of the starting point range. A range between 335-400mm was expected between 278.8 and 279.2 however this would be confirmed pending completion of the Mauri Model web survey. The v6 optimised option was displayed as an example of how a new operation might appear. Water quality modelling would be done on options.
12 Feb 2010	Rivers and Drainage met with Manawhenua (Ngati Pikiao and others) in Rotorua and listened to their issues. Feedback supported the cultural performance measures being proposed at that time for example lower lake levels would expose beaches. Lower levels were requested in acknowledgement of iwi's rights under the Treaty of Waitangi. Ngati Pikiao contended that they were not consulted prior to construction of the original flood mitigation measures implemented in Lakes Rotorua and Rotoiti. Ngāti Pikiao believed that the Ohau Channel had silted up as a result of 1972 channel re-alignment and requested that Okere Gates be opened during winter to enable the silt to be flushed. Water quality was considered very important to iwi.
28 Feb 2010	Rivers and Drainage attended a Ngati Pikiao hui to observe hapu with Dr Morgan complete the web survey. Dr Morgan was mandated by Ngati Pikiao to complete the Mauri Model web survey on their behalf. Dr Morgan informed hui that Ngati Pikiao and Te Arawa lakes Trust (TALT) option of choice was the low weir (Option 4) although the optimised option could be a possibility. Dr Morgan suggested to the hui that they may need to come back and remove the Ohau Weir after resolving the Okere Gate issue. Concern was expressed that some urupa were submerged and this issue needed to be addressed.
Feb/March 2010	Approximately 200 stakeholders (groups and individuals) were invited by Rivers and Drainage to complete the Mauri Model web survey. Stakeholders were asked to review and rank relative importance of performance criteria identified in the survey. Unfortunately the web survey was considered too complex and time consuming by the majority of stakeholders and returns were poor. It was not therefore possible to define stakeholder performance criteria weightings and all stakeholders were informed of this.
1 March 2010	Rivers and Drainage Group (Ken Tarboton) met with and updated the Te Arawa Lakes Standing Committee. A presentation very similar to that given previously to the RMO Committee on the 9th February 2010 was given. (see above).
March 2010	David Hamilton was engaged by Rivers and Drainage Group to carry out Water Quality modelling on the optimised v6 option with a view to ensuring that any proposed

Date	Action
	option does not compromise the nutrient diversion wall i.e. nutrient leakage around the wall to Lake Rotoiti is prevented or minimised.
5 March 2010	Rivers and Drainage Group met with and updated the Lake Rotoiti Community Association (LRCA). Feedback was that the Mauri Model was very difficult to implement. 20 on-line responses were received and one collective survey received from Ngati Pikiao. Rivers and Drainage Group could not use the survey results in its optimisation due to the small number of responses received, difficulty in completing the survey and two sets of weightings. Rivers and Drainage Group subsequently announced that the final operation would be based on small group consultation, all modelling done to date and best technical judgement. Immediately prior to this meeting Rivers and Drainage rationalised the original list of 35 performance measures to 10 simpler measures.
15 Mar 2010	Rivers and Drainage Group met with and updated RDC Works Committee. A presentation very similar to that given previously to the RMO Committee on the 9th February 2010 was given. (see above).
26 March 2010	Rivers and Drainage Group met with LRCA and Ngati Pikiao. In what became a two part meeting, Ngati Pikiao met first with LRCA to discuss differences in views such as lake level records and reasons for disappearing beaches. Rivers and Drainage Group joined in for the second meeting and presented the v7 optimised option, which would be presented at the Public Open days planned for 9 and 11th April 2010. Although Mauri Model weightings could not be used in optimisation modelling, survey results did indicate preference for a more natural lake level range and emphasised importance of WQ.
9 & 11 April 2010	Public Open Days – at Rotorua – Hydrologics Optimised Version 7 was tabled by Rivers and Drainage. Only 10 Performance Measures were considered (rationalised down from a previous 35 with Version 6) as part of the Optimisation modelling process. Feedback from stakeholders – especially LRCA, was that the Proposed (optimised) V 7 lake levels were too low in summer and autumn for effective use of many structures (jetties). This lead to further modelling and consultation to best address the concerns. A discrepancy was noted between BOPRC's lake level data and independent levels recorded by local Lake Rotoiti resident, Mr Michael Gill. River and Drainage subsequently checked its level data and found it had not been adjusted for tectonic settlement. Following adjustments to its levels Rivers and Drainage Group updated all its models.
15 April 2010	Rivers and Drainage updated TALT Executive at BOPRC Whakatane on outcome of the Mauri Model web survey and feedback from the April 2010 Open Days –TALT acknowledged that Rivers and Drainage Group had worked through a process with TALT from the beginning.
23 April 2010	Rivers and Drainage had a site meeting and field inspection at Hinehopu to meet with locals and LRCA to understand the local drainage and settlement issues.
26 April 2010	Rivers and Drainage updated the Te Arawa Lakes Standing Committee. Purpose was to update committee on content of the April 2010 Open Days and provide feedback. The committee was informed that further consultation would be undertaken with key stakeholder representatives (TALT, LRCA and Ngati Pikiao) to help it refine its preferred operation.
29 April 2010	BOPRC CEO and Rivers and Drainage Group Manager met with TALT Chairman. The consent process recognised TALT as a partner however TALT expressed concern that some views circulating amongst Te Arawa and Ngati Pikiao constituents were not the official view of TALT. Ngati Pikiao have had a significant influence in the consent process and their issues were being acknowledged. Some issues such as beach recovery could be addressed outside of the current consent process.
5 May 2010	Rivers and Drainage briefed the BOPRC Regional Monitoring and Operations Committee. A presentation similar to that given to Te Arawa Lakes Standing Committee on

Date	Action
	26 April 2010 was made.
6 May 2010	Rivers and Drainage met with BOPRC Maori Committee at Rotokawa (Mataikotare Marae) A presentation similar to that given to Te Arawa Lakes Standing Committee on 26 April 2010 was made.
6 May 2020	Rivers and Drainage provided RDC Technical Staff with a briefing. RDC support wider and higher level range for Lake Rotoiti and note that Hinehopu drainage issues are a problem for all level options.
7 May 2010	CEO's of TALT/RDC/BOPRC meet to consider current situation. Rivers and Drainage Group presented the latest preferred option, the B5 to the CEO's and representatives of LRCA. The B5 optimised operation evolved as a result of consultation undertaken since the April 2010 Public Open Days. -The B5 option took account of datum corrections resulting from tectonic settlement in Lakes Rotorua and Rotoiti.
11 May 2010	Rivers and Drainage met with Tapuika Iwi Authority (TIA) at Te Puke – discussed Kaituna River water quality matters. TIA concerns were that 1) any variances in flow should not adversely impact WQ in Kaituna River 2) river flow should be more natural 3) river flow should not worsen flooding 4) BOPRC and TIA scientists should get together and endeavour to reconcile their differing views on WQ in the Kaituna River.
11 May 2010	Optimising workshops with LRCA representative Warren Webber attended the first of two Rivers and Drainage Group modelling sessions. The aim of the workshops was to see if the differences between LRCA and Rivers and Drainage Group proposed operations (which at the time was the B5) could be reduced. The outcome was development of a new proposed option the C3-1, which Mr Webber believed could find favour with LRCA.
18 May 2010	Optimising workshops with LRCA representative Warren Webber attended the second Rivers and Drainage Group modelling session. A new optimised option had been developed namely the M19 optimised option. However this was rejected by LRCA since there was too much time below 279.1 Rivers and Drainage Group subsequently decided to revisit the C3-1 option.
19 May 2010	Rivers and Drainage met with TALT, LRCA at Rotorua and consider the Optimised C3 – 1 Proposed Option. General accord but LRCA was still concerned about Lake level below 279.1m for significant periods during Feb, March, April. A peer reviewed and updated version of Auercon's original Option 1 was presented for comparison purposes. Option 1 was Rivers and Drainage Group's best estimate of lake levels prior to Okere Gates being constructed. The updated natural Option 1 indicated lake levels higher than status quo. Several previously identified performance measures were recognised as being more appropriately managed separately from this consent process. They were drainage issues at Hinehopu/Ruato, sedimentation and flushing of the Ohau Channel and beach restoration. There was a general consensus that the operational strategy be reviewed every three years.
21 May 2010	Rivers and Drainage Group finalised Optimised Proposed Option (D7) which is forwarded to TALT and LRCA. The Proposed Option (D7) comprises at least 95% of the time between 279.05 and 279.25, less than 5% between 279.25 and 279.40. LRCA provide positive response; Ngati Pikiao have some concerns about higher lake levels and concerns for Hinehopu drainage and limited benefits for beaches. Rivers and Drainage Group confirmed that these matters that need attention be managed outside the consent process.
26 May 2010	Rivers and Drainage Group updated the Kaituna Catchment Control Scheme Liaison Group and presented the preferred optimised Proposed Option (D7).

Date	Action
9 June 2010	BOPRC RMO Committee are presented with the Proposed Operational Strategy based on modelling of the Proposed Option (D7) and are told that the AEE will be updated on the basis of this proposed strategy and modelled option.
18 June 2010	Boat field inspection by Rivers and Drainage Group, TALT, Ngati Pikiao and LRCA reps. See first-hand the current 'flush' trial; jetty depth and beach width effects under Proposed Option (D7) versus Status Quo.

5.3 Historical and Anecdotal Data

Historical water level data has been obtained from measuring gauges for Lake Rotoiti from 1906 and for Lake Rotorua from 1934. Data for Lake Rotoiti are shown in **Figure 12**. The measured historical data show a fluctuation of 400-500mm in lake levels seasonally and annually. The trend of increasing lake levels from the 1940's to the 1970's is attributable to increased runoff into the lakes with catchment development and land use change. Changes in lake levels are evident with the increase in capacity (widening/deepening/straightening of the Ohau Channel (1972), installation of the Okere Gates (1982), Ohau stop log weir installation (1989) and adoption of the current consents narrow operational range of 150mm in 1996.

Anecdotal recollection by Ngati Pikiao elders suggests that Lake Rotoiti levels were lower than they are now and that beaches were historically considerably wider than they are now. Mr Fred Whata of Ngati Pikiao has indicated that levels in the Ohau Channel in the vicinity of Mourea are about half a metre higher than his recollection of them before the structures were put in place (this may be due to sedimentation). Comparison of recent survey results with earlier surveys of the Ohau Channel indicate some sedimentation appears to have occurred in the period 1988 – 2002, however channel cross-section area appears to have stabilised since that period.

Investigations were undertaken to locate and use old photographs to validate anecdotal recollection. Investigations included searches of file and library archives as well as inviting local residents to submit photographs of various lake shore locations that showed levels and dates that could be easily cross-referenced and confirmed. Initial analysis of some photos indicates that beaches may have been wider due more to a greater range of water level fluctuation than necessarily lower lake levels.

Opus has peer reviewed the observed data record for Lake Rotoiti (as measured by a recorder on the jetty in the Okere Channel) and indicated that it is of good quality with care having been taken to track and address datum changes and instrument changes and locations over time.

The level of Lake Rotoiti is now also measured by BOPRC at Okawa Bay. Comparison of periods of overlapping record from the two recorders indicates that the Okere Channel water level recorder (operated by NIWA) is affected by drawdown due to flow velocity effects with the amount of drawdown increasing as the lake outflow increases. Both water level recorders are also affected by tectonic movement (ground settlement and uplift).

Since the Opus peer review, Rivers and Drainage Group has compiled an adjusted level record for Lake Rotoiti based on the Okere Channel record taking account of ground settlement of a reference survey benchmark but not drawdown effects.

Key observations of the adjusted 1906-1981 Lake Rotoiti level data set are:

- The uncontrolled lake level range under average hydrological conditions was typically between RL 278.83m and RL 279.77m (a range of 0.94m) with a median level of RL 279.16m and a 90 percentile exceedance value of RL 279.01m and a 10 percentile exceedance value of RL 279.33m (i.e. for 80 percent of the time the lake level range was about 0.32m).

- Compared to the long term lake level record, the 1960's and 1970's (1 Jan 1960 to 31 Dec 1981) was a very wet period with a very similar 95% exceedance lake level value but with a median lake level value about 0.06m higher and a 5% exceedance lake level value about 0.07m higher. Mean lake level was about 0.07m higher while mean outflows were more than $3m^3/s$ higher.

- Following commissioning of the Okere Gates in January 1982, the gates were initially operated until January 1997 so that the lake level regime was slightly tighter than the natural regime (a similar median value but a 5% exceedance value about 0.09m lower and a 95 percentile exceedance value about 0.08m higher)

5.4 Mauri Model

On 7th July 2009 at a Te Arawa Lakes Trust hui, attendees requested that Dr Morgan of Maihi Maioro Consultants join the working party to assist with the development of the operating regimes. This request was repeated at the Ngati Pikiao hui held a week later on 14th July 2009.

The Mauri model developed by Dr Morgan was suggested as a framework that would recognise and have regard for cultural values and has been used to help establish draft performance indicators and draft performance measures for use in evaluating different operational options. TALT has expressed in earlier meetings that it was not evident that this had been included in the original resource consent process and that it be included in the AEE process.

The Mauri Model integrates the intrinsic value of ecosystems (environmental), hapu (cultural), whanau (economic), and communities (social) using the indigenous concept of mauri as the performance metric across all four sustainability dimensions.

Mauri is 'the binding force between the physical and the spiritual, and it is the basis of kaitiakitanga as this is the ethic of working to enhance the mauri of all things'.

An explanation of the Mauri Model prepared by Dr Morgan is included in **Appendix 11**.

During March 2010 stakeholders found it difficult to understand and complete the Mauri Model web survey to establish performance criteria and there were very poor survey returns. To proceed, Rivers and Drainage subsequently simplified the 35 draft performance measures which were condensed down by the Working Party to 10 simpler performance measures. No additional assessment was carried out using the Mauri Model. Further refinement of performance measures and evaluation of options was thereafter based upon small group consultation, modelling, survey and data analysis, and best professional judgement.

5.5 How Consultation Was Used to Develop the Lake Rotoiti Starting Point Operating Range (December 2009) and the Proposed Option (D7) (June 2010)

A detailed account of consultation undertaken since the beginning of the application process is set out in the tabled log in Section 7.4 of this AEE. However it is summarised below for convenience.

As discussed previously, the Applicant entered into partnership with TALT at the beginning of 2009 to investigate options for the ongoing operation of the lake level control structures of both lakes. This resulted in the engagement of Dr Morgan in mid 2009, and the use of the Mauri Model to assist with the development of options.

Initial draft performance criteria were developed by the Applicant and TALT in September 2009.

These criteria were then taken to Ngati Pikiao and TALT members at two hui held on 2nd and 9th October 2009 respectively, in Rotorua.

At these hui, the criteria for Lake Rotoiti were refined, and those for Lake Rotorua were endorsed. Hydrologics Inc subsequently optimised the performance measures, which were received by Rivers and Drainage Group mid October 2009.

This proposed draft operating regime was presented to the Te Arawa Standing Committee at RDC on 19 October 2009.

As noted in Section 5.2 above, Dr Morgan indicated that the Hydrologics optimised range did not adequately represent anecdotal evidence of local iwi in the performance measures used for optimisation and requested a further refinement of the regime for Lake Rotoiti on behalf of TALT and Ngati Pikiao on 27th October 2009. Dr Morgan requested that a wider and lower range than the Hydrologics optimised range be presented at the Open Day on 28th October 2009. It was recognised there were differences between measured data and anecdotal recollection that had not yet been resolved. As a result, , the initial starting range for presentation at the Open Day was increased to 600mm with a lower minimum and median level. This matter was discussed by Rivers and Drainage Group with TALT Executive Officers. This refinement involved lowering the starting point minimum level to RL 278.60m, and was based upon Dr Morgan's concerns that the historical data held by BOPRC for Lake Rotoiti levels were in fact too high. Dr Morgan was concerned that anecdotal evidence from local iwi and Kaumatua must be taken into account, and this evidence suggested that the entire Lake Rotoiti level record was too high, probably by approximately 500mm.

It should be noted that, in response to Dr Morgan's concerns about the accuracy of the historic lake level record for Lake Rotoiti, Rivers and Drainage Group asked the independent peer reviewer of the modelling investigations undertaken for the March 2009 Aurecon report, Opus' Principal Hydraulic Engineer Dr Grant Webby, to also undertake a review of the historic lake level record. Dr Webby concluded that, in his view, the long term lake level record for 1906 to present held by NIWA on behalf of the Crown provides a reasonably accurate record of lake level over time with reasonably regular checks on the zero datum level of the lake level gauge having been made since 1953 to ensure the quality of the lake level record was maintained.

At the stakeholder meetings and open day on 28th October 2009, the widened range for Lake Rotoiti was described to stakeholders and the wider community. The stakeholders expressed a desire to meet with Rivers and Drainage Group to further discuss the proposed range and performance measures for both lakes, and so a workshop was arranged for 9 November 2009, facilitated by Dr Morgan. The intention of the workshop was to use the Mauri Model to refine the performance criteria for Lake Rotoiti with all key stakeholders present. The aim was to be able to supply the agreed performance indicators/measures/weightings to Hydrologics Inc so that an advanced modelled simulation of the lake levels for Rotoiti could be obtained by the end of November 2009 and incorporated into the resource consent AEE.

Unfortunately, time constraints on the day of the workshop meant that the performance criteria were not established, and so as at December 2009 (time of AEE lodgement), no further modelling had been undertaken since that provided to Rivers and Drainage Group in mid October 2009.

As a result, the resource consent application was based on the regime taken to stakeholders and the public on 28 October 2009, with an amended upper limit of the current maximum consented limit. This is the operating range described in the December 2009 AEE and application as the "starting point" operating range. This approach allowed the Applicant the ability to refine the operating range within the starting point range and to address stakeholder and community concerns during the period between initial lodgement and submission of a revised AEE with a Proposed Option and notification of the application.

The December 2009 AEE (with 800mm 'starting point range') was lodged with the consent authority on 21 December 2009. The December 2009 AEE with appendices was made available for viewing on the BOPRC web site from late December. It was made clear by Rivers and Drainage Group that the consent authority had not notified this initial application and was not seeking submissions on the AEE document.

Given that the 9 November 2009 Mauri Model workshop with key stakeholders (to develop performance criteria) facilitated by Dr Morgan, did not provide the outputs required, it was decided that a web based Mauri model survey be developed for use by stakeholders on the web. The intention was to use the performance criteria (indicators, measures and weightings) in optimisation modelling to help refine the preferred option. In February 2010 approximately 200 Stakeholders were invited to complete and return the survey by web link or post by February 28 February 2010. Unfortunately the web survey was considered by stakeholders to be too complex and time consuming to complete, and returns were poor. As a result it was not possible to provide a stakeholder ranked and weighted set of performance criteria. Stakeholders were informed of this in Newsletter Number 5 in March 2010.

To proceed, a collection of environmental performance indicators based on Mauri Model performance measures and that linked each wellbeing (cultural, environmental, social and economic) to Lake Rotoiti levels and flows was used to develop a simplified subset of performance measures. These performance measures were used to quantify differences between options and were used together with best professional judgement to select the proposed option (refer **Appendix 4**, BOPRC Rivers and Drainage Group, July 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application").

David Hamilton of Waikato University was engaged in March 2010 to carry out water quality modelling of the options being considered with particular attention to checking whether or not the effectiveness of the nutrient diversion wall was being compromised.

Public Open Days were held on the 9th and 11th April 2010 in Rotorua. These were well advertised. Rivers and Drainage presented Optimised V7 as the preferred option at that time (refer to **Appendix 4**) for further detail. David Hamilton also presented a summary of his water quality modelling findings relating to the potential impact of options on the efficiency of the nutrient diversion wall (refer to **Appendix 4** for the water quality monitoring report). The public open days were well attended by lakeside community landowners and occupiers – particularly those with lake bed structures (jetties and ramps) and LRCA representatives. There was significant concern by many that once Lake Rotoiti levels fell below 279.10m that structures became increasingly difficult to use and amenity was lost. Lower lake levels during the summer/autumn holiday and boating season were of particular concern.

Following this consultation further modelling and consultation occurred. Refer to **Appendix 4,** for additional information about optimisation modelling of options.

On 6 May 2010 Rivers and Drainage met with RDC Technical Managers and staff. RDC supported a wider and higher level range for Lake Rotoiti and acknowledged the difficulties with Hinehopu drainage but reinforced that this was already a problem for the status quo situation and other options under consideration.

On 19 May 2010 Rivers and Drainage met with TALT (including Ngati Pikiao reps) and LRCA. Rivers and Drainage presented the C3-1 Option (refer Tech Report, **Appendix 4**, for detail). There was general accord and consensus between the parties. However after the meeting LRCA still expressed strong concern at the number of days the lake was below 279.10m during late summer/autumn.

Rivers and Drainage Group finalised the optimised Proposed Option (D7) on 21 May 2010 (the Proposed Option). LRCA provided positive feedback and support. Ngati Pikiao expressed concern that their concerns (about the slightly higher lake levels and possible additional impact on Hinehopu and Ohau Channel levels) had not been well represented in a draft paper to be taken to the BOPRC Regulation, Monitoring and Operations (RMO) Committee. Their concerns were addressed by including an addendum to the RMO paper (tabled at the RMO meeting) indicating community consultation and summarising the opinions expressed by the different community groups.

On 9 June 2010 – BOPRC's RMO Committee was presented an update on the proposed operational strategies for Lakes Rotorua and Rotoiti and were told that the AEE would be updated on the basis of the Proposed Operational Strategy and Proposed Option (D7) (refer BOPRC PowerPoint presentation to RMO Committee on 9 June 2010 provided in **Appendix 13** of this AEE).

Inspection by boat of key beaches was held on 18 June 2010 with Rivers and Drainage Group, Ngati Pikiao reps and LRCA reps. The opportunity to inspect the current 'flush' trial, beach width matters and beach restoration was viewed in line with the Proposed Option (D7). It was agreed that certain matters could be more satisfactorily dealt with outside the strict confines of the resource consent process (for example beach restoration). General

accord was reached between Ngati Pikiao and LRCA reps over the Proposed Operational Strategy.

Small group consultation particularly with TALT, Iwi (Ngati Pikiao on several occasions, Tapuika at Te Puke), RDC (Standing Committees and Works Committee), BOPRC (RMO Committee, Maori Committee, Catchment Control Scheme Liaison Committee) and LRCA since January 2010, along with use of performance measure comparison and best professional judgement has been used to refine the optimised options and select the preferred options and thereafter the Proposed Option.

5.6 Use of Multi-Criteria Option Evaluation Matrix for Lake Rotoiti

5.6.1 Description and Application

A Multiple Criteria Analysis (MCA) is a framework for ranking the overall performance of options against multiple criteria.

This has been used to assist in the selection of the Proposed Option.

The criteria selected for this MCA are based on those collective performance criteria developed by stakeholders during the extensive consultation undertaken by Rivers and Drainage Group.

Note this evaluation is confined to Lake Rotoiti and the Okere Gates application.

The overall ratings are qualitative, however they are specialist professional opinions based where possible on quantitative studies (e.g. optimisation model) or comprehensive inputs to the project (e.g. consultation, water quality data, survey etc).

The 3 options used in the MCA were chosen as they represent the existing situation (status quo), a situation similar to what would happen if the gates were removed (low weir – Option 4 as requested by Dr Morgan) and the Proposed Operational Strategy that has been identified by Rivers and Drainage Group and the community through extensive consultation to be most acceptable quantified by the Proposed Option (D7).

The Evaluation Matrix contains three types of rating key descriptors. These rating descriptors are different to reflect the nature of the various criteria being used to assess the options. Because the criteria are quite different it is difficult to apply a single rating descriptor. Instead each of the rating descriptors provides a spectrum for evaluation as follows:

1. Project Objectives – Meets all; meets most; meets in part; barely/fails to meet.

2. Maori Cultural Values – Recognises in entirety; recognises most; recognises part; barely recognises; fails to recognise.

3. Water Quality, Environmental, Social, Economic, Affordability values – Very good; good; fair; poor; very poor.

The methodology used involved the relevant technical specialists involved in preparing this AEE (for example Water & Hydraulic Engineering, Ecology, Water Quality) assigning a rating for each option against the evaluation criteria.

After each specialist assigned their own ratings, there was discussion between the specialists, and agreement was reached on an overall rating for each option and criteria.

The outcomes are provided in **Tables 8 to 15,** below.

Table 8: Multiple Criteria Analysis of Overall Project Objectives.

Project Objectives (Rating : Meets all, Meets most, Meets in Part, Barley/Fails to Meet)				
Evaluation Criteria	**Performance Indicator**	**Option Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised D 7**
Project Objectives	Maximise benefits to the wider community balancing the benefits to the cultural, environmental, social and economic wellbeing's	Meets in part	Barely/Fails to meet	Meets most
	Actively engage the community, particularly TALT to assist in identifying the preferred operational regime	Meets in part	Meets in part	Meets most
	Summary (Best / Worst Performer)		WORST	BEST

Table 9: Multiple Criteria Analysis of Maori Cultural Values.

Maori Cultural Values (Rating: Recognises in entirety, Recognises most, Recognises part, Barely Recognises, Fails to recognise)				
Evaluation Criteria	**Performance Indicator**	**Option Status Quo**	**Option 4 –Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised Version D7**
Maori Cultural Values	Beaches - provide local iwi more access to beaches at specific locations	Barely recognises	Recognises most	Barely Recognises
	Manaakitanga - provide sufficient availability of kai for hakari	Recognises in part	Recognises most	Recognises in part
	Cultural practices – provide local iwi with access to traditional fishing/kai sources and recreational areas	Recognises in part	Recognises most	Recognises in part
	Kaitiakitanga Rotoiti – allow local Hapu to regain access to sacred/tapu sites at Lake Rotoiti	Fails to recognise	Recognises most	Recognises in part
	Kaitiakitanga Okere - allow Hapu to regain access to sacred/tapu sites along Kaituna River	Fails to recognise	Recognises in entirety	Recognises most
	Maintain Kaituna River Water Quality	Recognises in part	Recognises in part	Recognises in part
	Summary (Best / Better than Status Quo/Worst Performer)	WORST	BEST	BETTER THAN STATUS QUO

Beaches – although the Proposed Option (D7) provides little or no improvement on Status Quo with respect to beach width, Rivers and Drainage are working with the community (through the EEF) and community groups to help 'restore' beaches where sites are appropriate and respond well to vegetation control. This is frequently on Maori land and is being positively received and encouraged by stakeholders including local iwi.

To provide a quantitative assessment of benefits to kai is not possible without recorded historic data. Ratings for Option 4 low weir based on Ngati Pikiao (particularly Dr Kepa Morgan) comment.

Access to sacred/tapu sites requires a predictable lower seasonal lake level/river level.

For Kaituna River water quality matters it has been assumed that the nutrient wall remains functional and continues to direct Ohau Channel flow to the Okere Arm and out through the Okere Gates for all options.

Note – where ratings for a performance indicator are the same for all 3 options then it can be assumed that gate control/lake level has little impact on that performance indicator ie is essentially a neutral response.

Table 10: Multiple Criteria Analysis of Water Quality Values.

Water Quality (Rating: Very good, Good, Fair, Poor, Very Poor)				
Evaluation Criteria	**Performance Indicator**	**Option Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised D7**
Water Quality (Existing water quality = baseline for assessment)	Lake Rotoiti Water Quality – maintain diversion wall effectiveness	Good	**Very Good**	Very good
	Kaituna River Water Quality – maintain	Fair	Fair	Fair
	Summary (Best / Worst Performer)		EQUAL BEST	EQUAL BEST
Note – where ratings for a performance indicator are the same for all 3 options then it can be assumed that gate control/lake level has little impact on that performance indicator ie is essentially a neutral response. Assumes nutrient diversion wall is in place and fully operational.				

Table 11: Multiple Criteria Analysis of Environmental Values.

Environmental (Rating: Very Good, Good, Fair, Poor, Very Poor)				
Evaluation Criteria	**Performance Indicator**	**Option Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option 7 - Gates retained Optimised Version D7**
Environmental				
	Erosion – minimise on the margins of Lake Rotoiti	Fair	Good	Good
	Erosion - minimise on Kaituna River Banks	Poor	Good	Good
	Ecology - Kaituna River			
	- Aquatic Fauna/fish - Maintain existing	Good	Good	Good
	- Birds - Maintain existing	Good	Good	Good
	Ecology - Lake Rotoiti			
	- Birds eg Dabchicks – realise stable and robust population via appropriate rate of lake level increase	Very Good	Fair - poor	Very Good
	- Wetland – maintain and enhance health, extent and diversity	Fair-Good	Poor	Good
	- Fish, koura, kakahi – maintain healthy populations	Good	Good	Good
	- Aquatic plants (indigenous) – maintain and enhance diversity	Fair	Fair	Fair
	- Aquatic plants (exotic weed pests) – do not exacerbate current extent	Fair	Fair	Fair
	- Trout & Smelt – maintain healthy populations	Good	Good – very good	Good – very good
	Summary (Best / Worst Performer)			BEST

Health and extent of various species under the different options is difficult to quantify without good long term data and for several indicators, rating is therefore based on professional opinion/experience.

Note – where ratings for a performance indicator are the same for all 3 options then it can be assumed that gate control/lake level has little impact on that performance indicator ie is essentially a neutral response.

Table 12: Multiple Criteria Analysis of Social Values.

Social (Rating: Very good, Good, Fair, Poor, Very Poor)				
Evaluation Criteria	**Performance Indicator**	**Option Retain Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised Version D7**
Social	Fishing and angling – maintain established quality	Good	Good	Good
	Stormwater & drainage , including culverts under highway - function as designed – property drainage issues reduced at low lying Hinehopu/Ruato	Poor - Fair	Fair - Good	Poor - Fair
	Septic tank and soakage fields – function as designed – low lying Hinehopu/Ruato	Poor	Fair	Poor
	– Water Supplies (intakes from Lake) – maintain existing-	Very Good	Poor	Very Good
	Odour – minimise from weed strandings/decomposition	Good	Fair	Good
	Landscape/Visual – maintain existing natural character/landscapes – visual appeal	Good	Poor	Good
	Recreation			
	- Fishing & Swimming from public beaches – maintain/improve access	Fair	Good	Fair
	- Landings,Jetties, ramps, boatsheds – maintain existing access and function	Very good	Very Poor	Very Good
	- Near shore navigation - Maintain boat access to currently frequented bays and navigational channels with adequate draught & clearance depth for a range of users	Very Good	Poor	Very Good
	- Hinehopu Golf Course – improve drainage at 7th and 8th holes	Fair	Fair - Good	Fair
	Summary (Best / Worst Performer)	BEST EQUAL		BEST EQUAL

Performance Measures and Indicators were not able to be weighted through the Web Survey (Mauri Model) – but given the community consultation and feedback there is considerable concern (and therefore perceived high weighting) about any proposed option negatively impacting boat use of lake edge structures (Jetties etc), near shore navigation and stormwater or drainage on low lying properties. (The first two of these 3 indicators require more elevated lake levels and the latter requires lower lake levels). The variable Proposed Option ratings for these social indicators highlight why there are strong stakeholder preferences and potential conflicts.

Note – where ratings for a performance indicator are the same for all 3 options then it can be assumed that gate control/lake level has little impact on that performance indicator ie is essentially a neutral response.

Table 13: Multiple Criteria Analysis of Economic Values.

Economic (Rating: Very Good, Good, Fair, Poor, Very Poor)				
Evaluation Criteria	**Performance Indicator**	**Option Retain Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised Version D7**
Economic	Flooding and Flood Management Lake Rotoiti - do not increase risk of flooding to lake side properties and/or infrastructure such as roads (maintain road integrity)	Good	Good	Good
	Flooding and Flood Management Kaituna River - do not exacerbate downstream flooding by Okere Gate outflows	Good	Fair	Good
	Tourism			
	- commercial rafting/kayaking – maintain existing opportunities (river flows 13-26 m3/sec))	Good	Good	Good
	Geothermal (hot pools) – maintain or enhance function, integrity and access to Manupirua pools	Good	Fair	Good
	-			
	- Lake Tourism ventures – maintain growth	Good	Fair	Good
	Property values –manage lake levels such that property values are not adversely affected	Good	Poor	Good
	Summary (Best / Worst Performer)	BEST EQUAL	WORST	BEST EQUAL

Note – where ratings for a performance indicator are the same for all 3 options then it can be assumed that gate control/lake level has little impact on that performance indicator ie is essentially a neutral response.

Table 14: Multiple Criteria Analysis of Affordability Values.

Affordability (Rating: Very Good, Good, Fair, Poor, Very Poor)				
Evaluation Criteria	**Performance Indicator**	**Option Retain Status Quo**	**Option 4 –Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised Version D 7**
Affordability	Affordability Broad financial impact	Good	Poor	Good
	Summary (Best / Worst Performer)	BEST EQUAL		BEST EQUAL

Table 15: Summary of Multi Criteria Option Evaluation Matrix for Lake Rotoiti.

Option Evaluation Summary			
Evaluation Criteria	**Option Retain Status Quo**	**Option 4 – Low Weir (No Gates Structure)**	**Proposed Option - Gates retained Optimised Version D 7**
Achieve the Project Objectives			BEST
Maori Cultural values		BEST	
Water Quality		BEST EQUAL	BEST EQUAL
Environmental			BEST
Social	BEST EQUAL		BEST EQUAL
Economic	BEST EQUAL		BEST EQUAL
Affordability	BEST EQUAL		BEST EQUAL

Maori Cultural values (based on performance indicators put forward as part of the Mauri Model evaluation process, anecdotal evidence and Kepa Morgan in particular) rate most highly for Low Weir (no gates structure) Option 4. Note lake levels under Option 4 are significantly lower than status quo and recorded historic levels on average.
Note Rivers and Drainage Group recognises that the Proposed Option does not deliver wider beaches on average. However BOPRC already helps provide community opportunities to enhance beach restoration and access via the contestable EEF for vegetation management at appropriate beaches. While not necessarily deemed mitigation under this consent application, local stakeholders including Ngati Pikiao support such an approach.

Water Quality performance indicators rate most highly for No Structure (Option 4) and Proposed Option D7 based on Water Quality modelling which demonstrates least nutrient wall reflux for these options.

Environmental performance indicator ratings for the Proposed Option D7 are marginally better than for the Status Quo and Option 4. The reality is that without long term quantitative scientific monitoring data and information from pre gates and post gates to present day, it is extremely difficult to determine environmental impacts of the options. Dab chicks and wetland health can be predicted to be very good/good under the Proposed Option. Impact on smelt is unknown without analysis of the respective areas of shallow lake margins, but expected to be largely unchanged or slightly improved for Proposed Option. Most other species are unlikely to be impacted by the comparatively modest lake level changes proposed.

Social performance indicators are of greatest concern to stakeholder groups and the most difficult to rectify due to conflicting stakeholder needs. There is essentially no clear best performing option in terms of social impacts. The Status Quo and Proposed Option are largely indistinguishable. Stormwater, surface flooding and drainage issues are of genuine concern to Hinehopu (and to a lesser extent Ruato Bay) lake edge property owners/occupiers. These stakeholders are concerned about any proposed increase in lake levels and naturally favour low lake levels although there is evidence to suggest that these properties will remain at risk even with lower lake levels because of tectonic settlement. Given that the Hinehopu drainage issue has been recognised as a serious concern historically (pre gates) and since Okere Gates installation and the current lake level regime, no mitigation is being promoted. However EBOP and RDC recognise that there needs to be a longer term strategy with the landowners to possibly promote a relocation of these dwellings to a more suitable site.
Lower Lake levels (less than 279.05m) by contrast, can seriously impact accessibility of lake edge structures (jetties etc) and can compromise near shore navigation and thus amenity associated with boating/recreation/lake edge values.

Economic performance indicators are similarly equally rated between Status Quo and Proposed Option D7. There is very little discernable difference between these two options.

5.6.2 Discussion of Results

For Maori Cultural Values (largely based on performance indicators put forward as part of the Mauri Model evaluation process and anecdotal evidence by Dr Morgan in particular) the Proposed Option does not perform as well as the low weir (Option 4) but performs better than the status quo. This is due in part to no improvement with respect to beach width at specific cultural locations under the Proposed Option. However access to waahi tapu sites under the Proposed Option is better than under status quo but not as good as under low weir Option 4. It should be noted that lake levels under low weir Option 4 would be significantly lower than status quo and recorded historic levels on average.

Rivers and Drainage recognise that the Proposed Option does not deliver wider beaches. However BOPRC already assists community groups to enhance beach restoration and access through vegetation management at appropriate locations via the contestable Environmental Enhancement Fund. Local stakeholders including Lake Rotoiti Community Association and Ngati Pikiao already support such an approach.

Water Quality Modelling by Waikato University has demonstrated that Lake Rotoiti water quality (in terms of maintaining nutrient diversion wall effectiveness) is currently good under the status quo, is expected to be further improved (good to very good) under the Proposed Option and is recognised as potentially very good (marginally better than the Proposed Option) under the low weir Option 4.

For Environmental criteria the Proposed Option is deemed to perform slightly better than the Status Quo and the Low Weir Option 4. This is due to marginal improvements in erosion reduction, and marginal benefits to ecology. The reality is that without long term quantitative scientific monitoring data and information from pre gates and post gates to the present day, it is extremely difficult to determine environmental impact of the options. Wetland health and sustainability of dabchick populations can be predicted to be good/very good under the Proposed Option. Impact of the Proposed Option on smelt is unknown but depending on areas of shallow lake margin available for spawning may be very good or at least remain unchanged (good). Most other species are unlikely to be impacted by the comparatively modest lake level changes proposed.

For Social criteria there is on balance, little or no discernable difference (no clear best performing option) between the Proposed Option and Status Quo. Social issues are of greatest concern to stakeholder groups and the most difficult to manage due to conflicting stakeholder needs. Option 4 Low Weir generally does not perform as well as the Proposed Option or Status Quo. Stormwater, surface flooding and drainage issues are of concern to Hinehopu (and to a lesser extent Ruato Bay) lake edge property owners/occupiers. These stakeholders are concerned about any proposed increase in lake levels and naturally favour low lake levels. These properties remain at risk due to tectonic settlement and proximity to wetlands. By contrast lower lake levels (less than 279.05m RL) can seriously impact accessibility of lake margin structures (jetties etc) and can compromise near shore navigation and thus amenity associated with boating/recreation and existing lake edge values. Stakeholders who have interests in lake edge structures and boating naturally favour lake levels closer to the status quo.

Performance indicators for Economic and Affordability criteria are also rated similarly between status quo and the Proposed Option. Option 4 Low Weir does not perform as well as the Proposed Option or status quo for these criteria.

5.6.3 Conclusion

While Option 4 Low Weir provides superior ratings for Maori cultural values and some marginal improvement in rating for water quality (nutrient wall performance), the very low lake levels associated with the option are not considered representative of pre gates situation. The Low Weir Option 4 rated poorly for performance indicators associated with economic and affordability criteria and poorly for several key indicators associated with social criteria.

In summary the Proposed Option is rated better than the Status Quo for performance indicators associated with meeting project objectives, Maori cultural values, water quality and environmental evaluation criteria and therefore supports the selection of Proposed Option (D7).

(Refer Section 9.14 for a summary of effects on the environment of the Proposed Option).

6 Description of Proposed Operational Strategies as at June 2010

6.1 Lake Rotorua Proposed Operational Strategy

Modelling has included a range of possible structural configurations and operations for the Okere Gates. All of these options have indicated very little effect on Lake Rotorua (there is only a weak hydraulic link between Lakes Rotorua and Rotoiti). As a result **it is proposed to keep operating Lake Rotorua in the range of its current consent** keeping levels similar to their current levels. **Figure 18** shows ten years of Rotorua Lake levels since 1998 operated according to the 1996 consent. The proposed operations included in the figure essentially match the current operations (status quo).

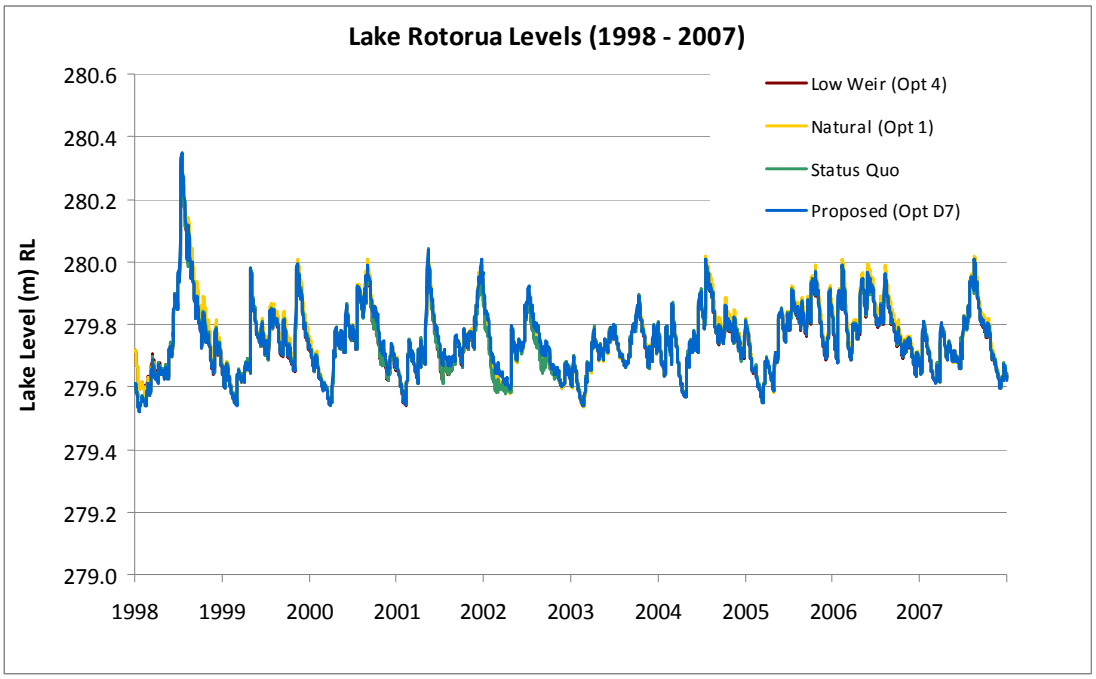

Figure 18: Comparison of Lake Rotorua Levels 1998 to 2008 for different operational options at Okere Gates

Therefore the proposed regime is to operate the Ohau Channel weir structure to ensure, as far as practicable, the level of Lake Rotorua is maintained between the following maximum and minimum levels (all level in terms of Mean Sea Level Moturiki Datum):

- Maximum RL 280.11m
- Minimum RL 279.50m

The lake levels will be managed by installing and removing the stop logs on the Ohau Channel weir structure.

6.1.1 Review and Operational Flexibility

Rivers and Drainage Group will develop operational procedures/guidelines to ensure the Lake levels are maintained within the level and ranges above. Draft operating guidelines for proposed Lake Rotorua operations are outlined in Appendix 5 of the Technical Report (AEE **Appendix 4**). These procedures/guidelines will be reviewed periodically (recommended every three years) possibly by the Rotorua Te Arawa Lakes Strategy Group and/or other representative stakeholder groups.

The procedures will be developed to allow operational flexibility within the above targets.

Operational flexibility within these targets could include initiatives such as rapid drawdown (flushing) to provide short term benefits for water quality if requested and approved via the Te Arawa Rotorua Lakes Programme.

Figure 19 shows the simulated Ohau Channel flow records for the 1998 to 2007 period corresponding to the simulated lake level records in **Figure 18**. As with the lake level records, the channel flows resulting from the Proposed Option (D7) for Lake Rotoiti show very little difference from the status quo outflows.

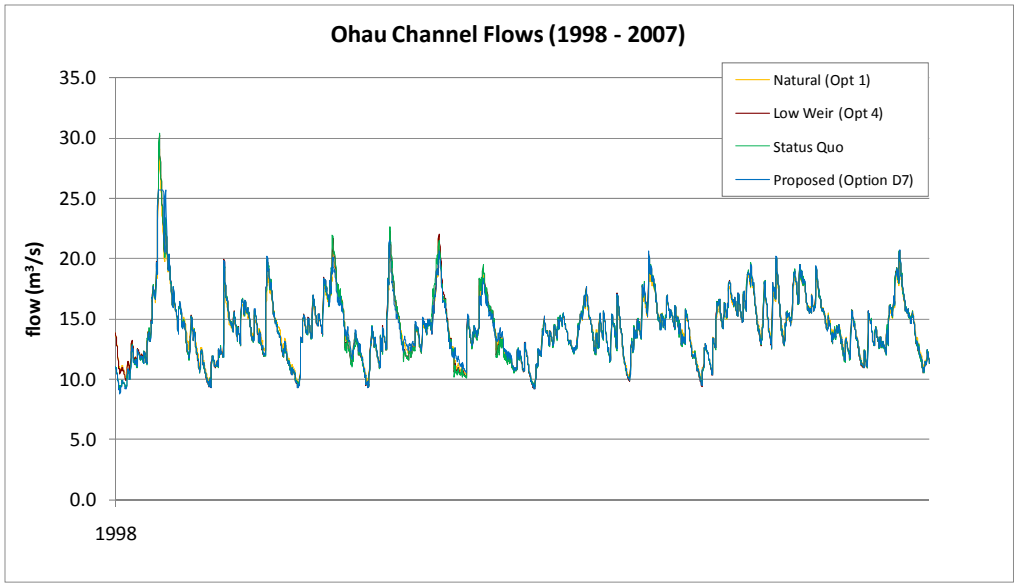

Figure 19: Ohau Channel Flows 1998 to 2007

6.2 Lake Rotoiti Proposed Operational Strategy

Options Considered

As part of the work to identify the proposed operations for the Okere Gates a number of options have been considered, modelled and discussed with the community. The following four options were identified as representing the wide spectrum of options considered. A consistent 10 year period from 1998 to 2007 with the same measured rainfall and inflows to both Lake Rotorua and Rotoiti was used in the different model simulations.

- Status quo. Measured Rotoiti levels resulting from current consented operations.
- Low Weir (Option 4). Simulated Rotoiti levels with the Okere gates replaced with a low stepped weir without restoring the original rock ledge (removed during construction).
- Natural Levels (Option 1). Simulated Rotoiti levels by installing a stoplog structure that replicates the pre-structure Rotoiti outlet morphology (i.e. gates removed and rock ledge reinstated) and the current 10 year rainfall and inflow.
- Proposed Option (D7). Model simulated operations to best meet the varied community goals for Rotoiti levels.

Through the consultation and modelling efforts, the Proposed Option D7 has been refined. The range of the Proposed Option is shown in **Figure 20** below and daily Lake Rotoiti levels over the 10 year period (1989-2007) for each option shown in level hydrograph **Figure 21** (below). The Proposed Option has a slightly wider and more natural range than the status quo. The Proposed Option does not have the variability of low weir (Option 4) or natural levels option but better meets other performance criteria.

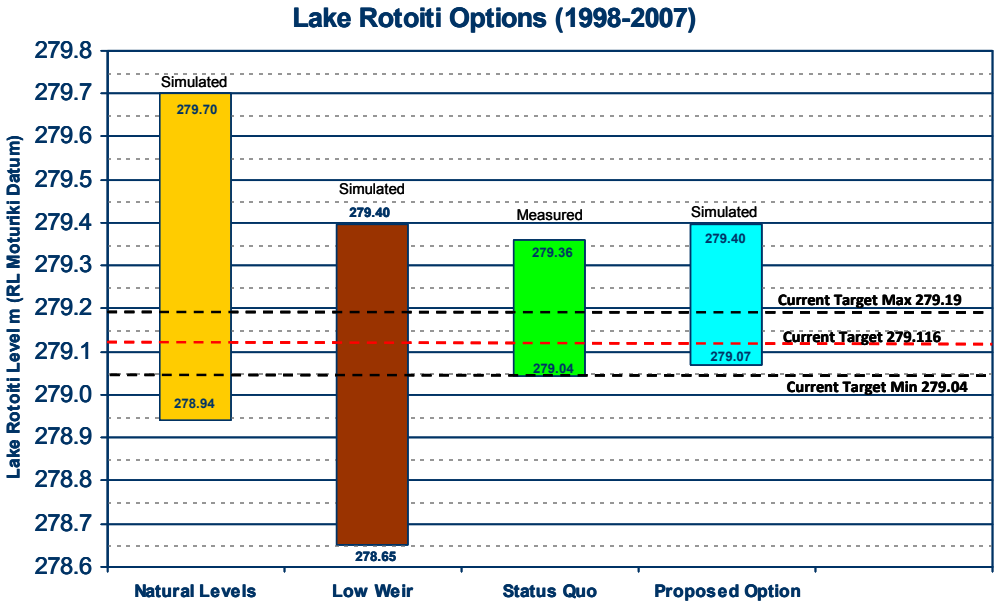

Figure 20: Comparison of simulated ranges for different Lake Rotoiti operational options compared with measured data from 1998 – 2007.

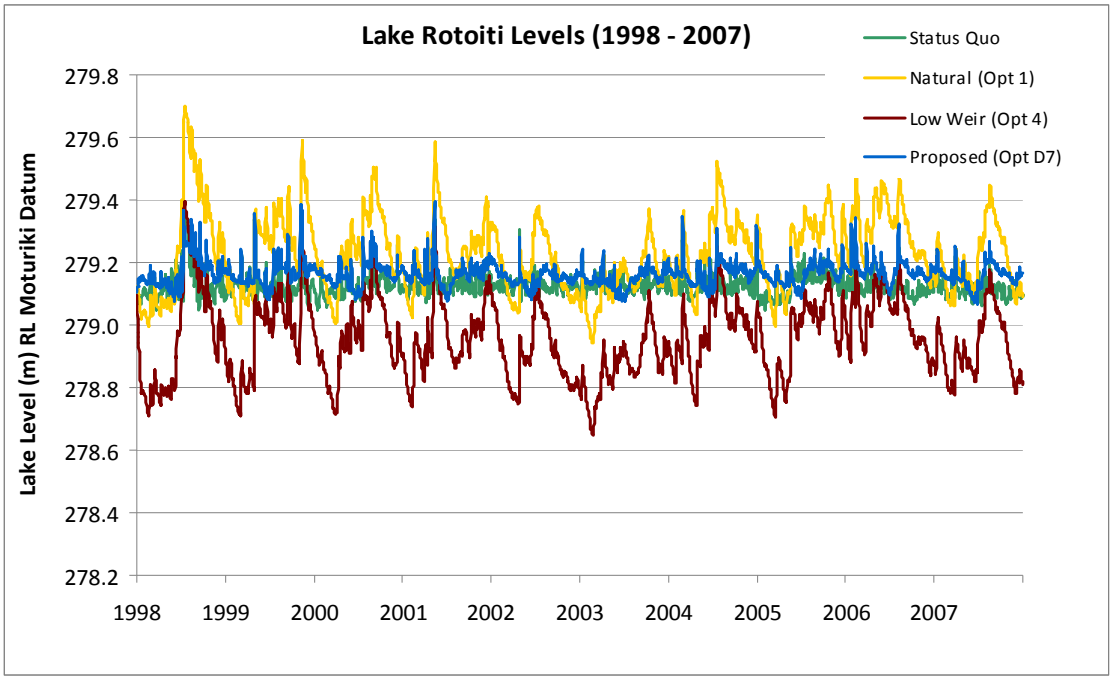

Figure 21: Daily Lake Rotoiti levels over 10 years with different operational options.

Based on the Proposed Option, the operational strategy for Lake Rotoiti controlled by the Okere Gates is proposed as follows:

***Principle*:** Improve environmental and cultural outcomes while not adversely affecting social and economic values. This is achieved by allowing for some seasonal fluctuation within specified target ranges. This differs from the current consented operations which have a static target level with tight variance around the target level

Proposed Maximum and Minimum Levels and Maximum Range and Proposed Operational Levels and Range are (all levels in m RL Moturiki Datum):

- Maximum level of 279.40
- Minimum level of 279.00
- 400mm Maximum Range.

(Note that 90% of the simulated Natural Levels are between the proposed maximum and minimum)

- Allow Operational Levels to rise above 279.25 for a maximum of 5% of each year in significant flood/rainfall events
- Target Operational Range of 200 mm between 279.05 and 279.25 with following target distribution
    - 5 -10% of year between 279.20 and 279.25
    - At least 80% of year between 279.10 and 279.20
    - 5 -10% of year between 279.05 and 279.10 in the months of May/June.

6.2.1 Review and Operational Flexibility

A schematic of the Proposed Operational Strategy compared with the current operational strategy is shown in **Figure 22** below.

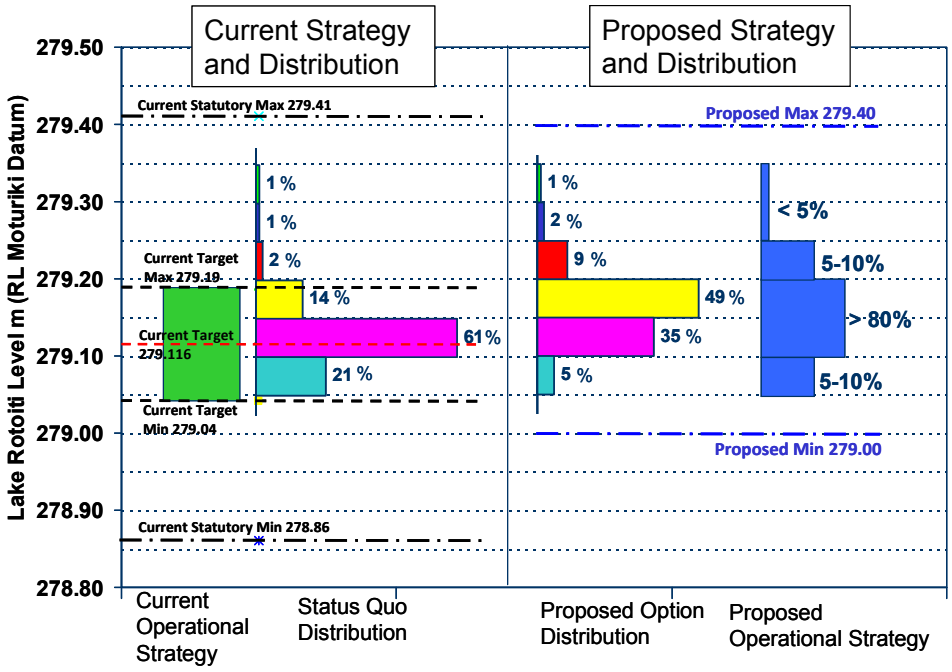

Figure 22: Comparison of current operational strategy and distribution with Proposed Option distribution and Proposed Operational Strategy for Lake Rotoiti.

Rivers and Drainage will develop operational procedures/guidelines to ensure the Lake levels are maintained within the level and ranges above. These will be reviewed periodically (recommended every three years) by the Rotorua Te Arawa Lakes Strategy Group. Draft operating guidelines for proposed Lake Rotoiti operations are outlined in Section 8.4 and Appendix 5 of the Technical Report (AEE **Appendix 4**). The draft operating procedures outline level and flow criteria as well as monitoring and review requirements.

The procedures will be developed to allow operational flexibility within the above targets.

Operational flexibility within the level constraints of these targets could include initiatives such as rapid drawdown (flushing) to provide short term benefits for water quality or flushing sediment if requested and approved via the Te Arawa Rotorua Lakes Programme.

In this respect, it should be noted that due to the relatively large area of the lake and the restricted discharge capacity of the lake outlet, the ability to rapidly draw down the lake level is very limited. In contrast to the operation of hydro-power lakes such as on the Waikato River, the response of the lake level to large changes in lake outflow is typically measured in terms of weeks rather than hours.

The proposed maximum flow to the Kaituna River is 80m^3/sec (same as the existing consent condition).

The proposed minimum flow to the Kaituna River is 7.9m^3/sec. This figure has been proposed as it is the same as the existing consent,), which was supported by Ross Titchmarsh (former Rivers and Drainage Engineering Manager) in his report of 1995:

"Analysis of the flow records indicate that the current minimum flow of 7.9m^3/s is sustainable with the likelihood that it is exceeded 0.0053% of the time".

Thus the applicant seeks to retain that figure set by the Applicant's Engineering Manager in 1995. It is also worth noting that the 7.9m^3/s figure was used as the minimum Kaituna River flow in the previous Water Right 76C (Condition 5.2.2).

The change in flow to the Kaituna River when closing the gates is proposed to not exceed 10m^3/sec per hour (to satisfy the physical constraint of being able to cross the flow instability zone for Okere Gates operation – (refer Section 9.3.3)).

The change in flow to the Kaituna River when opening the gates is proposed not to exceed 10m^3/sec per hour (same as existing consent condition).

Key benefits of the Proposed Option are as follows:

- Slightly more natural range (with target range rather than fixed target level) with some associated cultural and environmental benefits.
- Potentially slightly better water quality in Lake Rotoiti and down Kaituna River.
- Jetties and navigation unaffected by level range.
- Fewer flows greater 40 cumecs down Kaituna River thus reduced erosion and flood risk.
- Slight improvement in number of raftable days.
- Gentle rate of lake level rises being conducive to Dabchick breeding.

Below is **Table 16**, a Statistical Summary and Comparison of Options Assessed. Analysis is based on the number of days between 1 January 1998 and 31 December 2007. The table shows, for each option the period of time lake levels will spend in each 50mm band for a range of levels of particular interest to Lake Rotoiti stakeholders. The blue band represents the target operational range in the Proposed Operational Strategy which will range between RL279.05 and RL279.25. Option periods for status quo, 1906-46 natural and 1906-1981 natural are based on actual recorded daily averaged lake levels. All other option periods have been modelled.

Additional statistical summary information of Lake Rotoiti Levels since 1906 is available in **Appendix 4**.

Table 16: Statistical Summary and Comparison of Options Assessed.

	Proposed Hydrologics D7 - Time within Range over 10 years 1998-2007												10 year Range 1998-2007				1906-1946	1906-1981
Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Opt D7	Status Quo	Low Weir	Natural	Natural	Natural
> 279.400	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	2%	4%
279.350-279.400	0%	0%	0%	0%	1%	0%	0.6%	0%	0%	0%	1.0%	0%	0%	0%	0%	7%	3%	4%
279.300-279.350	0.6%	1%	0%	0%	1%	0%	1.9%	3%	1%	0%	2.0%	0%	1%	1%	0%	13%	5%	6%
279.250-279.300	0.6%	1%	1%	1%	1%	0%	6%	8%	4%	1%	1%	1%	2%	1%	1%	14%	9%	10%
279.200-279.250	10%	4%	3%	6%	8%	1%	5%	29%	12.3%	11%	2%	11%	9%	2%	2%	13%	8.3%	13%
279.150-279.200	75%	54%	34%	25%	26%	8%	26%	51%	76.3%	78%	61%	69%	49%	14%	3%	16%	15%	16%
279.100-279.150	14%	40%	62%	68%	59%	53%	45%	9%	6.3%	10%	33%	19%	35%	61%	6%	12%	17.2%	15%
279.050-279.100	0%	0%	0%	0%	3%	38%	14%	0%	0%	0%	0%	0%	5%	21%	11%	11%	16.4%	14%
279.000-279.050	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	5%	11.0%	10%
< 279.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	63%	1%	13%	9%
Total %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Maximum	279.325	279.346	279.294	279.283	279.397	279.214	279.369	279.338	279.327	279.272	279.387	279.319	279.397	279.361	279.397	279.701	279.546	279.768
Minimum	279.105	279.127	279.118	279.120	279.088	279.069	279.076	279.135	279.135	279.139	279.127	279.129	279.069	279.043	278.650	278.943	278.826	278.826
Median	279.169	279.156	279.145	279.140	279.143	279.106	279.136	279.191	279.179	279.175	279.157	279.168	279.160	279.121	278.948	279.221	279.127	279.159
Mode	279.167	279.156	279.135	279.135	279.138	279.105	279.116	279.202	279.172	279.177	279.153	279.166	279.167	279.119	279.068	279.263	279.089	279.074
Range	0.220	0.219	0.176	0.163	0.309	0.145	0.293	0.203	0.192	0.133	0.260	0.190	0.328	0.318	0.747	0.758	0.720	0.942

7 Consultation

7.1 Purpose

The primary purpose of the consultation to date has been to encourage stakeholder and public buy-in and to support authorisations required under the RMA.

Consultation to date has attempted to assist the stakeholders and the wider community to understand the proposal, issues and mitigation measures. The aim was to obtain feedback on those aspects, and use this feedback at an appropriate level during preparation of the assessment of environmental effects to accompany the applications for resource consent.

A database to record all consultation undertaken on this project between September 2009 and December 2009 was established. A copy of the material contained in the database is included in **Appendix 12.**

Table 17 below details the consultation that has taken place up to the time of writing, with a summary of key issues and feedback.

Notes and minutes of meetings, emails, letters, records of phone conversations, power point presentations, newsletters, media releases up to December 2009 are available in **Appendices 13(i), (ii) and (iii)**. Material post December 2009 is available in **Appendix 13(iv).**

7.2 Tangata Whenua

Rivers and Drainage Group recognised the importance of the management of the lake beds by Te Arawa, and entered a partnership with TALT early in 2009 to help develop the operating regimes for the Lakes.

The Te Arawa Lakes Trust and Regional Council's Maori Policy Section have provided advice on relevant and potentially affected iwi and hapu contacts

Specific consultation with tangata whenua has involved a number of meetings listed in Table 17. Two hui were held in 2009 to specifically discuss different operational options. These were facilitated by TALT, and held with available mandated representatives from individual hapu and iwi, to seek their views on the project.

Meetings were held with mana whenua and tangata whenua at:

- Taheke Marae, Okere Falls, Rotoiti, Rotorua, 2 October 2009
- Te Runanga Tea Rooms, Rotorua, 9 October 2009

The first meeting for Ngati Pikiao was requested by Mr Fred Whata. Mr Whata wanted to present the jurisdiction and history of the Kaituna River flows and Okere Gates. Draft performance criteria developed through the Mauri Model were discussed also.

The second meeting was with Te Arawa Lakes Trust. This meeting focused on the draft performance criteria developed through the Mauri Model.

Three options were presented at each meeting:

- Maintain the existing regimes for both lakes.
- Retain the Okere gates and operate them to provide a wider range of lake levels for Lake Rotoiti, to resemble a more natural lake regime, based on 1906 to 1946 lake level data.
- "Option 4", which replaced the Okere gates, with a low stepped weir to simulate Lake Rotoiti lake levels for a pre-gate scenario.

From these two meetings information and feedback was documented for the purpose of confirming the historic background and to acknowledge the tangata whenua customary and cultural elements, perspective, views and connection to Okere Falls Gates and Ohau Channel sites.

Since these meetings, Rivers and Drainage Group have held two more meetings and a lake visit with Ngati Pikiao representatives, and four meetings with Te Arawa Lakes Trust.

Meetings have also been held with representatives of Ngati Whakaue ki Maketu and Tapuika Iwi.

7.3 Other Stakeholders and the Community

Communication with other stakeholders and the wider community has also been undertaken using the following media.

- Backyard, BOPRC's newsletter which is regularly published and delivered to all households in the BOP.
- Dedicated project pages on BOPRC's website.
- A press release in October 2009.
- Key stakeholder meetings at the end of October 2009.
- A public open day at the end of October 2009 in Rotorua.
- A presentation at the public meeting with the Rotorua Lakes Community Board in October 2009.
- A presentation at the open meeting of the Te Arawa Standing Committee, RDC, in October 2009.
- A workshop with key stakeholders at the beginning of November 2009.
- Notes from the Workshop for 9 November 2009 were sent to participants in November 2009.
- Six e-newsletters sent to stakeholders who had advised they wished to be kept informed of the project, plus BOPRC Councillors, since November 2009.

- Mauri Model web survey on 19 February 2010 sent to stakeholders who had advised they wished to be kept informed of the project.
- Three meetings, two lake visits and two workshops with representatives of Lake Rotoiti Community Association.
- Two meetings with the Te Arawa Lakes Standing Committee.
- Four meetings with RDC (to officers and Works Committee).
- Four meetings with Bay of Plenty Regional Council Committees (3 to RMO, 1 to Maori).
- One meeting with Kaituna Control Scheme Liaison Group.
- One meeting with Todd Energy.
- Two public open days, on 9 and 11 April 2010.

7.4 Detailed Log of Consultation to Date

Table 17: Log of Consultation to Date.

Date	Consultation Activity	Summary of Key Issues/Feedback
4 March 2009	Initial briefing to Te Arawa Lakes Trust Management, TALT Rotorua. Purpose was to brief TALT management on work underway to update consents including review of current operation.	Not applicable
28 April 2009	Presentation of Okere Gates/Ohau Weir Control Structures Consent process to BOPRC Maori Committee.	Refer notes in Appendix 13
4 May 2009	Presentation of Okere Gates/Ohau Structures Aurecon March 2009 Report outcomes to Te Arawa Lakes Trust, Environmental Committee. Rivers and Drainage Group provided a Power Point Results of the Aurecon review were presented to the environmental committee. Presentation included summary of modelling results of Options 1 – 3, benefits and challenges, the proposed programme and process to obtain new consents.	Not applicable
11 June 2009	Presentation of Okere Gates/Ohau Weir Control Structures Consent process to BOPRC RMO Committee.	
29 June 2009	Meeting with Te Arawa Lakes Trust Management, TALT Rotorua Offices.	At this meeting it was discovered that TALT did not own the river/lake bed beneath the Okere Gate and Ohau Weir control structures. Ownership of these river/bed areas is thus presumed to be vested in BOPRC's Rivers and Drainage Group. However TALT are still viewed as major stakeholders and Rivers and Drainage Group will thus continue to work in partnership with the Trust to identify an operating regime acceptable to both parties before consulting with other stakeholders.

Date	Consultation Activity	Summary of Key Issues/Feedback
7 July 2009	TALT Hui, Nukuteapiapi Whare Tupuna.	TALT management presented results of Aurecon Review to trustees and received feedback. It was requested by Ngati Pikiao attendees that Dr Morgan, of Mahi Maioro Professionals Engineering Consultancy, join a working party to be established to progress the consent process in conjunction with Rivers and Drainage Group.
14 July 2009	Hui with Ngati Pikiao at Tupuaeharuru Marae, Rotoiti, on Te Pai Tawhitia Ngati Pikiao and Okere Flood Gates.	Attended by Bill Bayfield (BOPRC Chief Executive) and Ken Tarboton of BOPRC. It was again requested by Ngati Pikiao attendees that Dr Morgan, of Mahi Maioro Professionals Engineering Consultancy, join the working party (refer comments for 7 July TALT hui).
28 August 2009	Modelling of "Option 4" by Aurecon. At the request of Dr Morgan, Aurecon modelled a 4th Option comprising a low stepped weir at the location of the existing Okere Gates. The lowest invert in Option 4 is lower than that modelled in the original stepped weir (Option 2 of the Aurecon March 2009 Report).	Following discussion of the revised draft Performance Measures it was agreed that (i) they provided a sound first basis for presentation to the two hui scheduled for October 2009, (ii) the outcome of the hui, particularly the first meeting (expected to be Te Arawa/Pikiao trustees), could change draft Performance Measures, (iii) the draft performance measures are to be forwarded onto Hydrologics for optimisation. Any subsequent changes to draft Performance Measures resulting from the hui and other stakeholder consultation will 'fine tune' the optimisation results, (iv) Results of optimisation could be used as the basis of the AEE that Opus need to get underway in order to meet the consent lodgement deadline of end of 2009 (v) The Okere gates would probably be retained since a more variable operating range (approaching a more natural regime) could have more positive environmental effects.
2 October 2009	Hui at Taheke Marae, Okere Falls Road, Okere for Ngati Pikiao.	As result of feedback at the hui, the operating regime was further refined. Agreement to retain the Okere Gates, but operate them to create lake levels and flows to the Kaituna River that more closely match the pre-gates regime. For Ngati Pikiao, beaches have been a traditional pathway and they are seeking approximately 3m wide beaches at 9 key Lake Rotoiti locations. Ngati Pikiao in particular contend that the lake levels have been artificially raised by the operation of the Okere Gates since their installation, removing beaches & covering significant land marks. Ngati Pikiao want to see a return to more natural fluctuating lake levels which they suggest will lead to a return to wider beaches.
7 October 2009	Meeting with RDC, Peter Guerin, Tracey May and Peter Dine to update RDC on consent process and consultation.	Discussion around the number of private structures around the lakes, and the way these are managed in terms of leases and consents. Ownership of the space within which the lake water sits and the airspace above the lakes are LINZ.
9 October 2009	Hui at Te Runanga Tea House - Government Gardens Rotorua for TALT.	As a result of feedback at the hui, the operating range was further refined. Agreement to retain the Okere Gates, but operate them to create lake levels and flows to the Kaituna River that more closely match the pre-gates regime. The starting point for the applications should be a lowest lake level for Lake Rotoiti at approx 500mm lower than the current lower target level – this was based on anecdotal evidence that the lake levels historically were approximately this much lower than they are now. Recognition that all stakeholders were to be involved in the lake level decisions.
19 October	Presentation to Te Arawa Lakes Standing	Increasing the depth of Lake Rotorua should be considered. Commercial operators of Lake Rotorua need to be

Date	Consultation Activity	Summary of Key Issues/Feedback
2009	Committee of RDC – this presentation was based upon the Hydrologics Model developed 18 October 2009.	invited to the open day. Downstream flooding effects need to taken into account. Concerns about how a wide range will affect erosion around lakeshores of Rotoiti and the health of aquatic plants. Tuhourangi Iwi should be included in consultation.
28 October 2009	Stakeholder meetings – presented with the regime as proposed on 27 October 2009.	- rafters are more concerned about the flows than the lake levels - kayakers prefer a natural range of lake levels - rafters noted that their operating times are longer in the summer due to daylight saving - boat access may become an issue with lower lake levels - the effects on wetlands of a wider range of lake levels is not known - water quality is one of the major issues for Lake Rotoiti – further work is required, including discussing with David Hamilton of Waikato University the effects of a lowered level on the functioning of the Okere Diversion Wall - with lowered levels, jetty access is the biggest concern to lakeside property owners - septic tanks will all be gone in the short term, therefore not as important an issue as others - jetty access is not being given a high enough weighting compared to the importance of other issues for Lake Rotoiti - minimum level proposed for Lake Rotorua of RL 279.5m appeared to be too low - BOPRC need to be more pro-active in their management of stop logs in the Ohau channel weir during summer so that the levels do not fall as low.
28 October 2009	Open Day - presented with the regime as proposed on 27 October 2009.	- why was the lowest proposed level for Lake Rotoiti of RL 278.6 so much lower than the lowest historical level of approx RL 278.9? - proposed range too low and too wide - why change from the existing regime? - how would riparian rights be affected by the lower lake levels and widened beaches - jetty owners had just been required to obtain consents from BOPRC for jetties and structures in the lake. Would BOPRC allow variations to these structures and dredging of lake under the proposed operating regime? - What will be the economic impact of the proposed range on property values of lake edge properties?

Date	Consultation Activity	Summary of Key Issues/Feedback
		- Property values round edge of Lake Rotoiti will drop - estimated value of jetty to a property is $100,000 - have the effects of the proposed range on water quality been assessed? - lowered levels would result in navigational hazards e.g. sandbanks, reefs - lowered levels to Lake Rotoiti would impact on the Rotorua economy as fewer people would wish to visit - is there an alternative means to create beaches than widening the lake levels? Could spray be used to remove vegetation and widen beaches? - will rates be lowered if the property values are re-assessed and are less if the jetties cannot be used? - will BOPRC compensate owners of jetties for loss of property values if jetties become un-useable? - why use the Mauri Model? - commercial boat operators on Lake Rotoiti would be affected by the proposed lake level changes - there will be adverse effects on swimming, safety of users - weeds will be exposed and rot causing odour - Some sort of middle ground needs to be reached – proposed range is too large - the existing range is too narrow, some land never drains - better management of the Okere gates to control flooding downstream is required.
29 October 2009	Rotorua Lakes Community Board - presented a summary of material presented at the Open Day.	The increased lake level range will have a serious impact on the use of jetties, boat ramps and boat sheds.
9 November 2009	Mauri Model workshop to develop performance criteria with a range of key stakeholders present. Time constraints unfortunately meant that performance criteria were not completed.	New draft performance indicators were collected for the 4 well beings. Attendees will be asked to complete the determination of criteria themselves in 2010 – Dr Morgan to provide material for this. Many concerns were raised, including lake water quality effects, effects on the operation of the Ohau Diversion Wall, lack of consultation with the community, why is Lake Rotorua not being changed the same as Lake Rotoiti? Property values may be affected by the process, e.g. $60-80 million could be wiped, effects on jetty, ramp and boat shed use etc.

Date	Consultation Activity	Summary of Key Issues/Feedback
		Rafters noted that there were approximately 96 jobs generated by the industry, and it contributes approx $13M annually to the local economy.
23 November 2009	RB met with Maria Horne from Ngāti Whakaue ki Maketū , and Graeme Dobson, Ray Bushell, Greg Rolleston, Councillor Kevin Marsh (WBOPDC).	Would this AEE be extended to include the effects on the reach downstream of Okere Gates to the Maketū Estuary river mouth? Was a cultural assessment going to be included for the above? Ray Bushell wanted more water in the Wildlife Management Reserve and further downstream to Maketū. Water Quality should be assessed downstream of Okere Gates too. It is understood that Dame Sylvia Cartwright said in a High Court ruling sometime ago that WQ effects for Lakes Rotorua, Rotoiti and Kaituna River should be assessed together and not in isolation.
3 December 2009	Presentation of draft consent proposals to members of the Regional Council's Rotorua Lakes Technical Advisory Group (TAG), BOPRC's Rotorua Office.	Endorsement of further Water Quality modelling to be carried out by Professor David Hamilton, Waikato University after Rivers and Drainage Group have confirmed their preferred operational regime for Lake Rotoiti.
18 January 2010	Meeting with Todd Energy re: Kaituna Hydro Scheme.	Rivers and Drainage Group originally request feedback on how Okere Gates had performed from all stakeholders including Bay of Plenty Energy on 9 February 2009. Todd Energy (who owns Bay of Plenty Energy) did not respond because of issues it had encountered related to its proposed new hydro scheme on Lower Kaituna River. Rivers and Drainage Group outlined the status of the consent application as of December 2009, including background and reasons for nominating the 800mm placeholder lake level range in application. Todd Energy indicated they planned to lodge consent for a 13MW hydropower scheme during mid-2010.The current design was based on status quo lake level operations. It was agreed between Todd Energy and Rivers and Drainage Group to keep the two consent processes separate. Todd Energy would assess the impact of the proposed new lake level operation on their own proposed hydropower scheme.
9 February 2010	RMO Committee Meeting.	Rivers and Drainage Group update to RMO Committee. Recapped on what was presented in the December 2009 AEE i.e. the 800mm "blue band", also referred to as the "starting point" range. Presentation showed the v6 and likely refined range being 335mm to 400mm between 278.8 and 279.2, retaining the current 800mm consented range between 278.6 and 279.4 Intention was to complete the Mauri model web survey and have two public meetings on 5th and 7th March 2010. WQ modelling would be done on the preferred option.
12 February 2010	Meeting with Manawhenua (Ngati Pikiao & others e.g. Sandra Eru), R Britton, Rotorua.	Several views were expressed: 1) that raising levels in Lake Rotoiti would be a retrograde step for Rivers and Drainage Group to take. Lower lake levels were requested to expose beaches for inanga. Local iwi requested lower

Date	Consultation Activity	Summary of Key Issues/Feedback
		levels in acknowledgment of their rights under the Treaty of Waitangi. 2) water now laps the edge of SH30 at Hinehopu - it didn't before the Okere gates were constructed. Ngati Pikiao were not consulted on original flood mitigation measures for Lakes Rotorua and Rotoiti (i.e. Ohau weir, Okere gates, Ohau channel widening). The Ohau Channel re-alignment and widening (in early 70's) has resulted in sedimentation and velocity reduction. Can velocities be increased and gravel placed in bed of Ohau Channel? 3) Current consent conditions were written for jetty and boat owners 4) Can Okere gates be opened under a trial basis during winter? WQ is important. Some WQ treatment occurs downstream of Okere Gates due to turbulence. 4) Reduction of sediment could be made part of the Kaituna Asset Management Plan 5) Ngati Pikiao would vote for someone to represent them when required 6) Iwi's requirements would be reflected in the process as performance measures used to determine the preferred operation for Lake Rotoiti.
28 February 2010	Rivers and Drainage Group attend Ngati Pikiao hui to observe hapu complete Mauri Model web-survey.	Rivers and Drainage Group attended hui as it was invited to observe trust election process. Dr Morgan told Ngati Pikiao (NP) that the NP and TALT option of choice was Option 4 (low weir) although the optimised option could be a possibility. The NP choice conflicted with ratepayers choice to retain the status quo. Fred Whata said flow in Ohau Channel used to be faster and now there were nutrients and phosphorus in channel bed. Fred Whata called for Okere Gates to be lifted and perhaps removed and Lake Rotoiti left to find its natural level. Selection of the preferred operation had not taken account of iwi interests and NP's last option would be to place a claim on Kaituna River under Treaty of Waitangi. Toby Curtiss believed that 1 or 2 options needed to be put before the Minister. Rivers and Drainage Group responded saying it was following the RMA process with much consultation with NP and TALT. Dr Morgan's contract with Rivers and Drainage Group ended with conclusion of Mauri Model web survey. The NP hui resolved: to initiate direct negotiation in the political process through Te Arawa to come up with several options to improve the water quality of lakes through Management or removal of Okere Gates. Dr Morgan suggested to the hui that they may need to comeback and remove Ohau Weir after resolving Okere Gate issues. Joe Malcolm was concerned that some urupa were submerged and that this needed to be resolved. Rivers and Drainage Group would address this concern. Separate discussion between Rivers and Drainage Group and individuals: Dr Morgan said he was mandated by NP to complete the iwi's Mauri Model survey form on their behalf. Rivers and Drainage Group said use of the Mauri Model was being questioned on all sides and that Rivers and Drainage Group could not continue to support it.
1 March 2010	Te Arawa Lakes Standing Committee Meeting.	Purpose was to update the Standing Committee. Reported that status quo was likely to be retained for Lake Rotorua. For Lake Rotoiti the 800mm placeholder level range was being refined and Rivers and Drainage Group expected it to be narrower 335-400mm between 279.8 and 279.2. It was intended that results from Mauri Model web survey would be used in the optimisation process to help develop the preferred operating range. There were cultural, ecological, social and economic benefits to be gained by adopting a more naturally fluctuating lake level operation. The v6

Date	Consultation Activity	Summary of Key Issues/Feedback
		optimised option was displayed at this meeting as an example of how a new operation might appear. WQ modelling would be done on the preferred option before final endorsement and inclusion in the notified consent.
5 March 2010	Lake Rotoiti Community Assn Inc & others meeting.	Key points from Rivers and Drainage Group presentation: Mauri Model, is a good concept to balance well beings but has been extremely complicated to implement. The Mauri Model web survey was sent to numerous parties (approx 200) with only 20 on-line responses and one collective survey form received from Ngati Pikiao. The survey had not necessarily produced satisfactory weighting for hydrologic optimisation. The Mauri Model performance measures were being grouped and simplified for further use with applicant's best professional judgement on weighting. Small group consultation is being held to get input to simplified performance measure weightings. Final operation will be based on outcome of consultation, all modelling and best technical judgement. Options to be assessed are status quo, Option 4 (no gates) and the optimised operation Key points from discussion:1) original list of 35 performance measures had been rationalised/simplified down to 13, which included 3 rules meaning we now had 10 to work with. 2) LRCA response included a PPoint presentation in which status quo was requested because it had worked well since 1996 without reducing WQ. 3) LRCA believed it was difficult to assess fully the preferred optimised option without seeing WQ modelling results. Social and land valuation impacts also needed to be assessed before approving. 4) Rivers and Drainage Group used the Mauri Model to get the 'first cut' PM's but the preferred option could not be finalised until optimised. 5) Ratepayers money was being used to fund this re-consenting process and Rivers and Drainage Group have put one stakeholder ahead of others. 6) LRCA state that without a doubt lake levels were higher than that claimed by iwi 7) Rivers and Drainage Group suggested some weightings to LRCA for their consideration with more natural level range. However LRCA claimed the problem with the original consent was the more natural lake level range (causing flooding/droughts) 8) LRCA concluded that in the absence of robust modelling it was best to stick to status quo. Also beaches could be recovered by other means without fluctuating the lake level.
7 March 2010	Ngati Pikiao Hui at Takainga Marae – cancelled.	Not applicable.
15 March 2010	RDC Works Committee Meeting.	Rivers and Drainage Group gave a similar presentation to RDC to that given to Te Arawa Lakes Standing Committee on 1 March 2010.
26 March 2010	Meeting Ngāti Pikiao, LRCA,BOPRC.	TALT were not invited to this meeting called by NP. First part of the meeting excluded Rivers and Drainage Group. Purpose was for LRCA and NP to discuss their different views such as differences between recorded lake level data

Date	Consultation Activity	Summary of Key Issues/Feedback
		and anecdotal evidence and reasons for disappearing beaches etc. Second part of the meeting included Rivers and Drainage Group who presented the preferred option (at that time). All agreed that WQ was the most important performance measure which must not be compromised whatever operating option was finally selected. The preferred v7 option presented would be presented at the 9 and 11 April 2010 Open Days. Preliminary WQ modelling of the Hydrologics v6 option, low weir and status options indicated WQ resulting from the v6 and low weir were better than the status quo. It was explained that the Mauri Model web survey did not produce a single set of weightings that could be used for optimising. Survey results indicated preference was for a more natural lake level range. Ngati Pikiao results indicated a maximum lake level of 278.9 which compared to the on-line results which preferred the current narrow operating range. Secondary maximum and minimum boundary levels were endorsed. This would replace the existing consented maximum and minimum levels and provide a safeguard against levels unacceptable to the wider community. Ngati Pikiao requested that the cultural and ecological benefits be directly related to the proposed operation.
9 April 2010	Public Open Day No. 1 Weekday.	The purpose of the Open Day's was to present the current preferred operation to all stakeholders. The key points were: 1) Lake Rotorua operations remain as status quo, 2) preferred option for Lake Rotoiti is to widen the target range from current 150mm to 300mm without a target level 3) WQ modelling of the v6 showed the preferred operation and low weir options improved WQ in Lake Rotoiti. 4) The preferred operation (the v7) comprises: a) maintaining current consented max and minimum levels b) 80% of time between 279.05 and 279.2 c) 15% of time between 278.90 and 279.05 d) recognising in extreme droughts or floods levels rise below or above target ranges for a short time. General comments on Open Days: Some stakeholders did not attend such as NP and TALT. Generally wider range of about 300 mm accepted. Lakeside residents question lower band and indicate problems with navigation and jetty access for Rotoiti levels below 279.1m Feedback from boat owners was that they were unhappy with amount of time below 279.05 particularly during peak summer and autumn usage times (21% in January, 43% in February, 58% in March 41% in April and 19% in May). Mr Michael Gill noted that there was a discrepancy between Rivers and Drainage Group level data for Lake Rotoiti and his own readings of the staff gauge. Rivers and Drainage Group subsequently checked data and found some adjustments needed to be made to level data for both Lake Rotorua and Rotoiti. Adjustments were related to tectonic settlement. Model data was updated and models re-run. Push to work towards more natural range in Lake Rotoiti that is higher than current range.
11 April 2010	Public Open Day No. 2 Weekend.	as above.
15 April 2010	TALT Executive Update Meeting at BOPRC Whakatane.	Purpose was to update TALT Executive on content of the Open Day presentations and Mauri Model web survey. Respondents of the Mauri Model websurvey generally preferred more natural water levels and considered WQ most important in selection of a new operational strategy. A common question asked at Open Day's was: why change the status quo to which Rivers and Drainage Group responded - to achieve widest community benefit. TALT Executive

Date	Consultation Activity	Summary of Key Issues/Feedback
		acknowledged that Rivers and Drainage Group had worked through a process with TALT from the beginning of the project but believed the Trust would prefer a trial of the Okere gate opening. Rivers and Drainage Group response to a trial was that it would require a separate consent and therefore not be possible.
23 April 2010	Rivers and Drainage Group site meeting with LRCA at Hinehopu.	Purpose was to visit Hinehopu and assess the issues & impacts relating to raised lakes levels. Local resident Phil Thomas took representatives of LRCA and Rivers and Drainage Group around properties & described problems. Key points included: 1) Ground around dwellings was damp at current target lake level of 279.116. 2) Several properties had imported fill to raise ground level and it seemed RDC required some houses to be raised. 3) A creek runs behind houses in Tamatea Street. On the day the water level was at ground level. When RDC cleared creek discharges improved. 4) Ground became more spongy when lake level was above target level. 5) Apparently some timber components above their existing skids were removed in 1979/80. This could be a counter argument to the claim that Lake Rotoiti level had increased and thus drowned the skids. 6) The Hinehopu Gold course was already swampy at the 7th and 8th holes during the 1990's when the course was developed.
26 April 2010	Rivers and Drainage Group Presentation to Te Arawa Lakes Standing Committee.	Purpose was to update the lakes Standing Committee on content of the Open Day presentations and report subsequent feedback. Further consultation with key stakeholders was being undertaken to help Rivers and Drainage Group to refine its preferred operation.
29 April 2010	BOPRC CEO/TALT Chair meeting.	BOPRC CEO and Rivers and Drainage Group GM met with TALT Chairman. Purpose was to hear what key issues still remain for TALT and Ngati Pikiao. TALT was concerned that some views were being spread amongst its constituents that were not official TALT views. The consent needs to have acknowledged issues relevant to Ngati Pikiao. Ngati Pikiao has had significant influence on this consent process starting with hui held at Tupuaeharuru marae in July 2009. TALT has been recognised as a partner rather than another voice in this process. issues such as beach recovery could be addressed separate from this consent.
5 May 2010	RMO Committee Meeting.	Purpose was to update the RMO Committee on content of the Open Day presentations and report subsequent feedback. Further consultation with key stakeholders was being undertaken to help Rivers and Drainage Group to refine its preferred operation.
6 May 2010	Maori Committee Meeting, Mataikotare Marae, Rotokawa.	Purpose was to update the Maori Committee on content of the Open Day presentations and report subsequent feedback. Further consultation with key stakeholders was being undertaken to help Rivers and Drainage Group to refine its preferred operation.
6 May 2010	RDC Technical Staff Briefing, Rotorua.	Rivers and Drainage Group asked RDC what their view was on potential raising of Lake Rotoiti level under potential future operation. RDC's view on mitigation for Hinehopu was also sought. Rivers and Drainage Group showed RDC survey analysis of Okawa Bay, Town Wharf and Hinehopu bench marks. Town Wharf benchmark had risen by 71mm

Date	Consultation Activity	Summary of Key Issues/Feedback
		relative to Okawa Bay, Hinehopu benchmark had settled by 76mm relative to Okawa Bay and Okawa Bay itself had settled 34mm. Key Points were that RDC: 1) classified Tamatea St as a hazard zone and debate should not be on how to mitigate but how to stage withdrawal of houses from this area. 2) RDC considered provision of mitigation for Tamatea Street of little value and that RDC shouldn't really allow any further development. RDC will seek to discourage further development via the District Plan. 3) RDC have commissioned GNS to undertake a hazard assessment of the area to support a case to eventually abandon Tamatea St in future. 4) Development and mitigation by lowering ground water levels may conflict with ecological aspects especially Hinehopu wetland. 5) Peter Dine supported a much wider lake level range than current status quo range.
7 May 2010	CEO's Meeting: TALT/RDC/BOPRC.	Changes had been made to the data, modelling and a new preferred operation developed that took account of all new consultation received since the April 2010 Open Days. Purpose was to present the new information and the preferred option using datum corrected data to the CEO's and Chair of TALT and LRCA. Operations to Lake Rotorua would remain as before i.e. retain status quo. However a new preferred operation (the B5) for Lake Rotoiti was presented. Key points were: (1) Levels in Lake Rotorua cannot be controlled and thus fluctuate naturally with little control over flood peaks or extreme lows. (2) Lake Rotoiti operations have little effect on Lake Rotorua levels (3) Lake Rotorua had become shallow due to sedimentation and tectonic settlement and mitigation should be independent of this consent application (4) the preferred (B5) operation would comprise < 5% between 279 to 279.05, > 90% between 279.05 to 279.25 and < 5% between 279.25 to 279.4 (5) Preferred operation is more natural. Concerns surrounding low levels have been addressed however little can be done to protect Hinehopu from the peaks as time spend > 279.25 is similar for all options. (6) Hinehopu is settling and drainage mitigation should be addresses separately outside of this consent application. Key feedback from attendees included: 1) RDC agreed with proposed B5 option 2) LRCA made a PPoint presentation and in summary wants: • Natural average levels recognising 1906 to 1981 is most reliable reference • > and = 95% of all levels Above 279.1 • Regime that builds in storage volume and maximises water quality • BOPRC's assistance to model the FLUSH model including water quality modelling • Operational regime as an integral part of the consent 3) All agreed that status quo should remain for Lake Rotorua operations 4) Given there was 50mm difference between Rivers and Drainage Group 's minimum level of 279.05 and LRCA's minimum level of 279.10 suggested that agreement should be possible. 5) TALT requested that LRCA discuss with and come to agreement with TALT as to suitable operation otherwise the process would falter.

Date	Consultation Activity	Summary of Key Issues/Feedback
11 May 2010	Optimising Workshops with LRCA Representative, Whakatane.	LRCA came to Rivers and Drainage Group Whakatāne office to observe Hydrologics optimisation model working and contributed towards discussions in model development. At the end of the session the preferred option called the C3_1 was developed, one which LRCA could possibly work with. The proposed C3-1 operation comprised: Seasonally fluctuating wider range (more natural). Target operating range of 200mm between 279.05 and 279.25 m (> 95% of time). <15 % of time below 279.1 m, in late summer (May and June). < 5% of time above 279.25 (in extreme events).
18 May 2010	Tapuika Iwi, Te Puke.	Rivers and Drainage Group met with Hohepa Maxwell, of Tapuika Iwi Authority (TIA) in their Te Puke office. Tapuiki iwi are in post treaty settlement mode and expect to number 3000, representing up to 10% of TALT in the future. Mr Maxwell believed this potential future representation gave them right to be heard in this current consent process. TIA are particularly concerned about WQ in Kaituna River. BOPRC scientists claimed phosphorus loading in Kaituna River was diluted by the time flow reached Paengaroa however TIA scientists disagreed. Key points for TIA were 1) any variances in flow should not adversely impact WQ in Kaituna River 2) river flow should be more natural 3) river flow should not worsen flooding 4) BOPRC and TIA scientists should get together and endeavour to reconcile their differing views on WQ in the Kaituna River.
19 May 2010	TALT/BOPRC/LRCA Meeting, Rotorua.	Given that M19 option was unsatisfactory Rivers and Drainage Group adopted the C3_1 as its preferred option and presented this at the meeting held in Rotorua. The operating strategy of the C3_1 was compared to the previously proposed B5 (shown at the 7 May 2010 meeting). Also presented for first time was the natural option (1998 - 2007). This option modelled by Aurecon represents Rivers and Drainage Group best estimate of pre-gate lake levels and is preferred over the low weir option as the better replication. Regular operational review (every three years) to allow operational flexibility. Key points from ensuing discussion were: 1) confirmation that status quo would remain for Lake Rotorua operations 2) little can be done to reduce flood peaks in lake Rotoiti which were same for all options 3) shallowing at Town Wharf and settlement at Hinehopu and drainage issues needed to be dealt with outside this consent 4) CEO's & Chairs agreed need to work quickly to come to agreement and notify consent 4) permission given to agree to disagree but that differences documented in AEE. 5) General agreement was that the operational strategy should be reviewed and reported on regularly say every 3 years. 6) WQ was important and good baseline data was available for the lakes and Kaituna River. Need to monitor, and report on WQ following implementation of operating strategy 7) Was option environmentally sustainable? had environment changed since current consent implemented and what might change in future as result of new operation? 8) Ngati Pikiao's Fred Whata wanted to trial Okere Gate opening for a period of time, letting lake find its

Date	Consultation Activity	Summary of Key Issues/Feedback
		own level. The Ohau Channel and Okere Arm and silted up and a gate opening might flush out the silt build up. Fred believed that WQ had deteriorated since Okere Gates built. 9) LRCA would not endorse a open ended gate opening. WQ was most important to LRCA and Rivers and Drainage Group had taken adequate steps to ensure no reflux occurs in its modelling. 10) Rivers and Drainage Group would be prepared to do some dredging as part of the Kaituna scheme and asset management planning. Flushing might also be considered provided it benefitted WQ and was achievable within consent conditions. Natural level fluctuation would be better than long term gate opening as the latter could cause floods and droughts 11) A trial opening would require separate resource consent and impacts would need to be assessed. Although trial opening culturally advantageous it would be difficult to balance other three well beings and meeting RMA requirements would be difficult. 12) Returning to more natural state would require reinstatement of a rock ledge that was excavated downstream of the gates prior to its construction. 13) Suggestion was made to combine a flush with dredging to get best return. Flush would involve lifting Okere gates and Ohau weir stoplogs. 14) Notion of flush/dredging should be made subject of a separate study and be undertaken outside of this consent project. 15) Mutual agreement for TALT to work together with LRCA, people did not want to go to Environment Court over this consent. Apply common sense and compromise. Enough korero now need to move on. 16) TALT would like to hear final proposal and understand it enough to explain to constituents.
26 May 2010	Kaituna Catchment Control Scheme Liaison Group Meeting.	Purpose was to update the Liaison Group of developments in the Okere Gates consent application and proposed operation. Further refinement of the C3-1 model resulted in the new Proposed Option (D7) option which is Rivers and Drainage Group final preferred option and the version that will be included in its notified consent. The Proposed Option (D7) option comprises: at least 95% of the time between 279.05 and 279.25 and less than 5% of the time between 279.25 and 279.40. The operational strategy is yet to be confirmed.
9 June 2010	RMO Committee Meeting.	Purpose was to update the RMO Committee of developments in the Okere Gates consent application and proposed operation. The Proposed Operational Strategy based on modelled Proposed Option (D7) is Rivers and Drainage Group's final preferred option and the version that will be included in its notified consent planned for September 2010. Key points: 1) Lake Rotorua operation remains as per status quo with some flexibility to install and remove the Ohau weir stoplogs to allow for operational flexibility and more flexibility in maintaining downstream Lake Rotoiti levels without impacting lake Rotorua levels. 2) The proposed option was compared with natural, low weir and status quo options. The aim of the proposed option is to maximise benefits to the wider community. 3) Further extensive consultation had occurred since the consent was lodged in December 2009. Model refinements took into account feedback received from stakeholders since the 9 and 11 April 2010 Open Days. 4) Benefits of the Proposed Option (D7) are noted 5) The Proposed Operational Strategy based on Proposed Option (D7) option is: • Maximum level of 279.40

Date	Consultation Activity	Summary of Key Issues/Feedback
		• Minimum level of 279 (Note that 90% of the simulated Natural Levels are between the proposed maximum and minimum) • Allow levels to rise above 279.25 for a maximum of 5% of each year in extreme events • Target operational range of 200mm between 279.05 and 279.25 with following target distribution • 5-10% of year between 279.20 and 279.25 • At least 80% of year between 279.10 and 279.20 • 5-10% of year between 279.05 and 279.10 in the months of May to July. Review and Operational Flexibility It is proposed that a regular (every 3 years) review of this operational strategy is undertaken to allow operational flexibility within the above targets. Operational flexibility within these targets could include initiatives such as rapid drawdown (flushing) to provide short term benefits for water quality if requested and approved by the Te Arawa Rotorua Lakes programme. 6) WQ modelling is being done on all the options namely the Proposed Option (D7), status quo, low weir and natural options 7) The consent will be lodged in July 2010.

7.5 Summary of Feedback Received During Consultation

Summaries of open day feedback forms, a petition (22 signatures) collected from absentee owners of properties on Lake Rotoiti and presented by the Rotorua Lakes Community Board, records of telephone calls, copies of emails and letters, up to and including December 2009, are provided in **Appendices 13(i), 13(ii) and 13(iii)**. Material post December 2009 is included in **Appendix 13(iv).**

During the consultation process the community, represented by the groups consulted, has expressed aspirations. For completeness the sections below list key points or positions that show what Rivers and Drainage Group have heard the community wants. These positions represent Rivers and Drainage Group's understanding of the view of those involved in the consultation and is presented without prejudice as they do not necessarily represent the official view of that particular group or agency. When the consent is notified there will be opportunity (four week submission period) for agencies or groups to submit and present their official viewpoints.

The community aspirations have been considered in modelling undertaken to develop the Proposed Option for Lake Rotoiti from which the Proposed Operational Strategy for Lake Rotoiti has been developed. Due to the diverse nature of the community desires the Proposed Option and operational strategy does not meet all community desires, however it does attempt to meet the most important aspects and produce an operational strategy that the community "can live with". A number of the community requests can be met outside of this consent, and these are discussed further in Section 9 of this report.

7.5.1 Te Arawa Lakes Trust

- An open and transparent process.
- Environmental sustainability supported by all.
- Consideration of environmental and cultural aspects in the process.
- More natural regimes for the lakes and the Kaituna River.
- Better water quality in the lakes and the Kaituna River.
- Regular review of the proposed operations through the Rotorua Te Arawa Lakes Strategy Group.

7.5.2 Ngāti Pikiao

- Removal of Okere Gates, or at least lifting of the gates to allow Lake Rotoiti to find its natural levels with the gates fully open.
- A trial of the above operations.
- Modelling of removal of the gates scenario (note that Lake Rotoiti levels and the range of their levels for this scenario are represented by the Low Weir Option).
- Return of beaches.

- More flow though Ōhau Channel.
- Consider dredging of Ōhau Channel to increase flow.
- Operational ability to flush the Ōhau Channel.
- Natural flows in Ōhau Channel and Kaituna River.
- Better water quality for both Lake Rotoiti and Kaituna River.
- Consideration of the effects of high lake levels on the operation of septic tanks.
- Enhancement of trout and smelt habitat.
- Continued access to waahi tapu sites on the Kaituna River.
- Continued ability to undertake cultural practices around Lake Rotoiti e.g. mahinga kai (seeking traditional seasonal food sources that were commonly served at local marae in the past, e.g. smelt, Koura (fresh water cray) and Kakahi (fresh water mussels)).
- Concerns about high lake levels causing drainage issues at Hinehopu and high water table at Mourea.

7.5.3 Lake Rotoiti Community Association (LRCA)

- Lakes water quality is the top priority.
- LRCA would prefer lake level to remain above 279.1m RL. However, to help address cultural and ecological needs, they have agreed to a wider level range and strategy as proposed in Figure 22.
- Lake Rotoiti levels above 279.100 at least 95% of the time to ensure safe navigation and jetty access.
- A regime that builds storage and maximises water quality.
- Modelling of the flush concept.
- A trial of the flush concept.
- An operational regime as integral part of consent.
- Intelligent management that could enable flushing and better water quality.

7.5.4 Rotorua District Council

- A wider more natural operating range.
- Resolution of shallowing at the Rotorua town wharf and drainage issues at Hinehopu outside of this consent.

7.5.5 Kaituna Catchment Control Scheme

- Use of the Okere Gates to help reduce peak flood flows downstream.

7.5.6 Others (including other downstream iwi, Lake Rotorua Commercial Operators)

- Better water quality downstream.
- Return to natural downstream flows.
- More natural lake levels.
- No worsening of downstream flooding.
- Summer low lake levels in Rotorua be lifted by approximately 100 – 200mm (i.e. a minimum consented level of RL 279.7m (current consented minimum is RL 279.500m)) to prevent grounding in dry summers.
- Ensure that the stop logs in the Ohau Weir are installed prior to Christmas to ensure the lake level is kept higher during the peak summer period.

8 Statutory and Key Non-Statutory Documents

8.1 Statutory Context (What Causes the Need for Consents)

In accordance with Section 13 of the RMA, "Restriction on certain uses of beds of lakes and rivers", Section 14 of the RMA, "Restrictions relating to water", and Section 15 of the RMA, "Discharge of contaminants into environment", the placement and use of the Ohau Weir and Okere Gates, and the damming of Lake Rotorua and Lake Rotoiti by these structures, require resource consent under the BOPRC Operative Regional Water and Land Plan.

Table 1 lists the resource consents identified in the Regional Water and Land Plan, and the requirement for these is further discussed in Section 8.2.2 below.

8.2 Relevant Planning Instruments

8.2.1 Regional Policy Statement

The Operative BOPRC Regional Policy Statement, December 1999, (RPS) provides an overview of the resource management issues of the region.

The RPS is a document, which provides a framework for promoting the sustainable management of the region's natural and physical resources, by identifying the issues and outlining objectives, polices and methods, including processes, for addressing these issues.

Relevant objectives and policies are included in **Appendix 14(i).**

8.2.2 Regional Water and Land Plan

Status of Plan

The Regional Water and Land Plan (RWLP) became operative on 1 December 2008.

Rules

The discharge of water from Lake Rotoiti to the Kaituna River through the Okere Control Gates structure and the discharge of water from Lake Rotorua to Lake Rotoiti over the Ohau Weir constitute a discretionary activity under Rule 37 of the plan.

The placement and use of the structures constitute a discretionary activity under Rule 71 of the plan.

The damming and diversion of water at the outlet of Lake Rotorua and Lake Rotoiti constitute a discretionary activity under Rule 48 of the plan.

The artificial control of water levels in "Natural Lakes" is a discretionary activity under Rule 50 of the plan.

Objectives and Policies

The RWLP objectives and policies relevant to consideration of this application for consent are those relating to the integrated management of land and water, and discharges.

The relevant objectives and policies are contained in **Appendix 14(ii)**.

Status of "Statutory Levels" included in Existing Consent

The Statutory Levels included in the existing resource consents were at the time those were granted, specified in the Regional Council's Transitional Regional Plan.

When the Regional Water and Land Plan became operative, it replaced the Transitional Regional Plan (and the Regional Land Management Plan).

No reference exists in the Regional Water and Land Plan to the Statutory Levels, and therefore reference to or compliance with these levels is not required in the new consents.

8.2.3 Summary of Consents Required

Refer to the table in Section 1.4.1 for a summary of the resource consents required.

8.3 Resource Management Act

8.3.1 Application for a Discretionary Activity

The proposed activities constitute a discretionary activity in terms of Rules 37, 48, 50 and 71 of the Operative Regional Water and Land Plan.

An application for a discretionary activity must be considered in terms of **Section 104** of the Act, subject to **Part 2**, before a decision is made by Council pursuant to Section 104B of the Act.

Part 2 of Act

Part 2 – The **purpose** of the Act is to promote the sustainable management of natural and physical resources, in a way which enables people and communities to provide for their social, economic, and cultural well being, and for their health and safety, whilst avoiding, remedying and mitigating any adverse effects of activities on the environment.

Matters of national importance relevant to this proposal include:

> *(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
>
> *(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:*
>
> *(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*

Section 7 of the Act outlines **Other Matters** to have particular regard to:

> *(a) kaitiakitanga*

(aa) the ethic of stewardship

(b) the efficient use and development of natural and physical resources

(c) the maintenance and enhancement of amenity values

(d) intrinsic values of ecosystems

(f) maintenance and enhancement of the quality of the environment

(g) any finite characteristics of natural and physical resources

(h) the protection of the habitat of trout and salmon.

Section 8 of the Act states that the principles of the **Treaty of Waitangi** shall be taken into account when "…managing the use, development, and protection of natural and physical resources".

An analysis of this proposal against Part 2 of the Act is included in Section 10 of this report.

Section 104

This section outlines the following matters, which are relevant to Council's consideration of the application:

"(1) (a) any actual and potential effects on the environment of allowing the activity; and

(b) any relevant provisions of-;

(iii) a regional policy statement or proposed regional policy statement:

(iv) a plan or proposed plan; and

(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

(2) When forming an opinion for the purposes of subsection (1)(a), a consent authority may disregard an adverse effect of the activity on the environment if the plan permits an activity with that effect.

2(A) When considering an application affected by section 124, the consent authority must have regard to the value of the investment of the existing consent holder."

Council's decision in terms of the discretionary activity must be made in terms of **Section 104B** of the Act. Section 104B states:

"After considering an application for a resource consent for a discretionary activity or non-complying activity, a consent authority-

(a) may grant or refuse the application; and

(b) if it grants the application, may impose conditions under section 108."

Sections 95 – Public Notification

In terms of section 95(A) of the Act, the public notification of a consent is at the consent authority's discretion.

However, section 95(A)(2) states that a consent authority must publicly notify the application if it decides that the activity will have or is likely to have adverse effects on the environment that are more than minor, or the applicant requests public notification of the application.

8.3.2 Te Arawa Statutory Acknowledgement

Statutory Acknowledgements record the traditional significance to claimants of sites that are in Crown ownership. They require that the claimant group must be informed whenever a local authority receives a resource consent application affecting a site that is subject to a Statutory Acknowledgement; and that a local authority must have regard to the Statutory Acknowledgement when deciding whether the claimant group is "adversely affected" by an activity for which a resource consent is sought. When dealing with a resource consent application, the Environment Court must also have regard to any relevant statutory acknowledgements in determining whether the claimant group has an interest in the proceedings greater than that of the general public.

The Crown, in the Te Arawa Lakes Settlement Act 2006, has acknowledged the statement of association of Te Arawa to the statutory area, which is the Crown stratum above each Te Arawa lakebed. Hence, Te Arawa must be informed of this application by the consent processing authority, and the authority must have regard to the Statutory Acknowledgement when deciding whether Te Arawa is "adversely affected" by the proposal.

8.4 Draft Bay of Plenty Conservation Management Strategy

The conservation management strategy describes the conservation values present in Bay of Plenty Conservancy, provides context for the Department of Conservation's work, and outlines the rationale behind the outcomes, objectives and policies provided for the conservancy.

The conservation management strategy establishes objectives for the integrated management of natural and historic resources; recreation, tourism and other conservation purposes (section 17D, Conservation Act 1987). The strategy is a key conservation management tool, a conduit through which the department implements legal, policy and strategic goals.

Each conservation management strategy is prepared with public participation. The term of the Bay of Plenty Conservation Management Strategy is from July 2008 to June 2018. The Bay of Plenty Conservation Management Strategy has statutory recognition under the Resource Management Act 1991. Its content is considered when plans are developed under that Act.

Relevant Objectives and Policies are listed in **Appendix 15.**

An analysis of this proposal against Draft Bay of Plenty Conservation Management Strategy is included in Section 10 of this report.

8.5 Lakes Rotorua and Rotoiti Action Plan

The Lakes Rotorua and Rotoiti Action Plan was written by the Rotorua Lakes Strategy Group, made up of representatives from BOPRC, RDC and TALT. The Action Plan has been in consideration since 2004, and after three years of scientific reports, research and working part meetings, the group released its draft plan in 2007.

Key actions in the plan relevant to this project are:

- the Ohau Diversion Wall construction.
- septic tank reticulation or upgrades for all lakeside communities around Lakes Rotorua and Rotoiti.
- investigating in-stream and in-lake nutrient removal using plants and natural processes, for example wetlands, reed beds and algae/weed harvesting.

An analysis of this proposal against the Lakes Rotorua and Rotoiti Action Plan is included in Section 10 of this report.

9 Assessment of Actual and Potential Effects on the Environment

9.1 Introduction

In the run-up to this consent process to obtain new consents for the structures, the Applicant has carried out background technical investigations to review current lake level management strategies and performance, to investigate alternative lake operating regimes, and to identify benefits and disadvantages for Lakes Rotorua and Rotoiti of the current and alternative operating regimes.

The lake level regime of Lake Rotorua is predominantly a natural one as the influence of the outlet weir at the entrance to the Ohau Channel only occurs when the lake levels are low. This is because the lake behaves effectively as a natural lake with minimal outlet control. It is therefore proposed that the lake level operating range for Lake Rotorua will remain unchanged for the current consented limits of 279.5m and 280.11m. These limits are based on historical minimum and maximum values. Therefore, there is no further discussion in this section relating to effects on the environment for Lake Rotorua.

The investigation of alternative operating regimes has focused on operation of the Okere Gates at the outlet of Lake Rotoiti into the Kaituna River. Gate operating practices have very little effect on the level in Lake Rotorua. On the other hand Okere Gate operating practices have a significant influence on the level in Lake Rotoiti.

Investigations that focus on the Lake Rotoiti level response, outflow, water quality and impacts of the gate operating procedures (e.g. of changes in flows and lake levels) have continued post lodgement in parallel with the ongoing consultation process.

The options that have been further discussed in Section 9 of this AEE are:

1) **Status Quo** - Retain the Okere Gates and operate as per the existing resource consent. Measured Lake Rotoiti levels resulting from current consented operations.

2) **Option 1** – Natural Levels - Simulated Rotoiti levels by installing a stoplog that replicates the pre structure Rotoiti outlet morphology (i.e. gates removed and rock ledge in place or reinstated) and current 10 year rainfall and inflow.

3) **Option 4** – Low Weir - replace the Okere Gates with a low stepped weir at the location of the existing Okere Gates without restoring the original rock ledge (removed during construction). Proposed by Dr Morgan which he believed better replicated pre gate conditions.

4) **Option 7** - Proposed Option (D7) utilises the existing gates to control lake levels, and was developed by manual adjustment of a set of monthly discharge rules (expressed in the form of a lake level/discharge curve). Model simulated operations to best meet varied and sometimes conflicting goals for Rotoiti levels.

9.2 Baselines against Which Proposal Has Been Compared

When defining the environment against which the proposal is being measured, we have considered a number of issues, which are discussed below.

9.2.1 Existing Consented Environment

The primary baseline against which the potential effects of the Proposed Option has been compared to is that of the currently consented activities, and the effects of those activities that were anticipated in the consents.

Using the consented activities and their anticipated effects as the baseline for effects comparison is justified for the following reasons:

- The activities are lawfully established under the Resource Management Act 1991, and under the relevant Regional Planning Document applicable at the time the consents were granted.
- The existing regimes have been in place since 1996.
- Control of Lake Rotoiti water levels by means of the Okere gates, within the existing consented lake level range has been taking place since 1982 (refer water Right # 76c in **Appendix 16**).
- Control of Lake Rotorua water levels by means of the weir structure has been taking place since 1989 (refer Water Right # 2180 in **Appendix 16**).
- These long timeframes mean that the consented ranges and operating regimes have become the "baseline" environment for the two lakes.

9.2.2 Environmental Effects That Were Not Anticipated When the Existing Consents Were Granted

We have reviewed the Assessment of Effects report for the existing consents (Titchmarsh, 1995), and based upon complaints received, and monitoring undertaken by Bay of Plenty Regional Council, conclude that no adverse effects have arisen that were not anticipated when the existing consents were granted in 1997. This assessment was based upon a thorough search of files associated with the four existing consents listed in Table 1.

9.2.3 Environment if the Consents Were Not Renewed

In the event that Rivers and Drainage decided not to renew its consents then it would need to either replicate the pre-existing environment or leave the Okere Gates fully open.

Replication of the pre-existing environment is equivalent to Rivers and Drainage's modelled Option 1 (also referred to as the 'natural' option) and leaving the Okere Gates fully open is equivalent to modelled Option 3. A fuller description of the modelled options is provided in Section 4.1.2.

A brief assessment of the effects of these scenarios is included here.

Our understanding of the environment under Options 1 and 3, and some of the likely adverse effects, compared to Proposed Option D7 are:

Environment Compared to Proposed Option D7	Potential Adverse Effects
A much wider range of lake levels	Flooding would affect infrastructure e.g. drains, culverts, use of jetties and boat ramps; flooding would inundate properties; commercial operators wouldn't be able to use the Kaituna River to the current extent; low lake levels would adversely affect jetty and boat ramp use. There would be adverse effects on the visual landscape due to areas of lake bed being exposed.
Lake levels would be lower more frequently	More frequent loss of use of amenities eg boat ramps and jetties. Impacts on lake navigation. More frequent exposure of lake bed and lake weed resulting in weed decomposition and odour effects.
Lake levels would be higher more frequently	More frequent loss of use of amenities eg boat ramps and jetties. Potential increase in drainage problems such as backflow of stormwater culverts that discharge to lake. Potential for flooding of lower lying lake edge property. Some ecological disturbance could occur eg dabchick nests could be disturbed during floods if lake levels rise too quickly.

In addition, for Option 1 there would be considerable disruption to the environment as lake levels re-adjusted back to pre-existing conditions with a new stoplog fitted. For Option 3 minimum lake levels would be lower than any recorded levels since 1906 dropping as low as 278.2. Refer s5.1 of Aurecon Report (2009).

It is assumed that regardless of the option finally selected Rivers and Drainage would still need to apply for new resource consents.

9.2.4 Unimplemented Consents

Bay of Plenty Regional Council has undertaken a search of their files and database, and concludes that there are no unimplemented consents in the environment of the structures that are relevant to understanding the baseline environment.

9.3 Lake Rotoiti Level and Discharge Regimes, including Flooding and Flood Management, Erosion and Sedimentation

The following section provides a more detailed description of how the Proposed Option and Proposed Operational Strategy would affect Lake Rotoiti level and discharge regimes including flooding, erosion and sedimentation.

9.3.1 Proposed Lake Level Management Philosophies and Ranges

The proposed lake level management philosophy and ranges are discussed in detail in Sections 6.1 and 6.2 of this report. The only significant changes from the current management philosophy, is with respect to the operation of Lake Rotoiti. It is proposed that the lake level management strategy for Lake Rotoiti will be different from that which has been in place since early 1998. The current strategy is to try and hold the lake level within

a tight ± 75mm band of the target level of RL 279.116m above Mean Sea Level Moturiki Datum. This results in an artificial lake level regime with sharp changes in outflow occurring by means of the Okere Gates to effectively maintain a near-constant level.

The current consented maximum and minimum lake levels for Lake Rotoiti are 279.406. and 278.856m respectively. It is proposed to adopt RL 279.4m as the new maximum lake level limit with a new minimum lake level limit of RL 279.0m, giving a maximum operating range of 0.4m. However, there is also proposed to be a target operational range of 0.2m between RL 279.05 and 279.25m.

The lake level and outflow regimes resulting from the proposed management philosophies and the alternative operating strategies were investigated using a computational hydraulic modelling approach. This is discussed in the following section.

9.3.2 Computational Hydraulic and Optimisation Modelling of the Two Lakes System

Aurecon (2009) conducted one-dimensional computational hydraulic modelling of the Lake Rotorua/Ohau Channel/Lake Rotoiti/Okere Channel system and compared the model simulation results with the historic record for the 10-year period 1998 to 2007. The purpose of modelling was to investigate alternative operating scenarios for the Okere Gates, and to identify the benefits and disadvantages of the current and alternative lake operating regimes. Hydrologics Inc. developed a hydrological optimisation model of the Lake Rotorua/Ohau Channel/Okere Channel System. They established an optimised lake level management strategy for Lake Rotoiti (Proposed Option (D7)) based on a set on monthly discharge rule curves and compared the results of this strategy with those produced by hydraulic modelling (Status Quo, Option 1 – replicated natural channel, and Option 4 – lower weir). The monthly discharge rule curves which define the optimum lake level management strategy for Lake Rotoiti are designed to address a broad range of economic, environmental, cultural and social objectives. Options for Okere Gates at the outlet from Lake Rotoiti range from keeping the current narrow lake operating range to looking at total removal of the gate structure. To recap, the options considered for the Okere Gates included:

- The status quo.
- Option 1: install a stop log structure at Okere Gates that approximately replicates the hydraulic characteristics of the natural channel that existed prior to the construction of the Okere Gates Control structure (crest level of RL 278.38m).
- Option 2: Replacement of the Okere Gates with an alternative non-gated structure (represented in the hydraulic model as a stepped broad-crested weir with crest levels of RL 278.1m, RL 278.3m and RL 278.5m) that broadly aims to maintain current target lake levels.
- Option 3: Retention of the existing Okere Gates but keeping the radial gates permanently fully open (and to be closed only in an emergency).
- Option 4: Replacement of the Okere Gates with a low weir structure (represented in the hydraulic model of the Okere Channel as a stepped broad-crested weir with crest levels of RL 277.9m and RL 278.5m).

- Option 5: pre-gate scenario using the original cross-sections.
- Option 6: Hydrologics Version 6 - This comprised the latest optimisation modelling up to October 2009.
- Option 7: Hydrologics Proposed Option (D7) - Final version of optimum lake management structure strategy using the existing Okere Gates.

As previously noted in this AEE, only the status quo, Option 1 – replicating natural channel, Option 4 – low weir, and Hydrologics Proposed Option (D7) are considered. Option 2, a broad crested weir was ruled out of further investigation as Dr Morgan considered that it did not accurately replicate the pre-gate hydraulic arrangement. Option 3 was not pursued further since it resulted in very low minimum Lake Rotoiti levels (approximately RL278.5) although it did provide information on the maximum outlet capacity through the Okere Gates Control Structure with gates fully open. Option 5 was not pursued further due to model instabilities. Option 6 has been superseded by Option 7.

A peer review of the initial modelling carried out by Aurecon (Opus 2009 and 2009b) found that, while the general behaviour of the two lakes system was simulated satisfactorily (with the levels of both lakes rising and falling depending on the balance of inflows and outflows), the significant influence of channel friction in the Okere Channel on Lake Rotoiti outflows (and water levels) had not been recognised. This influence was identified from the observation that the flow under the radial gates of the Okere control structure was generally partially drowned. It was confirmed by measurements at two separate flows of the flow profile in the Okere Channel downstream of the control structure to the State Highway bridge, and upstream to the NIWA water level recorder gauge.

Following these flow profile measurements, a sub-model of the Okere Channel was constructed and calibrated to reproduce the measured water levels. The calibrated sub-model was used to determine lake level/discharge relationships for Options 1 and 4 at the site of the NIWA water level recorder gauge, similar to that for the pre lake control rating curves. These lake level/discharge relationships were then incorporated as the downstream boundary condition in a modified version of the Lake Rotorua/Ohau Channel/Lake Rotoiti/Okere Channel model. The modified model was rerun to obtain revised lake level outflow predictions for Lakes Rotoiti and Rotorua for Options 1 and 4.

Notwithstanding these revised simulation results for Options 1 and 4, the initial simulation results shown in **Figure 18** demonstrated that the simulated level response of Lake Rotoiti has only a very minor influence on the level and outflow regime for Lake Rotorua. This means that the predominant control on the level and outflow regime for Lake Rotorua is the geometry and frictional characteristics of the Ohau Channel linking both lakes.

The model simulation results also showed that the range and variability of Lake Rotoiti level increases significantly if the existing Okere Gates are replaced with any type of weir structure. For example **Figure 21** shows the predicted lake level response for Options 1 and 4 (based on the modified twin lakes model). This indicates that the lake level response of Lake Rotoiti with a weir replacing the Okere Gates reflects a more natural lake level regime.

This also compares with the Proposed Option (D7) operating strategy which shows a smaller operating range than Option 1 with maximums and minimums generally no higher

or lower than the consented limits of the current operating regime (status quo). Lake level is more variable for the Proposed Option (D7) strategy for the bulk of the time than for the current regime (status quo).

Prior to the construction of the Okere Gates in 1982, lake levels and outflows in Lake Rotoiti were controlled by a natural rock ledge about 35m downstream of the structure. This rock ledge was removed during construction of the control structure.

The recent investigations work demonstrated that in the present situation, the lake outflow is a function of:

- The channel characteristics (geometry and frictional characteristics) above and below the Okere Gates Control Structure.
- The bottom/sill level at the Control Structure.
- The opening of the gates.

The hydraulic control downstream of the control structure is another rock ledge (waterfall) about 75m from the Gates.

The lake level regime for Lake Rotoiti is a function of the balance between the lake inflows and the outflows and the management strategy adopted for the Okere Gates.

9.3.3 Practical Implementation of Proposed Management Philosophy for Lake Rotoiti

In the pre lake control situation, outflows from Lake Rotoiti were determined from a lake level/discharge rating curve which was defined by a series of gauging measurements over the range of possible outflows. The rating curve was re-evaluated from time to time. **Figure 23** shows the rating curves for the lake outlet used at different times up to 1981 when the Okere Gates were constructed. The rating curves no longer applied after the Okere Gates were commissioned as the lake outflows then became a function of the gate opening as well as the lake level.

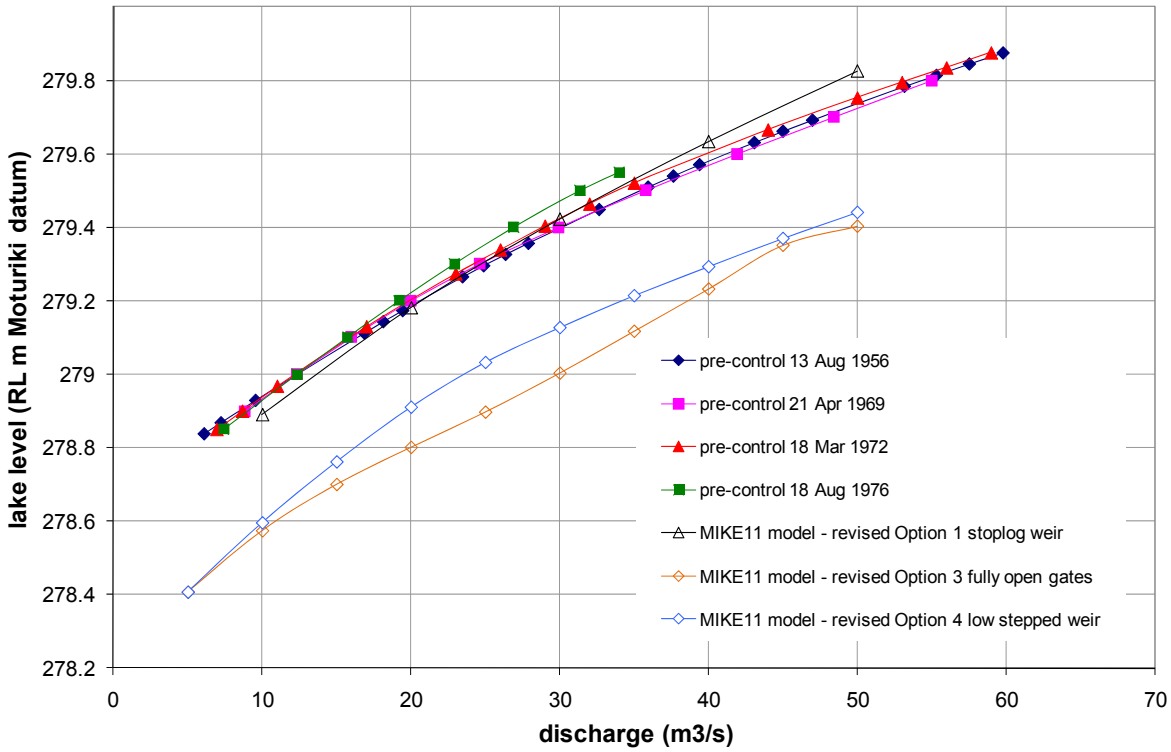

Figure 23: Rating curves for the Lake Rotoiti outlet.

Figure 23 also shows the lake level discharge rating curves for the Option 1 stoplog structure, the existing Okere Gates structure with the gates kept fully open (Option 3) and the Option 4 low stepped weir obtained using the calibrated computational hydraulic model of the Okere Channel. The crest level of the Option 1 stoplog structure was set so that the discharge rating for this structure replicates as closely as possible the pre lake control natural outlet ratings for the Okere Channel. The rating curve for the Option 4 low stepped weir follows a similar trend to those of the pre lake control natural outlet, but at a level approximately 200mm lower. It is not able to replicate the pre lake control natural outlet rating curves because of the modifications that were made to the downstream channel when the Okere Gates Control Structure was constructed in 1981. The shape of the Option 3 rating curve reflects a gradual shift in control of channel outflows from the sill of the existing Okere Gates structure at low flows to a narrow channel section downstream of the gates at high flows.

Common lake level management practice in New Zealand is to define a table of discharges to be released at different lake levels, with the discharge increasing as the lake levels increase. This table would in fact emulate the lake level discharge rating curves. The discharges specified by the table to be released would be achieved by opening the gates to the opening required to deliver that amount of water. In other words, the gate setting and hence the gate outflow would be defined according to the prevailing lake level. In practice to achieve a greater lake level variability for Lake Rotoiti than the status quo strategy, the lake level/discharge rule curve defined by the lake level/discharge table would need to be slightly steeper than those shown in **Figure 23**.

Possible lake level/discharge rule curves for each month have been defined and applied in the Hydrologics hydrological optimisation model to establish the Proposed Option (D7)

strategy. A typical example of such a rule curve is shown in **Figure 24**. This figure also identifies the lower and upper bounds of the zone of flow instability – for flows below the lower bound, the gates are controlling the lake outflow while, along the upper bound curve, the gates are fully open (this curve was in fact defined from the calibrated hydraulic model of the Okere Channel for Option 3). It is a physical impossibility for lake outflows to exceed the upper bound curve. If, for a given lake level, the gates are opened and deliver a specific flow volume within the flow instability zone, the flow will be highly erratic and hunt continuously between an orifice flow control regime (with the gates controlling the flow) and free-discharge regime (gates clear of water surface and not controlling the flow). In practice, this zone of flow instability is usually avoided completely when operating a control gates structure. The rule curve shown in **Figure 24** therefore incorporates a step change in flow across the flow instability zone to reflect this practical reality of gate operation.

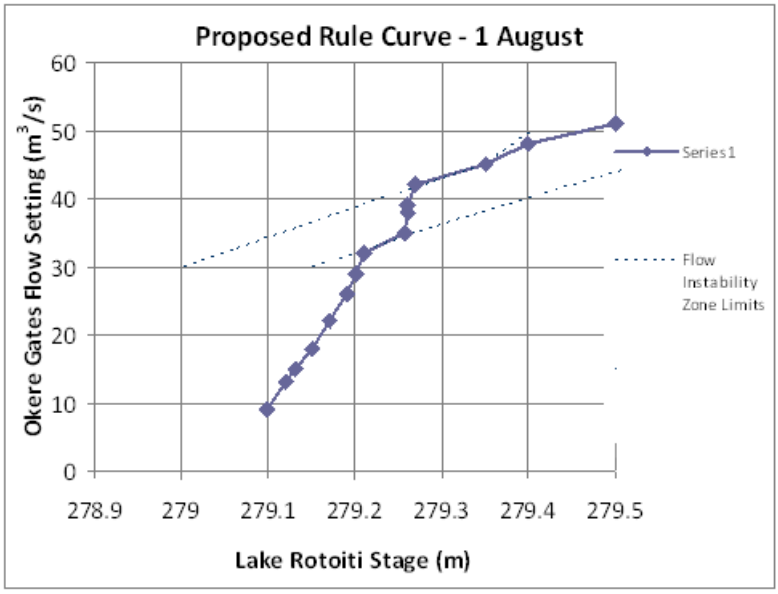

Figure 24: Typical Monthly Lake Level / Discharge Rule Curve for Proposed Option (D7) Operating Strategy.

The Okere Gates situation is complicated slightly by the requirement for the Gates to release specified recreational flows at certain times. This can still be achieved with the proposed implementation strategy by assuming that the proposed lake level/discharge table specifies daily average flow values. Recreational flow releases can still be achieved by discharging slightly higher flows over the required period and slightly lower flows for the rest of the day. Averaged over a day, the daily average flow value would still be the same using this approach. The total volume of water released in any one day would still be the same.

Changes in flow through the Okere Gates are presently governed by maximum ramping rate restrictions of 10m³/s per hour for increasing flows and 5m³/s per hour for decreasing flows. While it is appropriate to retain ramping rate restrictions from the points of view of public safety and downstream bank erosion, the ramping rate restrictions must also take account of the practicalities of gate operation.

In particular, it is not possible to control the flow through the Okere Gates for any lake level and gate opening values that deliver a lake outflow within the flow instability zone shown in **Figure 24** as the gate flow will be highly erratic, oscillating between two discharge regimes

(where the gates are either controlling the flow or not controlling the flow). With the proposed monthly operating rule curves, it will be necessary to step across the flow instability zone from the lower limiting curve (where the gates are able to continuously control the flow) to the upper limit or vice versa. The proposed ramping rate restrictions must therefore be able to accommodate this maximum step change across the flow instability zone which is in the order of 8-10m³/s per hour.

9.3.4 Ohau Channel

Implementation of the Proposed Operational Strategy represented by Proposed Option (D7) will have minimal effect on the flow regime through Ohau Channel as indicated by **Figure 19**.

9.3.5 Lake Rotoiti Levels

As noted in Section 6.2, **Figure 20** compares the lake level response to the Proposed Operational Strategy represented by the Proposed Option (D7)compared to the status quo and other alternative operating strategies (Options 1 and 4).

Figure 25 shows level duration curves[1] for the simulated 1998-2007 lake level for the Proposed Operational Strategy represented by the Proposed Option (D7)(blue line) compared to the status quo (green line) and other operating strategies. The Proposed Operational Strategy would result in a very similar operating range (RL 279.07 – 279.40m) to the status quo (RL 279.04 – 279.36m) although, overall, lake levels would be marginally higher.

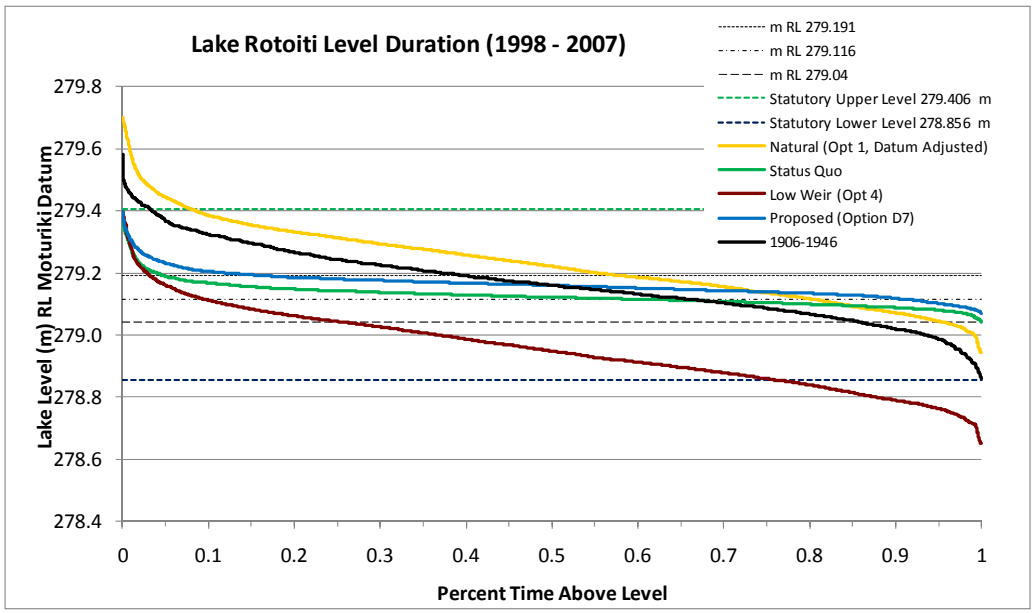

Figure 25: Level Duration Curves for Lake Rotoiti Levels 1998 to 2007.

To complement the level duration curves in **Figure 25**, **Table 18** below summarises the numerical values for the overall level distribution for the simulated lake levels for each operational strategy. The Proposed Option (D7) strategy results in a similar overall lake

[1] A duration curve or profile defines a cumulative distribution curve showing the range of a parameter (water level or flow) plotted as a function of the percentage of time that the parameter is less than a particular threshold value.

level range (RL 279.07 – 279.40m) and median value (RL 279.16m) to the status quo option (range RL 279.04 – 279.36m and median value 279.12m). However, whereas lake levels are predominantly confined within a very tight band of RL 279.10 – 279.15m (61%) under the status quo option, this tight band is more relaxed for the Proposed Operational Strategy with 84% of levels lying in the range RL 279.10 – 279.20m.

Table 18: Level Distributions for Lake Rotoiti 1998 to 2007.

	10 year Range 1998-2007			
Range	**Opt D7**	**Status Quo**	**Low Weir**	**Natural**
> 279.400	0%	0%	0%	8%
279.350-279.400	0%	0%	0%	7%
279.300-279.350	1%	1%	0%	13%
279.250-279.300	2%	1%	1%	14%
279.200-279.250	9%	2%	2%	13%
279.150-279.200	49%	14%	3%	16%
279.100-279.150	35%	61%	6%	12%
279.050-279.100	5%	21%	11%	11%
279.000-279.050	0%	0%	14%	5%
< 279.000	0%	0%	63%	1%
Total %	**100%**	**100%**	**100%**	**100%**
Maximum	279.397	279.361	279.397	279.701
Minimum	279.069	279.043	278.650	278.943
Median	279.160	279.121	278.948	279.221
Mode	279.167	279.119	279.068	279.263
Range	0.328	0.318	0.747	0.758

While **Figure 25** gives an overall indication of the lake level response over a year, **Figure 26** provides a more detailed comparison of the lake level response to the Proposed Option (D7) operating strategy compared to the status quo on a seasonal basis. **Figure 26** is a box and whisker plot with each set of box and whiskers showing monthly exceedance values (maximum or 0% exceedance, 10% exceedance, median or 50% exceedance, 90% exceedance and minimum or 100% exceedance) of lake level.

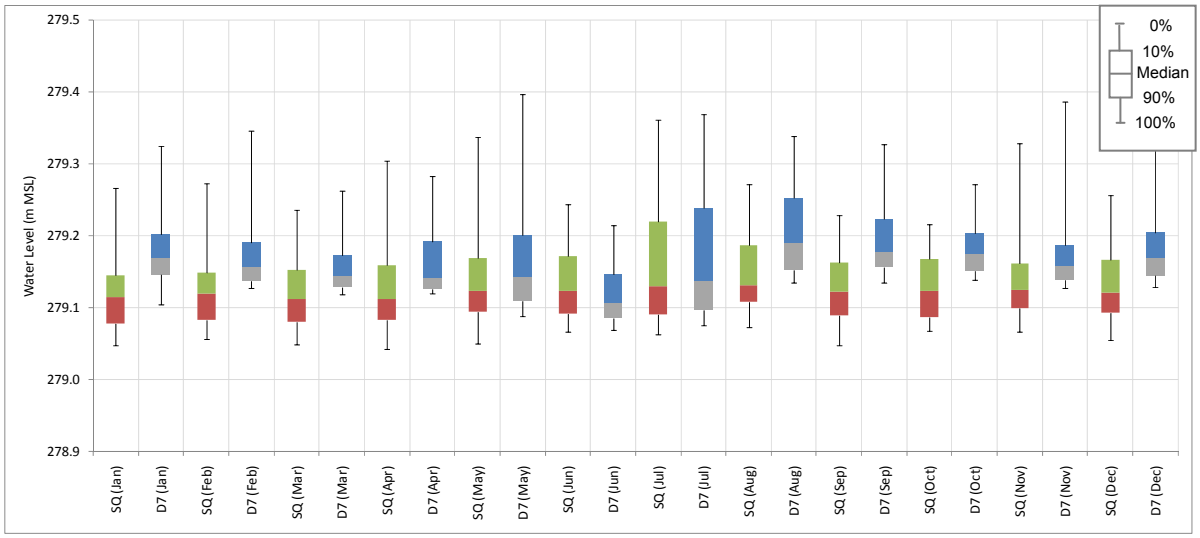

Figure 26: Box and Whisker Plot of Monthly Level Ranges for Lake Rotoiti 1998 to 2007.

Figure 26 indicates that with the Proposed Option (D7) operating strategy (compared to the status quo):

- The median lake level will be slightly higher (15-70mm) throughout the year except in the month of June (15mm lower).
- The median lake level will be at its lowest in June (RL 279.106m) and at its highest in August (RL 279.191m).
- Lake levels will consistently be slightly higher throughout the year except in the month of June.
- The lake level range will be approximately as wide or wider throughout the year except in the months of March, April and June.
- The widest lake level range (0.309m) and the highest lake level (RL 279.397m) will generally be experienced in May.
- The 80 percentile (10% to 90% exceedance) lake level range will be higher than the status quo range except in the month of June.

The lake level response to the Proposed Option (D7) operating strategy shown in **Figure 26** indicates that the degree of short term lake level fluctuation will be less than the status quo.

9.3.6 Kaituna River Flows

The lake level management strategy for Lake Rotoiti which has been in place since early 1998 (target level of RL 279.116m ± 75mm) has resulted in a lake level regime with sharp changes in outflow to the Kaituna River occurring by means of the Okere Gates to effectively maintain a near-constant level.

The Proposed Operational Strategy represented by the Proposed Option (D7) for Lake Rotoiti, although producing a similar outcome in terms of a lake level regime, results however, in a slightly different outflow regime. This is illustrated in **Figure 27** where the

Kaituna River flows, over the period 1998 to 2007 for Proposed Option (D7) strategy, are compared with the flows for the status quo regime.

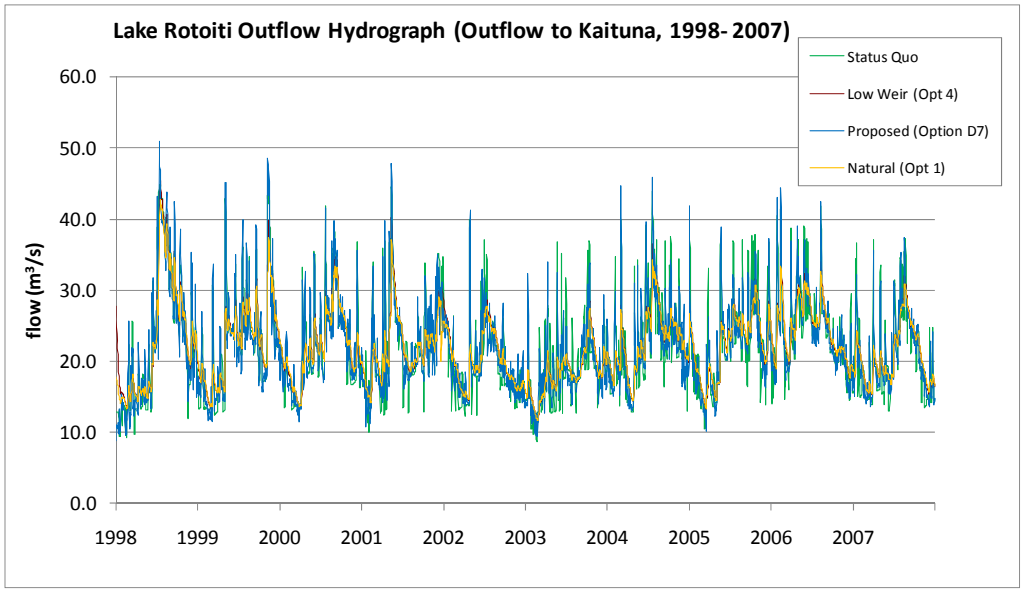

Figure 27: Comparison of daily Kaituna River flows 1998 to 2007.

The very 'spiky' status quo flow regime shown in **Figure 27** reflects the large number of gate changes to keep the lake level near constant. In contrast, the daily average flow regime becomes slightly 'smoother' for the Proposed Operational Strategy, as the number of gate changes would be reduced. Whereas the daily average low flows (<10m^3/s) and flood flows (>30m^3/s) would remain in a similar order (Figure 28) to that for the status quo regime, the distribution of mid-range flows (10 - 30m^3/s) covering the bulk of the time would be significantly altered. The occurrence of flows in the range would be reduced The occurrence of flows in the range 15-20m³/s would be increased and the occurrence of flows in the range 20-25m³/s would be similar.

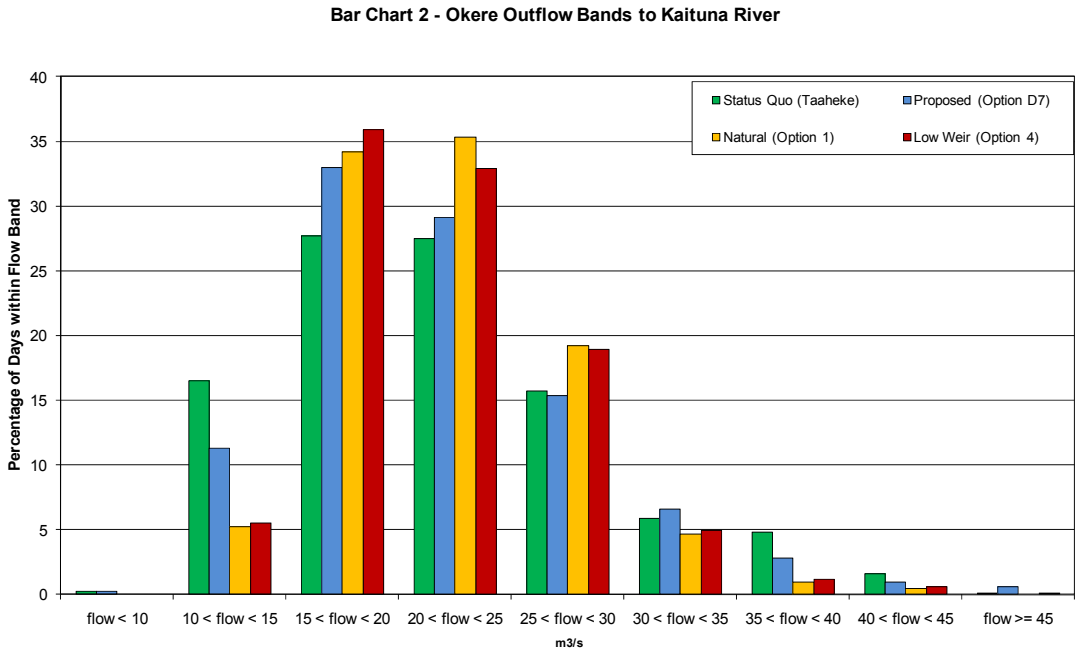

Figure 28: Comparison of the Okere outflow bands (1998-2008).

Recreational flow releases during the day would alter the daily outflow pattern but not the overall daily average outflow regime.

As discussed in Section 3.7.3, the contribution of Lake Rotoiti outflows to flood events in the Lower Kaituna River is small in relation to the contribution of downstream tributary inflows. The proposed lake level management strategy will not cause floods to be any worse in the lower river.

In fact the presence of Lakes Rotorua and Rotoiti is very beneficial with respect to the downstream flood hazard as the lakes significantly suppress runoff from the upper catchment. The bulk of the flood hazard in the Lower Kaituna River arises from the flood flow contributions of the Mangorewa River and other lower river tributaries.

A discussion of Instream Minimum Flows for the Kaituna River is included in Section 3.7.3 above. The minimum flow identified in the Proposed Operational Strategy represented by the Proposed Option (D7) is 7.9m^3/sec, which is lower than the Instream Minimum Flow of 9.842m3/sec, calculated as per the Method 179 of the RWLP. However it is considered that any potential adverse effects caused by the proposed minimum flow will be less than minor, as it has been shown that if Option D7 had been operating for the period 1 January 1998 to 31 December 2007, then the Instream Minimum Flow would have been met or exceeded 99.78% of the time.

9.3.7 Kaituna River Erosion

River bank erosion is an entirely natural process. However, it can be exacerbated by anthropogenic influences such as lake control structure or hydropower station operation (causing rapidly varying flows and hence downstream river levels), bank vegetation clearance and boat-generated waves.

In the case of lake control structures or hydropower operation, wetting-drying cycles in rapid succession on river banks can result in increased bank erosion downstream of an impounding or control structure, especially if a bank consists of non cohesive material. Fluctuations in near-bank river level induced groundwater level changes can cause shear failures (slips).

In this particular context, changes in lake outflows through the Okere Gates are governed by ramping rate restrictions with present maximum rates of 10m³/s per hour for an increasing flow and 5m³/s per hour for a decreasing flow. Due to the particular geometry of the Kaituna Gorge, such flow changes are translated downstream and may be observed as sharp rises and falls in water level as far downstream as the State Highway 2 Bridge at Te Matai. Further downstream of this bridge, the influence of the tide on river levels becomes more and more pronounced.

From measured water level records in the lower river, changes in gate flow of 5m³/s and 10m³/s correspond to changes in river level below the Maungarangi Bridge of about 0.2m and 0.4m respectively. These are relatively small changes in river level and are likely to be overshadowed as an erosive agent by other factors.

Notwithstanding this comment, a slightly "smoother" outflow regime as a result of the Proposed Operational Strategy Proposed Option (D7) for Lake Rotoiti may slightly reduce the likelihood of (potential) bank erosion in the Lower Kaituna River attributable to this agent.

Flood flows which generate much higher flow velocities than normal river flows will also be a significant agent for bank erosion in the lower river. As noted though, this is an entirely natural process.

McConchie and Toleman (2003) have investigated boat wakes as a cause of bank erosion on the Waikato River based on field measurements on the maximum waves generated by different pleasure craft and suspended sediment concentrations from boat wake-induced bank erosion. They found that the effectiveness of boat wakes as an erosion agent depends on:

- The resistance of the bed and banks where waves impact (affected by the nature of the bank sediment, vegetation, water level and bed and bank profile).
- The conditions under which the waves are generated (water depth, channel width, boat size, displacement and speed, the distance between the boat and shoreline and the frequency of boat traffic).
- The characteristics of the resulting waves (wave energy and frequency of wave impact).

They concluded that boat wake generated waves have a greater potential impact where boats are regular, concentrated and close to the shore, for example, in the vicinity of boat ramps. This is also true of a riverine environment such as the Kaituna River where the distance from a boat to the bank is relatively small. Wake impacts on the banks of the Upper Kaituna River have previously been investigated by BOPRC (New Zealand Jet Boat Association, 1993).

In the context of the Kaituna River, boat wakes are likely to be a more significant factor contributing to bank erosion than Okere Gates ramping rate induced changes in river level. However, the relative influence of high velocity flood flows on bank erosion is uncertain.

9.3.8 Climate Change Effects

Climate change is a 'natural' phenomenon due to anthropogenic induced effects on the upper atmosphere. They are not an adverse consequence contributed to by the proposed modifications to the lake level regime for Lake Rotoiti.

The effects of possible climate change will only become evident over a period of time. In this context they will be manifested in the form of an increased frequency and magnitude of storm events affecting the lake catchment (see MfE, 2008). This will give rise to increased inflows into the lakes, which since both lakes act as an integrator for inflows, may be reflected on a very gradual rising trend superimposed on the natural seasonal fluctuations in lake level range.

In the case of Lake Rotorua with no significant control on lake outflows at high lake levels, it would not be possible to influence the general rising trend of lake levels unless major changes to the Ohau Channel Weir control structure were implemented.

On the other hand, with the Okere Gates in place, any gradual rising trend in the lake level response over time of Lake Rotoiti could be easily alleviated by slight modifications to the lake level/discharge table defining the control strategy for the Okere Gates. This is a significant advantage of keeping the gates in place.

9.4 Stormwater and Drainage

9.4.1 Lake Rotoiti

It is not anticipated that the Proposed Option lake levels would cause any scouring or damage to stormwater infrastructure (pers comm Peter Dine, RDC Engineer). Practical experience dictates that small changes of lake level will not have significant effects on localised drainage issues.

RDC stormwater infrastructure around Lake Rotoiti is minimal, as catchments in the area are relatively short. The RDC don't anticipate any negative effect on stormwater or roading infrastructure from the minor change of the median lake level under the Proposed Option and Proposed Operational Strategy.

At Hinehopu and Ruato Bay stormwater can 'back up' in streams and stormwater drains during elevated lake levels and westerly winds/wave action in the lake. Localised flooding at Hinehopu (specifically along Tamatea Street) may be able to be partially mitigated by the installation of flapgates on the lake side of culvert pipes (subject to meeting any fish pass requirements), effectively stopping waves running up the culvert pipes & 'holding up' upstream stormwater.

The following **Table 19** records the invert levels of a number of Rotoiti margin stormwater assets, septic tank vents and wet areas on the Hinehopu golf course. Domestic septic tank (s.t.) heights were measured at the top of the plastic vent (above ground). Estimated soakage trench/field depth (esd) is assumed to be 450mm below ground level.

Table 19: Relative levels of stormwater assets and septic tanks

Location and type	Invert level	Height above current target lake level (279.116m)
Te Takinga Drain	279.33	0.214
Te Takinga Culvert Out	279.49	0.374
Te Takinga Culvert In	280.04	0.924
Hinehopu septic tank (s.t.) – 52 Tamatea St	280.065 (s.t.) (top of ring)	0.949 (s.t.) *0.499 (esd)*
Hinehopu septic tank – 68 Tamatea St	279.814 (s.t.) (top of tank)	0.698 (s.t.) *0.248 (esd)*
Tapuaeharuru septic tank – 1706 Main Rd	281.386 (s.t.) (top of pipe)	2.27 (s.t.) *1.82 (esd)*
Hinehopu golf course drain	279.65 (1 rep. point)	0.534
Hinehopu golf course – 'L' water hazard	279.55	0.434
Hinehopu golf course – Pond water hazard	279.55	0.434

BOPRC On-Site Effluent Treatment Regional Plan 2006; Schedule 3 (f) requires that there be 600mm depth from the bottom of soakage beds to the water table at all times. Assuming the groundwater level is similar to the lake water level, two of the three septic tanks represented here are currently probably not complying with this separation to groundwater requirement, so are unlikely to be functioning correctly. However, even with a drop in lake level some septic tanks would still not have adequate depth from soakage bed to water table to function correctly.

Survey work was carried out by Rivers and Drainage in June of 2010, comparing ground levels and water table levels in the Tamatea Street area (refer **Appendix 4**, BOPRC Rivers and Drainage Group, July 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application", for details). Results are presented in the following **Table 20**, and show very small differences between ground level (GL) and water table level (WT) Septic tanks in this area would not comply with the BOPRC schedule 3 requirements to maintain 600mm between septic tank soakage and water table.

Table 20: Comparison of ground levels and water table levels in the Tamatea Street area

Distance 15 m landside from the centre of house	Tamatea Street			
	Levels related to Rotorua Fundamental			
Location	At SH 30	At House No 26	At House No 48	At House No 68
Ground Level (GL)	279.87	279.744	279.574	279.764
Water Table (WT)	279.37	279.23	279.124	279.4
Difference (GL - WT)	0.5	0.514	0.45	0.364

Similarly, work done by BOPRC in 1996 (Memo Mathew Surman, Design Engineer 16 July 1996) showed that the groundwater levels at Gisborne Point (indicated by oxidised iron in soil profile) and Hinehopu (water level in a borehole) were respectively 370mm and 320mm above lake level at the time. A further investigation of surface water flooding at Hinehopu showed that the water level to be 680mm above the lake level. Mathew Surman suggested from this information that "the local water table level is high, with significant fall to the lake", indicating that local septic tank and flooding issues may be a combination of naturally high groundwater levels, and lake level, which may or may not be improved by a lowered lake level. This situation (in this case for Tamatea St) is demonstrated in **Figure 29** below.

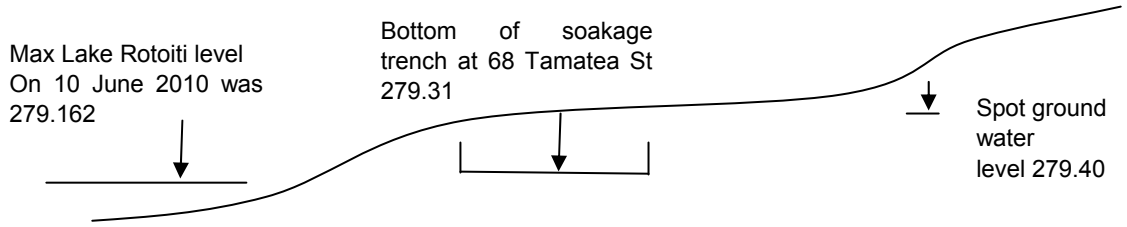

Figure 29: Relative levels of groundwater and Lake level, Tamatea St, Hinehopu Rotoiti.

As noted previously, RDC are planning staged reticulation of sewage/waste water for the Lake Rotoiti communities currently relying on septic tanks. Any septic tank sewage issues are therefore only relevant until the installation of reticulation. This is in the planning stages for many areas, and is scheduled to be completed in 2012.

A preliminary proposed program of completion for sewage reticulation is shown in **Table 21** below.

Table 21: Preliminary Proposed Program of Completion for Sewage Reticulation.

Area – Lake Rotoiti	Proposed date of reticulation completion
Okere/Otaramarae	2009
Te Weta Bay	2010
Gisborne Point	2011/12
Rotoiti	2012
Hinehopu	2012

There is clear evidence, historic and recent that high lake levels (higher than the current maximum operating levels) can lead to flooding, drainage, stormwater and septic tank issues in low lying areas around both Lake Rotorua and Lake Rotoiti. No stakeholders are seeking higher operating maximum lake levels than that currently in place. There is no reason to suggest that operating with greater variation within a similar range of Lake Rotoiti levels will have any negative effect on stormwater in the Lake Rotoiti area (pers comm Peter Dine, Engineer, RDC). Groundwater levels and drainage in certain areas (Hinehopu) may potentially be negatively affected by the proposed median increase in lake water levels (albeit a very modest increase) from 279.121 to 279.160.

It is widely accepted that drainage has historically been (pre gates), and currently is an issue in the Hinehopu area, particularly in Tamatea Street. Surface flooding and high groundwater levels are common. However, poor drainage is an existing problem, known to be compounded by high groundwater levels (see **figure 29** above, and **Figure 30** below), tectonic settlement – further reducing the ground level – and the proximity of the Hinehopu wetland to local housing. Tamatea St high groundwater levels, culvert levels and lake levels are depicted in **Figure 30** below.

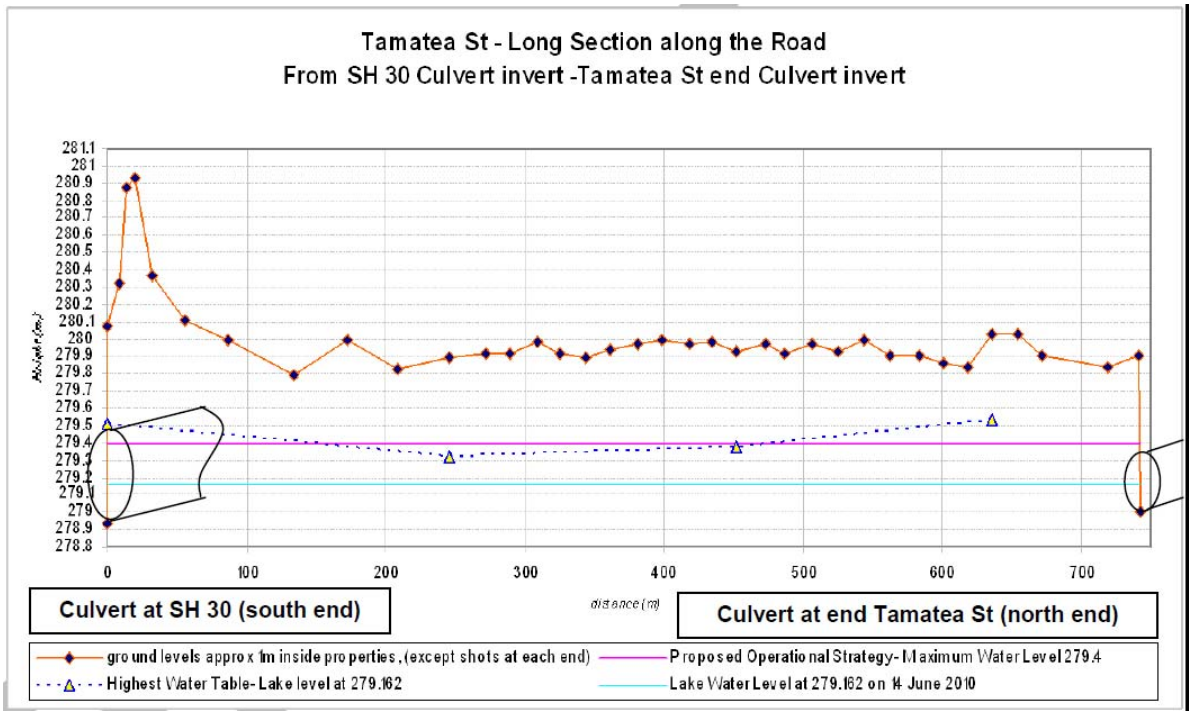

Figure 30: Groundwater levels and proposed lake water level for properties on Tamatea Street.

Also depicted in **Figure 30** above are the Proposed Operational Strategy maximum water level of 279.4 (purple line), and the lake level on the day of surveying (also being the proposed median lake water level – turquoise line). Groundwater levels are clearly higher than lake water levels.

Significantly, because of the localised drainage and flooding creating an identified hazard,, RDC may discourage further development in the Hinehopu/Tamatea Street area, through planning provisions under the district plan.

It is possible that mitigation of drainage issues (if successful) could negatively affect the ecology of the Hinehopu wetland if such activity resulted in the lowering of the groundwater in the wetland (Keith Hamill Opus, pers com).

In summary the proposed operating regime under the Proposed Option (D7) will raise the median lake level from 279.121 to 279.160, an increase of 39mm. Several low lying areas around Lake Rotoiti are already affected by poor drainage (and have been historically pre gates) and this is unlikely to improve under the proposed operating range. RDC stormwater assets are unlikely to be adversely affected by the proposed operating regime. Sewage soak fields at Hinehopu are already under pressure from high groundwater levels, and this situation is unlikely to improve under the proposed regime. However sewage reticulation is planned for by 2012, for all affected areas which will alleviate this particular issue.

River and Drainage Group's view is that the current drainage situation at Hinehopu (most notably at Tamatea Street) is untenable and that the relative impact of proposed changes will be minor. However the potential minor additional effects of slightly increasing the maximum lake level from the Status Quo 279.361m RL to the Proposed Option 279.397m RL (36mm difference) and slightly raising the median lake level from the Status Quo

279.121m RL to the Proposed Option 279.160m RL (39mm difference), are difficult to predict and quantify. At this point the Rivers and Drainage Group are not able to provide any specific mitigation. However if ongoing seasonal groundwater monitoring demonstrates that the Proposed Operational Strategy would result in minor additional adverse effects on groundwater levels at the Tamatea Street bach properties, the applicant is prepared to investigate commensurate mitigation to ensure there is no net loss of amenity relative to Status Quo.

9.5 Lake Navigation

9.5.1 Lake Rotoiti including the Ohau Channel

Any lowering of the median water level in Rotoiti would make access to some western basin and Ohau Channel areas marginal for larger craft at times. However it is intended that under the proposed slightly more variable lake level regime, levels will vary between seasons. A slightly more variable lake level range will reflect higher levels in the spring/summer seasons with lower levels in the late autumn/early winter (Refer BOPRC Rivers and Drainage Group, July 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application", **Appendix 4**, Figure 17).

Figure 25 shows a stage – duration curve of several operating options between the existing consented maximum and minimum. It shows the percentage of time the lake will be at or above a given level (RL), for the several possible options including the current operating regime.

With any lowering of the lake levels, there would be a requirement for BOPRC, under NZ Maritime rules and BOPRC bylaws, to reassess navigability of key channels, the need for dredging of specific sites (where clearance is already marginal) and determination whether any additional hazards would be exposed. Under the proposed operating range these actions are unlikely to be required. The BOPRC Regional Harbourmaster has stated (email of 24 August 2010) that the Proposed Option operating ranges will have no significant effect on Lake Rotoiti navigation. Lake Rotoiti is a relatively sizeable and deep lake (average depth 31m and deepest point at the crater of 93.5m). Navigation issues tend to focus around accessing the lake margin and the shallower bays in the western basin. The proposed lake level range is very similar to the current operating conditions, only with a slightly more natural variation. The range will be marginally beneficial for navigation, as there will be a slightly greater depth of water in the lake for a greater percentage of the time. Access to the shallower bays in the western basin and the lake margin will be marginally improved by the proposed operating regime.

Ironically clearer water leads to more prolific weed growth. Weed beds can be a problem for boat movement and navigation, e.g. keeled boats attempting to enter/exit Okawa Bay. BOPRC do spray weed around public boat ramps when necessary. Slightly greater lake level variability may expose weed beds at certain times of the year. Tall growing and problematic aquatic macrophytes need to be permanently wet to thrive. Wetting and drying of beaches in conjunction with wave action in shallow areas can limit weed growth on the margins if such beds are exposed in a dry autumn. Lake level variability may marginally improve accessibility/navigability through weed reduction nearer the lake edge – although any potential improvements are likely to be small.

In summary, navigation in the northern side of Lake Rotoiti is unlikely to be significantly affected by a slightly wider, slightly more natural operating range as the lake is deep and drops off sharply on that side. Lake Rotoiti north western bays (Otaramarae/Te Weta Bays/Okere Arm for example) and Okawa Bay are comparatively shallow and are more significantly affected when lake levels are low. Under the proposed operating regime lake levels will be lower in the late autumn, as would occur naturally. This coincides with periods of lower recreational and navigational use. The Proposed Option will have minimal affect on navigation relative to current lake levels as the median lake level of the Proposed Option is 279.160m RL (vs 279.121 for status quo) and the minimum lake level for the Proposed Option is 279.069 (vs 279.043 for the status quo). Effects on navigation will be further minimised by scheduling lower lake levels with periods of lower boating use.

9.6 Water Quality

9.6.1 Lake Rotoiti

Concern over the water quality of Lake Rotoiti led to the construction of the Ohau Channel Diversion Wall to divert nutrient and algae rich water from Lake Rotorua directly to the lake outlet and avoid mixing with the main body of Lake Rotoiti. The nutrient diversion wall is working very effectively. It is important that the Lake Rotoiti water level operation does not compromise the effectiveness of the diversion wall and as a simple operating rule it is recommended that the Okere gates release at least the same volume of water as is entering from the Ohau channel.

The mixing of Ohau Channel water with Lake Rotoiti is complex and changes seasonally. Consequently, the University of Waikato was commissioned to model the effect of different operating regimes on the effectiveness of the Ohau channel diversion wall. The results of this modelling are reported in Muraoka *et al* (2010), refer to Section 9.1 of **Appendix 4**. This modelling has shown that allowing a wider water level range with more flexibility in how the gates operate improves the effectiveness of the diversion wall at diverting Lake Rotorua water down the Kaituna River. Under the status quo a small amount of Lake Rotorua water was estimated to move into Lake Rotoiti (i.e. 0.25 - 0.5%). Less Lake Rotorua water enters Lake Rotoiti under the Preferred Option (0.21 - 0.39%) and less again under the natural (0.07 – 0.1%). Overall, the water quality benefits of the Proposed Option compared to the status quo are positive but very small.

Septic tanks are used to treat domestic sewage from a number of settlements around the lake including about 20-30 houses at Hinehopu. There is concern about poor treatment and localised contamination of the lake environment because of the high groundwater levels. This has led to a decision by RDC to reticulate this area in 2012 to alleviate the risk of septic tanks contaminating the lake.

A survey was done along Hinehopu in June 2010 to help establish the relationship between groundwater levels and lake water levels (see **Appendix 4**). This found groundwater levels marginally higher than lake water levels and groundwater levels were close to septic tank outlet levels. A hydraulic link between the lake and Hinehopu groundwater levels could not be confirmed without further monitoring (i.e. in summer), and regardless of lake water level, the effectiveness of septic tanks will be compromised by high groundwater levels from the wetland.

It is possible that increasing the lake level further compromises the effectiveness of septic tanks in Hinehopu, but the marginal impact is considered minor. If Hinehopu septic tank reticulation is delayed beyond 2012 then it is recommended that surveys are undertaken to determine if higher lake levels compromise septic tank performance during the summer.

9.6.2 Kaituna River

The main components of flow regime that influence the ecology of rivers are: very low flows, very high flows and the rate of change in flows.

Flow in the Kaituna River has been modelled for the proposed operating strategy, current state and natural conditions for the period 1998 to 2007 (Aurecon 2009). These are shown in **Figure 27** above. Summary flow statistics are in **Table 22** below. The results show negligible change in the median and average flows under the different operating regimes; negligible difference in the maximum flows that occur for only a few days in 10 years; but moderately high flows (>30 m^3/s) occurred less frequently and for a smaller period of the time under the proposed operating strategy and natural conditions. Both the proposed operating strategy and the natural scenario would reduce the percentage of time flows are less than 15 cumecs.

Extreme flows, at both the high end and low end are occur less frequently under the 'natural' scenario, followed by the proposed operational range followed by the status quo.

High flows have an important role in structuring aquatic communities. Biggs and Thomson (1995) found the frequency of flood flows greater than three times the median flow (FRE3) to be a major factor explaining the composition of periphyton and aquatic macroinvertebrate communities in streams. The FRE3 statistic is commonly used as a rule of thumb to define when high flows may have disturbed a river, moved bed substrate and removed periphyton. The FRE3 threshold was not reached in any of the modelled scenarios, and the Kaituna River behaved like a stable lake feed river with a relatively small range of flows. Consequently, any direct effect of changing the flow regime to the proposed option, while maintaining the current minimum flow, is expected to be minor.

It is possible that there is some indirect effect of changing the flow regime. In particular, fewer high flows and reduced ramping of flow could reduce downstream erosion (Redeker pers. comm. 2009). This may improve water clarity and reduce the quantity of fine sediments on the stream bed.

The way in which the Okere gates are operated has negligible effect on the quality of water passing through the gates and flowing down the Kaituna River. The quality of the water flowing down the Kaituna River is the weighted sum of the Ohau channel water and the Lake Rotoiti water. By slightly improving the efficiency of the Ohau Diversion Wall the proposed operating regime will slightly reduce dilution from the cleaner Lake Rotoiti water, but the net result will be negligible.

This is further discussed in McIntosh (2010) and McIntosh (2005). McIntosh (2005) concluded that the impact of the diversion wall itself, diverting poorer quality water directly down the Kaituna River, would be minor compared to the impact of diffuse pollution from further downstream.

In summary, the Proposed Operational Strategy will reduce high flow events in the Kaituna River compared to the status quo and have negligible impact on water quality.

Table 22: Summary statistics for Kaituna River at Okere outlet for period 1998-2007.

	Status quo flow	Proposed	Natural
Median (m^3/s)	21.0	20.9	21.4
Average (m^3/s)	22.0	22	21.9
% days >30 m^3/s	13.1%	11.6%	6%
% days > 45 m^3/s	0.1%	0.6%	0%

9.6.3 Summary of Potential Water Quality Effects

Table 23 below summarises the potential effects on water quality of the proposal.

Table 23: Summary of potential water quality effects of slightly increasing Lake Rotoiti water levels and increasing the magnitude of fluctuations as in the Proposed Option (D7).

Water quality component	Increase seasonal water level fluctuations	Slightly Higher average water level	Comments
Lake Water quality	positive	neutral	Slight improvement in effectiveness of diversion wall.
Kaituna River	Neutral/positive	neutral	Slightly positive in terms of less erosion and subsequent effects on WQ and ecology.

9.7 Ecology

Opus's Ecologist has prepared a report titled "Ecological effects of proposed change in Lake Rotoiti water level and range of fluctuation". A copy of the full report is included in **Appendix 10**.

9.7.1 General approach

The proposed operating strategy will result on average in a 4cm higher lake level compared to status quo (particularly during spring/summer), and a fractionally wider range of water level fluctuations. Low levels will generally occur around June and maximum levels generally around August. Assessing potential ecological effects associated with the proposed operating regime for Lake Rotoiti involves a degree of uncertainty. The ecology can be affected by both the direct effect of the changes and indirect effects flowing through the food web or as changes in habitat. Three approaches have been taken to assessing potential effects:

1. Historical data has been used where it is available and relevant, to assess the abundance of species before and after the Okere Gates were installed in 1982 and

before and after the more tight (0.15m) operating range was implemented in 1996. This approach can provide evidence as to how sensitive a species may be to a different regime, but it does not definitively identify cause and effect as many other factors could also be influencing species abundance.

2. Knowledge of the physical processes and habitat and feeding requirements of different species and systems have been used to identify potential positive and negative effects.

3. The proposed vertical change in water level has been converted into a corresponding width of amphibious zone (the zone periodically wet and dry) using representative cross sections of surveyed beaches. This was done to estimate potential formation of beaches or turf communities and corresponding potential change in spawning habitat for smelt.

Water level fluctuations have little impact on the open water food web and potential effects on aquatic flora and fauna will be generally restricted to where their habitat and life history occurs in shallow water near the lake edge.

9.7.2 Instream Minimum Flow for Kaituna River

A discussion of Instream Minimum Flows for the Kaituna River is included in Section 3.7.3 above. The minimum flow identified in the Proposed Operational Strategy represented by the Proposed Option (D7) is 7.9m^3/sec, which is lower than the Instream Minimum Flow of 9.842m3/sec calculated as per Method 179 of the RWLP. However it is considered that any potential adverse effects on the ecology of the river caused by the proposed minimum flow will be less than minor, as it has been shown in Section 3.7.3 that if Option D7 had been operating for the period 1 Jan**uary** 1998 to 31 Dec**ember** 2007, then the Instream Minimum Flow would have been met or exceeded 99.78% of the time.

9.7.3 Summary of Potential Ecological Effects

The expected effect of the proposed operating strategy on ecology and water quality of the lake is summarised in **Table 24** below. There is a degree of uncertainty about how a change in water level regime would impact on the ecology of the lake. Nevertheless, based on our knowledge of natural processes we expect, in the long term, slightly wider beaches, a possible slight improvement in spawning habitat for common smelt through increase extent of submerged sandy beaches, and a slight improvement in the effectiveness of the Ohau Diversion Wall.

The extent to which the increasing the range of water level fluctuations promotes formation of sandy beaches or diverse turf communities will depend to an extent on the degree of wave action on a particular beach, and the magnitude and frequency of inundation. The diversity of turf communities is optimised with water level fluctuations of up to 1 m that occurred in cycles shorter than two months.

The proposed operating strategy is not expected to impact on the breeding success of the NZ dabchick.

Only Hinehopu wetland and wetlands directly on the lake margin are expected to be influenced by the proposed change in lake level. Slightly increased water levels and water

level fluctuations are expected to be generally positive for wetland but the positive effect will be minor.

The Proposed Operational Strategy will slightly improve the efficiency of the diversion wall with a corresponding slight improvement in water quality.

Impacts on the Kaituna River are expected to be slightly positive. The proposed changes will maintain the existing minimum flow and provide a more natural flow regime by reducing high flow events in the Kaituna River compared to the status quo. This could reduce downstream erosion with possible improvements in water clarity.

Table 24: Summary of potential ecological effects of slightly increasing Lake Rotoiti water levels and increasing the magnitude of fluctuations.

Ecology component	Increase seasonal water level fluctuations	Slightly higher average water level	Comments
Aquatic plants	slightly positive	neutral	Little impact on turf community as little change in short term (e.g. bimonthly) fluctuations.
Fish(including trout), koura, kakahi	Neutral/positive	neutral	Potential increase in spawning habitat for smelt, little or no impact to trout spawning
Birds	neutral – slightly positive	neutral	Rate of water level change same as status quo.
Wetlands	positive	positive	Slight increase in water levels of Hinehopu wetland.
Kaituna River	positive		Reduced downstream erosion with possible improvements in water clarity.

9.8 Cultural

9.8.1 Lake Rotoiti and Ohau Channel

Feedback received through ongoing and regular consultation highlighted a number of issues important to tangata whenua.

- Beaches – some sections of tangata whenua have sought a wider Lake Rotoiti operating range and lower median to encourage wider beaches at key cultural locations particularly on the eastern margins. This matter is discussed in Section 9.10.1.

- Ohau Channel sedimentation – Ngati Pikiao would like to see improved flow velocity through the Ohau Channel to remove silt build up and reduce sedimentation of the channel. Refer Section 3.7.6.

- Smelt – a widened lake level range is perceived by tangata whenua as likely to have positive effects on spawning and the smelt fishery. This matter is discussed in Section 9.7 above.

- Septic Tanks – lower average lake levels would be expected to have a positive effect on septic tank operation – particularly at Hinehopu. Discussed in Section 9.4 above.

- Cultural practices associated with fishing for smelt, for Koura (fresh water cray) and collecting Kakahi (fresh water mussels) is considered by local iwi to be positively affected by a wider lake level range. Referred to in Section 9.7 above.

- Tangata whenua suggest that current (perceived as high) lake levels are associated with localised flooding and drainage issues at Hinehopu and stagnant water in drains at Mourea. Local iwi suggest that these issues will be resolved by lower average lake levels. Discussed in Sections 5.6, 9.4 and 9.14.2.

9.8.2 Kaituna River

A more natural flow regime in Kaituna River has been proposed by Dr Kepa Morgan on behalf of tangata whenua as a Performance Measure. (Refer BOPRC/TALT PowerPoint presentation to local iwi at Taheke Marae, Lake Rotoiti on 2 October 2009 in **Appendix 13** of AEE). It is likely under the Proposed Option with slightly more natural flows to the Kaituna River, that suitable periods of access to waahi tapu sites would be more predictable and therefore slightly improved.

9.9 Archaeological

The report included in **Appendix 7,** prepared by Opus Archaeologist Chris Mallows details the potential effects associated with Proposed Option (D7) and Proposed Operational Strategy with a lake level range of 0.328m (compared to the status quo of 0.318m) and a maximum lake level of 279.397 (compared to 279.361 status quo). It is clear that there will be no appreciable difference in effects (on archaeological interests) between the Proposed Option and the status quo. The report concludes:

"There are at least thirty-nine recorded archaeological sites around the immediate periphery of Lake Rotoiti. These recorded archaeological sites are predominantly pa, which are located on high spots overlooking Lake Rotoiti. As such, the majority of recorded archaeological sites will not be affected by a minor increase (0.036m) of Rotoiti lake level".

One recorded pa site (U15/30) is located on the Lake Rotoiti foreshore. The pa, known Pukurahi, has storage caves cut into the base of the cliff along the edge of Lake Rotoiti Stafford (1996) notes that the most of the storage caves were concealed by a build-up of oil and other matter. It is unknown if and when Stafford visited Pukurahi. No archaeological information on this site has been provided to the NZAA since Moore in 1973. As such the current condition of these storage caves – whether they are buried under silt and/or under the current Rotoiti lake levels, or visible and easily accessible – is unknown. However, an increase in Rotoiti lake levels of 0.036m will not have a significant impact on this recorded archaeological site."

It should be noted that tangata whenua may have knowledge of areas within the local vicinity that are waahi tapu but where no physical evidence was observed. Consultation with tangata whenua in areas such as this can assist in indentifying such areas that may not be identified as part of any archaeological work."

9.10 Recreation and Commercial Tourism

9.10.1 Lake Rotoiti

Tourism

During consultation, recreational lake users and commercial operators have expressed concern that any significant lowering of level in Lake Rotoiti could be damaging for commercial operators from an operational and aesthetic point of view, and may compromise the practicality of servicing various tourism ventures. There would likely be negative effects on recreational values around the lake as well. Landowners suggest that access to the water through metres of muddy 'foreshore' would not be a positive outcome. Rotoiti is less likely to have a muddy foreshore problem, but various areas may become marginal for larger vessels at lower lake levels. In particular access through Ohau channel, access to Okawa Bay boat ramp, access to Te Akau Marina and access to hot pools. Under the proposed operating regime lake levels will be marginally higher for much of the year, but lower in the late autumn/early winter. This coincides with periods of lower tourist numbers. Effects on tourism will be minimised by scheduling low lake levels in autumn and early winter. No significant effect is likely to result from the Proposed Option as there is less lake level time in the lower 279.05 to 279.100 range than status quo.

Boating

Levels of commercial (tourist) & recreational lake boating activity are at their peak from late October – specifically Labour weekend – until late April. Of particular relevance is the Lake Rotoiti annual Wooden Boat Parade (approx 75 craft), held in February each year in and around the Okere and Te Akau Bay areas. This event may be negatively affected if the lake level is reduced at this time of the year. Water levels in the Okere and Te Akau Bay areas are already marginal in places. The Lake Rotoiti Community Association reports that a number of its members have boat access and draught issues at their structures (jetties) when lake levels fall below 279.100m RL. The Proposed Option lake level range is slightly more favourable to boating with less lake level time in the lower 279.05 to 279.100 range than status quo. Under the proposed operating regime, lower lake levels are likely to be in May/June.

Boating activity is unlikely to be affected at this time and lake levels are expected to be less than 279.10 (ie 279.10 down to 279.050) for approximately 5% of the time. Under the status quo lake levels are in this lower range for up to 21% of the time.

Fishing

The implications of lake level change on the ecology of the trout fishery, is discussed under Section 9.7, 'Ecology' section of this report.

With respect to the activity of trout fishing, the implications of any lake level change centre around access to and upon suitable beaches by shore based anglers and access to the

lake itself by boat based fishers via ramps and jetties. Access via ramps and jetties will be slightly improved by the proposed operating range. There may be some slight reduction in shoreline access due to increased operating levels.

Over time, with a very narrowly controlled lake level, aquatic weed has encroached closer to the lake edge. The traditional Maori fishery may have been affected by weed growth in the shallower parts of Lake Rotoiti. A slightly more natural lake level range as proposed in the consent application has the potential (over a period of time) to slightly decrease weed growth in the shallow margins of the lake. This would be achieved by exposing the weed to air and sunlight at seasonally lowered lake levels'. It is thought that the (perceived) reduction in smelt and Koura abundance is due in part to the lack of clear, weed free shallow water around the lake edge.

Fish are generally caught (boat based lake fishing) from water 10 – 20 m deep, so any change in lake level within the proposed range as far as the trout are concerned - is unlikely to have impact on the location of the fish accessible to boat anglers.

The Ohau Channel trout fishery is not expected to be impacted by the Proposed Option (D7). Ohau Channel flows under the Proposed Option (D7) show very little difference to that of the current (status quo) flows.

Fisheries Officers from Eastern Region Fish and Game have raised some concern about the possible timing of occasional Ohau Channel flushing operations for sediment and algae control purposes. They contend that the increased velocity and levels in the Ohau Channel may result in lower Ohau Channel catches by shore based anglers for the duration of the flush operation (reputed to have been the case in the late June 2010 flush trial). Rivers and Drainage have noted these concerns and would endeavour to conduct channel flushing where possible in the non fishing season winter months of July/August in particular. If a channel flush was necessary in the late autumn months for algae removal in Okere Arm, then carrying this out sometime in May to early June is expected to result in least disruption to the Ohau Channel anglers.

Geothermal

For Lake Rotoiti there are no known geothermal issues associated with the existing lake level regime.

It is recognised that pre gates the lake was subject to wider level variation. So in itself a return to slightly more natural lake levels and variability should not adversely affect geothermal features.

According to GNS, a rapid dropping of water level is the greater issue. If pressure were to drop off rapidly in the geothermal system then this could result in more 'boiling', leading to surface changes and in the worst case, hydrothermal eruptions (pers comms, Brad Scott, GNS, 2009).

Beaches

Exposing wider beaches is an effect that a number of lake users are keen to see. The extent of beach will be a reflection of the local lake energy environment (wave exposure – including fetch), the availability of a sandy substrate locally (no sand means no beach), water level range and the duration of wetting/inundation. The periodic high water level is a dominant force in beach formation rather than simply the lower level. If inundation at the upper range occurs for some weeks then this will kill off terrestrial plant invaders and help retain raw sandy beach. A significant increase in the seasonal range of lake levels would promote wider beach exposure. Exposing beaches seasonally would improve and increase some foot access to and beside the lake, a desirable outcome for many. Theoretically a lower lake and more variable lake level regime would provide improved beach widths, particularly where beaches already exist, but these are unlikely to be continuous around the lake. Beaches (in some cases short lengths) may well continue to be interspersed with extensive sections of no beach - vegetation/banks and rocks which meet the water's edge. However under the Proposed Option and Proposed Operational Strategy there is negligible improvement and perhaps even an initial slight loss of beach exposure.

The following **Table 25** contains an estimated range of beach widths at 'beaches' 1 – 7; all of which are of particular interest to Ngati Pikiao from a cultural and walking access perspective . Refer to **Appendix 4,** Chapter 10, for cross sections of the beaches 1-7 and additional beach study information.

1 Tamatea Street

2 Taupuaeharuru Marae

3 Te Kura Kaupapa Maori o Rotoiti

4 Hinekura Marae

5 Emery Road

6 Ruato Bay

7 Curtis Road Beach.

Table 25: Beach widths under a range of operating conditions

	Beach 1	Beach 2	Beach 3	Beach 4	Beach 5	Beach 6	Beach 7
Natural (opt 1)	3.65	2.00	2.58	1.54	1.54	2.83	3.05
Status Quo	1.76	0.40	1.65	0.85	0.76	2.08	1.80
Low Weir (opt 4)	10.28	5.22	6.30	7.75	4.35	6.35	5.72
Proposed Option (D7)	1.68	0.09	1.42	0.73	0.56	2.04	1.90

The beach widths were generated from surveys of existing beach profiles and lowest lake depths, for the four options that were considered. It can be seen that the Status Quo and the Proposed Option give the narrowest beach widths, with the Proposed Option the narrowest. This is due to the proposed operating range having a slightly higher low lake level and a slightly higher maximum level than the status quo. With beach gradient at the upper end of the range being slightly steeper, this results in less beach exposure when lake is lower.

In the short term a slight increase in water level will result in slightly smaller terrestrial beaches and slightly larger areas of sand below the water surface when compared to the status quo. However, in the longer term a new equilibrium will establish (by inundation of terrestrial vegetation and wave action) and there is not expected to be any significant difference to beach width (compared to the status quo). In general, an increase in the water level range with a single annual draw down will potentially increase the extent of sandy beaches. However, the proposed change in water level range is only 1cm more than the status quo and the change will be barely noticeable.

Currently beaches around Lake Rotoiti are often narrow, as illustrated in the following photograph of Ruato Bay, **Figure 31** (water level at the current target). What can also be observed from these photos is evidence of a higher water level and potentially wider beach. Wave generated debris up to 2m from the target water level can be seen, indicating that if the water level were allowed to be higher for longer, the vegetation may recede, revealing more raw beach.

“Loss” of some beaches could be mitigated by judicious herbicide spraying along the existing landward beach edge, notably beaches at Hinehopu and Ruato Bay (profiles 1 and 6).

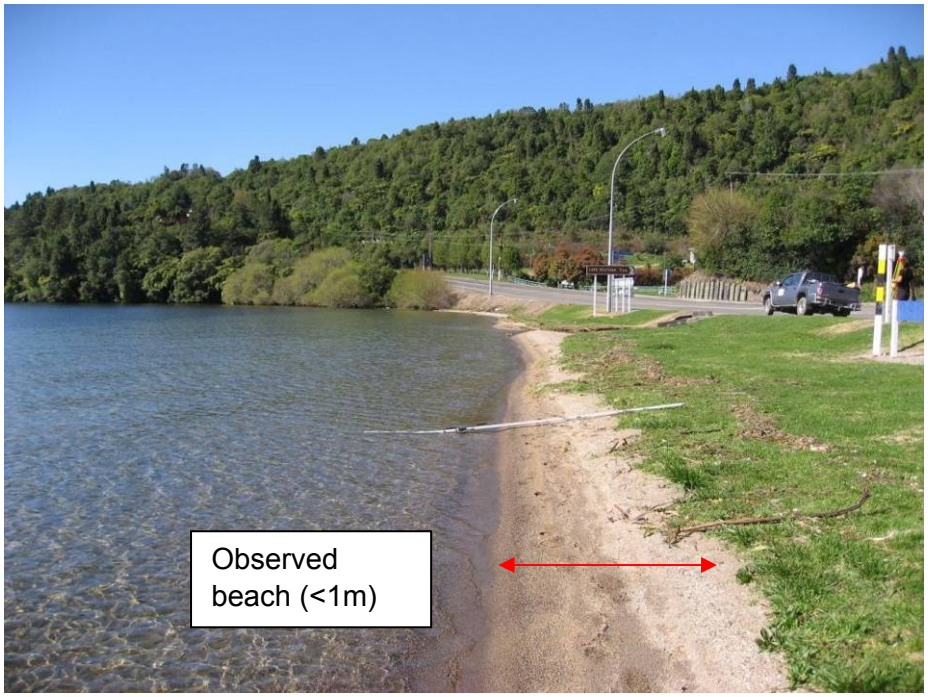

Figure 31 - Ruato Bay, Looking East.

During a recent (Friday 18 June 2010) visit to Lake Rotoiti by boat, taking in beach profiles 1 – 7 it was agreed by all present - representatives of Rivers and Drainage Group, LRCA, Ngati Pikiao, and local beach restorers - that there was no practical solution for the development of any significant or contiguous beaches for profiles 2 – 5. This is consistent with the observation (by all present) that there are virtually no observable beaches along this stretch of the lakeside, and historic recollections that there were only ever occasionally very small localised beach edge exposures in this area (Pers Comm Joe Tahana)_

In summary; historic recollections of beaches around Lake Rotoiti vary. Beaches (in areas of interest) greater than 2m wide could only be obtained by significantly lowering the level of Lake Rotoiti. Lake level variation needed to generate 3m wide beaches as requested by Dr Morgan, would need to equate to pre gates natural lake level ranges (at least 500mm). Adopting such a wide lake level range would lead to serious negative impacts on social and economic well being (for example loss of use of structures for many months of the year and serious disruption to existing lake based tourism enterprises) that could not be realistically mitigated.

Given the very minor initial effects of the Proposed Option's slightly higher median lake level on beaches, Rivers and Drainage Group is prepared to offer mitigation in the form of judicious herbicide application of encroaching exotic weeds and grasses along the landward beach margin at Hinehopu and at Ruato Bay.

In some areas, existing beaches could be (and have been) very successfully enhanced by removal of lake edge vegetation such as gorse and willows. Rivers and Drainage Group would work with community groups to restore the beaches described above.

Structures

From May 2010 depth surveys of consented structures in Lake Rotoiti (270 surveyed), it is now possible to accurately determine functionality of these structures at various water levels.

Table 26 below shows the number of jetties on Lake Rotoiti which become unusable at a range of lake depths (current target level of 279.11m, at 279.05m and at 279.0m), for vessels drawing 400mm or greater. The 400mm draught has been taken as a fair draught for trailered boats (outboard powered) of 5.5 -6m length. A number of pleasure craft draw less than that. It is appreciated that some larger vessels using the lake including a number of the approx 40 historic and classic wooden vessels, can draw up to 750 -900mm.

It should be appreciated that boats generally need to be able to tie up alongside jetties. In many case jetties are shared and so several boats can be moored at a jetty at any one time.

Table 26: Number of Jetty's unusable by vessels drawing >400mm at various water levels.

	Water Level (m RL)		
	279.1	279.05	279.0
Middle of jetty	30 (11.1%)	59 (21.8%)	82 (30.3%)
4m from end of jetty	18 (6.6%)	30 (11.1%)	53 (19.6%)
Lake end of jetty	5 (1.8%)	9 (3.3%)	15 (5.5%)

Further details and photos are contained in **Appendix 17,** Survey Data for Structures.

When Lake Rotoiti is at its lowest level under the Proposed Option (279.05), 9 jetties or 3.3% at their lake end point would be unusable with boats drawing more than 400mm; 30 or 11% would be unusable 4m from the lake end of the jetty. If lake levels were hypothetically, as low as RL 279.0m, 5.5% of jetties (15 jetties) would be unusable at the end and 53 or 19.6% would be unusable 4m from the lake end of jetty.

Under the current operating regime water levels drop below 279.1 for 21 % of the time (mostly during summer) and never drop below 279.05. In contrast the 'natural' regime would drop below 279.1 for 17% of the time but would occasionally be considerably lower (6% of the time < 279.05). Modelling of the proposed operating strategy show water levels will not drop below 279.05 and will be less than 279.1 for only 5% of the time. This short time below 279.1 will be mostly in June when the lake use will be lower.

The catamaran "Tiua" is a commercial craft which uses the Duxton Hotel Jetty as its base. The vessel draws 2m, and is sensitive to any drop in lake level. The proposed lake level range should ensure the continued operation of "Tiua" in Lake Rotoiti. It is possible that movements of this vessel could be restricted in late May/June, when Lake levels will be at their lowest.

A memorandum (refer full document in **Appendix 18)** from [then] design engineer Matthew Surman to [then] Environmental Consents Officer Andy Bruere dated 16 July 1996 clearly demonstrates issues which would be relevant to structure owners if the lake level is

reduced significantly. With the lake level at RL 279.225m (24/1/96), a boat shed in the Okere Arm entrance had depths of water ranging from 0.35 to 0.5m in the shed, making it unusable at that lake level, for a vessel drawing more than 500mm. The memo goes on to say that on the 15/7/96, when the lake level was at RL 279.163m a number of jetty's were measured, and while access to and use at the end would have been achieved without too many problems (depths of 0.8 – 1.8m), midway along a jetty in Okawa bay, the depth was only 0.3m. The proposed lake level range should ensure that most structures remain usable for most of the year.

The District Council is of the opinion that the functionality of several of the existing public boat ramp facilities may be adversely affected by significantly lower Lake Rotoiti levels. Ramp extensions could be necessary in such a situation (Peter Dine pers com). However the Proposed Option is not lowering lake levels relative to status quo and will not therefore compromise public boat ramps

Te Akau Bay in particular, is relatively heavily populated, with many private structures, and is also a very shallow area – as little as 0.6m deep in places.

Potential loss of amenity related to structures is of serious concern to many Lake Rotoiti property and structure owners/occupiers. Many lakeside property owners have stated that they would not have purchased their properties had there been no suitable jetty.

Jetties and boatsheds contribute a significant amount to property values around the lake(s), as well as to lifestyle & quality of life. Jetties can be worth between $25,000 – $30,000, and boatsheds up to $60,000, depending on the size, condition and location (figures provided by Steve Howard, Professionals Real Estate, Rotorua, in November 2009). Individual landowners suggest that values of $100,000 are not unusual even for substantial shared jetties.

Private owners of such structures are usually adjacent landowners.

Access to privately owned jetties, boat sheds and boat ramps is a significant issue to lake edge landowners in particular. Many of the populated areas around Rotoiti are alongside relatively shallow but accessible bays including Okawa Bay, Otaramarae, Te Karaka Bay, Te Akau Bay (Marina), Te Weta Bay, and Okere Arm. There are many private structures located in these areas and in other popular bays such as Hauparu Bay and near Rotoiti village. Historically some of these structures may not have been able to be used at times of low lake level. However, for the past 12 years, water levels have been maintained within a very narrow range and structure boat access has been largely unrestricted.

Structures which have existing resource consent can be modified, subject to Regional Council, District Council, LINZ and Te Arawa Lakes Trust approval, but because of the large number of organisations involved, this is a time consuming and costly process.

In summary, the proposed operating regime will make access to private and publicly owned structures around the lake edge (boat ramps, jetties and boat sheds) slightly more accessible for much of the year. There may be a period in the late autumn/ early winter when lower levels make access to these structures marginal for some users, however this is likely to coincide with periods of lower use.

9.10.2 Kaituna River

Rafting

Hydrologics Inc modelled a range of operating options including status quo, low weir (Option 4), natural (Option 1) and the Proposed Option (D7) (operating between the current consented maximum and current target minimum).

Under current operating conditions, suitable river flows for successful rafting are achieved 74.9% of the time. Under the proposed operating range, suitable river flows may be achieved 75.7% of the time during daylight hours (8am – 5pm).

The current very narrow operating range means that if inflows to the lake increase with rainfall events, then these flows must be released immediately in order to maintain the strict target operating level. This can sometimes result in spill flows exceeding the safe rafting outflow limit of 26m^3/s and thus loss of some rafting days. With a slightly wider operating range and no strict operating target, water from rainfall events can be retained and released over a longer period of time and the lake can still be within the operating range targets. This would result in more rafting days a year, as there will be slightly fewer days with flow less than 13.6m^3/day, or greater than 26m^3/day.

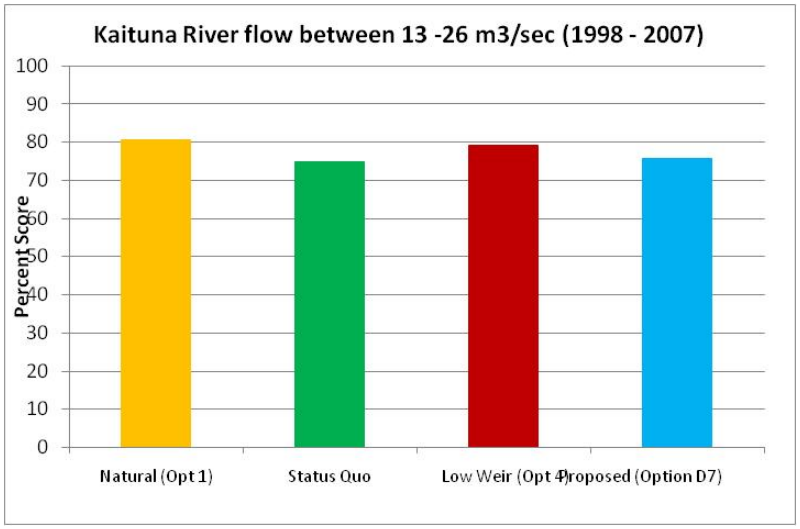

Figure 32: Outflow from Lake Rotoiti to Kaituna River.

Table 27 shows availability of the Kaituna River under two different operating regimes; the current closely controlled flow range, and the proposed operating option.

Table 27: Availability of Kaituna River for rafting.

Operating regime	% time flow less than 13.6m³/s	Days flow less than 13.6m³/s	% time flow greater than 26m³/s	Days flow greater than 26m³/s
Status quo	10	37	20	73
Proposed Option (D7)	4	15	19	70

Sourced from Hydrologics Inc modelling, "Version v10 D7 4 24 May 2010" (Proposed Option).

The Proposed Option represents a slight improvement for rafting operators, providing 25 more possible business days for rafting on the Kaituna River over the status quo (i.e. if the Proposed Option (D7) was operating over the modelled 1998 – 2007 assessment period).

9.11 Amenity Values

9.11.1 General

"Amenity values" are defined in the RMA as meaning *"those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes."*

Identification of amenity values is to some extent subjective and can depend on an individual's interests or involvement in a particular geographical place.

9.11.2 Odour

Exotic (introduced) aquatic macrophytes (lake weed) and hornwort in particular, are aggressive plants. When lakes are low, weed beds in margins and arms of the lake can be partly exposed. At the end of the growing season (autumn) this exposed weed can get broken off by wave action during storms and washed ashore resulting in weed strandings on beaches. The decomposing stranded weed can cause odour problems.

Given that the Lake Rotoiti level range under the Proposed Option is very similar to the status quo range and the minimum lake level under the Proposed Option is not quite as low as the status quo, no significant change in adverse effects on amenity from odour caused by rotting weeds when lake levels are seasonally lower is expected.

9.11.3 Landscape/visual

The landscape of Lake Rotoiti and its margins has become more constant since the installation of the lake level control structures. Lake margins do not change with the seasons as they did historically pre gates. Many people have become accustomed to this lake regime and in fact would regard any significant lake level variation with resultant margin exposure change as negative.

Others view some lake level variation positively and a part of the natural seasonal cycle.

The Proposed Option will, to the casual observer, provide no significant visual change to that experienced under the current/status quo scenario. The median lake level will increase slightly from the current 279.121m RL to 279.160m RL a 39mm change. Similarly the lake level range will increase by 10mm. These are very modest changes relative to the current/status quo levels. On this basis an expert opinion on natural character - landscape/visual effects was not considered warranted. It may be possible for locals to detect slightly higher lake levels during the early summer (Dec/Jan) and in late winter/early spring (Aug/Sept) and lower lake levels in June/early July. However these levels will still be within that currently accepted as normal.

9.12 Property Values

The Proposed Option and the Proposed Operational Strategy for lake levels will not lead to any significant change to lake navigation or access to and use of lake structures. As a result lakefront landowners with structures will not lose amenity, and property values are expected to be largely unaffected by the proposed changes. On this basis an expert opinion on the effect of the Proposed Option on land values was not considered warranted.

Hinehopu bach properties (Tamatea Street leasehold predominantly) are already affected by high groundwater, drainage and waste water soakage issues – partly as a consequence of being sited on the edge of a substantial wetland, partly because of the local topography and catchment position relative to the lake and increasingly because of tectonic subsidence. These Hinehopu properties have been recording such concerns since their establishment under historic pre gates lake levels and also under the status quo levels. The increased percentage of time (relative to the status quo) the lake level will be in the 279.150 to 279.200 range and the 279.200 to 279.250 range under the Proposed Operational Strategy represented by the Proposed Option (D7) is considered to cause less than minor adverse effects on existing property values, as the issues faced are largely occurring irrespective of the lake levels under consideration.

9.13 Future Electricity Generation

It has been known for quite some years (through media news articles), that commercial interests have been evaluating hydro power generation opportunities on the upper Kaituna River. Any such schemes are likely to be “run of river” (little storage”), designed to fit the current Okere Gates operational regime. Current and any future lake level management and Okere Gates flow and timing of release detail would obviously be of interest to power companies.

Bay of Plenty Energy (a 100% owned subsidiary of Todd Energy) has been one of the companies assessing potential opportunities. Bay of Plenty Energy made it known that

they consider themselves an interested party and potential stakeholder in terms of the resource consent for Okere Gates.

As at 1 June 2010, no consent application had been lodged with BOPRC for power generation facilities on the Kaituna River.

9.14 Summary of Actual and Potential Effects on the Environment

9.14.1 Lake Rotorua

The only option that has been considered is to retain the existing stop log weir structure, with the Rivers and Drainage Group seeking potential to enhance the management of lake levels by alterations to the management of the removal and replacement of the stop logs to maintain the lake levels within the same range as currently consented.

By more pro-active management of the stop logs placement and removal, BOPRC can ensure that any adverse effects to commercial tour operators as a result of lower lake levels during summer are avoided.

9.14.2 Lake Rotoiti

Table 28 summarises the positive, adverse or neutral effects on the different aspects of the environment of the Proposed Operational Strategy as represented by the Proposed Option (D7) of lake levels for Lake Rotoiti, and the proposed methods to avoid, remedy or mitigate the adverse effects where applicable, compared to currently consented situation. (Refer to Section 9.2.3 for very brief comparison against Options 1 and 3).

Table 28: Summary of Positive, Adverse and Neutral Effects, and proposals to avoid, remedy or mitigate the effects for **Lake Rotoiti against currently consented situation.**

AEE Section Number	Environmental issue	Effect of Proposed Option (D7) Compared to the Currently Consented Situation	Comments	Proposed Actions to Avoid, Remedy or Mitigate Adverse Effects (Not applicable generally applies to neutral or positive effects)
3.6.2 3.7.6 9.3.4 9.8.1	Existing sediment deposition in Ohau Channel and high water levels in the Ohau Channel	Neutral/Positive	Desired community outcomes are to improve Ohau Channel flow velocities and reduce sedimentation of channel. Some additional sediment build up at Channel mouth is related to nutrient diversion wall.	Proposed Option allows opportunity to periodically flush Ohau Channel and Okere Arm when both lakes are high. Continue to regularly survey Channel cross sections to compare bed level with previous surveys. May need to dredge Channel/mouth periodically. This matter is not directly related to this consent and will be managed separately as part of the Kaituna Catchment Control Scheme asset management maintenance programme
9.3.6	Effects of Okere Gates outflows on Kaituna River flooding	Neutral/slightly positive	Proposed Option attempts to minimise flows greater than 40m3/s. The Proposed Option will keep number of days with flows greater than 40m3/s slightly lower than status quo.	Not applicable
9.3.7	Bank erosion of the Kaituna River	Slightly Positive	Proposed Option provides slightly 'smoother' outflow regime, and will help minimise river bank erosion downstream	Not applicable
9.4.1	Stormwater and Drainage	Neutral/Slightly Adverse	Proposed Option provides median lake	At this point the Rivers and Drainage Group are not able to

AEE Section Number	Environmental issue	Effect of Proposed Option (D7) Compared to the Currently Consented Situation	Comments	Proposed Actions to Avoid, Remedy or Mitigate Adverse Effects (Not applicable generally applies to neutral or positive effects)
9.8.1	Hinehopu and Ruato Bay – property drainage and septic tank function		level of approximately 279.160 m RL (versus 279.121 for Status Quo). This slightly higher lake level may lead to slightly higher groundwater levels. Hinehopu – Tamatea St baches are inappropriately sited. Tectonic site settlement and wetland edge location has lead to historic and current drainage and septic tank soakage problems.	provide any specific mitigation. However if ongoing seasonal groundwater monitoring demonstrates that the Proposed Operational Strategy would result in minor additional adverse effects on groundwater levels at the Tamatea Street bach properties, the applicant is prepared to investigate commensurate mitigation to ensure there is no net loss of amenity relative to Status Quo.
9.5.1	Lake Navigation – all parts of lake	Neutral	Boat access and navigation are maintained	Not applicable
9.6.1 9.6.3	Water Quality Lake Rotoiti (effectiveness of the Ohau Diversion Wall)	Slightly Positive	Slight improvement in effectiveness of diversion wall.	Proposed Option ensures that Okere Gates flows are to be greater than Ohau Channel flows to minimise risk of backflow around the Nutrient Diversion Wall. (Rule)
9.6.2	Water Quality Kaituna River	Neutral/Slightly Positive	Slightly positive in terms of less erosion and subsequent effects on water quality and ecology. Neutral in that the Proposed Option will not change water quality entering the Kaituna River	Not applicable
9.7.2	Aquatic plants (macrophytes)	Neutral/Slightly Positive	Little impact on indigenous turf community as little change in short term (e.g. bimonthly) fluctuations.	Manage Proposed Option water levels so that within year variation is significantly greater than the inter-annual variation (between years) in order to promote diverse low growing turf communities on the lake margin.

AEE Section Number	Environmental issue	Effect of Proposed Option (D7) Compared to the Currently Consented Situation	Comments	Proposed Actions to Avoid, Remedy or Mitigate Adverse Effects (Not applicable generally applies to neutral or positive effects)
				BOPRC to continue to monitor the depth and distribution of aquatic macrophyte pest plants at representative beaches/public boat ramps. Maintain current spraying programme to control local infestations of aquatic pest plants
9.7.2 9.8.1	Smelt, Koura and kakahi	Slightly Positive	Potential slight increase in spawning habitat for smelt	Optimise utilisation of potential spawning habitat for smelt. Proposed option mitigates potential impacts by maintaining a seasonal water level fluctuation avoiding a fast decline in water level of > 0.5m /month during the peak spawning season (September – December).
9.7.2 3.8.1	Birds	Neutral/slightly positive	Rate of water level change under Proposed Option similar to status quo	Proposed Option mitigates by generally restricting the rate of water level increase during the period September to March to less than 0.1 metres per month, to protect Dabchick nests from inundation. Limit the exceptions to this condition. Mitigate by monitoring dabchick habits and populations before and after implementing the new regime. Monitoring should focus on the western end of Lake Rotoiti where dabchicks are concentrated (e.g. the section of shoreline between Otaramarae to Okere falls). The monitoring programme should address seasonal abundance (particularly during the breeding season).
9.7.2	Ecology of Wetlands	Positive	Slight increase in water levels of Hinehopu wetland	Not applicable
9.7.2	Ecology of Kaituna River	Slightly Positive	Reduced downstream erosion with possible improvements in water clarity	Maintain existing minimum flows of 7.9m3/s. (Rule).

AEE Section Number	Environmental issue	Effect of Proposed Option (D7) Compared to the Currently Consented Situation	Comments	Proposed Actions to Avoid, Remedy or Mitigate Adverse Effects (Not applicable generally applies to neutral or positive effects)
			(refer to Section 9.3.7).	
9.8.1 9.10.1	Beach Formation/width enhancement	Neutral/Slightly Adverse	Mitigation not possible for cultural beach profiles 2-5 (eastern shores L Rotoiti).	Some landward side of beach spraying of encroaching grass vegetation to widen area of raw pumice sand – e.g. at Ruato Bay.
9.8.1 9.7	Cultural practices associated with fishing for smelt, for Koura (fresh water cray) and collecting Kakahi	Neutral/slightly positive	Slightly wider range may enhance the ability to undertake these practices	Not applicable
9.8.2	Access to waahi tapu sites along upper Kaituna River margin and Lake Rotoiti margin	Neutral/Slightly positive	Lake levels will be lowest in late autumn/early winter. This will allow iwi to check/maintain waahi tapu sites on Lake margin. Flows will be slightly more natural/predictable and allow River margin inspection.	Not applicable
9.9	Archaeological features	Neutral		Not applicable
9.10.1	Recreational Boating	Neutral/Slightly Positive		Not applicable
9.10.1	Recreational Fishing	Neutral		Not applicable
9.10.1	Recreational use of geothermal areas	Neutral		Not applicable
9.10.1	Structures i.e. jetties, boat ramps and boat sheds	Neutral/Slightly Positive		Not applicable
9.10.1	Commercial tourism – structures	Neutral		Not applicable
9.10.1	Commercial tourism -	Slightly Positive		Not applicable

AEE Section Number	Environmental issue	Effect of Proposed Option (D7) Compared to the Currently Consented Situation	Comments	Proposed Actions to Avoid, Remedy or Mitigate Adverse Effects (Not applicable generally applies to neutral or positive effects)
9.10.2	Rafting/kayaking/jet boating – Kaituna			
9.11.2 9.11.3	Amenity Values – odour/visual/landscape	Neutral		Not applicable Collection and disposal of weed strandings in very public bays where odour is an issue

10 Assessment of Effects Against Statutory and Relevant Non-Statutory Documents

10.1 Part 2 of the Resource Management Act 1991

10.1.1 Section 5

As noted in Section 8 of this report, the **purpose** of the Act as stated in **Section 5** is to promote the '**sustainable management**' of natural and physical resources by managing them in a way and at a rate which enables people to provide for their social, economic and cultural well being and their health and safety, while –

(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and

(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Rivers and Drainage Group have considered and extensively researched a number of options for the operation of the control structures, and have undertaken extensive consultation with the local community, and in doing so have developed proposals that will meet the requirements of Section 5.

Enabling people to provide for their social, economic and cultural well-being

The continued existence and operation of the Ohau Channel Weir and Okere Gates enhances the social and economic well being of residents around both lakes Rotorua and Rotoiti by ensuring that the lake levels are managed to (i) avoid flooding, (ii) provide Kaituna River flows that allow commercial activities on the River, and (iii) avoid low lake levels to enable the use of existing facilities and infrastructure.

In terms of cultural well being, consultation with tangata whenua has identified a number of concerns relating to the operation of the weir and gates. We however believe that adverse effects on cultural well-being are able to be mitigated.

Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations

We consider the proposal and proposed mitigation measures will ensure that Lakes Rotorua and Rotoiti, and the Kaituna River will be sustained to meet the reasonably foreseeable needs of future generations. A key issue for these natural resources is water quality, and it has been shown that the proposal does not adversely affect the water quality of the lakes or the river. ***Safeguarding the life-supporting capacity of air, water, soil and ecosystems***

Of relevance to this proposal are water and ecosystems. The AEE in Section 9 of this report discusses effects of the proposal on the water quality of the lakes and the Kaituna River, and on ecosystems associated with the lakes and river. The conclusion is that adverse effects to the lakes water quality and ecosystems are generally less than minor,

and where adverse effects are identified, these can be adequately mitigated. Therefore we consider that the proposal won't reduce or harm the life supporting capacity of the water and the ecosystems associated with them.

Avoid, Remedy or Mitigate

The AEE has concluded that the adverse effects on the environment as a result of implementing Proposed Option (D7) will be less than minor, when compared to the currently consented activities.

There are two issues where there are potentially adverse effects, namely beach width enhancement at selected sites and property drainage at Hinehopu. These issues can be mitigated or remediated as discussed in Section 9 of this report.

10.1.2 Section 6 - Matters of National Importance

Matter of Relevance	Discussion
The preservation of the natural character of wetlands, lakes and rivers and their margins, and the protection of them from inappropriate subdivision and use.	The proposal will not adversely affect the existing natural character associated with the lakes and Kaituna River. The natural character of the lakes and Kaituna River have been modified over the years due to the artificial level management of the water levels and flows, and therefore we consider in the context of the existing natural character, the continued use of the gates and weir are not inappropriate.
The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.	Section 9 of this report identifies that the proposal will not adversely affect significant indigenous vegetation and indigenous fauna habitats that exist in the Lakes and Kaituna River.
The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers.	The proposal will not adversely affect the current access to the lakes edges. Spraying of weeds to mitigate for potential loss of beaches at Hinehopu and Ruato Bay will enhance lake access by pedestrians.
The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.	Extensive consultation has been undertaken with local tangata whenua and consideration of their relationship with the Lakes has been taken into account in the proposals developed and mitigation offered.
The protection of historic heritage from inappropriate subdivision, use and development.	Waahi tapu sites identified on the Kaituna River will not be adversely affected by the proposal, nor will the access to these sites. The majority of recorded archaeological sites around Lake Rotoiti will not be affected by the proposal.

10.1.3 Section 7 - Other Matters That Have Been Considered In the Development Of The Proposal

Matter	Discussion

Matter	Discussion
Kaitiakitanga and the ethic of stewardship	Extensive consultation was been undertaken with tangata whenua commencing March 2009. BOPRC recognised the significance of the project to local iwi, and therefore entered into a partnership with Te Arawa Lakes Trust in 2009 to develop the operating regimes for the lakes. Rivers and Drainage Group have offered that operational procedures (to ensure the Lake levels are maintained within the consented level and ranges) will be reviewed periodically by the Rotorua Te Arawa Lakes Strategy Group and/or other representative stakeholder groups. This demonstrates the applicant's commitment to ensuring ongoing kaitiakitanga by local tangata whenua.
The efficient use and development of natural and physical resources	By retaining the Ohau Weir and Okere Gates structures, Rivers and Drainage are efficiently using the existing physical resources to assist with the ongoing enhancement of the water quality of Lake Rotoiti, and management of flooding to lake edges and low lake levels. In addition, the ongoing management of lake levels per the proposed regimes ensures that existing infrastructure designed and built/established since the lake levels have been artificially controlled, will continue to be operable.
The maintenance and enhancement of amenity values	The proposal maintains amenity values at the same level as the existing situation.
Intrinsic values of ecosystems	The proposal will not prevent ecosystems from functioning.
Maintenance and enhancement of the quality of the environment	Table 28 of this report summarises the effects on the environment of this proposal. In general, effects are considered to be neutral or positive, and where adverse effects are identified, they can be mitigated. Therefore, we consider that the proposal maintains and enhances the quality of the environment.
Any finite characteristics of natural and physical resources	The proposal does not adversely affect any finite characteristics of natural and physical resources.
The protection of the habitat of trout	The proposal does not adversely affect the spawning habitats of trout, as discussed in Section 9.7.

10.1.4 Section 8 - Principles of the Treaty of Waitangi

BOPRC Rivers and Drainage Group established a Working Party at the commencement of the development of the proposal early in 2009. The Working Party comprised Rivers and Drainage group and Te Arawa Lakes Trust (TALT), as owners of the beds of the Lakes. The proposals have been jointly developed, and as such, the Principals of the Treaty of Waitangi have been recognised.

10.1.5 Summary

In terms of the preceding discussion, it is considered that this proposal fits within the framework of **sustainable management** established in Sections 5, 6, 7 and 8 of the Act.

10.2 Effects on Objectives and Policies of the Regional Policy Statement

The following table summarises the consistency of the proposal with the Regional Policy Statement.

Issue	Consistent Y/N	Comment
Principles of the Treaty of Waitangi are recognised and taken into account.	Y	Partnership with TALT and extensive consultation with tangata whenua.
Recognition of and provision for the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.	Y	Extensive consultation with tangata whenua has identified issues that have been accommodated into the proposal where possible, or alternative means to address have been identified.
Adverse effects of activities on social, economic and cultural well-being are avoided, remedied or mitigated.	Y	The proposal, and mitigation measures, provide the best outcome to manage adverse effects on well beings.
Water quality is maintained, and where practicable enhanced, to a level sufficient to safeguard aquatic life, to sustain the potential of water resources to be used and developed to meet existing and reasonably foreseeable future needs, and to provide for the protection of aesthetic or cultural values associated with water.	Y	The proposal does not adversely affect water quality, and will not affect the efficacy of the Ohau Diversion Wall.
The efficient management of water-body levels and flows which enables people and communities to provide for their well-being, preserves the natural character of wetlands, lakes and rivers and their margins, and protects outstanding natural features, aquatic life and significant values.	Y	The water level range proposed for Lakes Rotorua and Rotoiti are considered the best options by which communities can provide for their social, economic and cultural well being, whilst also preserving the wetlands and lake margins, and protecting aquatic life and the significant value of water quality.
The protection of historic heritage and outstanding natural features and landscapes from inappropriate subdivision, use and development.	Y	The minor changes to lake level range will not significantly affect archaeological sites.
The preservation of the natural character of the region, including the protection of significant indigenous habitats and ecosystems, having particular regard to intrinsic values of ecosystems.	Y	The proposal will not adversely affect the existing natural character of the Lakes, nor will it adversely affect indigenous habitats or ecosystems.

10.3 Effects on Objectives and Policies of Regional Water and Land Plan

The following table summarises the consistency of the proposal with the Regional Water and Land Plan

Issue	Consistent Y/N	Comment
Kaitiakitanga	Y	The proposal does not result in any significant adverse effects on the environment, therefore it can be argued that Rivers and Drainage are exercising kaitiakitanga in the care and management of Lakes Rotorua and Rotoiti. A significant issue for the Lakes is the enhancement of water quality, and the proposal does not adversely affect this.
Improving Water Quality	Y	The proposal will not affect the efficacy of the Ohau Diversion Wall.
Protect vulnerable areas from erosion	Y	The proposal will not increase erosion of Kaituna River Banks, nor will it increase erosion to the margins of the Lakes.
Manage land and water resources according to realistic management goals that are appropriate to the existing environmental quality and heritage values (including ecosystem values) of the location	Y	Rivers and Drainage have undertaken extensive consultation and investigations and have selected a proposal which seeks to manage the water resources in a way that is appropriate to the existing environment.
To allow resource use and development where there are beneficial effects on the social, cultural and economic wellbeing of people and communities; and adverse effects on the environment are avoided, remedied or mitigated	Y	The proposal provides many beneficial effects on the social, cultural and economic wellbeing of people and communities, and any minor adverse effects can be avoided, remedied or mitigated.
Discharges of water to water avoid, remedy or mitigate adverse effects on the environment	Y	The proposal does not increase the potential for flooding of the Kaituna River, does not adversely affect sites of significant to Maori on the Kaituna River, does not increase the potential for erosion to the beds and banks of the Kaituna River, and does not increase the potential for adverse effects on ecological values of the Kaituna River.
Damming and diversion activities avoid, remedy or mitigate adverse effects on the environment, as appropriate to the values, uses and existing environmental quality of the water body and downstream of the activity	Y	The proposal allows for the adverse effects to be avoided, remedied or mitigated. The proposed minimum flow through the Okere Gates to the Kaituna River may result in the Instream Minimum Flow for the Kaituna River not being met for up to 0.22% of the time. The Instream Minimum Flow requirements are always met for the Proposed Option based on the 7 day rolling average flows. Thus the Proposed Option is considered

Issue	Consistent Y/N	Comment
		to have a negligible effect on the environment of the Kaituna River.
Land use and development activities avoid, remedy or mitigate adverse effects on the natural flow of water, including flood flows	Y	Flows in the Ohau channel have been identified as being an issue by Ngati Pikiao. BOPRC will monitor and manage this issue within the Kaituna Catchment Control Scheme asset management maintenance programme
Management of Flood Hazards and Land Drainage The effects of flood hazards on the region's people, communities, and natural and physical resources are avoided or mitigated	Y	The Okere Gates and Ohau Weir are able to assist Rivers and Drainage Group in the management of lake margin and of downstream flooding.
Control of Water Levels in Natural Lakes Where it is necessary to artificially control lake water levels, the activity will avoid, remedy or mitigate adverse effects on: (a) Water quality of the lake and associated surface water bodies. (b) Water quantity and flow variability in surface outflows. (c) Beds and banks of surface outflows. (d) Wetlands on the margins of the lake. (e) Riparian vegetation. (f) Natural beach-forming processes in the lake. (g) Ecological values in the lake and downstream surface water bodies. (h) Recreational, landscape, natural character, and Maori cultural values. (i) Existing urban development and infrastructure.	Y	Rivers and Drainage Group have considered all the issues identified, and where any adverse effects exist, the proposals are able to avoid, remedy or mitigate adverse effects on them. Effects on the environment of the Instream Minimum Flow of the Kaituna River not being met for up to 0.22% of the time are considered to be negligible.
Aquatic ecosystems, aquatic habitats of indigenous species, spawning areas and migratory pathways of fish, and significant aquatic vegetation are maintained and enhanced.	Y	The proposals do not adversely affect aquatic ecosystems, aquatic habitats of indigenous species, spawning areas and migratory pathways of fish, and significant aquatic vegetation.
Trout habitats are protected.	Y	Trout habitat is not adversely affected.
Adverse effects on fish passage and migration along rivers and streams is avoided, remedied or mitigated.	Y	Fish passage is not changed from the existing situation. Any use of culvert flap gates will be subject to fish passage requirements.
Activities in, on, under or over the beds of streams, rivers and lakes:	Y	Rivers and Drainage Group have considered all the issues identified, and where any

Issue	Consistent Y/N	Comment
(a) Do not significantly impede the flow of flood waters, except where the activity is necessary for flood control purposes. (b) Provide for water flow and volume requirements in downstream areas, including authorised water abstractions and non-consumptive uses. (c) Avoid, remedy or mitigate adverse effects on natural hydrological processes of the stream, river or lake, or downstream areas. (d) Do not lead to accelerated erosion of the beds and banks of streams, rivers and lakes. (e) Maintain existing public access to and along the margins of rivers and lakes, where appropriate. (f) Avoid or mitigate the contamination of water by sediment. (g) Avoid adverse effects on areas of significant natural character. (h) Avoid, remedy or mitigate adverse effects on ecological values.		adverse effects have been identified, the proposals are able to avoid, remedy or mitigate them.
Structures in, on, under or over the beds of streams, rivers and lakes are: (a) Designed to commonly accepted design standards (including flood design standards) in relation to the use and location of the structure. (b) Constructed to a standard to withstand flood events. (c) Designed and used to account for natural lake level fluctuations.	Y	The proposals do not alter the existing structures which have been constructed and are maintained to accepted design standards.
Wetlands The preservation of the remaining wetlands in the Bay of Plenty.	Y	The proposals do not adversely affect the existing wetlands.

10.4 Effects on Objectives and Policies of the BOP Draft Conservation Management Strategy

The following table summarises the consistency of the proposal with the BOP Draft Conservation Management Strategy.

Issue	Consistent Y/N	Comment
Terrestrial and freshwater ecosystems, habitats and species - To progressively improve the quality and functioning of the ecosystems and habitats of …freshwater wetlands, …..and geothermal environments - To ensure the survival and recovery of threatened priority species at species and site levels.	Y	The proposal will not affect the efficacy of the Ohau Diversion Wall, therefore assisting to progressively improve water quality in Lake Rotoiti, and hence associated ecosystems and habitats. The proposed gentle rate of lake level rise is conducive to Dabchick breeding.
Geological Features, Landforms and Landscapes - To protect, on public conservation lands, sites recognised as regionally, nationally or internationally important landscapes, landforms and geological features.	Y	The proposed options for both lakes do not adversely affect important landscapes.
Freshwater Wetlands - To maintain or enhance the habitat quality and level of indigenous biodiversity of wetlands primarily through control of pest animals and plants and maintenance and enhancement of water levels.	Y	Proposed Option (D7) does slightly alter water levels and water level fluctuations compared to the existing situation. Increased water levels and water level fluctuations are expected to be generally positive for wetlands but the positive effect will be minor.

10.5 Effects on Key Actions of the Lakes Rotorua and Rotoiti Action Plan

10.5.1 Lake Rotorua

As there are no proposed changes to the lake level range for Lake Rotorua, there will be no effects on the key actions of the draft plan.

10.5.2 Lake Rotoiti

The effects of the Proposed Operational Strategy represented by Proposed Option (D7) on the ongoing operation of the Ohau Diversion Wall are slightly positive.

Sewage soak fields are already under pressure from high groundwater levels at Hinehopu and to a lesser extent Ruato Bay, and this is unlikely to improve under the proposed regime, however sewage reticulation is planned for by 2012, for all affected areas.

The Proposed Operational Strategy represented by the Proposed Option (D7) will not adversely affect existing wetlands.

11 Conclusion

BOPRC's Rivers and Drainage Group (consent holder) are applying for new resource consents to continue operating Okere Gates and Ohau Weir lake control structures. The programme to renew the consents for the above structures was developed by the Rivers and Drainage Group together with the Te Arawa Lakes Trust (owner of the Lake beds).

Existing consents expired on 30 June 2010 and Rivers and Drainage Group lodged a resource consent in December 2009, six months before expiry in order to continue operating the structures under existing conditions whilst new consents are being issued in accordance with s124 of the RMA.

The December 2009 consent application followed considerable community engagement and consultation. Modelling of several different options was also considered during this stage and it was decided to request the status quo operational strategy for the Ohau Weir that controls levels in Lake Rotorua. No change in the operating range for Lake Rotorua is proposed since existing operations appear unaffected by any operational changes proposed for Lake Rotoiti and consultation to date with key stakeholders has indicated general support for the existing 'consented environment'. Rivers and Drainage Group as Applicant, is therefore applying for Lake Rotorua operating levels as determined by the Ohau Channel Weir Structure, to have a range between 279.5m RL and 280.11m RL.

A wide starting point range was initially specified in the December 2009 consent application for Lake Rotoiti and Okere Gates operation to allow for further consultation, modelling and refinement of a suitable operational range (as opposed to the current target level).

Further hydraulic, optimisation and water quality modelling and extensive consultation has been carried out, since lodging the December 2009 resource consent (with key stakeholders including Ngati Pikiao and the Lake Rotoiti Community Association). Consultation has also been necessary to determine performance criteria that are relevant to stakeholders and required in the modelling. The purpose of modelling has been to establish future lake level operations for Lake Rotoiti that optimise benefits for the wider community.

Data used in modelling such as water level records and survey datum have been thoroughly checked and independently peer reviewed.

Using the information obtained during extensive investigations, survey and modelling work, and through the consultation process, Rivers and Drainage Group in conjunction with the Te Arawa Lakes Trust have proposed an operational strategy based on the proposed option for the Okere Gates structure and Lake Rotoiti levels. The proposed operational strategy is represented by the optimised Proposed Option (D7) which has been accepted by major stakeholder groups and is deemed the best option that the community could live with.

The Proposed Operational Strategy comprises:

- a maximum level of 279.4 and minimum level of 279 (90% of natural levels resided within this 400mm band).
- allowance to rise above 279.25 for up to 5% of each year in extreme events.

- a target operational range between 279.05 and 279.25 with the following distribution:
    - 5 – 10% of year between 279.20 and 279.25
    - At least 80% of year between 279.10 and 279.20
    - 5 – 10% of year between 279.05 and 279.10

The Proposed Operational Strategy Lake Level range is marginally wider with a slightly higher median (40mm) lake level than that of the status quo. There is no set target level as is the case under the current regime. Regular reviews of the optimal operation will be undertaken to allow for operational flexibility within the target ranges.

Impacts of the Proposed Operational Strategy, represented by the Proposed Option (D7) on water quality in Lake Rotoiti and Kaituna River have been assessed. Water quality modelling of Lake Rotoiti shows backflow traces around Ohau Diversion Wall are less than for the status quo – in other words a slight improvement in water quality on the current lake level regime. Neither the effectiveness of the nutrient diversion wall or Lake Rotoiti and Kaituna River water quality is compromised.

Impact of the Proposed Operational Strategy on environmental performance indicators (ecology and erosion) is deemed to be slightly positive – marginally better than for the status quo. This is due to the lake being allowed to fluctuate in a slightly more natural way subject to ensuring that at least 95% of each year lake levels are between 279.05 and 279.25.

Impact on Maori cultural values is also considered to be marginally better than the status quo but does not provide wider beaches. Wider beaches can however be achieved in some locations by control of terrestrial weed and grass vegetation.

Social impacts are of great concern to stakeholder groups and are difficult to rectify due to conflicting stakeholder needs. There is no clear best performing option and little difference between the Proposed Operational Strategy and the status quo. Amenity of lakeshore structures (jetties), associated recreation and near shore navigation is not impacted by the Proposed Operational Strategy. However the long standing drainage and septic tank soakage issues at Hinehopu and to a lesser extent Ruato Bay largely driven by tectonic settlement, remains an issue under all options considered including the Proposed Option (D7).

Economic impacts of the Proposed Operational Strategy are considered to be neutral and in line with the status quo.

The AEE raised several matters that show some community aspirations cannot be realistically met by the Proposed Operational Strategy For example the existing substandard drainage at Hinehopu (Tamatea St properties) is untenable and cannot be realistically rectified. The effects of slightly increasing the median lake level under the Proposed Operational Strategy may potentially have minor additional effects. At this point the Rivers and Drainage Group are not able to provide any specific mitigation. However if ongoing seasonal groundwater monitoring demonstrates that the Proposed Operational Strategy would result in minor additional adverse effects on groundwater levels at the

Tamatea Street bach properties, the applicant is prepared to investigate commensurate mitigation to ensure there is no net loss of amenity relative to Status Quo.

The AEE also showed that it is not realistic to be able to expose wider Lake Rotoiti beaches without significant lake level variation and consequent social and economic impacts. Under the Proposed Operational Strategy there is negligible improvement in beach width and even potential for slight initial loss of width. By way of mitigation for this potential slight initial loss of width it is proposed that Hinehopu and Tamatea beaches be enhanced by the judicious spraying, by BOPRC, of encroaching exotic weeds and grasses along the landward beach edge. Rivers and Drainage Group would work with community groups to restore the beaches described above.

There are other existing matters of concern to the community which are best addressed as separate projects outside this consent process. For example Ohau Channel sedimentation and restoration of flow velocity. It is proposed that this be managed under Rivers and Drainage Groups Kaituna Catchment Control Scheme.

Rivers and Drainage Group (as Applicant) is therefore applying for Lake Rotoiti operating levels as determined by the Okere Gates structure in line with the Proposed Operational Strategy as generally outlined above and as detailed in this AEE document and supporting appendices.

The development of the Proposed Operational Strategy is considered the best compromise solution deemed acceptable to the key stakeholders. It provides some lake water quality and other marginal environmental benefits relative to the current lake operation while minimising impacts on social and economic matters. While there have been significant differences between some key stakeholders and their objectives and expectations, there has been a genuine and commendable willingness of the parties to dialogue the issues and arrive at the Proposed Operational Strategy which is the basis for future Lake Rotoiti levels and this resource consent application.

An assessment of the proposal against the RMA and relevant statutory documents has shown that it is consistent with the principles, objectives and policies of these documents.

12 References

APR Consultants, Economic impact of tourism on the Rotorua District Economy 2004, pg 42

AURECON (2009) "Review of the benefits of the Okere Gates Control Structure for Bay of Plenty Regional Council"

Barnett & MacMurray (2005) "Ohau Channel Sedimentation: Effect of Proposed Guide Wall"

Beca Infrastructure Ltd (2005) "Ohau Channel Diversion: Assessment of Effects on the Environment", Volumes One and Two

BOPRC (2005) "Revised Operating Guidelines – Operating Guidelines for Okere Gates between Lake Rotoiti and the Kaituna River (as at 30 November 2005)"

BOPRC On-Site Effluent Treatment Regional Plan 2006

BOPRC 2008 "Ohau Diversion Wall Information Sheet"

BOPRC (2009) "Kaituna River & Ongatoro/Maketu Estuary Strategy", August 2009

BOPRC Rivers and Drainage Publication 2010/01, ISSN: 1174 0124, July 2010 "Technical Report to support Rivers and Drainage Okere Gates and Ohau Weir Consent Application"

Hamilton, D., McBride, C. and Uraoka, T. (2005) "Lake Rotoiti fieldwork and modelling to support considerations of Ohau Channel diversion from Lake Rotoiti"

McConchie, J A and Toleman, I E J (2003) "Boat wakes as a cause of riverbank erosion: a case study from the Waikato River. New Zealand", Journal of Hydrology (NZ)., Vol. 42. No. 2, pp163-179.

Ministry for the Environment (2008) "Climate change effects and impacts assessment – A guidance manual for local government in New Zealand – 2nd edition"

Ministry of Tourism - NZ Regional Tourism Forecasts 2008-2014 - Rotorua RTO Ministry of Tourism - NZ Regional Tourism Forecasts 2007-2013 – Rotorua RTO).

Muraoka, K.; Paul, W.; Hamilton D.; Von Westernhagen N. (2010). *Effect of different operational regimes of Okere Gates on the effectiveness of the Ohau Channel diversion wall in Lake Rotoiti.* CBER Contract Report 107. Prepared by CBER, University of Waikato for Environment Bay of Plenty.

NIWA (2003) "Water level fluctuations in Lake Rotoiti and their ecological implications", NIWA Client Report: HAM2003-156 prepared for BOPRC

NIWA (2004) "Modelling diversion walls for diverting the Ohau Channel inflow from Lake Rotoiti" New Zealand Jet Boat Association (1993) "Regional Council checks wake impact of jet boats on the banks of the Kaituna River", Jet Boating: Official Journal of the NZ Jet Boat Association, Vol. 9, No. 4, pp11-15.

Opus (2009) ”Peer Review of MIKE11 Model of Lake Rotorua / Ohau Channel / Lake Rotoiti / Okere Gates System”

Opus (2009b) ”Peer Review of MIKE11 Model of Lake Rotorua / Ohau Channel / Lake Rotoiti / Okere Gates System - Additional Comments”

Rasch G. 1989. Wildlife and wildlife habitats in the Bay of Plenty region. *Regional Report Series 11*. Department of Conservation, Rotorua 136 p.

Scholes P; Bloxham M 2005. Rotorua lakes water quality 2005. Bay of Plenty Regional Council Environmental Publication 2005/24

Spigel, R.H. (1989) “Water Balance of Lake Rotoiti, North Island: Floods and short circuiting of inflows from Lake Rotorua”, Journal of Hydrology (NZ), Vol. 28, No.1

Te Arawa Trust Deed of Settlement and Settlement Act 2006

Titchmarsh, B.R. (1995) “Lake Rotorua and Lake Rotoiti – Report on the technical issues and effects to be considered in the application for resource consents”, BOPRC Operations Report 95/5

Vincent WF; Gibbs MM; Dryden SJ 1984. Accelerated eutrophication in a New Zealand lake: Lake Rotoiti, Central North Island. *New Zealand Journal of Marine and Freshwater Research* 75: 431-440.

Wilson (1972) " Lakes Rotorua and Rotoiti – Flood control – Environmental Impact Study”, Report 96/146060, BOPRC Library no. 00423

APPENDICES

APPENDIX 1	Status Report of Land Ownership of Beneath Okere Gates and Ohau Channel Weir
APPENDIX 2	Existing Consents
APPENDIX 3	BOPRC Operating Guidelines for Okere Gates between Lake Rotoiti and the Kaituna River
APPENDIX 4(i)	BOPRC Rivers and Drainage Group, September 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application"
APPENDIX 4(ii)	Appendix 11 to BOPRC Rivers and Drainage Group, September 2010 "Technical Report to Support Rivers and Drainage Okere Gates and Ohau Weir Consent Application"
APPENDIX 5	Gisborne Point Aerial Photographs 1974/2006
APPENDIX 6	Map Showing General Location of Lake Rotoiti Consented Structures
APPENDIX 7	Archaeological Report
APPENDIX 8	Lake Rotoiti – Map of Land Ownership Types
APPENDIX 9	Map of the Kaituna Catchment (including Lakes Rotorua and Rotoiti)
APPENDIX 10	Opus Report "Ecological Effects of Proposed Change in Lake Rotoiti Water Level and Range of Fluctuation"
APPENDIX 11	Explanation of Mauri Model
APPENDIX 12	Consultation Database
APPENDIX 13 (i)	Copies of Presentation Materials, Meetings and Notes of the Meetings, up to December 2009
APPENDIX 13 (ii)	Copies of General Correspondence, up to December 2009
APPENDIX 13 (iii)	Copies of Formal Correspondence, up to December 2009
APPENDIX 13 (iv)	Copies of Consultation Material, after December 2009
APPENDIX 14 (i)	BOPRC Regional Policy Statement – Relevant Objectives and Policies
APPENDIX 14 (ii)	BOPRC Regional Water and Land Plan – Relevant Objectives and Policies
APPENDIX 15	Department of Conservation Draft BOP Conservation Management Strategy – Relevant Objectives and Policies
APPENDIX 16	Water Rights 76c and 2180
APPENDIX 17(i)	Survey Data for Selected Structures
APPENDIX 17(ii)	Depth Survey of 270 Jetties – Lake Rotoiti 2010
APPENDIX 18	Memorandum from [then] Design Engineer Matthew Surman to [then] Environmental Consents Officer Andy Bruere dated 16 July 1996
APPENDIX 19	BOPRC Publication 'Guide to Lake Structures'