ROTOKAWA GEOTHERMAL POWER STATION: RESOURCE AND RMA ISSUES

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SUMMARY - An 18 MW(e) power station is being developed on the Rotokawa geothermal field, situated about 10 km from Wairakei. Resource consents for the development were granted under the Resource Management Act 1991 (RMA). The RMA is intended to promote the sustainable management of New Zealand's resources, by balancing the needs of development (which enables people to provide for their well being, health and safety) against misuse of the resource being developed and damage to the environment. The resource consents granted for the Rotokawa power station are the first major geothermal consents granted under the RMA and thus break new ground in geothermal developments in New Zealand. The significant issues of sustainable use of the geothermal resource and discharges to the air are addressed.

1 INTRODUCTION

In August 1993, the Tauhara North N°2 Joint Venture (a joint venture between the Tauhara North N° 2 Trust - the land owner, Taupo Electricity Limited - the local electricity supply company, and WORKS Geothermal Limited - a geothermal engineering company) was granted resource consents from the Waikato Regional Council (WRC) to permit the taking of geothermal fluids sufficient to provide 110 tonnes per hour of steam.

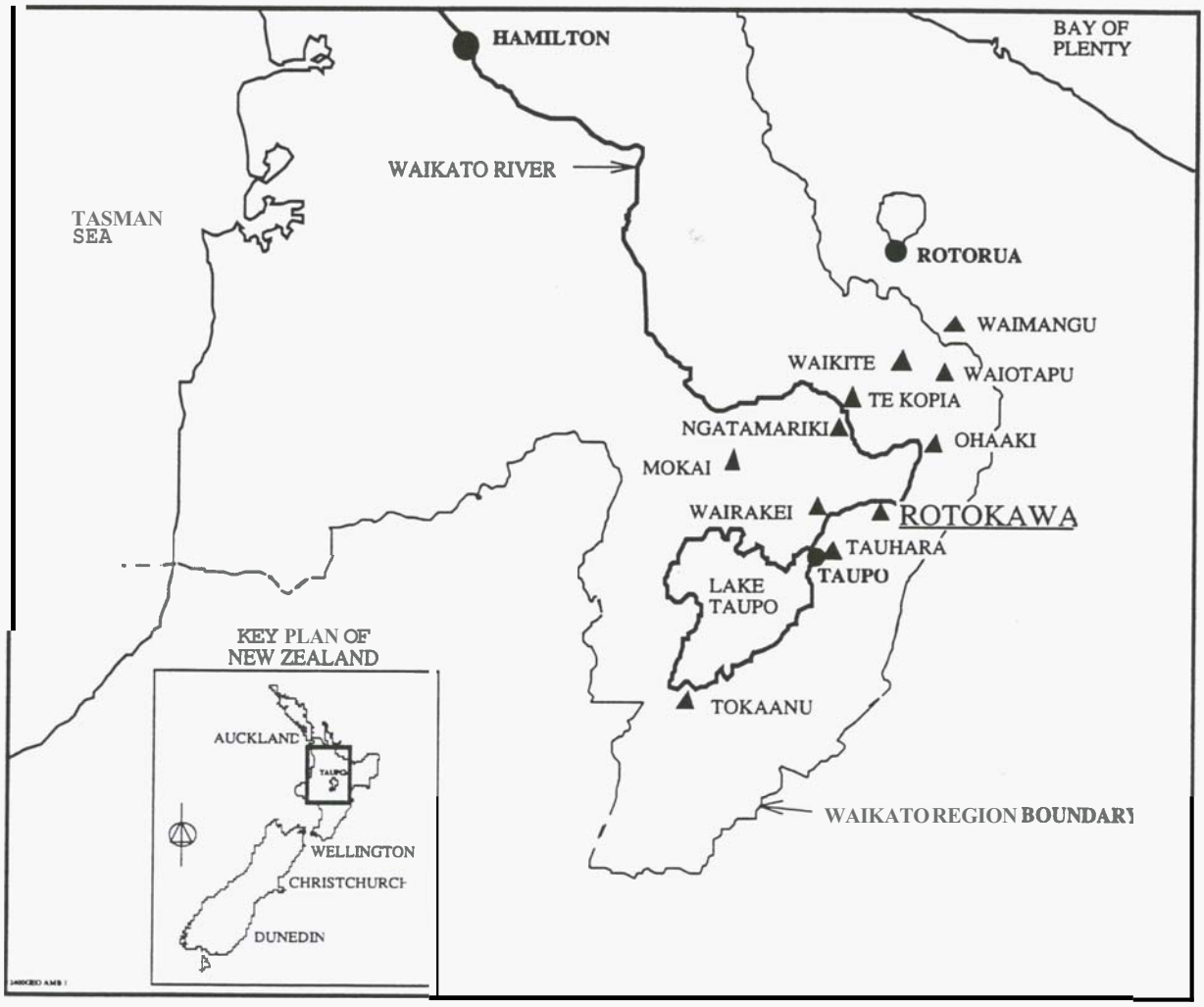

Figure 1 Rotokawa in the Waikato Region

These consents include all necessary water permits and discharge permits to enable the taking of the fluid and for its disposal (generally by reinjection into geothermal aquifers); for steamfield well testing and for taking and disposal of water for power station operation. The Joint Venture was also granted development plan approval for the project from the Taupo District Council (the Territorial or District Authority). Specific land use consents for the development were not required as the area had been previously zoned for geothermal development.

This paper is primarily concerned with the consents for use of the geothermal fluid (regional council administered), rather than the land use consents (district or territorial council administered.)

These consents, being the first granted under the innovative Resource Management Act are significant for geothermal development in New Zealand. The Rotokawa development is one of several 10 to 50 MW(e) geothermal power projects currently under evaluation in New Zealand. Although each geothermal development has different environmental issues, many of these are common. These include sustainability of the resource, protection of unique geothermal features and habitats and contamination of air and water from geothermal discharges.

2. GOVERNING LEGISLATION

2.1 The Resource Management Act

Geothermal developments in New Zealand have been controlled by the Resource Management Act 1991 (RMA), since its introduction in October 1991. The purpose of the Resource Management Act is to promote the sustainable management of New Zealand's natural and physical resources. To do this it must balance the needs of development, enabling people to provide for their well being, health and safety, against conservation - the misuse of the resource being developed and damage to the environment. It is emphasised that the purpose of the Act is to promote appropriate development, within environmental and sustainability criteria; the purpose is not to prevent development, nor to permit only developments with zero effects on the environment.

In the Act, "sustainable management" means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well being and for their health and safety while -

- Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- Safeguarding the fife-supporting capacity of air water, soils, and ecosystems; and
- Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

"Environment" is used in the widest sense: ecosystems including people and communities, all natural and physical resources, amenity values, and social, economic, aesthetic and cultural values of these.

Other aspects that must be addressed under the Act (from the Fourth Schedule to the Act) include:

- Nature of discharge and sensitivity of receiving environment
- Possible alternative methods of discharge including discharge to another receiving environment.
- Treaty of Waitangi issues and "kaitiakitanga" (or traditional Maori guardianship of natural resources).
- Identification of people interested or affected, consultation undertaken and the response to the views of those consulted.
- Risks to the environment from hazardous substances or installations.
- Description of mitigation measures.
- The monitoring scheme to be put in place.

The Act requires that all detrimental effects are avoided, remedied or mitigated. Intrinsic mitigation is the economic benefits which arise from the development.

2.2 Application of the Act

The Act controls the taking of water and geothermal energy, it also controls discharges of water and discharges of contaminants to water and to the air. (The definition of a "contaminant" is very wide; it is anything which changes the nature of the receiving environment; including heat.) Control is effected by the issue of "consents" to carry out these activities. Issuing of consents is primarily under the jurisdiction of regional councils, at Rotokawa, the Waikato Regional Council.

Management is through the mechanism of a hierarchy of national, regional and district policy statements and plans. The policy statements give desired objectives and outcomes; the plans are more detailed documents containing rules to ensure that the objectives are achieved.

Activities may be permitted as of right, they may be discretionary - where an application for a consent is examined against the intent of the RMA, or they may be prohibited. Plans are prepared through a consultative process, in which any person can make submissions.

2.3 Resource consents sought.

The consents sought may be separated into three areas: production (the actual use of the resource and the associated long term takes and discharges), drilling, and testing. A schematic representation of the fluid flows and associated consents is given in Fig 2.

Production - These are a water permit - to take geothermal fluid and energy - and three discharge permits: to discharge separated geothermal fluid and steam condensate to geothermal aquifers - separated water and steam condensate reinjection; to discharge spent geothermal vapour to the air (both from the cooling tower and from steam vents and silencers), and to discharge geothermal fluid to the ground, at times of plant start up and shut down and including steam

traps.

Also included is a water permit: to take water from the Waikato River, for power station use.

Drilling - This includes a water permit: to take water from the Waikato River for drilling; and two discharge permits: to discharge natural water and drilling fluid to underground formations during well drilling, and to discharge natural water and drilling fluid onto land or to the ground during well drilling, via holding ponds, with the water being lost by seepage.

Testing - This includes a water permit: to take geothermal fluid; and three discharge permits: to discharge geothermal fluid to geothermal aquifers, if simultaneous production/reinjection testing is undertaken; to discharge geothermal vapour into air, the steam component, and to discharge geothermal fluid onto land or to the ground, the liquid component from a vertical discharge test, or seepage from a holding pond prior to reinjection as above.

Other resource consents - Sewage and stormwater disposal are covered by 'permitted activities'. That is, they are conventional discharges which are permitted subject to constraints on the systems used.

The application considered both the nature of discharges and environments they are to discharge to, in particular: reinjection to the reservoir, water into ground water, and vapour to the air.

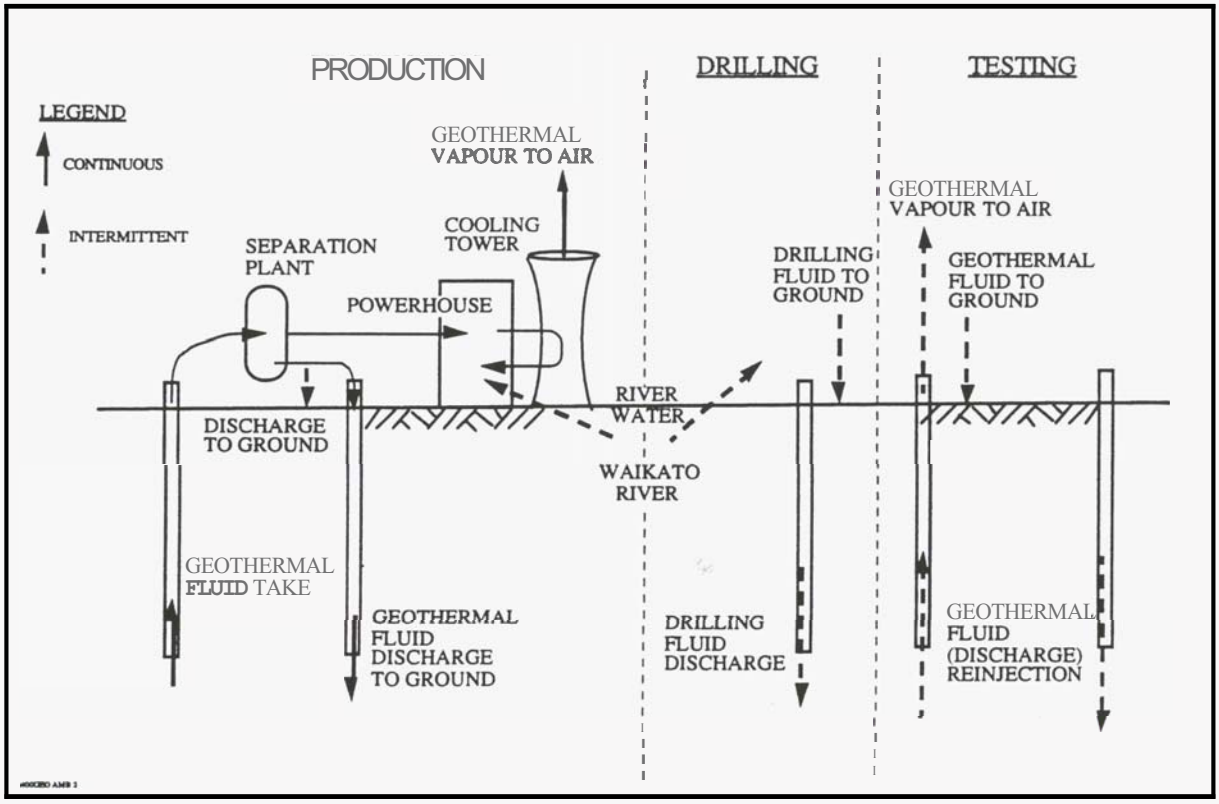

Figure 2 Fluid Takes and Discharges

3 SIGNIFICANT RESOURCE MANAGEMENT AND ENVIRONMENTAL ISSUES AT ROTOKAWA

In terms of geothermal development, there are two major issues: equitable and sustainable use of a natural resource - resource issues, and effects on the surface environment - environmental issues

3.1 Resource Issues

The major concern is sustainable management of the geothermal resource. This includes ensuring that the development is as efficient as possible, and that the rate of withdrawal of energy and fluids is within the longer term capacity of the resource.

Other issues include ensuring that parties with an interest in the resource are not unduly disadvantaged by the development. This includes the Maori people, particularly as the geothermal resource is considered a "taonga", or treasure, by Maori, and this interest is protected by the Treaty of Waitangi. Other interested parties included those who own land over the resource and thus control access to it. (Under current New Zealand law, the resource itself is owned by the Crown, although Maori are recognised as having "kaitiakitanga", or guardianship rights and responsibilities for the resource.)

3.2 Environmental Issues

These relate to the surface environment, and include

contamination of the air, land and surface and ground water. It also includes changes to natural features, and to changes in the ground, such as subsidence.

A major concern at Rotokawa is the effects of hydrogen sulphide discharge. The Rotokawa resource has a relatively high gas content, a little over 2% by weight of non condensible gas as a proportion of steam. Hydrogen sulphide is a small percentage of this, amounting to a discharge to the air of some 60 to 70 kg per hour. The method of disposal is to discharge the gas above the cooling tower where the warm moist vapour plume will aid dispersal. Modelling studies (Hadfield and Wratt, 1993) indicated that the proposed guideline of 70 $\mu g/m^3$ would be exceeded under certain meteorological conditions. But this is mitigated to a certain extent by the low habitation of the area - the nearest houses are some four km from the power station, and highest levels are expected to occur on higher ground - such areas are uninhabited, being covered in forest. High levels are also expected close to the cooling tower under high wind conditions.

A particular concern of the Maori people was that there be no geothermal discharges to the Waikato River. The River already receives geothermal discharges, both natural and from previous developments, from over half of the geothermal fields in the central North Island. This contributes significant amounts of chemicals and heat. The project has been designed to meet this requirement.

Rotokawa is a field with relatively few surface features and these are dominated by Lake Rotokawa, a shallow acidic geothermal lake (pH of about 2), in the south of the field. The remainder of the field shows little evidence of surface geothennal activity. Scenic and recreational values of the geothermal features are low, and these will not be affected to any great degree at the proposed level of development. The lake area has been mined for sulphur on several occasions over the past 50 years. (Geothermal steam has been used in such developments, both for the Frasch process and to *dry* the ore.) Owing to past mining operations around Lake Rotokawa the aesthetic values of the geothermal features and ecosystems have been severely impaired. There are no known unusual, fragile nor unique features.

HOW THE RESOURCE AND ENVIRONMENTAL ISSUES HAVE BEEN ADDRESSED

When the consents for Rotokawa were applied for (December 1992), the Regional Plans had not been prepared, although the Regional Policy Statement (RPS) was in *draft* form. In consequence the application was considered in detail against the requirements of the RMA which were mirrored in the RPS. A comparison of Rotokawa consents against geothermal objectives of the RPS are given below.

Resource issues

The primary objective of the RPS is, *"To* recognise the wide range of values associated with the region's geothermal resource by providing for the protection of intrinsic and amenity features, while allowing for use and development." It further requires, "To ensure the taking or use is carried out in a sustainable manner".

Sustainability of the geothermal resource covers many aspects. Primarily it includes managing the resource as an energy source, but it also includes sustaining those features unique to geothermal resources, that is, geological, biological and scenic features. Waikato Regional Council propose managing sustainability on a region wide basis by categorising geothermal fields either for current development, or for preservation. Fields in the preservation category will not be developed, but the unique geothermal features will be preserved and where possible enhanced. Rotokawa is categorised as a developmental field; it is recognised that changes in natural geothermal features are likely to be occur. This is considered satisfactory so long as such changes can be remedied or mitigated. Mitigation can be provided by the benefits of the development, including economic benefits to the district and to the region.

As the resource is undeveloped, the precise nature of the resource is unknown and significantly more information will be gained once production begins. Following a staged development, where the first stage applied for in this application is a fraction of the estimated potential of the resource, will ensure that the resource is not unintentionally over exploited. The development of 18 MW(e) compares to estimates of the field potential of 270 to 400 MW(e). A requirement of the RPS is that information on the resource will be continuously obtained, so ensuring well informed decisions are made. The reservoir has been modelled, and this model will be continuously upgraded to ensure that the development is the most appropriate for long term sustainable use of the resource. A comprehensive monitoring programme will ensure that appropriate and accurate information is obtained as the field is developed.

The power generation process is among the most efficient currently available. (In future it may be possible to extract further energy from the fluid before reinjection.) Reinjection philosophy is to reinject fluid into aquifers of substantially the same temperature. This is in compliance with the RMA requirement of greatest reduction of "contamination" of the receiving environment, it is also sound reservoir management practice. Chemical composition of the reinjectate will also be similar to the aquifer into which it is being discharged.

A significant problem with geothermal development is the issue of multiple tappers of the one resource. That is, optimal and thus most efficient use of the resource is felt unlikely to occur with independent users, as the preferred developments for each individual user are likely to be in conflict. At Rotokawa there are four major land owners, three of whom have a declared interest in future geothermal developments. In order to meet the desirable goal of having a "single tapper" of the Rotokawa geothermal resource, an agreement has been reached between the major land owners that no subsequent developments will occur until a unified steamfield management organisation (or SMO) has been formed. The final structure of this SMO has yet to be determined, but it will include representation of all stakeholders and the primary objective will be integrated development of the resource within the environmental guidelines of the RMA.

Environmental Issues

The project minimises discharges to the environment and hence minimises effects on the environment. This is achieved by reinjecting virtually all of the used geothermal water. (The only major surface loss is water vapour from the cooling tower.) Reinjection will be at a relatively high temperature owing to the requirement to keep the separated water above the silica saturation temperature. (Glover & Mroczek 1992, Taylor 1994). Apart from the vapour discharge from the cooling tower - including non-condensible gases - all discharges are intermittent and of short duration. These discharges will occur at plant start up and shut down, which will occur once or twice a year once commissioning is complete. Discharges will also occur during turbine trips and failures of plant, for example reinjection control valves. Experience has shown that these Occurrences will be infrequent.

Effects may be estimated but they can only be confirmed once production commences. It is necessary to ensure that the development is on a small scale so any undesirable effects are correspondingly small and can thus be addressed when at a low level. Staged development is a path by which this problem may be overcome. It is thus imperative that a system of monitoring is put in place to measure actual effects. This will be structured so that the programmed monitoring is targeted at those effects seen as significant, and results will be compared against predicted values and on which the application has been based. A particular case is that of hydrogen sulphide concentrations. Although the actual discharge can be estimated with some degree of certainty, ground level concentrations are significantly harder to predict. In addition the appropriate maximum level for such concentrations has not been determined. The monitoring conditions imposed on the vapour discharge consent have been structured towards determining these parameters.

An objective of the RPS, not specific to geothermal development, is to achieve a nett reduction in C02 emissions. As geothermal developments are relatively low emitters of CO_2, and as they are high on the "merit order" of thermal electricity generation options, geothermal power developments will bring about a nett reduction in CO_2 emissions from electricity generating plant.

Consent Conditions

The Waikato Regional Council considered that the environmental effects of the project were likely to be minor and localised, since the probable effects occurred at Rotokawa naturally. As a consequence of the project the effects were likely to be somewhat more pronounced. Effects were generally of low magnitude or low significance, except for the issue of hydrogen sulphide emissions. (This emission had also been a concern of submitters to the application.)

The consents sought were granted by the Regional Council with a term of 20 years. Conditions have been applied to the consents. The majority of the conditions are monitoring requirements - both of the resource and environmental. A significant concept of the conditions is that the development is subject to review by an independent panel of geothermal experts - a "peer review panel". In general the required monitoring has not been detailed, which differs from previous geothermal consents granted under earlier legislation. Instead, the panel is to review proposed operation and monitoring of the field, to confirm agreement with it, or to recommend changes if it is considered necessary for the sustainable management of the field. (The panel has already been convened to review the proposal to drill make up production and reinjection wells. Their recommendation to WRC, which was accepted, was that the proposals should be permitted.)

Monitoring

Monitoring is required for two purposes:

1. To monitor the operation of the steamfield, reservoir and power plant.

2. To monitor effects of the proposal on the environment.

The former is primarily a requirement of the owner, to monitor efficiency of plant and particularly the behaviour of the geothermal reservoir. The latter is primarily a requirement of the regional council in its role as protector of the environment. The requirements of resource consents have been integrated with the general monitoring schedule.

Being the first significant development on the Rotokawa field imposes certain restrictions. There is a requirement to undertake a relatively stringent baseline monitoring programme, so that effects of the development can be accurately determined and compared against natural states.

A schedule of monitoring has been proposed. The schedule is in two parts:

1. A 'baseline' survey to establish what existing conditions are prior to station start up.

2. Ongoing monitoring, which may be on a monthly, annual or biennial basis.

Coverage includes:

- Geothermal well temperatures and pressures, casing condition
- Production flows, temperatures and chemistry
- Subsidence and gravity surveys
- Ecological (flora and fauna)
- Natural surface heat flow
- Weather/climate
- Ground and surface water
- Noise

Monitoring results will be reported to the regional council, as required by the consents. Results will also be reported to the peer review panel, in particular in conjunction with development proposals. Data should not be gathered for data's sake. Instead, monitoring must be targeted to obtain the information necessary to sustainably manage the resource, and as such will be available to the peer review panel, to the regional councils and to researchers.

Taupo District Council (the Territorial or District Authority) granted development plan approval for the construction and

operation of the geothermal power station. The District Council also granted right of way approval for the access off the public road. Land use consents were not required as the activity is permitted under the District Plan - the area was zoned for geothermal development, including electricity generation, about eight years previously. Subdivision consents were required however, for the separate leases for the power house and steam field installations. These have also been granted by the District Council.

CONCLUSION

The Rotokawa project will ensure the resource is developed at a rate which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while sustaining the potential of the resource to meet the needs of many future generations. It safeguards the life supporting capacity of air, water and soil. Adverse effects are generally avoided, some remedies or mitigation are possible.

The development will recognise historical, cultural and spiritual values of the Rotokawa geothermal resource as held by local people. This will be done through the development being undertaken by the Tauhara North Number 2 Trust who represent the tangata whenua, or people of the land overlying the resource. The development complies with the Resource Management Act 1991.

ACKNOWLEDGMENT

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