17 Geothermal Resources

17.1 Introduction

This chapter explains management options of ways to protect freshwater resources in the Tarawera River catchment from unnecessary contamination from the disposal of geothermal wastewater into the environment. Rules to minimise the effects of geothermal wastewater discharges into fresh surface and groundwater are established.

Geothermal resources include groundwater systems heated by volcanic (hot magma) heat sources to a temperature of 30°C or more. They include, also, any hot rock and aquifer systems and any associated surface features. Although such systems may be interconnected at depth, where they have a limited known surface extent and an identified area of pressurised capping layers, they are referred to as a geothermal field. Each geothermal field is defined by the boundary between the area of low resistivity within the field and the higher resistivity of the surrounding groundwater.

There are four major geothermal fields in the catchment of the Tarawera River. These are the Rotomahana-Waimangu, Tikorangi, Puhi Puhi, and Kawerau geothermal fields. Only the Kawerau Geothermal Field has been utilised, resulting in effects on catchment water resources.

Surface geothermal activities are present at Waimangu, western shore of Lake Rotomahana, and the southern shore of Lake Tarawera. Minor geothermal inflow also occurs on the eastern shore of Lake Okataina. Other Tarawera Lakes have no significant thermal inflow.

Two areas of warm springs are found in the Mangakotukutuku and Waiaute Streams. A thermal infra-red survey along the Tarawera River between Lake Outlet and Kawerau indicates that thermal anomalies occur almost continuously between Lake Outlet and the confluence of Mangakotukutuku Stream with the river.

The area of the Kawerau Geothermal Field is about 19-35 square kilometres at 500 metres depth. Natural thermal activities include hot springs, seepages, steaming ground and hot ground. Surface thermal activities have declined significantly in this century, even before exploration of the field. The heat sources of the Kawerau field are probably from Putauaki (Mt Edgecumbe) and the vicinity of Mt Tarawera. The temperatures of the geothermal borehole waters in the Kawerau field range from 250-315°C. The recharge source of the Kawerau field water is thought to be mainly from the colder local shallow groundwater[113].

The rules in this regional plan apply only to activities relating to the Kawerau Geothermal Field. The management of the Rotomahana-Waimangu, Tikorangi and Puhi Puhi geothermal fields is in the policy of the *Operative Bay of Plenty Regional Policy Statement* and the *Regional Water and Land Plan*.

[113] Pang, L, Environmental Report 94/4.

17.2 Discharge of Geothermal Water

In 1994, the total authorised abstraction of the geothermal water from the Kawerau Geothermal Field was about 29,914 tonnes per day. After reinjection of about 6,240 tonnes per day is subtracted, the net abstracted geothermal water requiring discharge calculates to about 23,674 tonnes per day.

Measured pressure drawdown of the reservoir is not significant. The deep inflow of 290°C water into the field has been calculated to be between 6,000 and 7,200 tonnes per day. The subsidence rates in the production field are greater than in the background area. Subsidence rates were greater in the pre-1987 earthquake period that in the post-earthquake period. In recent years, subsidence rates have reduced. The relevance of subsidence to this regional plan relates to the effect on groundwater levels and the potential for flooding as a result of lowered ground surfaces. Subsidence has little effect compared with the down-cutting of the Tarawera River.

About 6,240 tonnes per day of geothermal wastewater is being injected into the shallow strata at 100-200m depth. This is 21% of the total withdrawal of geothermal fluid from the Kawerau Geothermal Field.

In 1993 the mean daily discharge of separated geothermal wastewater was being discharged into the Tarawera River from the two geothermal outfalls. The river also intermittently received a small amount of condensate waste and effluent associated with drilling of geothermal wells. The Ruruanga Stream received about 714 cubic metres per day of warm geothermal water discharged from the Kawerau Swimming Pool and the Kawerau Thermal Motel[114].

The quantity discharged into the Tarawera River from the two principal geothermal outfalls had obviously decreased since 1990. Consequently, the chemical loadings into the river from the geothermal discharge had reduced. This was due to the disposal of geothermal wastewater by reinjection trials in recent years. The cooling channel had also reduced the discharge of heat and hydrogen sulphide.

The mass flow, chemical fluxes and heat flow of the geothermal wastewater discharged to the river from the two outfalls have been below the discharge limits required by consent No. 2635.

17.3 Natural Geothermal Inputs to the Tarawera River

The most significant geothermal inputs are evident in the Mangakotukutuku Stream, the entire length of the Tarawera River, and Tarawera Western Drain. The latter contains largely Tarawera River water.

With various degrees of dilution, geothermal influence is also identified in Awaiti Canal, Omeheu Drain, Omeheu Canal, Waiaute and Waiwhakapa Streams, Ruruanga Stream, Awatarariki Stream Waitepuru Stream, Mangaone and Karaponga Streams. The geothermal components in Awaiti Canal, Omeheu Drain, and Omeheu Canal coincide with the presence of the boron anomaly in the shallow groundwater of the Rangitaiki Plains on the Lower Tarawera catchment. This suggests a hidden geothermal source underneath this area, possibly a sub-surface outflow path from the Kawerau field.

The Kaipara, Korutu, Mangawhio, Otuhangu (Buddles), Mangate, Waikamihi Streams, Awakaponga Canal, and Wilson's Creek show no significant geothermal inputs.

[114] Pang, L, Environmental Report 94/4.

Estimate of heat flow and C1 flux balance of the Tarawera River suggests that Lake Tarawera contributes the highest heat flow (28%) and C1 flux (34%) into the Tarawera River. A large amount of geothermal inputs into the river is from seepages or unidentified warm springs present under the riverbanks. The area for hidden heat and C1 reservoir lies between Lake Outlet and Edwards Road Bridge, and is derived from the Tikorangi Geothermal Field. The Tarawera River gains the majority of heat flow and C1 flux upstream of Kawerau.

17.3.1 Supporting Technical Report

The following technical report, written as part of the preparation of this *Regional Plan for the Tarawera River Catchment*, contains more detailed information on the groundwater resources in the Tarawera River catchment:

Pang, L 1994 (July), Geothermal Water Resources of the Tarawera Catchment, Environment Bay of Plenty Environmental Report 94/4.

17.4 Issues, Objective, Policies, Principal Reasons, Methods of Implementation and Anticipated Environmental Results

17.4.1 Issues

Geothermal issues relevant to this regional plan include:

17.4.1(a) Without sustainable reinjection or treatment of waste geothermal fluid, discharge effects caused by geothermal contaminants entering Tarawera River water are increased.

17.4.1(b) Heat in fluid discharged into the Tarawera River is not being fully utilised for the benefit of the community, particularly for electricity generation, tourism and therapeutic uses, or mineral extraction and as a consequence increases the risk of heat contamination effects on the river water.

17.4.1(c) Inappropriate methods of reinjection may cause the contamination of groundwater.

17.4.1(d) The effects of natural geothermal discharges into the Tarawera River cannot be understood or taken into account without ongoing monitoring and assessment of those effects.

17.4.1(e) Significant geothermal surface features and associated biota should be protected.

17.4.1(f) The development of the Kawerau geothermal field may increase the risk of land subsidence and tilt.

17.4.2 Objective

Protecting freshwater resources from unnecessary contamination from geothermal fluid while maximising the utilization of geothermal waste streams.

17.4.3 Policies

17.4.3(a) To limit the effects of fluid discharge on the Tarawera River by encouraging reinjection of waste geothermal fluid into the Kawerau field.

17.4.3(b) To restrict and limit the discharge of waste geothermal contaminants into the Tarawera River.

17.4.3(c) To encourage the use of residual heat and minerals from geothermal discharges, providing the requirement to achieve sustainable reinjection is not compromised.

17.4.3(d) To monitor the effects that the use of the Kawerau Geothermal Field may have on surface and groundwater resources, and land subsidence and tilt.

17.4.3(e) To monitor and assess the effects of natural geothermal fluid discharges and changes inflows of fluid into the Tarawera River.

17.4.3(f) To discourage the adverse effects of development on significant geothermal surface features.

17.4.4 Methods of Implementation – Rules

17.4.4(a) The taking of geothermal mass, water, heat or energy from the Kawerau Geothermal Field shall be a Discretionary Activity.

17.4.4(b) The discharge of geothermal water to the Lower Reach of the Tarawera River for which discharge permits were held on the date of public notification of this regional plan and the replacement of any of those consents for equivalent or lesser allocations shall be a Discretionary Activity.

17.4.4(c) The discharge of geothermal water to the Lower Reach of the Tarawera River resulting from any new geothermal resource use activity shall be a Discretionary Activity.

17.4.4(d) The reinjection of geothermal fluid into the Kawerau Geothermal Field shall be a Discretionary Activity.

17.4.4(e) Resource consent applications under Rules 17.4.4(b), 17.4.4(c), and permits authorising the taking, discharge and reinjection of geothermal mass, water, heat or energy from the Kawerau Geothermal Field may be considered together. Consents granted will be subject to conditions to ensure the protection of groundwater and surface water quality from geothermal contamination, and land subsidence and tilt.

17.4.4(f) Authorised users of geothermal resource from the Kawerau Geothermal Field shall be required to develop and implement a wastewater management strategy for their existing geothermal discharges, with particular regard to:

(i) The efficient utilization of the heat and mineral content of the wastewater; and

(ii) The classification standards of Rule 15.8.4(h).

17.4.4(g) The use of heat from waste geothermal fluid shall be a Permitted Activity, provided that the use activity, or the requirement for heat, shall not limit the sustainable reinjection of geothermal fluid.

17.4.5 Principal Reasons

Geothermal mass is removed from the Kawerau Geothermal Field by production bores used in the paper industry and in electricity generation. Waste from this use is both discharged into the Tarawera River and reinjected. Also, continuing natural fluid outflow from the field has an impact on surface water resources.

Users of the geothermal field have a high investment interest in using and sustaining the productive potential of the field. It is acknowledged that the extent and location of reinjection do affect the production potential of the field. However the management of waste geothermal fluid and the contaminants it contains also affects the quality of water in the Tarawera River. Environment Bay of Plenty must ensure that the level of reinjection of geothermal mass condensates from the

production system is balanced in such a way that the field production capacities are not reduced on one hand, yet on the other the geothermal wastes form field production do not have an unnecessarily high effect on water quality in the Tarawera River.

To achieve this balance, Environment Bay of Plenty will work together with the industry managers and users of the Kawerau geothermal resource to ensure that best practicable options to minimise effects are achieved. This will be managed at this time through the resource consent process. In the future the geothermal resources of the Kawerau field are likely to be managed by a regional plan specifically designed for geothermal resources.

Environment Bay of Plenty will also encourage the further use of both the energy (heat) and mineral recovery potentials in waste geothermal fluid. The removal of excess heat and valued minerals could considerably reduce the impact of geothermal discharge and provide further employment for the people of Kawerau.

17.4.6 Anticipated Environmental Results

17.4.6(a) Uncontrolled discharges of waste geothermal fluid into the Tarawera River will be avoided.

17.4.6(b) Actual and potential effects on the quality of water in the Tarawera River resulting from discharges of waste geothermal fluid will be minimised.

17.4.6(c) Activities that would remove residual heat and contaminating minerals will be encouraged, lessening impact on the Tarawera River.