APPENDIX B

Lake Okareka Catchment Management Plan

June 2011
Report No. 1078207446

DRAFT

Rotorua District Council

Lake Okareka Catchment Management Plan June 2010

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1. INTRODUCTION

1.1 The Need for a Stormwater Management Plan

In 2004 the Rotorua District Council (RDC) submitted a Stormwater Catchment Management plan for the Mamaku Township to Environment Bay of Plenty.

In 2010 as part of the council's application for a comprehensive catchment stormwater discharge resource consent, a catchment management plan has been prepared for the Lake Okareka catchment, a significant and sensitive receiving environment within the Rotorua District. The catchment management plan allows the RDC to consolidate existing information and provide a framework on which to base future catchment planning.

In March 2001 EBOP prepared *Draft guidelines for Comprehensive Catchment Stormwater Discharge Consents*. The aim of the guidelines is to provide guidance to territorial authorities on the development of discharge consent applications that cover multiple discharges.

1.2 Objectives of the Plan

The primary objectives of the Lake Okareka Stormwater Management Plan are to:

1. Document the existing stormwater collection and disposal infrastructure.
2. Identify and assess the effects of the stormwater discharges on the receiving environment.
3. Make recommendations if necessary for the mitigation of adverse impacts and the monitoring of the discharges.

1.3 Legislative Background

Territorial Authorities functions under section 31 of the RMA include:

"The establishment, implementation and review of objectives, policies, and methods to achieve integrated management of the effects of the use, development and protection of land and associated natural and physical resources of the district.

The control of any actual or potential effects of the use, development, or protection of land, including for the purpose of the avoidance or mitigation of natural hazards and the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances on land."

"The control of subdivision of land".

Under sections 124 to 129 of the local Government Act 2002, TAs are required to carry out a water and sanitary services assessment.

There is no statutory requirement, therefore, for TAs to provide public stormwater drainage works but in practice the service is provided as a 'public good'. All discharge activities relating to stormwater drainage are subject to the provisions of the RMA and the relevant regional council policies and planning instruments.

1.4 Consultation

The consultation process included interviews with staff from the Regional and District Councils to determine a historical record of stormwater related issues within the Catchment.

Rotorua District Council record files have also been consulted in order to identify complaints or notified stormwater issues within the Catchment.

On completion of the draft management plan a public meeting will be organised with residents in order to discuss potential stormwater and drainage issues.

2.0 BACKGROUND TO THE MANAGEMENT PLAN

2.1 The Study Area

Lake Okareka is situated between Lake Tikitapu and Lake Tarawera about ten kilometres east of Rotorua City (cf. Figure 1). The lake has a surface area of 344ha, a land catchment area of 1,865ha, with a maximum depth of 33.5 metres. A small settlement covering 43ha is located on its western shores, although in summer the population swells with holidaymakers. The settlement is accessed via Okareka Loop Roads from Tarawera Road.

The Lake Okareka catchment has some rural land use activates on its southern and western sides, although these are not the most intensive forms of agriculture. The lake is extensively used for recreation, including boating, fishing, water skiing and bathing. Public reserves around the lake provide good access (cf. Figure2). There are wildlife habitats, natural wetlands and a native forest backdrop on the northern and eastern shores of the lake.

For the purpose of the stormwater management plan the study has been taken to include land up to 321.7ha.

2.2 Current Resource Consents

There are seven Environment BOP consents in the immediate surrounds of Lake Okareka for: bridge works, earthworks, vegetation removal, septic tank and soakholes, aeration plants and water take.

There are no current stormwater discharges to land or stormwater discharges to water (lake) consents.

2.3 Existing Outlets into Lake Okareka

The study covers the analysis in terms of quantity and quality for the six stormwater pipe outlets and one open channel commonly known as the 'wash' flowing through the northern part of the settlement and draining mostly rural surfaces (cf. Figures 3 and 10).

3.0 EXISTING ENVIRONMENT

3.1 Geology and Soils

Lake Okareka occupies a valley that has eroded into an ignimbrite plateau on the western margin of the Horohoro Caldera that lies within the Okataina Volcanic Centre. The valley originally drained into Lake Tarawera but was truncated by lava associated with the Te Rere eruptive episode.

Geology and soil features of the study catchment are divided into two zones (cf. Figure 4).
The high western surfaces are underlain by volcanic ignimbrites and lake sediments of Pleistocene age (from 1.8 million years ago to 11 thousands years ago). The soil is described as a shallow sandy loam. Hydraulic conductivity of these layers is high.
The lower lying surface, where the settlement is located, is composed from lacustre deposits, Whaiowhiro Sand, which is strongly gleyed. Therefore the subsurface layer is poorly drained.

3.2 Groundwater

There are large volumes of underground water seepage from the Blue Lake to Lake Okareka and then through to Lake Tarawera. There is no evidence that these underground water movements interact directly with the surface water within the settlement, which means that the water tables are always below the ground level. The wash is ephemeral and contains no base flow during periods of dry weather. As there appears to be no significant ground water issues, no further investigations are being undertaken.

3.3 Lake Drainage

The lake is land-locked and until 1960 the outflow was entirely via underground seepage to the Waitangi Stream (resurfacing at the Waitangi Springs) and Lake Tarawera. Lake Okareka residents began lobbying for additional, artificial drainage in the 1950s as lake levels rose. In 1962 lake levels rose again, and in 1963 a pump scheme was installed between Lake Okareka and the Waitangi Stream. Pumping stopped in 1964 and the current gravity pipeline was completed in 1965.

From the lake, water drains via a set of six parallel culverts, of varying diameters and invert levels, into an outlet canal. In times of high lake level, water will also overtop what is effectively a weir between the lake and the outlet canal (cf. Figure5).

The canal is approximately 250m long and has an inlet structure with debris screen and pipeline at its eastern end. The inlet has an invert level of around 352.94m to help control minimum lake levels.

The pipeline consists of 317 metres of 450mm diameter pipe and 125 metres of 300mm pipe, separated by a gate valve to control flow with a maximum discharge of 200 litres per second. The valve is controlled by the Rotorua District Council under a delegation from EBOP. The 1995 resource consent application suggested a water levels range from 353.4 metres to 353.9 metres. However, the current range is set from 353.5 metres to 353.9 metres.

3.4 Lake Quality

In December 2003, Environment BOP published the *Proposed Lake Okareka Catchment Management Action Plan* set out the factors that influence the long-term environmental quality of Lake Okareka. Although Lake Okareka had in 2003 the best water quality of the five lakes studied, it was considered to be at a point where future deterioration could increase markedly. Therefore, the "Trophic Level Index" (Phosphorus and Nitrogen concentrations) that has been set was 3.0, while the Lake TLI was 3.2 in 2002.

The main nutrient sources pointed out in the report were predominantly generated by grazing animals, sewage from human communities through septic tanks and natural contribution from the spring and sediment. In 2010, Rotorua District Council started the construction of a new sewerage scheme to convey sewerage effluent from the entire settlement to the Rotorua Waste Treatment Plan by a pressured pipe system. Consequently, the use of sceptic tanks will be totally abandoned at the end of 2010. These works are expected to have a positive impact expected on the quality of the lake in the near future.

The stormwater network was not identified as a potential contaminant source for nutrients (Phosphorus and Nitrogen) in the Environment BOP 2003 Report. The potential pollution hazard contaminants such as heavy metals, pathogens and hydrocarbons, primarily sediment, nutrients has to be assessed to prevent any long-term adverse effects. No base flow is flowing out of the pipe system. The wash is described as an ephemeral waterway. Therefore the totality of the discharge is originating from direct runoff or through flow. One sampling point (SP1) has been selected to be representative of a typical urban catchment (O5). The outlet pipe of catchment O5 collects runoff from road reserves and thirty-five properties. The discharge point is into a vegetated area twenty meters upstream of the lake.

3.5 Rainfall

Rainfall analysis is based on four databases:

1. The Environmental Data Services (EDS) section of Environment Bay of Plenty has operated a daily reading record rain gauge since 1966 at 8.00 a.m. The gauge is located within the northern settlement on Loop Rd.

2. The Environmental Data Services (EDS) section of Environment Bay of Plenty has operated a meteorological station at the Lake Tarawera settlement since 1998 including a rain gauge recording with a 10 minutes time step.

3. The HIRDS version 1.5b program supplied by NIWA.

4. The 2010 updated rainfall depth-duration-frequency graph published by Rotorua District Council.

The mean annual precipitation on Lake Okareka is 1529mm. Lake Okareka is in the mid range of yearly rainfall amounts within the District. The rainfall gradient varies from 1500-1600mm per year at Lake Okareka up to 2100-2200mm at Lake Tarawera which is only 4kms to the east.

Design storms have been produced for the 10year, 50year and 100year return period storms. Rainfall depths for the events were taken from HIRDSv1.5. It was assumed that no temporal spatial variation occurs within such a small catchment (although the steepest parts might receive more rain because of the orographic effect). All rainfall depths were increased by a factor to allow for potential climate change effects on the severity of rainfall events. The factors used are those recommended in Table 2.3 and 5.2 of Climate Change and Impacts Assessment (MfE, 2008) for a 2.2 degrees temperature increasing from 1990 to 2090 for the Bay of Plenty Region. The rainfall depths derived for use in this study are shown in Figure 6.

MfE guidelines predict an increase of 16.8% in the 50year ARI rainfall depth for all durations. Design rainfall storms have been constructed by nesting rainfall depths for each duration up to 24 hours. This means that the 20 minute storm contains the 10 minute rainfall at its centre, and the 30 minute storm contains the 20 minute storm at its centre, etc. This method follows the nested Chicago storm profile method used in the TP108 (ARC, 1999). The design rainfall events for a 24 hour duration are plotted in Figure6.

3.6 Principal Catchments

The drainage from the Rotorua District Council's stormwater assets into Lake Okareka originates from seven urban and two rural catchments (cf. Figures 7 and 8). Sixty-seven properties along the lake shores and on the Acacia Road Peninsula do not discharge into the Rotorua District Council network but directly into the lake through overland flowpaths. These separate outlets are out of the scope of the catchment plan. The total catchment area is 312.7ha, with sub catchments ranging in size from 0.7ha (catchment O1) to 157.8ha (catchment O3). Catchment areas are listed in Table 1. Catchment delineation was achieved from visual observation during site visits and a digital elevation model based on the LIDAR database provided by Rotorua District Council (cf. Figure 9).

3.7 Catchment Discharge Points

To meet the requirements of the EBOP comprehensive catchment guidelines, the catchment discharge points into Lake Okareka were defined. The piped District Council stormwater reticulation systems discharge directly onto Lake Okareka shoreline at six separate locations. While the RDC is responsible for the stormwater system within Okareka settlement, the discharge of stormwater run off from bush and pasture areas located outside the settlement boundaries is the responsibility of the Regional Council.

Discharge points for each catchment are, along with identification points, shown on Drawing 1.

3.8 Land Use

Lake Okareka is included in the Lakes A Zone under the current Rotorua District Plan. The document contains specific provisions to manage the unique and sensitive attributes of the lakes' environment. The high degree of intactness of the lakes' environment contributes to the national significance of their catchments.

On the western shores of Lake Okareka, zoning plans describe settlement and sensitive rural zone features. The residential zoning is bounded according to the current settlement boundaries. No future residential development is proposed in the near future outside of the current settlement boundaries.

Zoning plans are displayed on Figures 13a and 13b.

3.9 Existing Stormwater Disposal

As part of the preparation for this management plan the Rotorua District Council carried out a detailed network as building at Lake Okareka in December 2009. The whole system has been visually inspected during site visits and integrated in the RDC stormwater asset database (cf. Drawing2). The reticulation is limited in size with pipes varying from 225 to 375mm diameter pipe. Stormwater pipe lines are short in distance with a maximum length of 452m along Summit Road. The discharging environment is the lake through seven outlets. Pipe grades are high (>4%). Culverts are numerous, mainly draining road reserves and rural areas. Once again the culvert diameters are small with a maximum of 750mm diameter at the corner of Summit Road and Okareka Loop Road draining a large bush area of 123ha.

Residential properties are not connected to RDC piped stormwater reticulation; instead roof and driveway runoffs are collected through soakholes or other on-site disposals and drained by the pumice soils. During periods of intense rainfalls, when soakholes are surcharged, runoff flows through road reserves acting as overland flow paths or through

land flowing down to the lake directly. There are no ponding areas identified within the urban catchment as watersheds are steep conveying runoff efficiently to the lake.

The wash is located on the northern side of the settlement and collects discharge from the rural catchment O3 and the urban catchment O2 (cf. Figure 10) and has a total area of 167 hectares. The catchment land use is mainly pastured with significant bush surfaces. The wash is 440 meters long and flows under Millar Road and Steep Street via bridge crossings. The open drain is privately owned and has several private constrictions such as footpath bridges which have been constructed across the channel. The portion of the drain along the reserve at 71 Okareka Loop Road is on public reserve and the legs downstream of Steep Road and upstream of Millar Road are covered by an easement in favour of the Rotorua District Council. Although the wash is essentially a highly modified natural water course it is maintained as a public drain under the Local Government Act 2002, 1974.

3.9 Existing Stormwater Management Issues

3.9.1 Stormwater Flooding

The observations in this section were deduced from RDC file records and from personal communications of residents knowing the history of the settlement.

Flooding issues have occurred in the past on the properties at 4, 6 and 8 Millar Road with overland flow coming from the upstream catchment of the wash. The runoff was flowing through these properties and crossing Millar Road because the entrance to the wash within the rural catchment was inefficient. Environment BOP has subsequently reshaped the inlet (2007) to control and direct the overland flow in the wash.

Historically the left bank of the wash between the road bridges was over topped at the council reserve located at 77 Loop Road (Andy Bell, pers. comm.). From here the water made its way to the lake through the residential properties on Steep Street via overland flow. The severity of floods is not easy to assess as there are no historical records available.

There were other localised overland flowpath issues raised in the past years on Calder Road, Summit Road and 1-3 Okareka Loop Road (runoff coming from a farm pasture). The Rotorua District Council has undertaken the necessary improvements to solve the issues identified.

4. CATCHMENT ANALYSIS

The dwellings within the Lake Okareka settlement are projected to increase from 260 to 275 from 2010 to 2021. This represents an increase of 5.5%. It is not significant enough to run a projected scenario to estimate such lower runoff increasing in 2021.

4.1. Design Parameters

The design parameters are based on the requirements of:

- Council's Civil Engineering Industry Standard 2000 - Chapter 5 Utility Services Stormwater and Land Drainage.
- Lakes A Zone Volume 1 – Section 35.1.

All buildings and all hard surfaces (including all driveways) shall be provided with a stormwater collection and disposal system within the site complying with the following conditions:

1. It is designed to accommodate at least a 10% AEP storm event by:
   a) Soakage
   b) Vegetated swales
   c) Ponding
   d) Wetlands

2. Surface Water does not enter habitable buildings from a 2% AEP storm event; and

3. Where the system uses pipes that:
   a) Accessible inspection chambers are provided at all changes of grade and direction
   b) Self cleansing velocities are maintained; and
   c) The system has a functional design life of 50 year.

Primary stormwater systems i.e. all open drains and pipes within the road reserve are designed to carry surface water resulting from a 1 in 10 year return period storm (10% Annual Exceedance Probability). Open drains through private property (secondary flow) are designed to accommodate surface water resulting from a 1 in 50 year return period storm (2% AEP). Secondary stormwater systems are designed to ensure that buildings are not affected by surface water from such an event.

4.2. The Wash

The discharge from the wash is the largest concentrated inflow into Lake Okareka. In March 2009 the Rotorua District Council undertook a hydrological and hydraulic modelling project on the Wash which is a highly modified ephemeral waterway. The software packages used were HEC-HMS3.3 for the hydrological model and Aulos3.3 for the hydraulic. Twenty-three cross-sections were surveyed including road bridges and other obstacles across the channel. The conclusions provided in this section are detailed on the RDC report *Catchment Okareka – Stormwater Modelling Report (2008)*. The project assessed the 1 in 50 year flood crossing numerous private properties and the flooding implications due to the many private bridges and fences which cross the wash.

The wash collects the runoff from the upper rural catchment of 167 hectares and an urban catchment at its end. There are is measured flow data for the study catchment. The closest flow gauge is located on the Whaingaehe catchment which is adjacent to Lake Okareka (Flow site 14606 at State Highway 30). Environment Bay of Plenty (EBOP) provided the report "Whaingaehe Stream Hydraulic Capacity Review" in February 2008. The soils of both catchments, Whaingaehe and Okareka, are similar (pumice layer with high hydraulic conductivity). The process to calculate the runoff coefficient using the SCS Curve Number method is described in the RDC report. The Curve Number is estimated as 15 for the rural catchment. The rainfall database used is the Intensity-Duration-Frequency Graph version 2010 provided by Rotorua District Council staff including climate change factors.

The inlet of the wash up to Millar Road has been modified and improved by Environment Bay of Plenty in order to provide a suitable crossing for the owner of Edwards Farm and reduce the effects of runoff from the rural catchment on Millar Road. According to EBOP hydrological and hydraulic guidelines, the downstream water level representing by the lake has to be a 1 in 20 year return period water level combined with a 1 in 50 year return period flood in the wash. The 20yr ARI lake level has been estimated from EBOP hydrological level summary report on Lake Okareka: 254.306m (Moturiki Datum).

The design flows computed for the wash at the lake outlet are as following:

1. 10% AEP: $Q_{10} = 1.6m^3/s$
2. 2% AEP: $Q_{50} = 5.5m^3/s$
3. 1%. AEP: $Q_{100} = 7.5m^3/s$

As stipulated in section 4.1, open drains through private property (secondary flow) are designed to accommodate surface water resulting from a 1 in 50 year return period storm (2% AEP). The freeboard long section graph in Figure11 shows that some sections can flow full and spill over the banks into private properties.

This flooding issue occurs between chainage 10,110 and chainage 10,230. A site visit has confirmed that sediment and garden waste dumped in the drain has built up on the bed reduced the channel capacity. A clearing work programme has to be scheduled for mid 2010 with the property owner's permission, in order to improve the flow capacity within the wash. The aim is to restore the capacity of the wash able to carry the 50year flood flows.

4.3 Pipe Network Capacity Analysis

Rotorua District Council policy stipulates that primary stormwater systems i.e. all open drains and pipes within the road reserve are designed to carry surface water resulting from a 1 in 10 year return period storm (10% Annual Exceedance Probability).

The Rational Method has been used to compute the design flows through the pipe network reaching the lake. According to the Rotorua Civil Engineering Industry Standard, road reserve runoff coefficient including sealed surface, footpath and berm is 0.8. The residential area C factor is 0.45. Soakholes are inefficient for such events greater than 5 year ARI. Therefore roofs and drive ways runoff contribute to the flows at the discharge outlet of urban catchments.

The Intensity-Duration-Frequency graph is displayed on Figure 6. This graph has been updated by Rotorua District Council works division in 2010.

The results are displayed on Table1. Discharge flows are very variable from 148 to 2,672 Litres per second. The urban catchment contributions are minor in term of flow into Lake Okareka. The highest flow -2,672 L/s- is supplied by the extensive bush area belonging to Department of Conservation Rotorua and not under the control of the Rotorua District Council.

4.4 Lake Okareka Drainage

The Technical Services Section of Environment Bay of Plenty published a report in February 1999 labelled *Lake Okareka – Level Control (Philipp Wallace)*. The report discussed the opportunity to improve the lake drainage at the outlet system (valve and inlet) operated by Rotorua District Council staff. The conclusions outlined in the report stated that:

- Lake levels were within the desired range 76% of the time between January 1978 and January 1999
- Lake Levels were in excess of the maximum 12% of the time
- Lake Levels were below the minimum for 12% of the time

The maximum operating levels are set up 353.9 meters and the minimum is 353.5 meters. The outlet flow is limited to 239l/s with the valve fully open which allows a maximum of 5mm drop per 24 hours. The increasing in height during heavy rains is higher than 5mm therefore the control valve does not ensure a total control during flooding. A small

number of dwellings, mainly on the eastern side of the peninsula, have been built close to the lake with low floor levels. There is a risk posed to these houses by high lake levels (cf. Figure12).
Also the Rotorua District Council stormwater reticulation is controlled by the lake level. The wash and the flat graded pipelines on Steep Street and Acacia Road are controlled by the outlet lake level. Therefore the RDC can not guarantee draining the urban catchments as a result of high lake levels.

Therefore it is recommended that improvements be made to the outlet system in order to control the lake level more efficiently. An option raised in the EBOP report was to enlarge the first section of pipe to allow 400l/s outflow.

5. WATER QUALITY

Two samples have been taken in 2010 at the stormwater outlet of the typical urban catchment O5 (cf. Drawing or Figure XX). Staff from Rotorua District Council's Engineering Works Department collected 500ml and 50ml samples during these following storms: 22 January and 24 March 2010. RDC's Environmental Laboratory analysed the samples.

Each sample was analysed for: suspended solids, pH, chemical oxygen demand, ammonia nitrogen, total kjeldhal nitrogen, total nitrogen, total oxidised nitrogen, diss. Reactive phosphorus, total phosphorus, zinc, diss. zinc, copper, diss. copper, lead, diss. lead, iron, diss. iron, arsenic, diss. arsenic, cadmium, diss. cadmium, chromium, diss. chromium, nickel, diss. nickel, total petroleum hydrocarbons. The analysis of samples was carried out in accordance with the requirements of IANZ.

The stormwater trigger level table (cf. Table 3) has been based on the following guidelines:
- EBOP Regional Water and Land Plan Rules 30 to 30c.
- Stormwater Trigger Levels – Mamaku Stormwater Catchment Management Plan, 2003.

Table 4 contains the test results for the two samples. Most of parameters comply with quality guidelines except for: suspended solids, pH, diss. reactive Phosphorus, total phosphorus, zinc.

Stormwater discharges for both storms show a high concentration in suspended solids (205 and 362 mg/L). Samples were taken during first flush explaining these high rates. Also the sample point is located downstream of an earth swale which can mobilise suspended solids during storms that are not coming from the upstream urban catchment. Future sampling will be taken after the first flush in order to have a better understanding of the average suspended solids ratio within the catchment.

Phosphorus analyses are slightly above trigger levels during the 24 March 2010 storm.

Other parameters are below trigger levels which prove that Lake Okareka residential catchments do not generate significant heavy metals concentrations.

At present the sampling has been temporarily suspended while the Okareka Sewerage scheme construction works are undertaken, as there is a risk of additional and unusual sediment loading. The sampling campaign will be continued through 2010 and especially during winter months.

6. POTENTIAL STORMWATER MANAGEMENT ISSUES AND RECOMMENDATIONS

The hydraulic model confirmed that a potential flooding issue exists along the section of the Wash between the road bridges of Millar Road and Steep Street. From a practical engineering point of view, there are numerous constrictions along this portion of the drain where blockages are likely to happen in events such as a 50year flood. Obstacles like fences and foot bridges across the channel are likely to trap debris and cause flooding issues.

Maintenance of the channel upstream of Steep Street is limited and difficult due to the access restrictions through the private properties. Sediment and debris (essentially lawn clippings) dumped by the residents adjacent to the channel are also a problem as they build up and reduce the channel capacity.

Castlecorp, council's maintenance contractor, has been instructed to clear the section of drain between Steep Street and Millar Road and remove all vegetation built up within the bed. The residents whose property the wash crosses have been contacted via letters to explain the works that are to be undertaken and to warn them of the potential risks that their private foot bridges and fences across the channel may cause.

7. STORMWATER DISCHARGE CONSENTS

The stormwater management plan forms part of the documentation that will be submitted to Environment BOP for the comprehensive catchment stormwater discharge consent. This consent will authorise the Rotorua District Council to discharge stormwater to land and water for the entire catchment identified on the management plan.

Prior to submitting the consent application to Environment Bay of Plenty, the Rotorua District Council intends distributing copies of the catchment plan to key stakeholders for review and comment.

8. CONCLUSION

The proposed stormwater management plan seeks to manage the stormwater discharges in the Okareka settlement more effectively and efficiently.

Evidence has been raised that the outlet control structure from Lake Okareka into Lake Tarawera will eventually need to be upgraded in order to improve the level control for the lake under severe storm conditions.

A clearing operation for the wash has been programmed for mid 2010 by the Rotorua District Council in order to restore the initial capacity able to drain the 50 year ARI flood.

Otherwise no significant changes to the current management framework are proposed.

Any adverse effects of the stormwater reticulation in terms of quantity and quality are considered to be less than minor.

It is concluded that the proposal is not contrary to the provision of the Act nor the relevant planning documents.

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