KAWERAU GEOTHERMAL POWER STATION

Assessment of Environmental Effects

August 2005

PART A: RESOURCE CONSENT APPLICATIONS TO ENVIRONMENT BAY OF PLENTY, KAWERAU DISTRICT COUNCIL AND WHAKATANE DISTRICT COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of applications by MIGHTY RIVER POWER LIMITED to ENVIRONMENT BAY OF PLENTY pursuant to section 88 of the Act for resource consents to establish and operate a geothermal power station at Kawerau

APPLICATION FOR RESOURCE CONSENT – ENVIRONMENT BAY OF PLENTY

To: Environment Bay of Plenty
PO Box 364
WHAKATANE

1. Applications by Mighty River Power Limited:

1.1 Mighty River Power Limited hereby applies for the resource consents required to authorise all activities associated with the establishment and operation of a geothermal power station and associated facilities and infrastructure, as particularised in paragraph 1.2 hereof and more fully described in the assessment of environmental effects ("AEE") annexed and forming part of this application.

1.2 Without limiting the generality of the foregoing, the types of resource consents which Mighty River Power Limited requires from Environment Bay of Plenty ("EBOP") and the specific activities to which this application relates are as follows:

(a) Land use consent - to authorise earthworks and vegetation removal associated with the construction of a power station and well pads.

(b) Land use consent - to authorise the use, construction and maintenance of geothermal production, reinjection and monitoring wells.

(c) Water permit - to authorise the take and use of up to 16.425 megatonnes per year (average 45,000 tonnes per day) of geothermal water and energy from underground strata for power production and other downstream uses.

(d) Water permit to authorise the take and use of up to 15,000 tonnes per day of geothermal water and energy from underground strata for well testing purposes.

(e) Discharge permit to authorise the discharge of storm water to ground and/or surface waters for the purposes of storm water disposal.

(f) Discharge permit to authorise the discharge of up to 16.425 megatonnes per year (average of 45,000 tonnes per day) of geothermal water and energy to ground via soakage and/or reinjection for disposal and pressure support purposes.

(g) Discharge permit to authorise the discharge of up to 15,000 tonnes per day of geothermal water and energy and drilling additives to ground via soakage and/or reinjection for well drilling and testing purposes.

(h) Discharge permit to authorise the discharge of steam line condensate and geothermal residues to ground via soakage for operational, constructional or maintenance purposes.

(i) **Discharge permit** to authorise the discharge of anti-scalant and other chemical inhibitors to ground via reinjection for well maintenance and operational purposes.

(j) **Discharge permit** to authorise the discharge up to 5 cubic metres a day of wastewater to ground via septic tank.

(k) **Discharge permit** to authorise the discharge of up to 10,000 tonnes per day of geothermal vapour and gases to the atmosphere from the steamfield, power plant and other downstream uses.

(l) **Discharge permit** to authorise the discharge of up to 10,000 tonnes per day of geothermal vapour and gases to the atmosphere for well testing purposes.

1.3 Mighty River Power Limited seeks resource consents of a 35 year duration as provided for by section 123(c) of the Resource Management Act 1991.

2. The name and addresses of the owner/occupier (other than the applicant) of land to which the application relates:

2.1 The application relates to land described in the attached Schedule of Ownership.

3. The location of the proposed activity is as follows:

3.1 The northern end of land owned by Norske Skog Tasman (NST) which is currently a grassed airfield strip, to the west of State Highway 34 (SH34).

3.2 Production pads are to be located on NST land and to the east of SH34 on land owned by the Putauaki Trust with reinjection pads located on the northern part of the Putauaki Trust land.

4. The following additional resource consents are needed for the proposed activity and have been applied for:

4.1 Kawerau District Council - Land use consents to authorise:

(a) The use and storage of hazardous substances required for the operation, construction and maintenance of a proposed geothermal power station otherwise located on the Norske Skog Tasman site.

(b) The construction, maintenance and use of over-height structures associated with transmission lines and geothermal drilling rigs associated with the construction, operation and maintenance of a geothermal power station otherwise located on the Norske Skog Tasman site.

4.2 Whakatane District Council – Land use consent to authorise:

(a) Well-drilling activities, which are anticipated to exceed one month duration. In addition, the proposed well drilling operations are unlikely to comply with permitted nuisance performance standards.

(b) Land use consent - to authorise the placement, maintenance and use of permanent geothermal well head structures associated with the construction, operation and maintenance of a geothermal power station.

4.3 Mighty River Power Limited intends to rely upon an existing EBOP Consent 02 4226 held by Norske Skog Tasman for project water requirements, including well drilling and testing, power station cooling and ancillary site water needs.

5. An assessment of environmental effects is attached:

5.1 Mighty River Power Limited attaches in accordance with the Fourth Schedule of the Resource Management Act 1991, an assessment of environmental effects ("AEE") in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment.

5.2 The assessment of environmental effects describes the activities proposed in connection with the establishment and operation of the proposed power station, actual or potential adverse effects, and the measures proposed to avoid, remedy or mitigate actual or potential adverse effects. The AEE contains details of the nominal generation capacity of the power station and other specific engineering details of the power station. To the extent that this information is not directly related to the effects of the proposed activities, it is intended to be indicative only and, in particular, is not intended to limit the generation capacity of the proposed power station.

6. Other information supplied:

6.1 Any information required to be included in this application by the district plan or regional plan or the Resource Management Act 1991 is indicated in the AEE.

Stuart Lush
General Manager Generation Development
Mighty River Power Limited

Dated: 22 August 2005

Address for Service of Documents:

Mighty River Power Limited
60 Peachgrove Road
PO Box 445
HAMILTON

Ph: (07) 857 0199
Fax: (07) 857 0192

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by MIGHTY RIVER POWER LIMITED to the KAWERAU DISTRICT COUNCIL pursuant to section 88 of the Act for resource consents to establish and operate a geothermal power station at Kawerau

APPLICATION FOR RESOURCE CONSENT – KAWERAU DISTRICT COUNCIL

To: Kawerau District Council
Private Bag 3075
KAWERAU

1. Applications by Mighty River Power Limited:

1.1 Mighty River Power Limited hereby applies for the resource consents required to authorise all activities associated with the establishment and operation of a geothermal power station and associated facilities and infrastructure, as particularised in paragraph 1.2 hereof and more fully described in the assessment of environmental effects ("AEE") annexed and forming part of this application.

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4. The following additional resource consents are needed for the proposed activity and have been applied for:

4.1 Environment Bay of Plenty – as follows:

(a) Land use consent - to authorise earthworks and vegetation removal associated with the construction of a power station and well pads.

(b) **Land use consent** - to authorise the use, construction and maintenance of geothermal production, reinjection and monitoring wells.

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(a) Well-drilling activities, which are anticipated to exceed one month duration. In addition, the proposed well drilling operations are unlikely to comply with permitted nuisance performance standards.

(b) **Land use consent** - to authorise the placement, maintenance and use of permanent geothermal well head structures associated with the construction, operation and maintenance of a geothermal power station.

5. An assessment of environmental effects is attached:

5.1 Mighty River Power Limited **attaches** in accordance with the Fourth Schedule of the Resource Management Act 1991, an assessment of environmental effects ("AEE") in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment.

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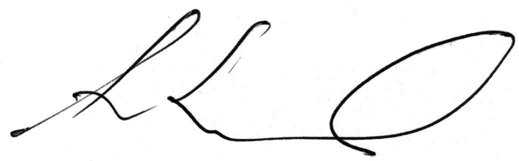

Stuart Lush
General Manager Generation Development
Mighty River Power Limited

Dated: 22 August 2005

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APPLICATION FOR RESOURCE CONSENT – WHAKATANE DISTRICT COUNCIL

To: Whakatane District Council
Private Bag 1002
WHAKATANE

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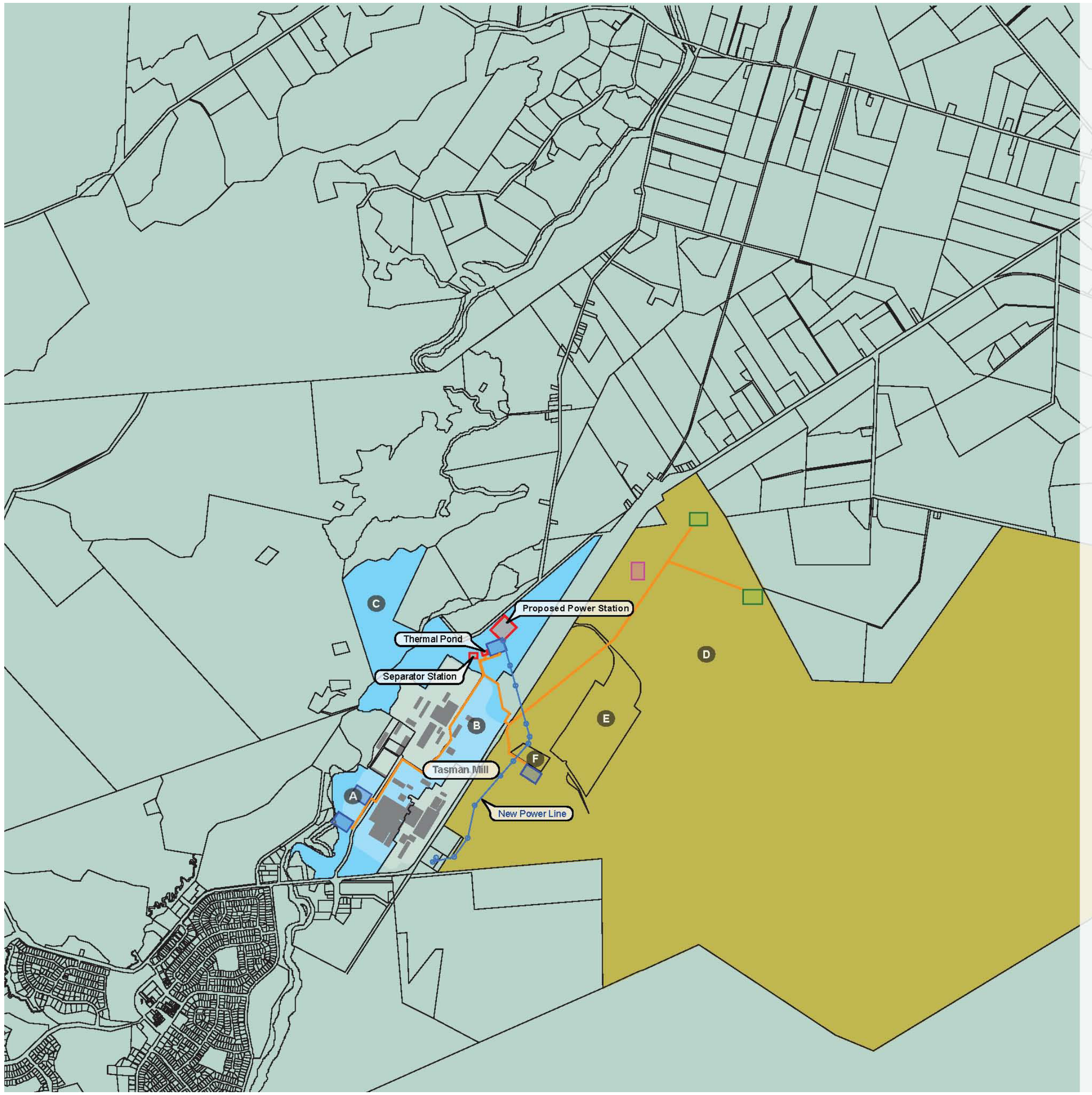

Key	Legal Description	Owner
A	DPS87801 LT2	Norske Skog Tasman
B	DPS90818 LT2	Norske Skog Tasman
C	DPS2878 LT1	Norske Skog Tasman
D	DP308053 LT3	Beverly Hughes Anaru Ririwai Rangiheuea Tamaoho Waaka Vercoe Tiki Hunia John Hunia Charlie Elliot
E	DPS87786 LT1	Carter Holt Harvey Ltd
F	DPS63847 LT1	Anaru Ririwai Rangiheuea Tamaoho Waaka Vercoe Keith Cameron Tiki Hunia John Hunia Charlie Elliot

Schedule of Ownership

PART B: ASSESSMENT OF ENVIRONMENTAL EFFECTS

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1 INTRODUCTION

1.1 KAWERAU GEOTHERMAL PROJECT

Mighty River Power proposes to establish a nominal 70MW geothermal power station at Kawerau to provide more than 50% of the electricity demand in the Kawerau region. The location of the proposed power station is on the northern end of land owned by Norske Skog Tasman (NST) which is currently a grassed airfield strip (Figure 1.1). Wells will generally be located on NST land and to the east of State Highway 34 (SH34) on land owned by the Putauaki Trust unless additional land access is secured. The power station will be linked to the wells by pipelines which require road and rail crossings. The power station will be located wholly within the Kawerau district whilst the wells, pipelines and the transmission line will straddle the boundary between Kawerau district and Whakatane district.

The power plant design will be optimised to extract energy from the geothermal fluid within technical and economic constraints. Various proven energy conversion technologies are being considered and the choice of technology will be finalised after the consenting process.

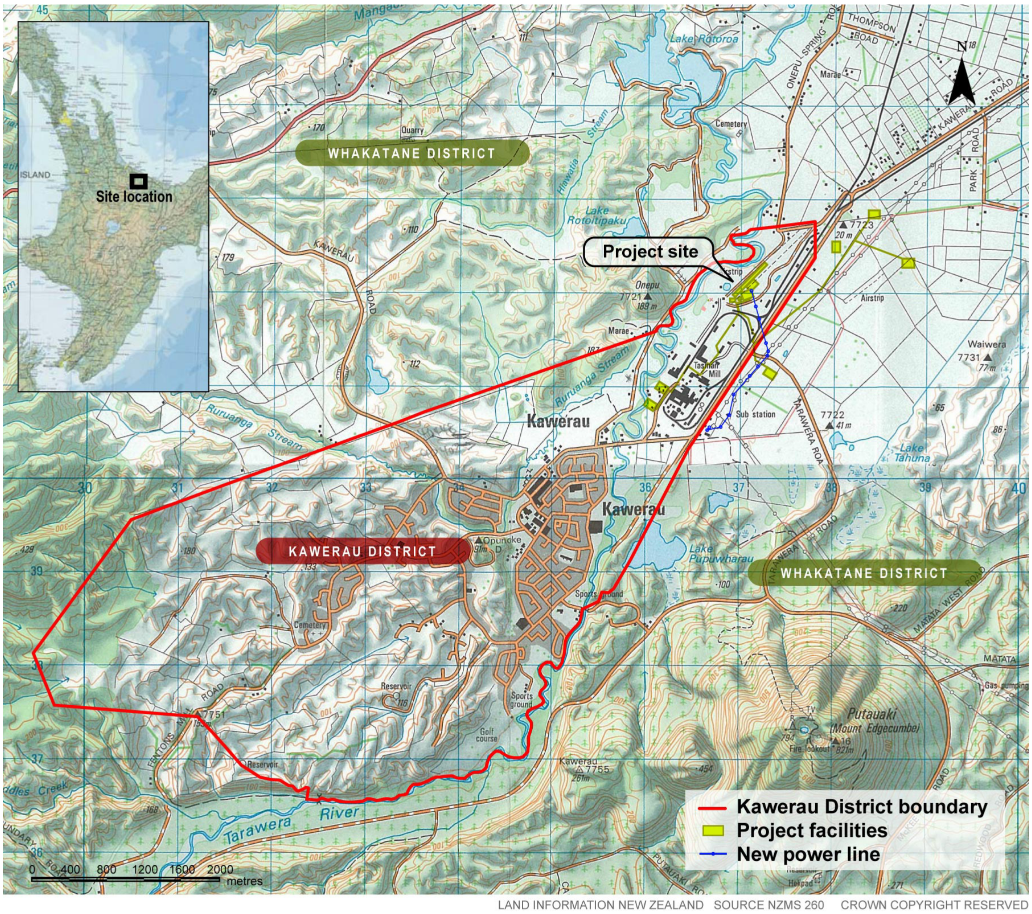

Figure 1.1: Project Site and the Kawerau Locality.

1.2 MIGHTY RIVER POWER

Mighty River Power is a state-owned enterprise, established pursuant to the State-Owned Enterprises Act 1986. The company is a significant participant in the New Zealand geothermal industry through ownership and operation of the 98MW Mokai and 33MW Rotokawa geothermal plants in conjunction with Maori partners. In addition, Mighty River Power owns the hydro electric power electricity generation facilities along the Waikato River, thermal power stations at Marsden Point and Southdown, as well as landfill methane gas electricity generation plants. The company produces approximately 13% of New Zealand's electricity requirements and approximately 23% of the peak demand of the upper North Island. Mighty River Power also sells electricity and gas to more than 300,000 customers through its retail business, Mercury Energy.

Mighty River Power is exploring a range of generation options to help meet future demand, involving a range of different fuel sources including small hydro, wind, gas and coal. In particular the company considers that geothermal energy represents an appropriate renewable energy source which is able to provide a significant contribution to electricity demand in the short term, and accordingly, has committed to putting in place a world class geothermal team to deliver geothermal projects.

1.3 STRATEGIC PARTNERSHIPS

1.3.1 DEVELOPMENT PARTNERS

There are three organisations participating with Mighty River Power in this proposed development project. They are:

- Ngati Tuwharetoa Geothermal Assets Ltd (NTGA), a wholly owned subsidiary of Ngati Tuwharetoa (Bay of Plenty) Settlement Trust, has purchased most of the Crown's Kawerau geothermal assets following the transfer of assets to Mighty River Power. Mighty River Power will operate and maintain the assets on behalf of NTGA. Both parties will work together to ensure the field is developed in a responsible manner.

- The Putauaki Trust, landowners in the Kawerau region – Mighty River Power has been investigating the geothermal resource that underlies the Trust's land since 2003 and has an agreement with the Trust for well drilling, steam extraction and reinjection.

- Norske Skog Tasman (NST) – the largest employer in Kawerau and one of the largest users of electricity in the region. NST will largely benefit through the security of locally generated electricity supply. In addition, the power plant and a number of wells will be constructed on the company's land.

Mighty River Power has worked extensively with these three parties to develop a comprehensive approach to the future development and integrated management of the steam field.

1.3.2 STEAMFIELD MANAGEMENT PLAN

Mighty River Power, NST and NTGA have entered into a geothermal steamfield management agreement setting out the general principles and plan compliance processes which seek to ensure the ongoing sustainable management and integrated development of the Kawerau geothermal resource. As a result of this agreement, the parties have developed a steamfield management plan (the plan).

The plan:

- Outlines the philosophies of sustainable management;
- Establishes a minimum criterion that any geothermal development at Kawerau should satisfy in order to achieve compliance with the plan;
- Provides direction on achieving integrated management of the Kawerau geothermal resource when considering a new development and when seeking resource consents for that development; and
- Outlines existing, planned and potential field developments over a 10 year horizon.

The plan is designed to focus on reservoir issues rather than the wider environmental issues and therefore is separate from what otherwise may be contemplated by way of a condition of any consent. The objectives for the management of the Kawerau geothermal resource as described in this plan are to:

- Optimise the long-term energy potential of the geothermal reservoir;
- Provide for multiple operators on the field by identifying acceptable impacts of new development on existing developments;
- Minimise adverse environmental impacts associated with geothermal extraction and reinjection;
- Increase the understanding of the Kawerau geothermal system;
- Maintain co-operation and knowledge-sharing between the different field developers and well owners; and
- Ensure coordinated development of the field.

1.4 EXISTING CONSENTS

NST holds a number of resource consents under the Resource Management Act 1991 (RMA) relating to the current pulp and paper operation on the industrial site. These include a storm water discharge permit, a water permit to take water from the Tarawera River and an air discharge permit. Other industrial parties also hold consents relating to the use of resources in the vicinity.

NTGA holds a number of resource consents relating to the current operation at the industrial site. These include water extraction, reinjection and discharge permits for the existing geothermal operations and for ongoing well drilling and well maintenance. Some of the NST and NTGA consents may be utilised to support the project.

1.5 RESOURCE CONSENTS REQUIRED FOR PROPOSED POWER STATION

Land use consents and water and discharge permits are required under the RMA for the proposed power station. In general terms the consents required are:

From Kawerau District Council:

Land use consent to authorise:

- The height of the proposed transmission lines and the height of the mast of any drilling rig otherwise employed on a temporary basis; and
- The storage and use of hazardous substances.

Construction of a power station and pipelines within Kawerau district is a permitted activity.

From Whakatane District Council

Land use consent to authorise:

- The use, construction and maintenance of geothermal wells and associated earthworks; and
- The construction of well head structures.

From Environment Bay of Plenty (EBoP):

Land use consent to authorise:

- Vegetation removal & earthworks; and
- Construction, alterations & maintenance of geothermal production, reinjection and monitoring wells.

Water permits to authorise:

- Take of geothermal water and energy for well testing, power production and other downstream uses; and
- Take of water for station construction and operation, cooling purposes[1] and dust suppression purposes[2].

Discharge permits to authorise:

- Disposal of storm water to ground and/or surface waters;
- Discharge of geothermal water and energy to ground;
- Discharge of geothermal water and energy and drilling additives to ground via soakage and reinjection;
- Discharge of steam line condensate and geothermal residues onto or into land associated with operational, construction and maintenance activities;
- Discharge of abatement chemicals into the ground via wells;
- Discharge of geothermal vapour and gases to the atmosphere from the steamfield and power plant; and
- Discharge of domestic wastewater to ground.

The consents from EBoP are sought for a period of 35 years.

This Assessment of Environmental Effects (AEE) has been prepared to meet the requirements of Section 88 and the Fourth Schedule of the RMA. In relation to the take and discharge of geothermal water, the Environment Bay of Plenty Proposed Regional Water and Land Plan also has specific requirements which must be met. These requirements and those relating the other relevant regional and district plans are fully set out in Section 10 of this AEE.

1.6 TECHNICAL STUDIES UNDERTAKEN

A series of technical studies have been undertaken as part of the design and environmental assessment process for the required consents. The findings have been utilised in the preparation of this AEE and the complete reports are presented on the CD-ROM appended to this document.

The technical study reports presented in the appended CD-ROM are listed below:

- *Assessment of Effects of the Air Discharges from the Proposed Kawerau Geothermal Power Station*, Endpoint Consulting Partners, June 2005;
- *Impact of Increased Production on the Kawerau Geothermal Field*, Industrial Research Limited, March 2005;
- *Kawerau Geothermal Power Station - Landscape and Visual Assessment*, Kingett Mitchell Limited, June 2005;

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[1] Authorised by existing consent 02 4226 held by NST.
[2] Authorised by existing consent 02 4226 held by NST.

- *Kawerau Geothermal Power Station - Ecological Assessment*, Kingett Mitchell Limited, June 2005;
- *Kawerau Geothermal Power Station, Traffic Assessment*, Traffic Design Group, August 2005;
- *Kawerau Geothermal Power Station – Assessment of Benefits*, Concept Consulting Group, July 2005;
- *Kawerau Geothermal Power Station - Assessment of Noise Effects*, Kingett Mitchell Limited, June 2005;
- *Geoscientific Review of the Kawerau Geothermal Field*, Institute of Geological and Nuclear Sciences Limited, July 2005;
- *Kawerau Geothermal Power Station - Water Management*; Kingett Mitchell Limited, June 2005;
- *Kawerau Subsidence Interpretation,* Geothermal Engineering Ltd;
- *Thermal Features at Kawerau*, Institute of Geological and Nuclear Sciences Limited, July 2005;
- *Induced Seismicity at Kawerau*, Institute of Geological and Nuclear Sciences Limited, July 2005; and
- *Proposed Kawerau Geothermal Power Station – Information Brochure*, Mighty River Power.

1.7 STRUCTURE OF DOCUMENT

This AEE is set out in eleven sections as follows:

Section 1: Introduces the project and provides background information in relation to the proposal and consent applications.

Section 2: Provides details of the existing human and natural environment.

Section 3: Provides a description of the plant design and activities associated with the operation of power station.

Section 4: Describes the economic and community benefits of the project.

Section 5: Describes the cultural implications of the project.

Section 6: Assesses the actual and potential effects of the project on geothermal resources and subsidence.

Section 7: Assesses the actual and potential effects of the project on water resources and ecological values.

Section 8: Assesses the actual and potential effects of the project on amenity values including air, noise, traffic, visual and landscape effects.

Section 9: Provides details of the consultation process undertaken, including requirements under the RMA, the approach adopted, the issues raised and the responses received by key stakeholders

Section10: Provides a review of the relevant statutory documents, including commentary on compliance with their provisions.

Section 11: Summarises the environmental outcomes of the project, taking into account the mitigation measures that will be incorporated into the project.

2 EXISTING ENVIRONMENT

This chapter provides an overview of the environment within which the proposed power station and its associated facilities are located. The existing environmental conditions in the locale provide a baseline against which to assess the actual, potential and cumulative environmental effects as a result of the proposed power station. These will be discussed in more detail within Chapters 5 to 8 of this document.

2.1 GENERAL DESCRIPTION

2.1.1 THE SITE

The site overlies the Kawerau geothermal field, located just north of Kawerau township and approximately 40 km east of Rotorua City. The field has been supplying steam to the pulp and paper mill operations at Kawerau for process heat and electrical power since 1957. The timber mill and associated forest activities were established to process wood from the Kaingaroa forest plantations for pulp, tissue and newsprint. Although the site is shared by other enterprises, forestry and milling are still the main focus of commercial activity in the area and are a major source of employment for people in the Kawerau District and the wider Bay of Plenty Region. Today, the forest plantations, the water supply from the Tarawera River, the people and the geothermal energy all continue to provide the necessary resources for the industrial activity on site.

The site straddles the boundary of Kawerau District and Whakatane District as shown on Figure 1.1. The Kawerau District boundary in this area is defined as that land containing the NST timber mill and associated industrial activities plus a strip of land to the east of SH34. Land further to the east and bordering the NST site to the north and west falls within Whakatane District Council's jurisdiction.

2.1.2 KAWERAU DISTRICT

Under the Kawerau District Plan, the NST site is zoned Industrial Area 1 Zone and is characterised by *"activities utilising extensive buildings and structures of irregular shape and considerable height"* as a result of the established wood processing industries located in the zone.

The components of the power station that are located within the Kawerau District include the generating system on the airfield and production pads that are located on the mill compound. The pipeline that connects the production wells located on NST land to the separator station is also routed through the Kawerau District's Industrial Area 1 Zone, as is a new 110kV transmission line connecting the power station to Transpower's Kawerau Substation.

2.1.3 WHAKATANE DISTRICT

The steamfield area east of SH34 falls under the jurisdiction of Whakatane District and is zoned Rural 1 Plains Zone under the Proposed Whakatane District Plan.

The components of the power station that fall within the Whakatane District are the pipelines east of SH34 that run across the open Putauaki Trust land and converge at the existing privately owned bridge that crosses over SH34. Production pads and reinjection pads that are located east of SH34 are also located within the Whakatane District, as is a small section of the 110kV transmission line.

2.2 GEOTHERMAL RESOURCE AND UTILISATION

The Kawerau geothermal field is the most north-easterly of the known major, high temperature geothermal systems in the Taupo Volcanic Zone (TVZ). The geothermal field is located within the flood plains of the Tarawera River close to the andesitic Putauaki volcano and rhyodacite domes forming the Onepu Hills. Although its natural thermal activity is not spectacular, one of its hot springs, Umupokapoka, features in the Maori Legend of Ngatoroirangi and his sisters who created New Zealand's geysers and volcanoes.

The highest measured temperatures, pressures and discharge chloride concentrations at Kawerau occur towards the southern part of the field, in the vicinity of the Putauaki volcano. This is consistent with the deep upflow and major heat source occurring in this part of the system. The geothermal field has a low resistivity signature extending over an area of up to 35 km^2, compared to 28 km^2 for the Rotokawa geothermal field whilst most geothermal areas in the TVZ average about 15 km^2.

In 1951/52 the Department of Scientific and Industrial Research and Ministry of Works carried out scientific surveys and shallow drilling to investigate the geothermal potential of the Kawerau area for power production and process heating. One year later, Tasman Pulp and Paper Company decided to site a mill in the vicinity of the field in order to utilise the geothermal energy potential for industrial applications.

The drilling of geothermal production wells for Tasman led to the first geothermal steam being supplied for power production and for process heat to the mill in 1957, with the steam supply system fully operational in 1961. Reinjection of separated geothermal water began in 1991. As the timber processing plant expanded, demand for geothermal steam increased up to 300 t/h, with separated water used in two small binary power plants (total output of 6MWe) and a greenhouse. More than 30 wells have been drilled for various purposes, although no more than six or seven have been in use at any one time. Currently geothermal fluid is extracted from around 1000 m depth at an average rate of 1400t/h. Geothermal water is reinjected into a shallow aquifer located above the present production aquifer. The balance of the separated water is discharged into the Tarawera River.

The net withdrawal over the last 15 years has produced minimal long-term pressure changes at production depths in the Kawerau field. A total pressure decline of 0.3 bar is estimated, based on changes in elevation of flowing hot springs and seeps, whilst some of the early shallow wells have experienced incursion of cool groundwaters. The present production from about 1000 m depth is relatively stable.

2.2.1 GEOTHERMAL SURFACE FEATURES AND USES

A review of current geothermal surface features indicates that these consist largely of feeble steam discharges associated with barren, clay-altered ground and stunted scrubby vegetation. There is a concentration of these features in the Parimahana Reserve/Ruruanga Stream area. Extensive seeps of high temperature thermal water occur almost continuously along the Tarawera River.

Apart from the electricity and steam use described above, private and community use of the steam resource is limited to the Kawerau swimming pool and a limited amount of domestic heating. The glasshouses referred to above have since been demolished.

2.3 GEOLOGY

The Kawerau geothermal field is composed of greywacke basement overlain by interbedded/interspersed volcanics and alluvial/sedimentary units. The existing borefield area is extremely complex, with rhyolitic domes and buried andesitic cones, together with ignimbrite flows, pyroclastic and hydrothermal breccias, and various sedimentary formations.

For the purpose of this AEE there are four key horizons, being recent alluvial deposits from the surface to approximately 100 m depth, Matahina ignimbrite at approximately 100-150 m depth, Huka Group sediments at approximately 500 m depth and the greywacke basement below about 800-1000 m depth.

The recent alluvial sequence is somewhat complex and not well documented, but appears to contain beds of greywacke gravels, volcanic materials, marine sediments, dune sands, swamp beds and sedimentary deposits. These younger materials may be prone to on-going creep (secondary compression) under the weight of overlying material. They are generally relatively permeable and will consolidate rapidly (months or years) as a result of any groundwater change. However, the presence of localised high porosity / low permeability lenses cannot be ruled out.

The Matahina ignimbrite is a marker bed throughout the Whakatane graben. It consists of several different members, including a bottom and top massive unit (unwelded to slightly welded) and a central welded columnar unit. This central unit appears to be a favoured aquifer that is targeted by irrigation bores. It will also, due to the very high permeability central core and low permeability massive unwelded units on either side, act as a pressure barrier between the upper sediments and the lower more volcanic derived materials.

The rhyolite domes are likely to comprise stiff, highly permeable zones, though the edges could be more or less permeable, depending on whether they are covered with breccias or fine grained and potentially compressible ash layers. Breccias, tuffs and ash layers are present between the different rhyolite domes.

The Huka Group appears to be a relatively persistent layer (or series of layers) across the field, and may be acting as an impermeable cap, although breaches in this cap are likely to be present where it is cut by domes, vents, and faults. These sediments are known to be compressible elsewhere (e.g. Wairakei), and more importantly are likely to be bedded, with alternating sand and clay layers. This internal structure means that lateral drainage is more important than vertical drainage. The nature of this unit may differ to that elsewhere, since at Kawerau it may be partly of marine origin, and not entirely lacustrine.

Below the Huka Group is a similar sequence of units to that lying above. The Huka on-laps to some rhyolites that predate the Huka Group. The Rangitaiki and Te Teko Ignimbrites are found across much of the area. The fractured Kawerau Andesite is found largely in the western areas. The Waikora Formation containing gravels and sediments is seen in several locations above the greywacke basement.

The greywacke basement comprises indurated sandstone and siltstone, and fluid flow is dominantly along fractures. It is marginally compressible. A generalised geological interpretation is presented in Figure 2. 1.

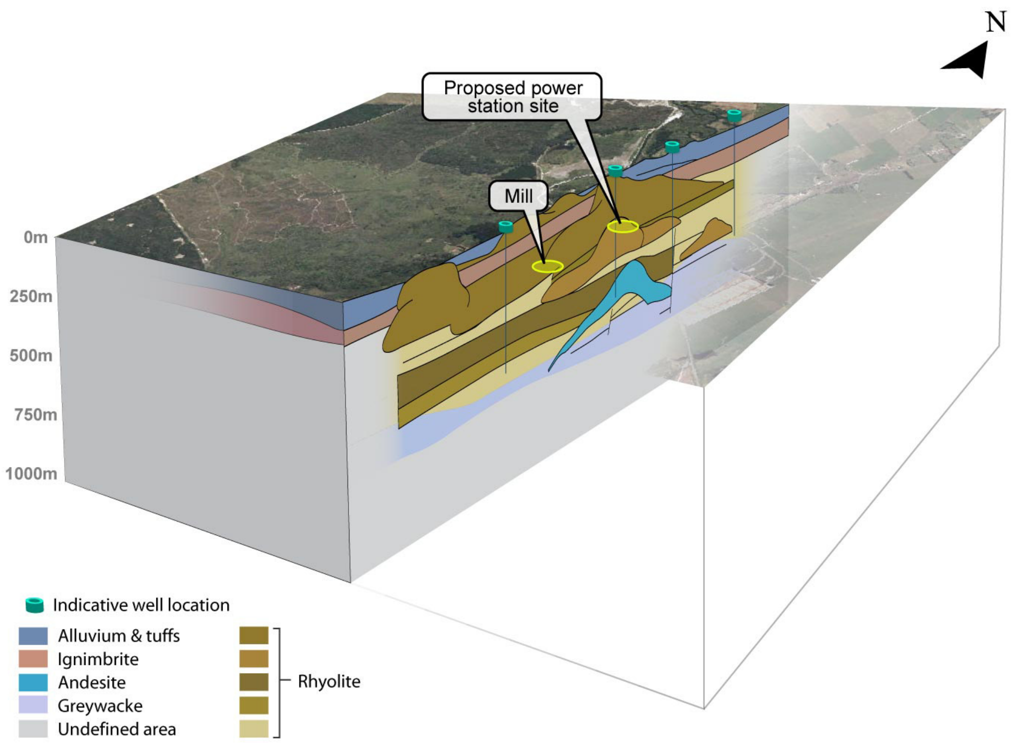

Figure 2.1: Generalised Stratigraphy at Kawerau.

Faulting

The geothermal field is located within the Whakatane graben. As such, there are numerous NE-striking faults, with cross faults also present. These faults permit the ready transmission of pressure changes and fluid along the length of the fault, but may also reduce the transmission of pressure changes across the faults. Faulting is considered to play a key role in providing vertical permeability within the present production area and is probably important in transmitting any pressure changes due to production.

2.4 SUBSIDENCE

Background regional tectonic subsidence is of the order of 5mm per year or less. For example, large areas of the Taupo region – hundreds of square kilometres – have vertical movements of the order of 7mm per year. Subsidence in the Whakatane graben is between 1 and 3mm per year. Other areas of New Zealand have greater vertical and horizontal movements.

Levelling surveys have been regularly carried out at Kawerau since the early 1970's. The most recent survey confirms the general pattern, being a broad subsidence bowl lying north west of the Tasman site. This bowl extends over the entire Kawerau geothermal field and some way beyond (Figure 2.2). In addition, there are two rather more steeply contoured localised bowls located to the north east of the Tasman site.

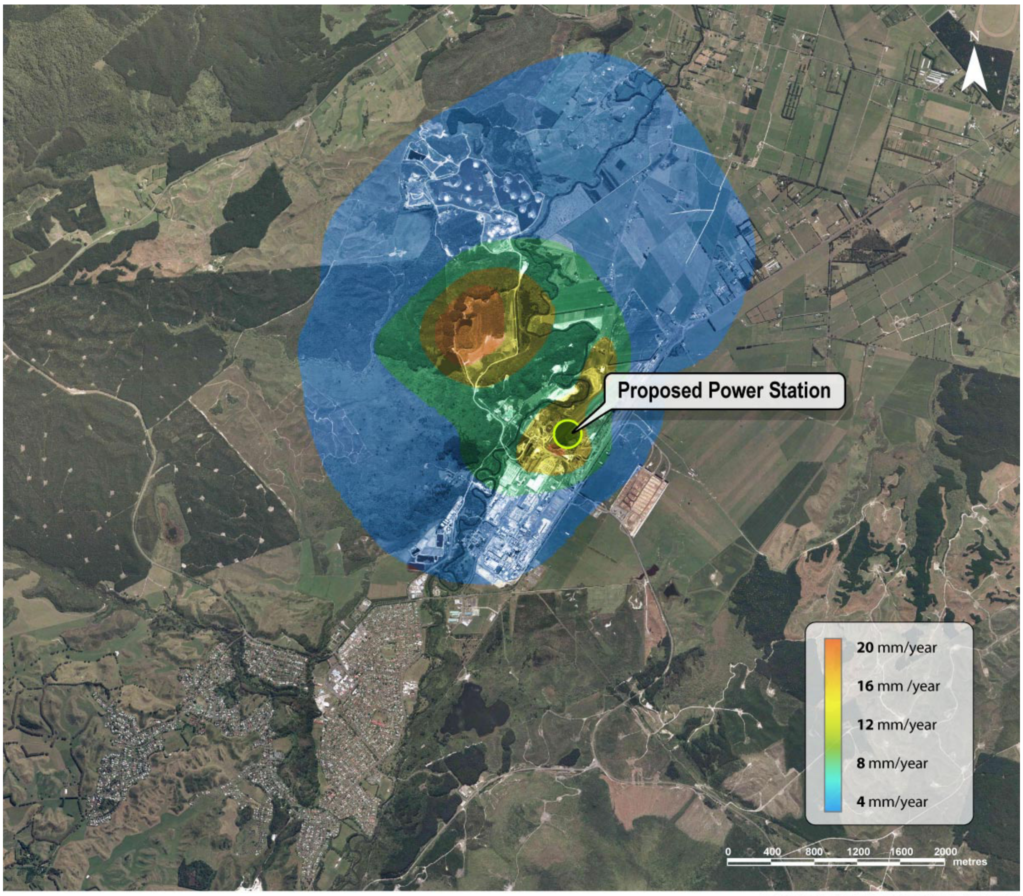

Figure 2.2: Historical Geothermally Related Subsidence at Kawerau (1976–2004).

There appears to be no single cause of subsidence at Kawerau. In addition to regional and tectonic factors, subsidence may occur as a result of the compaction of a buried volume of rock, which is caused by pressure drawdown and thermal contraction.

It is likely that the broad subsidence bowl with its centre north west of the Tasman site has resulted from the compaction of buried rock and is likely associated with the withdrawal of fluid from the reservoir. Conversely, the small localised subsidence bowls indicate a near-surface mechanism for the compaction. These bowls are unrelated to geothermal abstraction.

In comparison with Figure 2.2, the marked effect of the 1987 Edgecumbe earthquake is apparent in the subsidence data shown in Figure 2.3 for specific levelling survey points. The annual mass withdrawal, up to the current rate of about 1370 t/h is also shown. The subsidence during the earthquake was similar to the aggregate effects of all geothermal subsidence up to that time. Damage to the mills from the earthquake was substantial – not from the subsidence, but from the seismic shaking. Damage to the steamfield was slight: one pipeline on a bridge across the Tarawera River came off its supports, but did not fracture or leak.

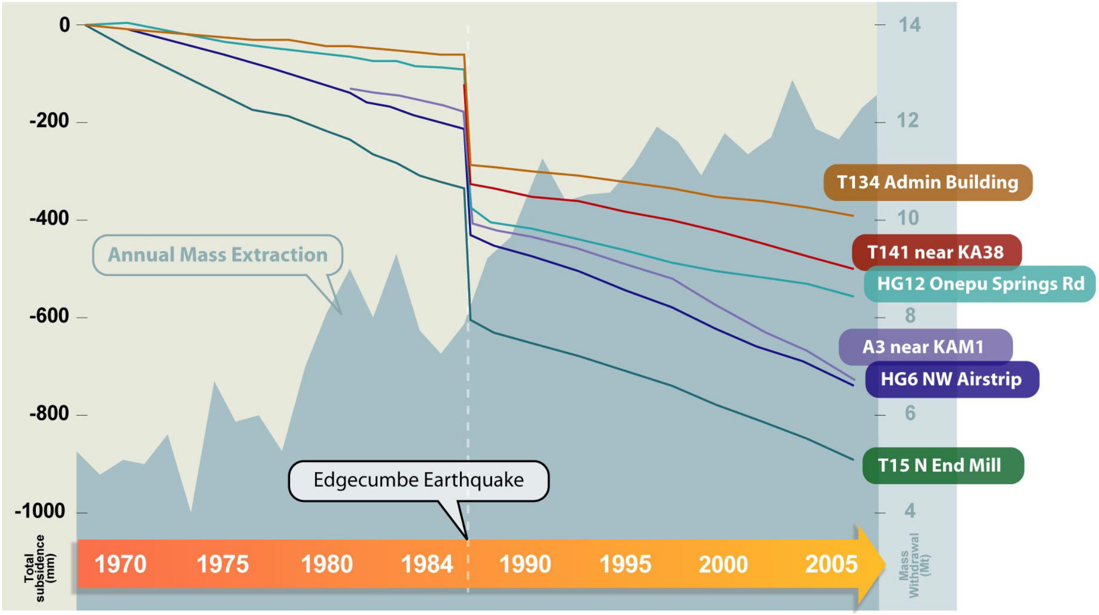

Figure 2.3: Kawerau Subsidence (1970 – 2005).

2.5 WATER RESOURCES

The Kawerau industrial area has two main water resource receiving environments located in close proximity. These are the Tarawera River, which runs along the north western boundary of the site, and the shallow groundwater system beneath the site. Establishing the existing environment in terms of water quantity and quality will form a baseline for the assessment of environmental risks involved with spills, leaks and failures to pipelines and other equipment associated with the power station.

While it is not expected that there will be any major effects on either of these two environments in terms of water takes and discharges, the potential for spills and storm water discharges generates the requirement to establish the baseline environment.

The following sections provide a description of the existing receiving water environments and identify any sensitive ecology or water quality issues that need to be considered when assessing site discharges to surface water and ground.

2.5.1 TOPOGRAPHY

The Tarawera River runs along the north-western boundary of the site and meanders toward the sea to the north. The area in and around the station is generally flat and tends to drain towards the river. The main topographical features in the general area are Putauaki (Mount Edgecumbe) approximately 4.5 km to the south at an elevation of 821 m and Onepu, Otukoiro and Tirotiro Whetu approximately 1 km to the west at an elevation of 189 m.

2.5.2 GEOTHERMAL RESERVOIR HYDROLOGY

The top of the primary geothermal production areas ranges from -900 to -1,500 m, and there are various upflow conduits inferred across the geothermal field. A heat source is inferred to lie beneath Putauaki with a steep temperature gradient from depths of -4,000 m to the surface. The thermal fluids are brought to the surface along fault planes and fractures underlying the field. Near to the surface there is a mixing zone of the high chloride, high temperature geothermal fluids and the low chloride, low temperature groundwaters (Figure 2.4).

The surface features of the geothermal field include hot springs, seepages and associated sinters, hydrothermal eruption vents and altered and steaming ground with small fumaroles. The tapping of the steam and entrained fluids over the last 50 years has resulted in small changes to the surface geothermal features and slight surface subsidence.

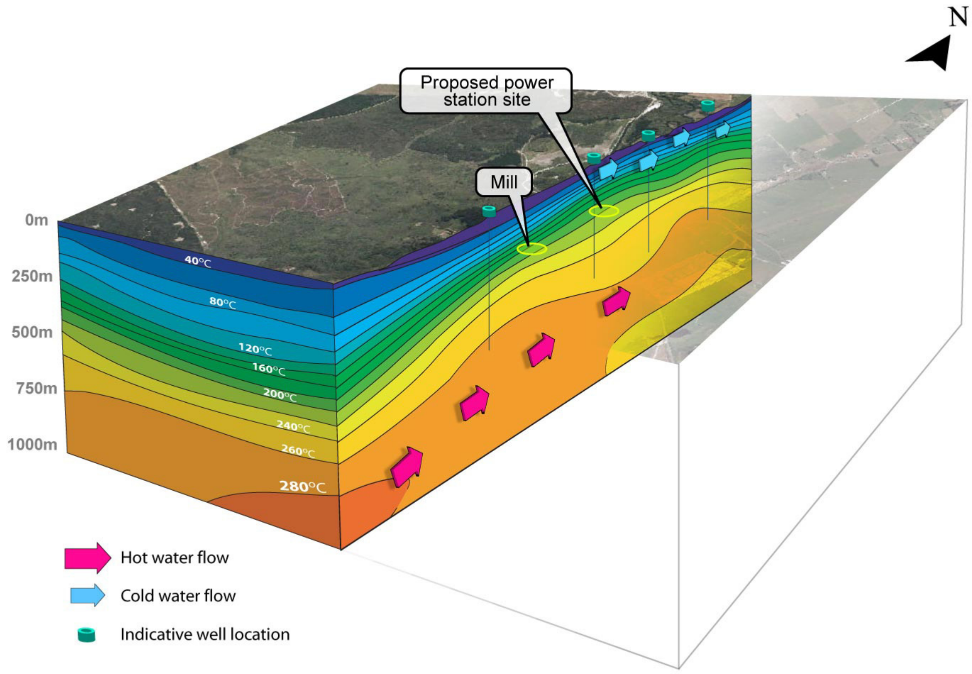

Figure 2.4: Diagram of Geothermal System at Kawerau.

2.5.3 GROUNDWATER HYDROGEOLOGY

Shallow sediments (e.g. undifferentiated pyroclastics or Matahina Ignimbrites) host a cold groundwater system replenished by deep circulation from Putauaki and surface recharge. Overlying these sediments recent alluvium, comprising peats, sands, gravels and unconsolidated or re-worked pyroclastics, forms a layer of 10 to 50 m thickness across the Tarawera River valley floor. Outside the immediate zone of surface geothermal features, the shallow volcanogenics and alluvial deposits contain a cold groundwater system operating under conventional hydraulic gradients rather than the thermal convection cells of the geothermal field.

Environment Bay of Plenty records indicate at least 38 shallow water bores or wells in the Onepu area to the northeast of the NST industrial complex. Typically, the bore logs down to depths of 30 m mention peat deposits, interspersed with pumaceous sands and gravels. This typical profile is suggestive of a moderately complex sedimentary history with alternating high energy (gravel/sand) and quiescent (peat) periods of plain development. The arrangement is consistent with the formation of a stratified groundwater system, which is segmented by local peat layers but is otherwise contiguous across the alluvial plain and integrates cold groundwater flow vertically. It is understood that the groundwater flow pattern at Onepu is recharged by excess rainfall upon the land surface and tends to discharge to the Tarawera River and the lower reaches of some tributaries.

Beneath the NST site itself, reinjection of separated geothermal waters commenced in 1991. The reinjection of geothermal fluids has led to a distinct rise in groundwater chloride content from less than 400 g/m^3 to 650 g/m^3. However, relatively low chloride concentrations in the groundwater at near by Onepu suggest that the area affected by reinjection is relatively restricted.

2.5.4 TARAWERA RIVER

Flow records show the lowest daily average flow recorded was 15.2 m^3/s in 1979 and the maximum average daily flow was 74.2 m^3/s in 1995.

The Tarawera River at the mill is characterised by a neutral pH, low suspended solids and conductivity, and an elevated alkalinity supported by a high bicarbonate concentration. The elevated bicarbonate is reflective of input from geothermal waters, which is further evidenced by elevated silica, sodium, chloride and boron. This water signature is typical of the upper reaches of the Tarawera River and is natural for this region. Another geothermal influence is an increase of 0.5ºC in water temperature of the Tarawera River as it flows past Kawerau. Natural thermal seeps contribute the majority of this, with the remainder being site outfalls. The elevated concentrations of nutrients in the river near the mill is the likely result of discharge from the sewerage treatment plant on the western side of the Tarawera River, just north of Kawerau town.

2.5.5 GEOTHERMAL WATERS

Both the well ponds and pipelines would contain geothermal water. There is the potential for geothermal water to enter groundwater and surface water through seepage or spills. The geochemistry of the local geothermal waters is well documented in the geoscientific review carried out by GNS (2005).

Historically, natural heat and mass flow from the Kawerau geothermal field has discharged to the Tarawera River and is estimated to have been around 190 L/s of water at 100°C. The use of the geothermal field for process steam and power generation is likely to have caused some drawdown of fluid pressures in the field and hence reduce some of the natural seeps into the Tarawera River.

As fluids rise from the reservoir, depressurisation and cooling occurs, changing the chemistry of the fluids. Although Kawerau has typically low calcium concentrations, calcite scaling can form at the flash-point in the discharging wellbore, where the loss of CO_2 accompanying boiling leads to a large equilibrium shift and calcite deposition. The discharge water becomes oversaturated with respect to amorphous silica, resulting in silica deposition at the outflow.

The geothermal water is elevated in sodium, chloride, bicarbonate, silica, lithium, boron and hydrogen sulphide. Comparisons to other systems suggest that fluids from the Kawerau geothermal field do not have levels of toxic metals that will cause environmental concern. This is due to their relatively low salinity, moderate gas content, and neutral-chloride type waters.

Chemical parameters typically associated with freshwater contamination that may be of concern due to their presence in geothermal fluid are boron, dissolved hydrogen sulphide, mercury, ammonia and arsenic. Each of these parameters have been considered when assessing potential environmental effects associated with geothermal fluids from the Kawerau geothermal field.

2.5.6 EXISTING STORM WATER SYSTEM

The existing storm water system from the Tasman industrial site is managed by NST and is authorised under resource consent 02-4221 from Environment Bay of Plenty. Storm water from the industrial site is collected within one of three catchments and is treated within each catchment's storm water pond. The storm water ponds each have an inlet structure that retains floating products and coarse sediments. The storm water ponds generally discharge to ground with over flows to the Tarawera River during larger rainfall events.

2.6 ECOLOGY

The natural environment surrounding the site features low scrub and bush covered hills with some geothermal sites as well as the Tarawera River, its riparian margin and associated lakes and wetlands. Kawerau crosses the boundary of two ecological districts, being Rotorua Lakes and Te Teko.

2.6.1 NATURAL FEATURES OF THE TARAWERA RIVER CATCHMENT

The Tarawera River catchment covers an area of approximately 984 km^2. The majority of the upper Tarawera catchment area is covered in indigenous or plantation forest, the native forest generally confined to steeper and more erodable parts of the catchment. The lower Tarawera catchment is bounded to the west by the Manawahe Hills, which rise to *c.* 300 m above sea level. The Manawahe hills are covered in a mixture of indigenous and plantation forest in the Kawerau area and carry mostly pasture elsewhere.

The upper reaches of the Tarawera River are an attractive water body, typically blue-green in colour and of high visual clarity. It contains diverse and abundant plant and animal communities indicative of a clean water environment. The water quality here can generally be described as being close to its natural state. The lower Tarawera River, which starts from Kawerau Bridge and flows past the Tasman mill site as well as through farming communities, is relatively modified. There is little or no benthic vegetation in this section of the river and the fauna present consists principally of species indicative of reduced aquatic habitat. Riparian vegetation is mostly weedy trees and shrubs.

The hills west of the mill are on the edge of the Kawerau geothermal field and contain warm soils, a geothermal cliff face, geothermal pond and small scattered geothermal sites, which provide habitat for specialised native plants such as prostrate kanuka, dwarf mistletoe, ferns and orchids. Most of this area is protected (Parimahana Scenic Reserve), or recommended for protection (Parimahana Extension).

2.6.2 PARIMAHANA SCENIC RESERVE AND PARIMAHANA EXTENSION

Parimahana Scenic Reserve and Parimahana Extension are situated southwest of the Tasman site. Parimahana Scenic Reserve (4.4 ha) is a protected area administered by the Department of Conservation. It contains secondary vegetation dominated by rewarewa and kanuka, specialised geothermal vegetation around the geothermal cliff face and pond referred to above. The geothermal vegetation is dominated by prostrate kanuka (*Kunzea ericoides* var. *microflora*), which is known only from geothermal areas in the central North Island. A threatened fern *Dicranopteris linearis* is locally abundant in this reserve and comprises one of the largest populations of this species in New Zealand. Other species present that are uncommon in the Rotorua Lakes Ecological District are the ferns or fern allies *Psilotum nudum, Schizaea bifida, S. dichotoma, Lycopodium cernum, Nephrolepis* cf. *cordifolia* and *Chielanthes humilis,* the orchid *Genoplesium pumilum*, and dwarf mistletoe *Korthalsella salicornioides*. *G. pumilum* is known only from one other site in the ecological district. *C. humilis* is known only from two other sites in the ecological district.

Parimahana Scenic Reserve is contiguous with Parimahana Extension (326 ha), which is classified as a natural heritage area in the Whakatane District under multiple Maori ownership. Parimahana Extension is a Recommended Area for Protection (RAP) in the Rotorua Lakes Protected Natural Areas Survey. Here, manuka scrub is common on the hill slopes. Kanuka and rewarewa forest, with local whauwhaupaku and some radiata pine comprises the dominant vegetation type over the hill slopes and gullies. Small geothermal areas occur locally in the northern part of this RAP and contain prostrate kanuka and the threatened fern *Dicranopteris linearis*. Two small lakes are present and a moderate sized wetland extends along the main valley floor in the south of the RAP.

Parimahana Scenic Reserve and Parimahana Extension form a relatively large example of indigenous vegetation that is under represented in the reserve system of the Rotorua Lakes Ecological District and of significant conservation value. Characteristic geothermal plants are present which are sensitive to subsurface geothermal changes, such as cooling of the substrate in which they live.

2.6.3 TARAWERA RIVER RIPARIAN ZONE

The current vegetation of the Tarawera River Riparian Zone consists of a mixture of exotic and indigenous species, comprising mainly tree land with some willow forest present. Several remnant stands of kanuka are present including a range of indigenous species. However, they are also infested with a variety of invasive weeds such as crack willow, Chinese privet, pampas, buddleia, blackberry and tradescantia.

A RAP site has been identified within the Tarawera River Riparian Zone in the Te Teko Ecological District Protected Natural Areas Survey report. The 2.0 ha site is named Tarawera River Kanuka and occurs on the true right of the river, immediately north east of the central access road bridge. Although degraded, the site contains the best example of kanuka forest on alluvial plains remaining in the Te Teko ecological district. A small area of geothermally heated moss and rock land on the margin of the RAP represents one of only three areas of geothermal activity in the ecological district.

2.6.4 KAWERAU AIRSTRIP AND PUTAUAKI STEAMFIELD VEGETATION

Most other natural areas around the mill are heavily modified or degraded. Vegetation around the Kawerau Airstrip consists of rank pasture, pampas, brush wattle (*Paraserianthes lophantha*) and fennel (*Foeniculum vulgare*) with the occasional native *Muehlenbeckia australis* vine, while the Putauaki Trust farm is covered in pasture.

2.6.5 FRESHWATER ECOLOGY OF THE LOWER TARAWERA RIVER

The diversity of freshwater fish species in the upper Tarawera River system is limited in comparison with other river systems in the Bay of Plenty. It is likely that a number of factors have contributed to this, including land use changes (forestry, agriculture, wetland drainage), over fishing (whitebaiting), channelisation, exotic fish introductions and industrial pollution restricting upstream migration of some fish species. Of the six fish species recorded from the upper Tarawera River and its tributaries, five are indigenous to New Zealand. Only the long fin eel is considered to be of conservational significance and classified as being under gradual decline.

Fish diversity is greater in the lower Tarawera River and its tributaries. Fish recorded from the lower Tarawera River and tributaries considered to be of conservation significance include the long fin eel (gradual decline), giant kokopu (gradual decline), short jaw kokopu (gradual decline) and lamprey (sparse).

The aquatic plant communities in the lower Tarawera River consist of emergent species such as sweet grass (*Glyceria maxima*), raupo (*Typha orientalis*), willow weed (*Persicaria decepiens*) and wild mint (Mentha sp.). Sweet grass lines both banks of the river and covers up to 25% of the riverbed. Periphyton communities are sparse to absent.

2.7 AMENITY VALUES

2.7.1 LANDSCAPE AND VISUAL AMENITY VALUES

The existing mill site is characterised by an extensive array of buildings and structures that are associated with the pulp and paper processing plant. These include a proliferation of above-ground network utility structures such as pipelines and transformers in addition to isolated structures of irregular shape and considerable height. These industrial features are located amongst more conservative groups of buildings that are typically utilised for office or workshop purposes. Native planting and landscaping surrounds the mill's more conventional buildings, which is in contrast to the hard surfaced and dusty areas that are a distinguishing feature of the land that surrounds the timber yard and the industrial structures associated with the mill.

The foothills referred to previously form a backdrop on the western side of the site while Putauaki is visible to the east and the Tarawera forest is located to the south. The Rangitaiki plains stretch out in front of the site in a north eastern direction and are bounded by the Tarawera and Rangitaiki rivers. The Tarawera River runs along the western boundary of the site and meanders towards Lakes Rotohipake, Rotorua and Tamurepihi to the north where the eastern site boundary lies parallel to SH34 and the adjacent railway line.

Present and past pastoral activities have resulted in strong linear patterns derived from shelterbelts and hedging, which create a grid-like effect across the plains area. A number of residential dwellings and ancillary buildings are sporadically located within a 1.5km radius of the site and are predominantly screened by well-established vegetation.

2.7.2 EXISTING NOISE ENVIRONMENT

The ambient noise environment in the vicinity of the site is controlled by the existing activities within the Kawerau Industrial Zone as well as transport activity on SH34, Onepu Springs Road and the adjacent railway line. From SH34, ambient noise monitoring recorded daytime noise levels of L_{10} 78 dB(A), while the night time noise level measured L_{10} 69dB(A). Ambient noise levels at Onepu Springs Road during daytime and night time hours were recorded as L_{10} 52 dB(A) and L_{10} 41 dB(A), respectively.

The combined effects of these multiple sources result in relatively high noise levels throughout the day and night at distances of up to some 1000m. The noise from the industrial zone falls to inaudible levels at distances of 2 to 3 km, with road and rail noise remaining audible at greater distances from the site along the main transport corridor.

2.7.2 EXISTING AIR QUALITY

Kawerau is typical of a largely rural environment which is also exposed to geothermal emissions and major industry. The principal feature of geothermal emissions is hydrogen sulphide (H_2S) from existing fumaroles and vents. Mercury is also measurable at higher levels than a non-geothermal area but in concentrations that are well below

Ministry for the Environment (2002) guideline levels. The industrial activity also contributes H_2S and some other sulphur compounds.

As a result of these combined sources, H_2S emissions are noticeable within the Kawerau township in the sense that the majority of the population are likely to smell the presence of the gas. However, H_2S emissions are barely discernable in areas on the periphery of Kawerau such as Te Teko and Edgecumbe. Measurement of H_2S in Kawerau indicates that noticeable levels of H_2S are more likely to derive from natural emissions than from the existing industry.

2.8 TRAFFIC ENVIRONMENT

2.8.1 LOCATION IN THE TRANSPORTATION NETWORK

The Tasman mill, in the context of the surrounding transportation network, is located alongside SH34 to the east, Fletcher Road to the south and Onepu Springs Road to the north. At present the mill only has two vehicle accesses onto the public road network - one at the signalised intersection of Fletcher Avenue and SH34 on the southern edge of the site and the other on the eastern side of SH34 adjacent to the overbridge. The Fletcher Avenue entrance provides access mainly for staff and visitors. The private road bridge over SH34 connects the mill with the forests to the east and provides high standard access onto the state highway and is capable of carrying the long triple trailer units that are not allowed on public roads. The power station will be accessed via this entrance.

The site provides access directly onto the state highway network thereby connecting it to nearby Whakatane, Tauranga and Rotorua. The site is well located with ample options for transporting people and goods to the site by sea, air, rail or road. The railway takes an almost direct line up to Tauranga Port and continues on through the Kaimai Tunnel to connect with the North Island Main Trunkline at Hamilton.

It is expected that most imported materials and components would arrive by sea at Tauranga Port. Deliveries can be transferred to either the railway, or to trucks which can then follow SH2 and SH34, or alternatively SH30 to the site. Road deliveries can come entirely on the state highway network without any need to use any local roads in the Kawerau District.

2.8.2 TRAFFIC FLOWS

Traffic flows on SH34 between the Mill and SH30 have peaks around 750 vehicles per hour (vph) from 7.00 to 8.00am and 4.00 to 5.00pm. These are coincident with the start and end of the day shifts as Tasman Mill, which is by far the largest traffic generator in the region. Interpeak traffic flows are reasonably flat at 350 to 400vph and overnight traffic is minimal. There are no commuter peaks in the weekend. Heavy vehicles comprise 15% of all traffic on SH30 and show a reasonably consistent level of 500vpd during the week, dropping to around 250vpd on the weekend.

2.8.3 ROAD SAFETY

The Land Transport New Zealand (LTNZ) accident records for the whole eastern Bay of Plenty area between Te Puke, Rotorua and Whakatane for the last five years indicate that the majority of the injury accidents in this part of the Eastern Bay of Plenty occurred on the state highways and in the main urban areas, while non-injury accidents were more likely to occur at or near intersections. LTNZ has identified poor observation, drink driving and speed as the major contributors to accidents in the area.

3 PROPOSED POWER STATION AND WELL DRILLING

The proposed power station at Kawerau is based on an average 45,000 tonnes per day of geothermal fluids and will operate at a nominal 70MW capacity to provide more than 50% of the electricity demand in the Kawerau region. As outlined in Section 1, the proposed power station will be located at the approximate centre of the Kawerau Industrial 1 Zone to the north of the NST site, at the southern end of the existing airstrip and to the west of SH34. The proposed production pads are located on both NST and Putauaki Trust land with reinjection pads initially located on the northern part of the Putauaki Trust land as generally depicted in Figure 3.1. This section provides a detailed description of the plant technologies, geothermal fluid gathering and disposal systems, drilling activities and construction process associated with the power station.

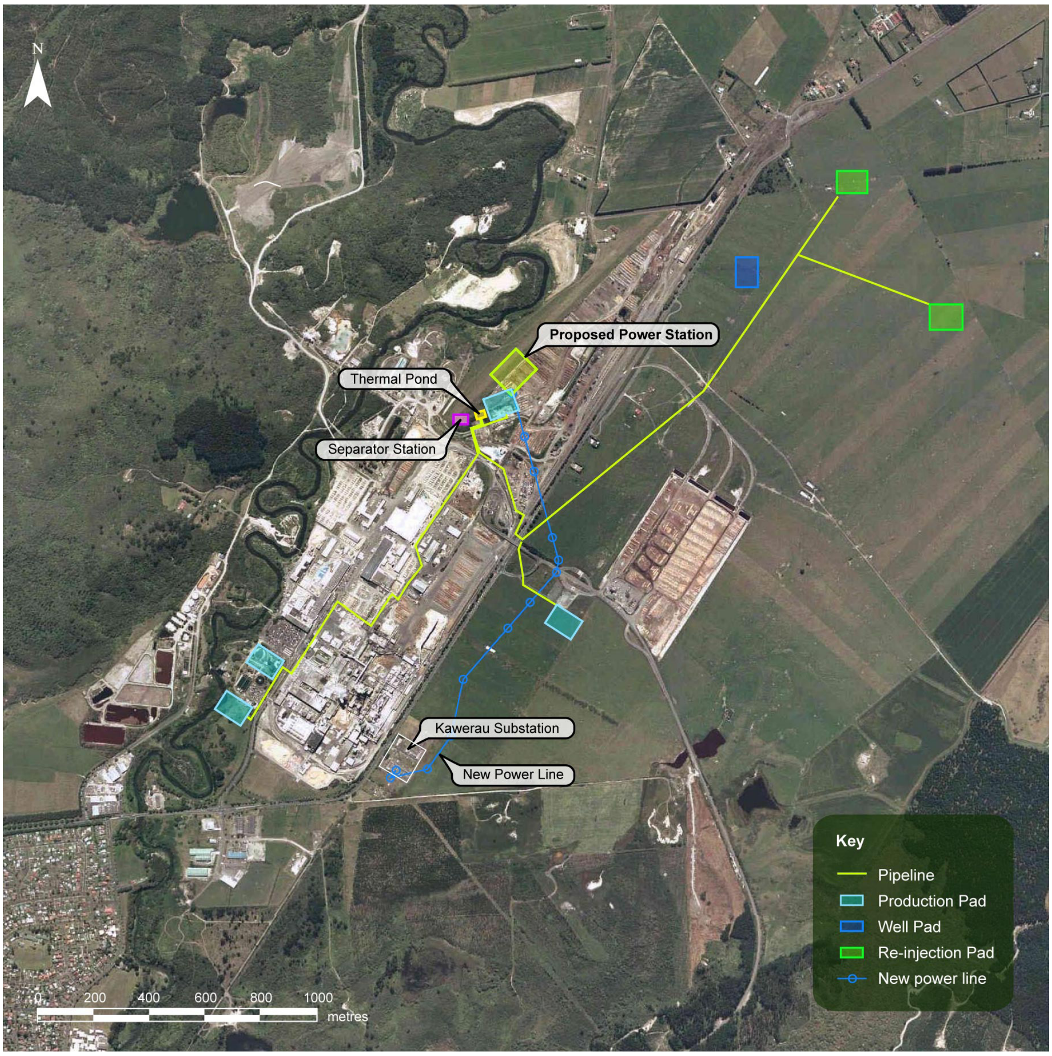

Figure 3.1: Proposed Power Station and Steamfield Layout.

3.1 POWER PLANT DESCRIPTION

Three basic technology options are being considered for the conversion of geothermal energy to electricity and looks to optimise the efficiency of energy conversion within economic limitations. The three technologies being considered are the condensing steam turbine, the Organic Rankine Cycle (ORC) and the Kalina Cycle. These may also be combined to provide design solutions that have a wider application or better efficiency. Final selection of the energy conversion technology will be subject to international competitive tendering. Each of these technologies is described below.

3.1.1 CONDENSING STEAM TURBINE (STEAM RANKINE CYCLE)

A condensing steam turbine option presents the smallest footprint. The process involves flashing geothermal fluid to a lower pressure and separating the steam from the liquid (brine). The brine may be flashed again at a lower pressure to produce additional steam for power generation. The steam is expanded through the turbine converting energy into electrical power, whilst the brine is returned to the reservoir for reinjection. The steam from the turbine passes into a direct contact condenser. The condensate is then pumped to a cooling tower which forms a cooling water circuit with the direct contact condenser. About 80% of the condensate entering the cooling water circuit is evaporated in the cooling tower, while the balance is reinjected to the reservoir. Figure 3.2 illustrates a typical condensing steam turbine plant.

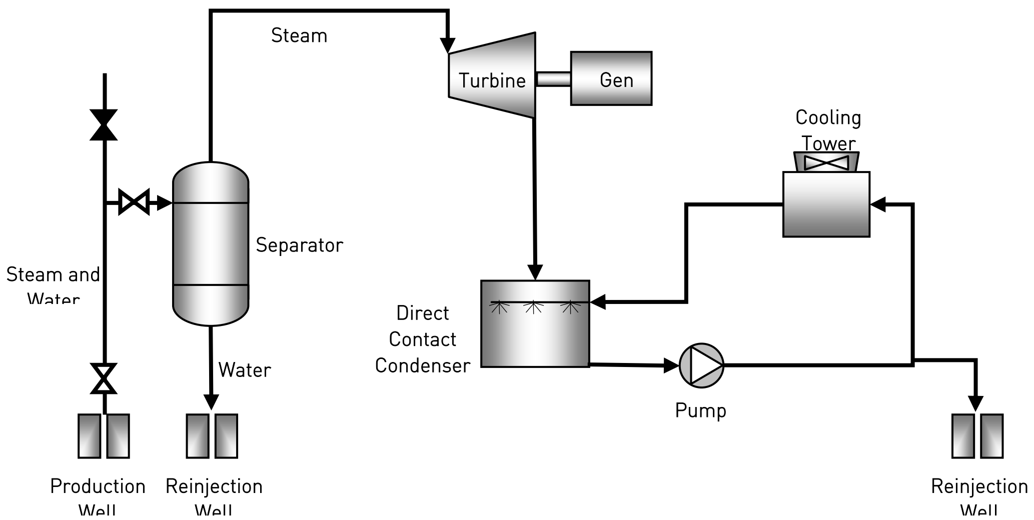

Figure 3.2: Condensing Steam Turbine Schematic.

3.1.2 ORGANIC RANKINE CYCLE (ORC)

The ORC is a derivative of the steam Rankine power cycle, which has been used in traditional thermal power generation for over a hundred years. What makes the ORC different is the use of a hydrocarbon, pentane, as the working fluid. The pentane is circulated in a closed system and operates in much the same way as a household refrigerator. Heat from the geothermal steam and brine boils the liquid pentane, the resulting pentane vapour expands through a turbine, which drives the generator and produces the electricity.

The vapour from the turbine is condensed by cooling with air blown over a series of finned tubes, similar to an automotive radiator. The cycle is completed when condensed pentane is pumped back to the vaporiser, where it is again boiled. Cooled geothermal fluids are then reinjected back into the geothermal reservoir. Figure 3.3 illustrates a typical ORC plant.

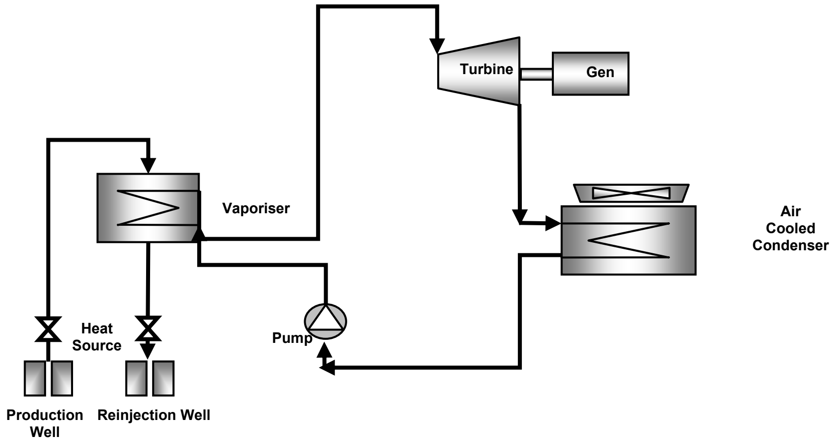

Figure 3.3: Organic Rankine Cycle (ORC) Schematic.

3.1.3 KALINA CYCLE

The Kalina cycle uses a mixture of ammonia and water in a closed system similarly to the Organic Rankine Cycle. The composition of this mixture varies throughout the cycle. This process includes variable temperature evaporation and condensing, and a high level of recuperation which may provide a higher heat to electrical energy conversion efficiency than the ORC plant. A typical Kalina Cycle is illustrated in Figure 3.4.

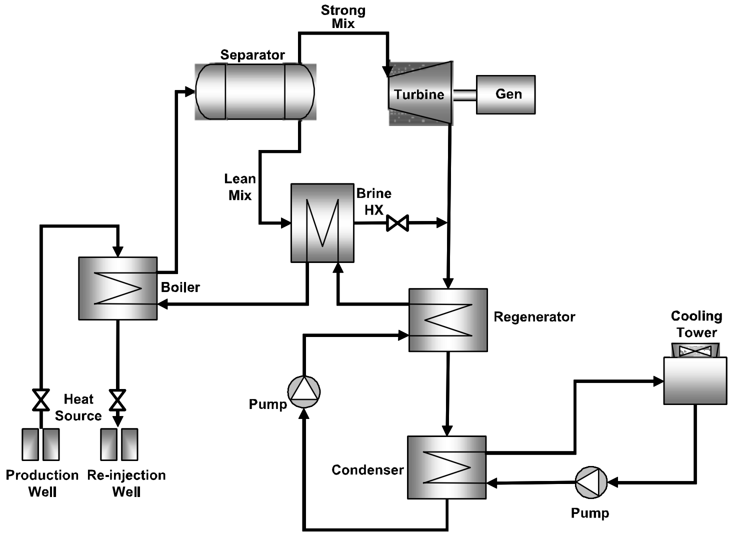

Figure 3.4: Kalina Cycle Schematic.

3.1.4 TURBINES

Condensing Steam Turbines

The condensing steam turbine will be a multi-stage industrial steam turbine designed for geothermal duty with an under slung direct contact condenser. This unit would be similar to the unit installed at Poihipi, just north of Taupo.

Backpressure Steam Turbines

A backpressure steam turbine may be used in conjunction with an ORC plant, whereby the turbine exhausts at about 120°C providing steam for the ORC vaporiser. This arrangement would be similar to the Mokai installation. The backpressure steam turbine would be an industrial steam turbine designed for geothermal duty similar to the condensing steam turbine, but only about half the size.

Organic Fluid Turbines

The organic fluid turbines are designed to operate with pentane. The turbine is a two-stage impulse machine. The turbines may be arranged to operate in parallel or in series.

Ammonia/Steam Turbines

The molecular weight of ammonia is similar to steam, which enables a standard industrial steam turbine to be used for the Kalina cycle. The turbine would be a multi-stage machine similar to the back pressure steam turbine described above.

3.1.5 STEAM CLEANING AND PRESSURE CONTROL

Cleanliness of the steam being supplied to a steam turbine is critical for its long term operation. To achieve this, about 60 t/h of clean condensate may be injected into the steam line close to the separator. About 50% of this injected flow is drained to seepage pits along the steam line.

In the event of sudden load changes a pressure control system will operate and discharge steam to the atmosphere. Should the control system fail to maintain the pressure, safety relief devices will vent steam near the well heads until the well is closed. This would typically take a few minutes and the hot brine would be discharged to the sump.

3.1.6 COOLING OPTIONS

All thermal power generation cycles require that heat be rejected from the system. The possible options are either air cooled condensers or mechanical draft wet cooling towers. Typically, air cooled condensers are employed with ORC plant and cooling towers are commonly used for condensing steam turbines. A description of each cooling system is provided below:

Air Cooled Condenser

The air cooled condenser is an induced draft air cooled heat exchanger, in which the motive fluid is condensed while flowing in the tubes by the air which flows outside of the finned tubes in a cross flow pattern. Air cooled condensers are depicted in Figure 3.5. The Kawerau air cooled condensers could have approximate dimensions of 500 m (length) x 20 m (width) x 8 m (height).

Figure 3.5: Air Cooled Condensers.

Mechanical Draft Wet Cooling Tower

A mechanical draft wet cooling tower such as at Poihipi sprays the condensate being cooled over a fill material and fans induce a flow of ambient air across the fluid. A small portion of the condensate evaporates, whereby the latent heat of evaporation causes the remainder of the fluid to cool. This is generally perceived as a more efficient method of cooling as it requires a smaller area than the dry cooling. Wet cooling towers are approximately 70 m long, 20 m wide and 17 m high. An example of a wet cooling tower is shown in Figure 3.6:

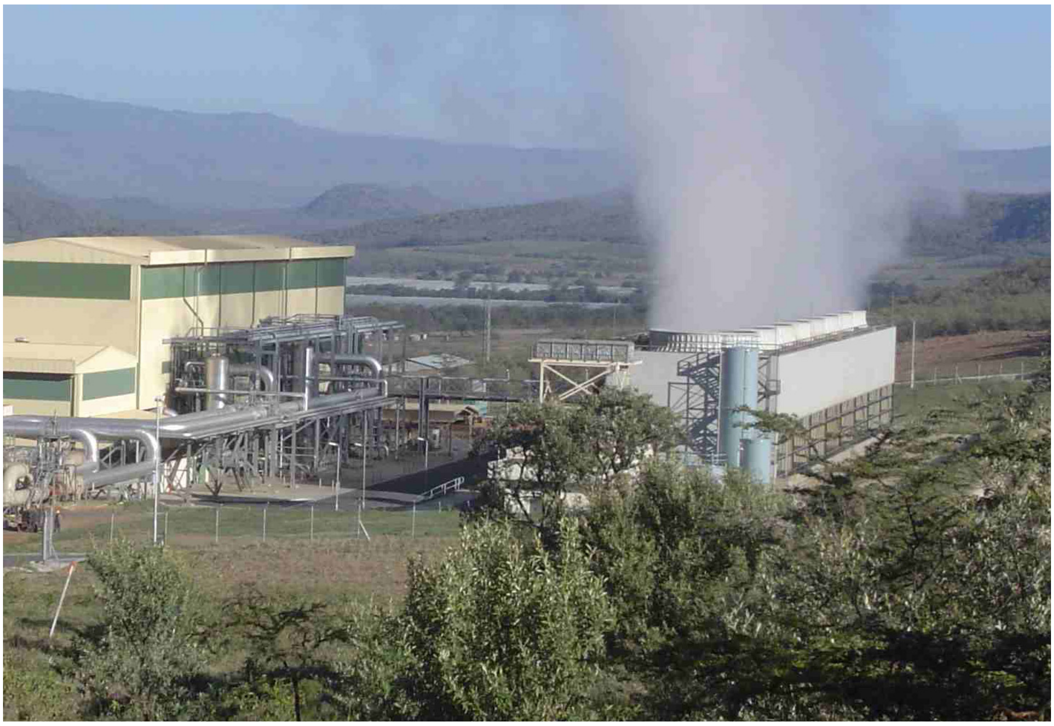

Figure 3.6: A Mechanical Draft Cooling Tower.

3.1.7 OIL SYSTEM

The turbine generator oil system is skid mounted and serves the following purposes:

- To supply lubrication oil for the bearings of the turbines and the generator;
- To supply sealing oil for the mechanical seals of the turbines (ORC); and
- To supply hydraulic oil for the control and governor system (steam turbines).

Each system is equipped with the required oil pumps, filters, coolers, tank(s), control valves, relief valves and instrumentation. Emergency systems are provided to supply the lube and seal oil in case of loss of electrical supply to the main oil pumps.

3.1.8 CONTROL SYSTEM

The central station control system governs the power plant and steamfield operation under all operating conditions. The system controls and monitors the start-up procedure, normal operation, normal and emergency shut-off, protection, alarms and other functions. The controls provide for protection and automatic operation of the plant.

3.1.9 RAW WATER SUPPLY

The requirements for raw water for the power station are limited to fire fighting water, service water for washing and flushing plant during maintenance and filling the cooling tower basin on start up if this technology is used. The largest consumption will be for filling of the cooling tower basin which will require 1200m^3 of water over a 24 hour period. This is expected to occur once every three years. Raw water is supplied to the site from the Tarawera River under existing consents. The project will use the existing raw water infrastructure and consents to supply the power station.

3.1.10 FIRE PROTECTION

A comprehensive fire protection system will be installed at the power station. This will comprise a fire ring main and spray system that covers the physical plant and an inert gas (CO_2, inergen, or similar) discharge system for the control room and building annex. A fire fighting water tank will be required and sized in accordance with NZ Fire Service standards. The system will be independent from the NST fire protection system except for the supply to the fire fighting water tank.

Deluges would be provided for the motive fluid storage and other critical equipment. Monitoring systems associated with the fire protection system would be spaced around the site as required by NZ Fire Service standards.

3.1.11 BUILDINGS

A large portion of the generation equipment will be housed in a turbine hall. This will be constructed to include a control and electrical equipment annex. This room will contain all the electrical switchboards and control system panels required for the operation of the power plant. The building size and layout will depend upon the final equipment selected. A conservative estimate of the building size is up to 50 m in length, 25 m in width and 20 m in height.

A machinery room will also be required to house air compressors, fire pumps, batteries workshops, stores and toilet facilities. The machinery room will be approximately 20m long by 14m wide by 13m high. Dispersed control systems and chemical treatment facilities are likely to be based on pre-assembled containerised designs. It is expected that up to six container buildings may be required, each measuring 2.5m wide by 2.5m high by 12m long.

A photograph of a typical turbine hall is shown in Figure 3.7.

Figure 3.7: Typical Turbine Hall and Ancillary Buildings.

3.2 GEOTHERMAL FLUID GATHERING AND DISPOSAL SYSTEM

The gathering system will use several production well pads connecting the production wells to a separator station located on an existing well pad near the existing steamfield north-east of the mill. The separated brine and condensate will be collected and returned to the reservoir via reinjection well pads. With time and towards the latter stages of the project there will be additional make up wells required. The whole gathering and disposal system is located in a very flat area. The pipelines east of SH34 are in open farmland while those in the mill are in an existing industrial area. Under normal operation there will be no discharges of fluid from the steam lines. Drains will be provided for maintenance purposes, which will only be used infrequently and will discharge to soakage pits or drilling sumps. Figure 3.1 shows the locations of the proposed well-pads and pipeline routes.

3.2.1 WELL HEADS

Each well is contained inside a well cellar (pit) below the well pad level. The wellhead for the Kawerau wells consists of a casing head flange (CHF) with two small (50mm) wing valves. A master valve is bolted on top of the CHF. One wing valve is connected to a pressure gauge used to monitor the well.

A tee piece mounted on top of the master valve connects the well pad branch pipe to the well. On the top of the tee is a well sampling valve for well monitoring. The branch pipe runs from the tee to the ground. A typical production well has an electric motor driven throttling valve and manual isolation valve mounted near the edge of the well pad. A typical reinjection well will have a check valve and isolation valve. Each of the wellheads is guided by a thrust frame to safely take horizontal forces from expansion or earthquake loads. It is anticipated that the well will expand by 100 to 150 mm when the well gets hot.

Each well pad is designed to take a number of wells (4 to 8). They are spaced to allow drilling rigs to move between them during a well work-over (re-conditioning) without having to shut down adjacent wells. The piping arrangement on the well pad will be designed with allowance made for this operation.

Typically a well pad sump is provided on each well pad to accept fluids from wells on bleed, occasional discharge from pipe drains and the storm water drained from the well cellar.

Several well pads are required to accommodate the production wells and reinjection wells for the Kawerau development. The production well pads are located typically in zones where there is an up flow of geothermal fluid and the reinjection well pads are located typically in the outflow region.

3.2.2 PIPELINES

A single two-phase pipeline (with 50mm thick thermal insulation) will connect the production well pad to the separator station and will be routed through the mill's industrial area. The pipelines will generally be 1 m above the ground and will include thermal insulation, drains, vents and control and instrumentation.

The pipelines from the well pads north-east of the mill travel under an existing rail crossing and it is proposed to use the existing stock crossing. The preferred route has the pipelines from the Putauaki area converging at the existing privately owned bridge that crosses over SH34 and will be supported off the bridge. On the mill side of the bridge, the pipelines will run alongside existing roads to the separator station on the airfield. A two phase production line, a brine reinjection line and a condensate reinjection line will also cross the bridge.

3.2.3 SEPARATOR STATION

The two phase lines converge at the separator station and will flow into a vertical separator vessel where the steam is separated from the brine. Steam will flow into the new power plant for electricity generation. The condensate from steam and the spent brine are then pumped to the reinjection wells at the edge of the reservoir. The steam separators will typically be cylindrical vessels with a diameter and height of 3 m and 8 m, respectively.

To provide a constant flow of brine with minimal fluctuation, a brine accumulator may be used to provide buffer storage of brine. This is essentially a large vessel with a volume sufficient to control the brine flow to the brine power plant. The brine accumulators are cylindrical vessels measuring approximately 3 m in diameter and 15 m in length. Figure 3.8 illustrates a typical example of steam separators and brine accumulators.

Figure 3.8: Steam Separators and Brine Accumulators.

3.2.4 THERMAL POND

A holding pond will be provided for emergency fluid dump and will drain brine from process piping and equipment. The collected fluid will be either pumped back into the geothermal resource using the reinjection system or will soak from the pond into the ground.

3.2.5 PIPELINE AND PRESSURE VESSEL CONSTRUCTION

All pressure equipment will comply with the New Zealand Regulations & Construction Code requirements. The pipelines will be designed in accordance with the ASME B31.1 Power Piping Code. Pressure vessels (such as the separators) will be designed in accordance with the ASME VIII Boiler Code. These codes take into account seismic loadings, wind loadings, thermal expansion, corrosion and fluid pressure.

The pipelines are of welded steel construction and are insulated with mineral fibre insulation which is in turn protected by sheet aluminium. The pipelines are supported by steel structures that are cast in concrete foundations. The pipeline route is approximately 7m wide to allow for vehicular traffic and to facilitate routine inspection and maintenance activities. There will be several road /railway crossings.

3.3 RESERVOIR MANAGEMENT STRATEGY

This section outlines agreed strategies to achieve the resource management objectives described in Section 1.3.2.

3.3.1 PRODUCTION

Guiding Principles
Interference between production wells as may occur through increased field production will be minimised through careful selection of production well location. At Kawerau, new production wells will concentrate on the deep reservoir known to exist in greywacke basement rocks to ensure minimal drawdown of shallow thermal aquifers that may otherwise be in communication with cooler groundwater. This will also act to minimise shallow effects such as subsidence and thermal feature changes.

Well Design
Production wells will be designed to optimise the long term energy potential of the resource. New production wells will generally be cased into the greywacke reservoir to avoid communication with shallower aquifers that could lead to contamination of potable water sources or the ingress of cooler fluids to the reservoir.

3.3.2 REINJECTION

Guiding Principles
Reinjection strategies will be designed, modelled and monitored to avoid interference between the production and reinjection zones and to avoid injected fluid breakout to the surface. Reinjection areas will generally be located at the margins of the geothermal reservoir such that pressure support is provided to the productive reservoir whilst minimising the potential for cooling. Targeted reinjection may also be considered as a method of mitigating subsidence originating from compaction in the deep geothermal reservoir, or to manage changes in heat flow to the surface.

Reinjection of all spent geothermal water is also considered the best means of avoiding the unnecessary discharge of heat and other contaminants to the Tarawera River.

Well Design
Wells designed for deep injection will be cased into basement greywacke. Wells designed for targeted reinjection will be cased into competent formations to prevent surface breakout, and be completed so as not to interfere with the producing reservoir.

3.3.3 MONITORING

Reservoir monitoring serves to confirm that actual changes are consistent with predictions and to provide forewarning of any unexpected changes. Monitoring programmes will be designed and reviewed with these purposes in mind. The requirements for monitoring at Kawerau, with its near fifty-year history of geothermal development, are quite different from a green field development. Specific baseline monitoring is not required as the data is available from the existing development.

Production Monitoring

Production monitoring involves the monitoring of parameters, such as flows and temperatures, within the production system. It includes both reservoir specific information and equipment condition monitoring. It comprises recording of wellhead pressures, of production steam and water flows and may include some or all of the following monitoring:
:

- **Production -** Flows from individual wells will be recorded where possible and all the production well flows summed to give the total mass extraction from the reservoir.

- **Reinjection -** Flows to individual wells will be recorded and the flow to all the reinjection wells summed to give the total mass returned to the reservoir.

- **Geochemistry –**
    - Liquid phase analyses of pH, calcium, sodium, potassium, lithium, magnesium, chloride, sulphate, bicarbonate, boron, ammonia, silica, arsenic and hydrogen sulphide to monitor changes in the reservoir characteristics over time.
    - Gas phase analyses of carbon dioxide, hydrogen sulphide, hydrogen, oxygen, nitrogen, methane, ammonia, and argon to monitor changes in the reservoir characteristics over time.

- **Downhole temperature and pressure measurements -** Measurements may be recorded under both static and flowing conditions. Measurements under static conditions will not be possible under production, so these will be done during plant shuts.

- **Go-devil runs -** Determination of scaling rates and locations in production and reinjection wells.

- **Water levels, temperatures and chemistry -** Measurements in specific reservoir monitor wells using existing monitor wells and new wells as required.

- **Tracer tests -** Use of chemical tracers to determine reinjection flow paths and possible returns to production wells.

- **Pressure transient tests -** To record pressures at wellheads or downhole when changes in production rates occur.

- **Well logs -** Logging of well casings to detect corrosion and breaks.

Discharge Monitoring

All significant points of discharge of steam or brine must be monitored. In general the discharges should be measured and recorded continuously. Such discharges include brine dumps and steam vents. Minor discharges, such as pipeline drains that are only used for short periods when the system is started up or shut down, need not be measured as the quantity of fluid discharged at each event can be calculated with reasonable accuracy if required.

Effects on groundwater can be assessed by monitoring specific groundwater wells (10-100 m deep) to measure changes in water levels, temperatures and chemistry.

Surface Features
Monitoring should include periodic surface observations to show whether areas of surface thermal manifestations are expanding, contracting or migrating, and characterisation of surface features to determine long term changes in nature.

Subsidence
A monitoring programme of shallow aquifer pressures and of surface benchmark elevations is required. An extensive network of benchmarks has been established at Kawerau. Presently, the central part of the network is re-surveyed every two years, with a more extensive survey being undertaken every six years. If subsidence is found to be significantly different from current patterns, then surveys should be performed more frequently.

Gravity
Microgravity measurements are a tool for determining changes in mass in the reservoir and hence tracking subterranean movement of fluid. They are useful for tracking movement of injected brine and hence may give a forewarning of incursion into productive zones.

Sharing Of Information
Environmental information gathered as conditions of resource consents will be provided to Environment Bay of Plenty, Whakatane District Council and Kawerau District Council and to other operators on the Kawerau geothermal field.

3.4 HAZARDOUS SUBSTANCES STORAGE

All hazardous substances will be stored within the power plant in site.

Pentane Storage
Pentane is a hydrocarbon, similar to butane or LPG. The pentane storage tank would be designed, manufactured, installed and tested to ASME Boiler and Pressure Vessel Code Section VII Div 1. The storage capacity of the pentane tank would have a volume of approximately 66 m^3 (approx 3 m diameter by 9 m long). The tank would be in a bunded area to contain spillage and will be provided with a fire water spray system.

Ammonia Storage
Ammonia is toxic, corrosive, and ecotoxic and is flammable at certain concentrations. The tank would be designed, manufactured, installed and tested to ASME Boiler and Pressure Vessel Code Section VII Div 1. The storage tank would be approximately 66 m^3 tank (approx 3 m diameter by 9 m long). The area will be within a bund sized to retain the entire contents of the storage vessel. Vents and drains will be piped to a blow down tank where any discharges will be dissolved in water and disposed of off site.

Acid Storage
Acid may be required to reduce the pH of the condensate and brine prior to reinjection to prevent silica deposition. Acid will be either sulphuric or hydrochloric and would be stored in a separate naturally ventilated storage area. The area would be within a bund sized to retain the entire contents of the acid storage vessel.

Caustic Storage

Caustic soda may be required to increase the pH of the cooling water circuit to prevent corrosion and to reduce silica scaling and would be stored in a separate bunded, naturally ventilated storage area. The caustic would be stored in liquid form in two tanks each comprising volumes of approximately $15m^3$. These tanks would be laid on their side and would be approximately 2.5 m diameter and 3.5 m long. The area would be bunded and sized to retain the entire contents of the caustic storage vessel.

Biocide Storage

Biocide may be required for treatment of mechanical draft wet cooling tower water. Biocide would be stored in a separate, naturally ventilated storage area and contained in a $4m^3$ tank. This tank would be laid on its side and would be approximately 1.5 m diameter and 2.5 m long. The area would be within a bund which will be sized to retain the entire contents of the biocide storage vessel.

Dispersant

Dispersant may be required to prevent material collecting in the cooling water circuit. It will also be stored in a $4m^3$ tank in a separate, naturally ventilated storage area in. Again, the tank would be laid on its side and measure approximately 1.5 m in diameter and 2.5 m in length. The area will be within a bund which will be sized to retain the entire contents of the dispersant storage vessel.

3.5 TRANSMISSION LINES

A new 110 kV transmission line approximately 1000 m long will connect the power station to the 110 kV switchgear at Transpower's Kawerau Substation. The line will leave the power station and proceed directly towards SH34 where it will cross the railway line and the road before proceeding south-west adjacent to the eastern SH34 road reserve to the Transpower substation (Figure 3.1).

The line will be constructed using standard Transpower pole configurations and will be designed to comply with all relevant Transpower standards. Each of the conductors for the three phases would be approximately 26mm diameter. An earthwire of approximately 10mm diameter will be installed over the full length of the transmission line to protect adjacent equipment.

Octagonal concrete poles will be used throughout and will typically be 16m high with spans of 160m between poles. Insulators will be the composite post type and will be mounted almost horizontally. Each insulator will be 1200mm long and attached to 2600mm long steel crossarms. The bottom crossarm will typically be 13m above ground, with the second arm positioned 3300mm above the bottom crossarm. A steel post extending some 2600mm above the top of the concrete pole will provide support for the earthwire.

3.6 MANAGEMENT OF PLANT EMISSIONS

Some emissions will be released into the environment during the operation of the proposed power station. While the following provides a brief summary of the typical emissions from the power station, a more thorough description and an assessment of effects of the identified emissions is provided in Sections 7 and 8.

3.6.1 GEOTHERMAL FLUID AND WATER TAKES AND DISCHARGES

Brine

Two phase geothermal fluid will be extracted from the field production wells at an average rate of 45,000 tonnes per day. If air cooled condensers are used for the power plant cooling system the same amount of fluid will be reinjected via the reinjection wells (except for small drain flows and vents to discharge as described in section 3.1.5). If a cooling tower is used for the power plant cooling about 7,500 tonnes per day will be evaporated and the fluid to be reinjected will be reduced accordingly.

Condensate (Cooling water discharge)

Cooling water may have chemicals added such as dispersants, biocides, acid and caustic. In all these cases, these chemicals will be reinjected into the reservoir.

Cooling Water Take

Cooling towers require an initial filling of water which would be undertaken from the NST raw water system supply. The water usage is estimated in section 3.1.9 and will be within the current NST resource consent conditions.

Condensate Traps and Steam Cleaning

The fluid from these drains will comprise small quantities of clean water that will be drained to ground along the steam line between the separator station and the power station.

Brine Dump Water

In situations where the brine needs to be bypassed from the power plant (i.e. plant trip) the brine will be discharged to a thermal pond. From this pond the brine will seep into the ground. This is a geothermal area and the contaminants in the brine (i.e. silica) are common in the area. This pit is expected to be approximately 40 m long by 15 m wide by 1.5 m deep which provides approximately 30 minutes discharge capacity.

Geothermal Fluid Discharge to Well Ponds

Well pad ponds located proximal to the river (<50 m) for inadequate cooling, filtration and dilution to be achieved will be lined. This water will then be pumped to the pad pond located adjacent to the power station. The remaining ponds will not be lined and the geothermal fluid and rain water will infiltrate into the ground through the permeable soils.

Storm Water

Rain water collected from the turbine hall area and sealed roads will be directed to a storm water collection system. This system will be designed to accommodate the maximum storm water influx based on a 50 year average recurrence interval, 12,000m^2 sealed power station area, 37,000m^2 roads and general purpose areas, 48,000m^2 gravelled or grassed area and 13,000m^2 for the storm water management area. The system will also cope with any spillages that may occur through damage to the plant. Storm water run-off from the main power station site will be collected and reticulated to a swale system along the western edge of the plant and diverted to a 3700 m^3 soakage basin as shown in Figure 3.9, the size of which has been determined using High Intensity Rainfall Design (HIRDS) data and a simple spreadsheet based model. The parameters for this modelling are described in the appended Water Management report.

Storm water from the production and reinjection pads will be treated separately due to its distance from the proposed power station area. This storm water will report to the well sumps and soak into ground.

3.6.2 EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION

During construction, there is the potential for sediment to be generated as a result of earthworks. To control this sediment, a number of general and site specific sediment and erosion controls measures will be adopted.

General Sediment and Erosion Control Measures

- Reducing the disturbance to those areas specifically required for access or construction during intense rainfall events;
- Staging of earthworks to keep the area being exposed to a minimum at all times. Exposed areas will be rehabilitated as soon as practical and feasible upon completion of each stage of earthworks to limit erosion;
- Avoidance of sensitive areas such as drainage areas and erosion prone areas where possible and provide a high level of sediment control where construction in these areas cannot be avoided;
- Installation of perimeter controls such as cut-off drains and silt fences to divert run-off from the construction area to sediment control mitigation measures such as sedimentation ponds;
- Continual monitoring of all erosion and sediment control devices;
- Contractors will be required to keep the site as tidy as possible;
- The contractor will apply water to the site to minimise dust and movement of sediment off-site; and
- Contractors will drive vehicles in areas designated for their use to avoid disturbing soils unnecessarily.

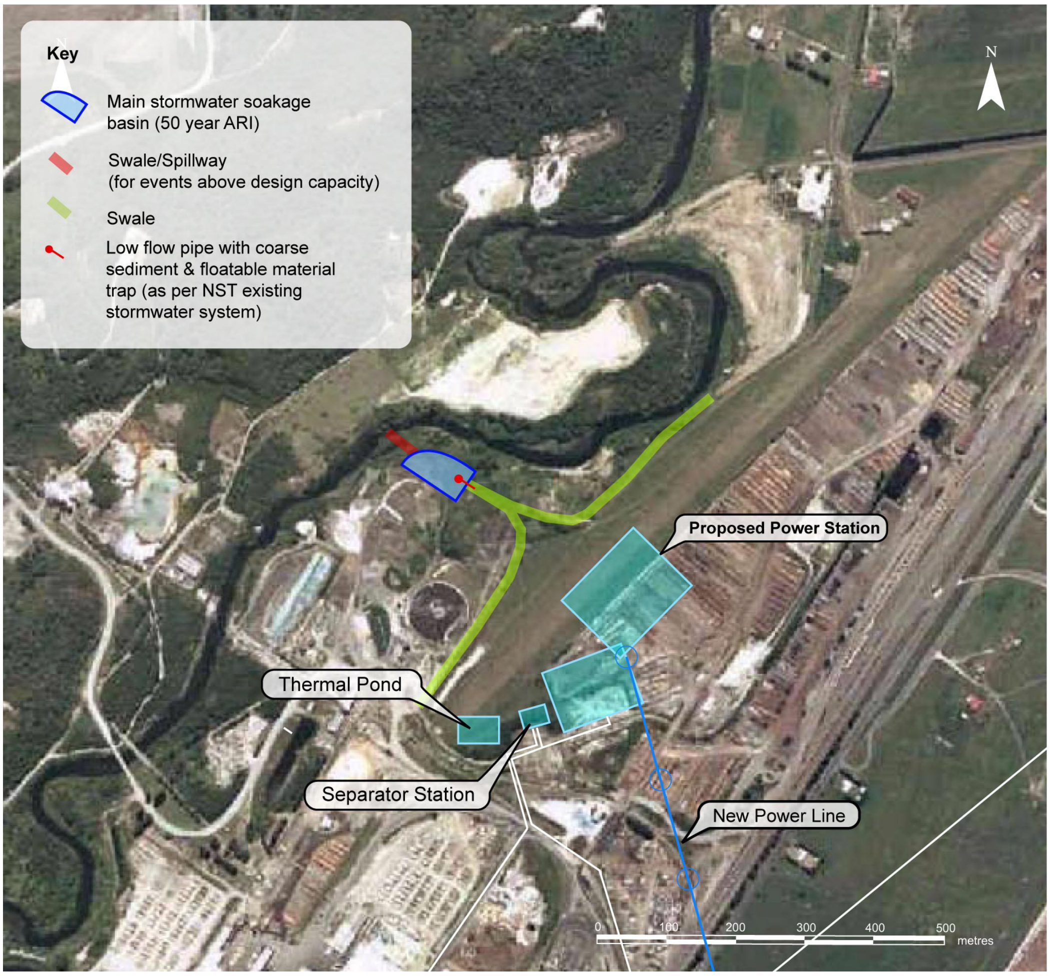

Figure 3.9: Site Storm Water System.

3.6.3 DOMESTIC WASTEWATER

On-site effluent treatment systems will be required for the power station construction, well drilling and on-going power station operations. In each situation proprietary systems will be installed to cater for on-site needs. The construction and well drilling systems will be temporary and removed on the completion of these activities. Resource consents will be sought in accordance with the EBoP On-Site Effluent Treatment Regional Plan.

3.6.4 AIR DISCHARGES

Non Condensable Gas (NCG)

Geothermal fluid contains a small percentage of non-condensable gases primarily $C0_2$, CH_4 (methane), N_2, (nitrogen) and H_2S (hydrogen sulphide). These gases separate from the geothermal steam as it condenses. This gas stream is evacuated from the condenser and vented to atmosphere on top of the air cooled condenser or cooling tower. The hot air from the air cooled condenser or cooling tower dilutes and disperses the non condensable gases.

3.6.5 NOISE

Operating Noise

The major noises from the proposed power plant will be from:

- Start-up and shutdown venting;
- Fin fan air condensers;
- Steam turbine attenuated by the turbine hall building;
- Binary cycle turbine attenuated by an acoustic enclosure; and
- Cooling tower induced draft fans.

Construction Noise

The construction activities that will emit the highest noise levels are the piling and steam blowing during commissioning. These activities will be restricted to times when higher noise levels are permitted if required. All construction activities will comply with NZS 6803:1999 *Acoustics – Construction Noise* which applies to any construction activity that takes place for more than a 20 week period when measured at 1 m from the façade of any dwelling. Table 3.1.sets out the levels in the standard.

Table 3.1: Construction Noise Levels.

Time	Weekdays		Saturdays		Sundays & Public Holidays	
	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
0630-0730	55	75	45	75	45	75
0730-1800	70	85	70	85	55	85
1800-2000	65	80	45	75	45	75
2000-0630	45	75	45	75	45	75

3.7 DRILLING ACTIVITIES

Pre-Drilling Activities

Well drilling sites require a pad to be constructed on which the drilling rig is located. The site for a single well is approximately 100 m by 100 m, with a drilling waste pond approximately 15 m wide constructed along one side. The ponds are typically 4 m deep with a volume of at least 2000 m^3.

Imported material for the sites is usually not required, although a layer of base course may be required to surface the site if in situ material is unsuitable for heavy vehicle movement. Consolidation grouting of the drill pad may be undertaken to strengthen the site. The drill sites cover an area of approximately 7000 m^2 each. Clean storm water from the drill pad would be diverted from the location while any potentially contaminated water from directly around the rig will be directed into the drilling ponds.

Description of Drilling Process

The well is created by drilling a section of hole, then running and cementing a protective steel casing into the hole section to stabilise the hole section and contain well pressures. The next section is drilled with a smaller bit size to the next casing depth and this section is then cased and cemented. The process is repeated using smaller hole and casing sizes to reach the required depth. The final hole section (the "production" hole) has a perforated pipe called a liner run into it to prevent cave-ins with the holes allowing the geothermal fluid to flow into the liner and up the well bore to the surface.

The depths and the sizes of each casing is determined by the final production hole size and depth required, and the geological conditions expected. The first section of casing is likely to be pre-collared to a depth of 15-30 m and will be about 500-760mm in diameter, and the lower section is typically 200-300mm in diameter.

Drilling Method

Drilling with a water-based bentonite mud is the typical drilling method used. The use of drilling mud serves many functions during a drilling operation, including:

- Cleaning the hole and lifting the drilled cuttings to the surface;
- Cooling and lubricating the bit and hole;
- Pressure control to prevent influx of geothermal fluid/gas while drilling;
- Stabilisation to the walls of the drilled hole;
- Reduction in slip velocity of drilled cuttings when circulation of mud has been interrupted; and
- Releasing cuttings at the surface to enable drilling fluid to be recycled.

The drilling muds consist of a suspension of sodium montmorillonite (bentonite) clay and/or polymers in fresh water. The base drilling mud is treated where necessary with chemicals and various natural and synthetic polymers to prevent corrosion, control contaminants and maintain the desired rheological properties. A list of drilling mud additives that would typically be used at Kawerau is shown in Appendix 1.

The mud is fed continuously to the drill bit during drilling and the return flow is processed in the surface storage and treatment system for re-use. This system consists of:

- A series of mud storage tanks;
- A linear motion shakers with fine screens;
- A solids removal system;
- A mud mixing facility which enables the powdered mud additives to be added via a hopper and mixed into a solution and added into the active mud system; and
- A mud cooling tower to remove the heat extracted from the geothermal formations.

As the mud returns to surface, it is passed through the solids removal system that removes the drilled cuttings and solids. The filtered mud then flows though the storage system to be cooled using a cooling tower and treated as necessary with the addition of various viscosity increasing or reducing additives to ensure the mud's properties remain within the design parameters. The mud is then pumped back down the hole to repeat its functions as a drilling fluid.

The drilling cuttings are usually analysed by a geologist to help gain a better understanding of the formations that have been drilled and thus of the geothermal field itself. Drilling fluids require relatively high pH to prevent drill pipe corrosion and to enhance the performance of some drilling mud additives, and sodium hydroxide is often used for this purpose. Most other constituents in the mud that may include lignites and various polymers are thermally degradable or biodegradable.

Well Cementing

Cementing is used to consolidate the surface formation at the drill site, to securely anchor the well casings into the ground and to seal off unwanted permeable zones when met in the course of drilling. In cementing casings, the objective is to provide a complete fill-up of cement in the casing hole annulus and anchor the casings firmly to the ground and to each other. The hardened cement sheath protects the casing against possible corrosion by geothermal fluids and gases and prevents the uncontrolled flow of geothermal water and steam up the outside of the casing.

The cement that would typically be used at Kawerau is Portland Cement with the addition of various additives to control the setting time, the fluid loss and the pumpability of the cement slurries. These additives form less than 1% by weight of the cement and all have low toxicity values.

The Code of Practice for Deep Geothermal Drilling (NZS 2403:1991) requires that the cementing operations are undertaken to high technical standards. Generous quantities of cement slurries are used to ensure thorough sealing of the annulus between casings and formations. The majority of the cement slurry is displaced from inside the casing during the cementing operation, leaving only a few cubic m of "green" cement to be drilled from the casing after completion of the cementing.

Water Drilling

It is normal practice to use water or aerated water as the drilling fluid when drilling in the production zone of a geothermal reservoir as continuing to drill with mud in this section of the well could seal off permeable strata and damage the well's future productivity. Small quantities of polymer are sometimes added to the water periodically to assist in wiping the hole and reducing cutting build up. Also, fixed volumes of mud (between 1,000-5,000 litres), called "sweeps" may be required to be pumped periodically when drilling with water to help clear the cuttings away from the bit.

Some or all of this water may be lost to the geological formations depending on the permeability of the well. Such losses indicate that fractured or permeable formations have been encountered and it is these loss zones that ultimately produce geothermal fluid for production.

Well Measurements during Drilling

Information is collected during drilling that is essential for understanding the subsurface geological structure and distribution of geothermal activity. During well drilling, there will be comprehensive geological and alteration mineralogy logging utilising the cuttings and cores returned to the surface in conjunction with drilling parameters.

Well Completion and Discharge Testing

Well completion tests, monitoring of well heating after drilling, and discharge tests are all necessary to provide key data upon which the geothermal reservoir capacity and viability of the geothermal development is assessed.

Well completion tests are usually performed while the drilling rig is still positioned over the completed well. The drilling rig pumps are used to perform a water loss survey and injection tests at several different flow rates. Downhole pressures are monitored during injection, and a spinner flow meter will be run to determine the depths of permeable zones where fluid is being injected.

Following the completion testing, the well is left to heat for several weeks and the rate of temperature build-up is monitored by periodically running temperature and pressure logs during the heat-up period. When the well is heated, several discharge tests are made. The first well discharge will last a few hours allowing the well to discharge vertically direct to atmosphere through a short stand pipe mounted on the wellhead valve. This discharge will clear the well of any rock cuttings remaining after drilling. Preliminary measurements of well productivity and chemistry can be made during the discharge.

A longer discharge test period of between 2 and 4 weeks will be used to obtain a more reliable estimate of well productivity and chemistry. Long flow periods are necessary to test the well at several operating conditions and also to assess the stability of the discharge. This test will utilise a well test separator that separates the steam and liquid water components of the discharge. The steam vapour will be discharged to the atmosphere. The majority of the water component will be discharged to underground strata by reinjection, although some will be stored and/or lost via soakage in the drill ponds. The underground reinjection will utilise one of the exploration wells drilled for this project, or a purpose built well dedicated for reinjection, depending on the results obtained from the drilling.

The total mass extracted during such tests will depend on the well productivity. Similarly, the relative flows of steam and liquid will depend on the enthalpy of the discharge fluid. It is not possible to know these parameters in advance of the well tests, so application for fluid take and discharge is made based on assumed upper limits expected for each parameter. The actual flows and energy of fluid take and discharge for this testing should be less than applied for, and in total less than 15% of the flow rates that would be applied for in any energy development on this project. Regardless, the duration of the flows is limited and therefore any potential effects on the reservoir will be no more than minor.

3.8 CONSTRUCTION

3.8.1 CONSTRUCTION TRAFFIC

Scope of Works

Mighty River Power intends to commence construction of the project in early 2006, subject to receiving resource consent. The plant is expected to become fully operational by late 2007 or early 2008. Construction involves eight stages and includes site clearance, excavation and the construction of the new power plant.

During construction it is proposed that truck access to the site will be gained from the highway using the NST over bridge. This roadway provides an appropriate standard of access / egress to meet expected demands.

It is intended that all parking demands created by construction and sub-contractor vehicles be accommodated wholly on-site. It is expected that the project will employ up to 100 people during construction.

Staging of Work

The project consists of eight key stages. Table 3.2 summarises the staging of works, including the peak number of truck movements expected during the defined periods.

The project plant items, including over-dimension loads such as turbines will be treated as special cases and delivered on appropriately designed vehicles. Specific permits will be necessary once the particulars of the load and intended routes are defined.

Table 3.2: Staging of the Works and Truck Numbers.

Stage	Activities	Hours of Operation	Length of Works	Expected Number of Trucks per Stage	Expected Number of Trucks Per Day (average)	Expected Peak Truck Movements per Hour (two way)
1	Establishment and Site Clearance	7am-7pm	2 Weeks	40	4	2
2	Earthworks	7am-7pm	2 Months	640	16	4
3	Foundations – Concrete	7am-7pm	2 Months	340	9	8
4	Support Structures	7am-7pm	3 Months	180	3	2
5	Plant Installation	7am-7pm	7 Months	200	2	1
6	Testing & Commissioning	7am-7pm	2 Months	0	0	0
7	Performance Acceptance Tests	24 hrs	2 Weeks	0	0	0
8	Disestablishment and Clean Up	7am-7pm	2 Weeks	20	2	1

Vehicular Movements to and from the Site

At some stages during construction, up to 100 personnel may be employed at the construction site, contributing to approximately 1500 truck visits. This will vary depending on the commitments required of the various staging of works. The most intensive period of work will be during the construction of foundations, which will generate up to 120 vehicles per day with staff generating approximately 200 vehicles per day. The majority of vehicles are expected to arrive in the morning peak period 6:00 - 8:00 am. The existing main roadway is considered sufficient to accommodate the additional trips.

Following construction, regular traffic to the site will be generated by maintenance and operational staff and the occasional delivery. It is expected that the number of vehicle movements on or off the site each day will not exceed 15 vehicles per day. Periodic maintenance of the power station will also generate a small level of heavy traffic from time to time.

Parking

Workers and sub-contractors shall be required to park on-site during all stages of construction. Parking shall be maintained entirely clear of adjacent roadways and visibility sight lines, and shall be dedicated within the existing and newly formed site parking areas.

4 ECONOMIC BENEFITS OF THE KAWERAU GEOTHERMAL PROJECT

4.1 THE IMPORTANCE OF ELECTRICITY TO THE NEW ZEALAND ECONOMY

Electricity is a critical element in our daily lives. In New Zealand, electricity currently accounts for over 25% of annual energy end use consumption and almost half of all non-transport related energy consumption. Economic growth and electricity demand are inter-related. In coming decades, if New Zealanders wish to grow their standard of living and by implication real GDP per capita, continuing investment in electricity generation will be required. If these investments are constrained to higher cost options, this will have adverse economic implications.

Internationally, New Zealand has been fortunate to have enjoyed comparatively low electricity prices due to our large historical hydro supply base and the large and flexible Maui gas field. Low prices have provided corresponding social and economic benefits and have been a significant source of competitive advantage for the economy relative to our trading partners.

However, the outlook for electricity supply is changing. While the electricity bills for New Zealand households and businesses remain significantly lower than average international electricity supply prices, the direct advantages previously enjoyed by industry, commerce and families relative to many countries are under pressure as prices rise relative to other countries. Utilisation of lowest cost development options (such as the Kawerau geothermal project) is critical to maintain downward pressure on electricity prices.

4.1.1 KYOTO COMMITMENTS

In order to meet its Kyoto commitments, New Zealand will need to reduce its aggregate greenhouse gas emissions in the face of continued growth in the demand for energy.

In any event, the country will have ongoing dependence on reliable base load generation such as geothermal. This will be an important feature of New Zealand's electricity system for the foreseeable future. In addition to contributing to demand growth, these technologies will also be needed to ensure that the supply system can respond effectively to the uncertainty of other renewable supplies such as hydro and wind.

Geothermal energy is a low carbon, consistent supply, renewable energy source that has lower than average carbon emissions when compared with the national grid average emissions.

4.1.2 ELECTRICITY DEMAND TRENDS

Since 1980, electricity demand growth has averaged approximately 2.5% per year. Total annual demand for electricity in New Zealand is approximately 40,000 GWh. All realistic forecasts for the period through to 2025 are for sustained electricity demand growth of around 2.0% pa. Almost 9,000 GWh pa of new generation will be required over the next 10 years. That is roughly equivalent to 1.5 new Huntly power stations, more than 3.5 times the total production from New Zealand's existing geothermal power stations, or around 25 times the expected annual supply from New Zealand's largest wind farm (Te Apiti) in the Manawatu region.

4.1.3 SUMMARY

There is no one solution for meeting New Zealand's electricity demand growth, and all fuels should be considered. In the short to medium term, economic renewable options are likely to be the key contributor to satisfying demand growth. In the medium to long term, demand growth may need to be met by thermal fuels. To the extent that the development of otherwise economic supply options is constrained, more expensive alternatives will be required, imposing additional economic burdens.

4.2 SIGNIFICANCE OF ELECTRICITY GENERATION IN THE BAY OF PLENTY

There are a range of national and regional benefits that can be identified from the proposed Kawerau geothermal power station. The nominal 70 MW station would generate around 580 GWh of electricity annually (equivalent to 1.5% of current national electricity demand). As the Kawerau proposal operates as a baseload station, the energy generated per MW of capacity is high. From 70 MW of capacity it will produce the same amount of electricity as a 160 MW wind farm, roughly the level of existing installed wind farm capacity in New Zealand, or a 120 MW hydro power station. From a regional perspective, the electricity contribution of the station would result in locally generated electricity being increased from an existing 26% to 60% based on a current regional consumption of 1800 GWh/annum (Figure 4.1).

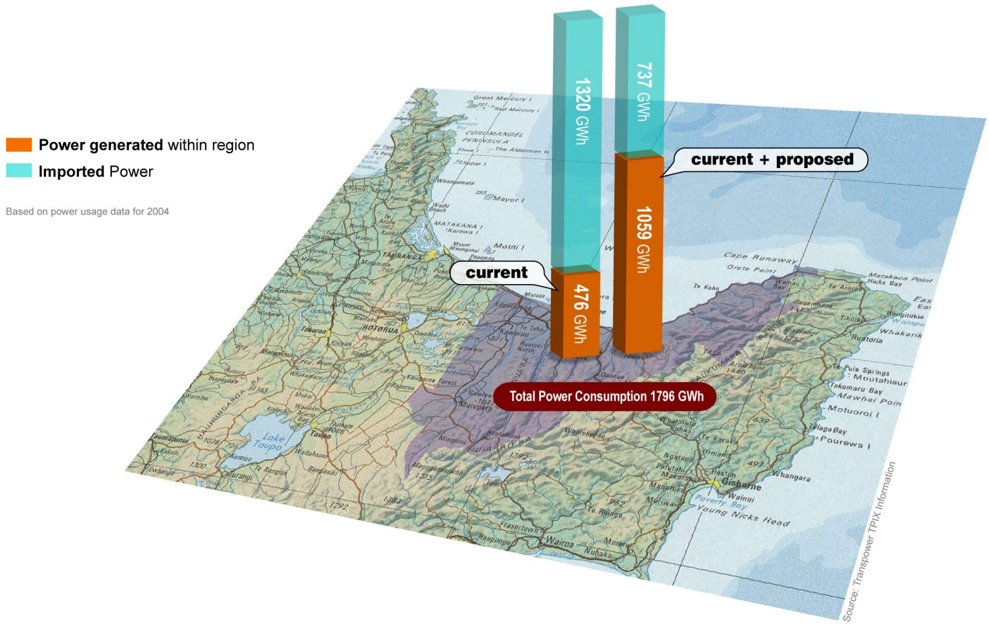

Figure 4.1: Power Generation and Consumption in Eastern Bay of Plenty.

4.2.1 GREENHOUSE GAS EMISSIONS BENEFITS

Although geothermal power stations emit some greenhouse gases, the level is significantly less than the national grid average. Table 4.1 compares emission rates from thermal power stations to expected emission rates from the Kawerau project. This project would avoid around 240,000 tonnes of carbon dioxide annually when compared with the average national grid emission levels.

Avoidable emissions can be considered in terms of physical contribution to New Zealand's Kyoto commitments. Thermal electricity generation currently accounts for around 21% of energy sector emissions. Relative to 1990 levels, annual emissions from thermal generation have grown by around 2.5 million tonnes. Avoidance of CO_2 emissions due to the proposed Kawerau project would equate to around 13% of the increase since 1990.

Table 4.1: Typical Power Station Carbon Dioxide Emission Factors.

Technology	Kawerau Geothermal	National Grid Average[3]	Combined Cycle Gas Turbine[4]	Open Cycle Gas Turbine[5]		Steam Thermal[6]		
Fuel			Gas	Gas	Oil	Gas	Coal	Oil
Tonnes/ GWh	210	625	370	570	710	530	930	820

3 *This average takes into account the 60 – 65% of electricity generation that emits no CO_2*

4 *Modern high efficiency gas powered generators like Contact Energy's Otahuhu and Stratford power stations.*

Using the international price of traded carbon credits/permits, it is possible to calculate the value to the NZ economy of the avoided emissions as a result of individual projects.

With the proposed carbon tax value of $15 per tonne, the value of carbon emissions avoided annually as a result of the Kawerau project would be approximately $3.6m. Assuming a conservative 20 year project life, that would represent a potential value to the New Zealand economy of the order of $32m[7] in today's dollars.

4.2.2 TRANSMISSION LOSS BENEFITS

Transmission losses occur when electricity is transmitted from one location to another. In the New Zealand electricity market these losses are signalled directly via electricity prices (nodal pricing). Spot prices at Kawerau are typically higher than at many other locations in the country indicating that the Bay of Plenty is a net importer of electricity. As such, transmission losses could be reduced if more supply were available at Kawerau. Each GWh of losses avoided means a GWh of supply can be avoided.

For the proposed additional supply at Kawerau, assuming 580 GWh annually, and noting that electricity typically flows from south to north, 26 GWh of Transpower transmission line losses could be avoided annually. Assuming a long run supply cost of 6c to 7c/kWh, savings to the Kawerau region would equate to approximately $1.7m annually through lower wholesale prices.

4.2.3 SUPPLY SECURITY AND COST BENEFITS TO KAWERAU

Transmission circuits importing electricity into the eastern Bay of Plenty region can at times be constrained (approaching or reaching physical capacity limits). The addition of new supply in the Kawerau region will significantly reduce these problems, increasing security of supply to all consumers in the region. In addition, this new regional generation capacity will allow growth in the local economy and in electricity demand without the need for new transmission capacity. The geothermal project will supply energy equivalent to 15 years regional growth based on recent economic trends.

The NST mill at Kawerau provides an illustration of the benefits that will accrue to local industry. NST is a large exporter, supplying a third of Australia's newsprint requirements. It also exports to other markets in Asia and the South Pacific. The mill supplies all of New Zealand's domestic newsprint requirements making the country self sufficient in this commodity.

NST has estimated through economic impact studies that from a national perspective, around five times the number of employees at its Kawerau site (700) depend on the

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5 *Lower efficiency oil or gas fuelled power stations that are low in capital cost but expensive to run. For example, the Whirinaki plant purchased by Government in 2004 for dry year reserve energy purposes.*

6 *Conventional coal, gas or oil fired steam boiler based technologies (for example, Huntly and New Plymouth power stations).*

7 *In other words, the projected value accumulated over a twenty year period (a conservative plant life estimate) expressed in today's dollars using a discount rate of 10% (consistent with rates used by governments for cash flow projection purposes).*

continued viability of the mill. This would suggest that the mill contributes directly and indirectly to the employment of around 3,500 full time persons with wages and salaries of the order of $150 m per annum.

NST has in the past expressed concerns about the need for secure and cost effective electricity supply[8]. While other factors will also influence its ongoing viability, electricity supply accounts for around 25% of the mill's costs. In addition to the physical security that NST and other industry will receive from the project, agreements associated with this project will provide NST with a degree of price certainty for an extended period of time.

4.2.4 CONSTRUCTION AND OPERATIONAL EMPLOYMENT

Direct local benefits can be expected during both the construction of the project and throughout its operating life. While a significant amount of large electrical and mechanical equipment is likely to be imported if the project proceeds, its construction would contribute directly to the local economy through opportunities for direct project employment, contracting, support services and the like. Up to 100 people would be involved directly in construction. Around 10 full time persons would be employed to operate the power station following construction, with other service providers contracted to undertake maintenance activities. Periodic geothermal well drilling activity will also provide employment and other opportunities for local service providers.

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[8] *For example, a submission from Norske Skog Tasman to Hon. Pete Hodgson, Minister of Energy, in relation to the electricity review following the dry winter of 2001.*

5 CULTURAL MATTERS

5.1 HISTORICAL BACKGROUND

The Bay of Plenty region has been continuously occupied since the arrival of the great waka between 500 and 1000 years ago. Two waka most commonly associated with the eastern Bay of Plenty are Mataatua and Te Arawa. Maori land confiscation in the Bay of Plenty region has resulted in Treaty claims and cross claims within the Bay of Plenty. Both Ngati Tuwharetoa (Bay of Plenty) and Ngati Awa iwi have reached settlement, whilst other iwi claims in the Bay of Plenty are outstanding. In its settlement agreement with the Crown, the Ngati Tuwharetoa (Bay of Plenty) Settlement Trust has statutory acknowledgement around its relationship with the Kawerau geothermal resource.

5.2 CULTURAL HERITAGE

Heritage can refer to a place or feature of special significance for spiritual and cultural reasons. Cultural heritage resources of tangata whenua are considered to be taonga. The Bay of Plenty region has a wealth of places of cultural heritage significance including numerous sites associated with human occupation such as pa sites and waahi tapu. The region's diverse natural features and landscapes are also part of its cultural heritage and are strongly influenced by water and geothermal resources. Some landscape features and ecological features, which are associated with the region's geothermal resources, are recognised as being of cultural significance. It is therefore appropriate to identify sites or features of cultural significance and to recognise the important heritage values associated by tangata whenua with these sites and features. Mighty River Power is working with tangata whenua to better understand and be sensitive to these areas of cultural significance.

5.3 POTENTIAL CULTURAL EFFECTS

Tangata whenua are kaitiaki of their resources. Inappropriate land uses and adverse effects upon Maori cultural heritage are a concern to tangata whenua who wish to be consulted and heard with regards to their concerns. As further discussed in Section 9 of this document, Mighty River Power will continue to consult with iwi representatives and Maori land owners in order to identify places, values and relationships of significance to tangata whenua to assist Mighty River Power to identify methods to mitigate, avoid or remedy adverse environmental effects resulting from the establishment of the proposed power station.

5.3.1 PROTECTION OF GEOTHERMAL RESOURCES

Geothermally active areas are usually notable for their surface features. In Kawerau, as in Rotorua, Wairakei and Ngawha the geothermal resource is manifested in surface features such as hot pools and geysers. These are valued as taonga for tangata whenua and it is told that they were gifted by the atua (god), Ruaumoko. Tangata whenua retain a strong sense of history, well-being and identity due to their cultural connection with the geothermal resource. For example, it is told that shortly after his birth, Tuwharetoa was left in the care of his grandparents at the kainga besides Lake Rotoitipaku. The warm spring that fed the lake was used to calm the infant when he was crying for his mother's milk, and hence the spring's name of Te Wai U o Tuwharetoa (the breast milk of Tuwharetoa).

Tangata whenua are kaitiaki of this geothermal resource, which is a taonga of great significance to them. Tangata whenua strongly assert the necessity to protect significant natural geothermal surface features from inappropriate use and development. Section 6 of this report also demonstrates that the use, development and protection of the region's geothermal resources will be managed in a safe and sustainable manner, thus ensuring the protection of geothermal taonga for future generations. In particular:

- The further development of the field is to be undertaken pursuant to a steamfield management plan, which has goals of sustainable and efficient development of the geothermal resource;
- Reinjection of the geothermal take is proposed to mitigate the effects of abstraction so that at the end of the power station lifetime at 2050, the field will remain available for future generations;
- The extent of subsidence will have only negligible effects on the area's infrastructure and plant;
- The proposed development adopts accepted practices of hazard avoidance; and
- There will be no significant effects on existing geothermal features and ecosystems.

5.3.2 WATER QUALITY

Another cultural issue facing tangata whenua in the region is the degradation of mauri in water bodies. Essentially, water provides Maori with food and spiritual resources which are directly affected by water abstractions and discharges. Tangata whenua believe that the use and cultural values of the Tarawera River has been adversely affected by contaminant discharges. While this remains the situation today, it is apparent that many contaminant discharges are better controlled now than in the past. Tangata whenua do not accept that their waterways should be used to transport or treat contaminants and in particular human and industrial waste. However Ngati Tuwharetoa (Bay of Plenty) regard some discharge of geothermal water into the Tarawera River as 'natural' as many of the hot springs that used to flow into the river have been lost as the result of land use changes and the development of the geothermal field.

With respect to the proposed power station and as discussed in Section 7 of this report, the proposed power station has no direct effect on the Tarawera River or other surface water body through takes or discharges. In addition, storm water discharges, geothermal fluids and other wastes in well pad ponds and the accidental discharges into the Tarawera River during cases of extreme rainfalls will be managed so as to avoid or minimise any adverse effects on both ground and surface waters. On this basis Mighty River Power has sought to avoid the degradation of mauri in water bodies and as a consequence there will be no adverse effects on the cultural and spiritual values of tangata whenua of the region with respect to in-stream water quality.

5.3.3 PROTECTION OF OTHER CULTURAL HERITAGE ITEMS

As discussed further in Section 5.4, Part II of the RMA identifies matters of national importance, places a responsibility on decision-makers to recognise and provide, for the protection of heritage sites and features, and the relationship of Maori and their culture and traditions with their ancestral lands, waters, waahi tapu, sites and other taonga. These sites and features include marae, urupa and other waahi tapu which connect tangata whenua with its past. It has been made clear that the removal or destruction of waahi tapu is not acceptable to tangata whenua.

District Plans are one mechanism by which to protect cultural heritage, which can be adversely affected by activities. For example, sites of particular cultural heritage value have been scheduled for protection in consultation with iwi and are identified within the District Plan so resource users can take into account any effects on these places that may arise from activities. However Mighty River Power acknowledges that not all places of significance to tangata whenua are identified in district plans. Mighty River Power has consulted and will continue to seek the assistance of the Ngati Tuwharetoa (Bay of Plenty) Settlement Trust, NTGA Ltd, Ngati Awa, the Putauaki Trust and other Maori land owners to ensure that appropriate protections are in place.

Kawerau District

The Kawerau District Plan contains a schedule of heritage items that are of cultural significance to Maori. In assessing the environmental effects of the proposed power station, consideration was given to items of cultural significance within the Kawerau District.

In undertaking the AEE, consideration has also been given to the adverse effects on Parimahana Scenic Reserve with respect to ecology as the reserve contains flora that establishes in areas of geothermal activity due to soil temperature. Effects on plant ecology are particularly important when considering geothermal extraction, especially since the Kawerau steamfield underlies the Parimahana Scenic Reserve. Should the cooling of the soil be significant, this would be likely to change the flora of these areas.

The findings of the independent study conducted by GNS have confirmed the net withdrawal and reinjection of steam and water from the Kawerau geothermal field by the mill over the past 15 years has produced negligible long-term pressure changes at production depths in the field. Further, changes to heated ground, such as that which supports geothermal vegetation in Parimahana Scenic Reserve can occur naturally in response to changes in subsurface hydrology. Based on these findings, the assessment of ecological effects in Section 7 of this report has concluded that effects on geothermal vegetation at Parimahana Reserve should be negligible. On this basis, the geothermal vegetation of the reserve will not be affected by any more than a minor degree, thus ensuring the protection of this culturally significant site for future generations.

While there are no scheduled heritage sites in the Kawerau District that will be destroyed or altered in any manner as a result of the construction or operation of the proposed power station, Mighty River Power has also undertaken to consult with local iwi/hapu in respect of any taonga which is not identified in the District Plan to ensure suitable protection is afforded where appropriate.

Whakatane District

Similarly, Whakatane District includes a unique number of places of cultural heritage value relating to Maori, which have been identified for protection and considered in this AEE. The physical signs of a long history of occupation such as pa sites, urupa and middens are generally found around the banks of the Tarawera River and the coast line. As with the Kawerau District, significant resource management issues for tangata whenua in Whakatane relate to the loss or destruction of cultural heritage features. Consequently, perpetual protection of areas of cultural heritage value from inappropriate development is sought.

As noted above, Putauaki is a taonga with the location of burial sites for iwi. Figure 5.1 depicts the burial reserve and the relationship between the maunga and the mill area. It is clear that the proposed power station has no direct effect on Putauaki. However, in recognition of its status the visual effects assessment (Section 8) has taken into account any potential interruption of local views to the maunga. The assessment concluded that while the power station created additional industrial structures in the mill locality, these had no effect on the visual connection to Putauaki.

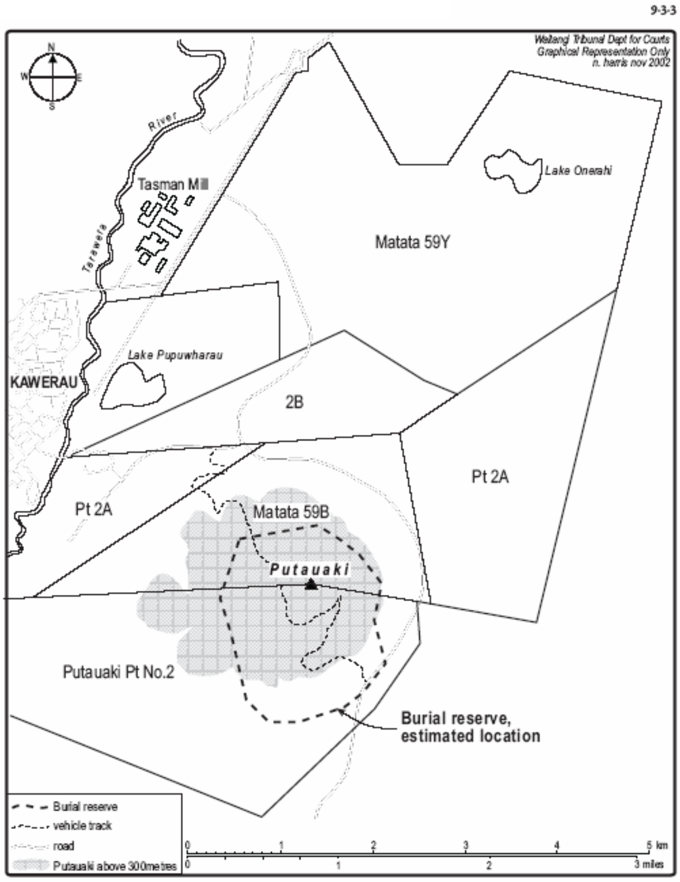


Figure 5.1: Putauaki Maunga

In summary, the proposed power station will not result in the modification of any scheduled sites or features within the Whakatane District. Mighty River Power has also undertaken to consult with tangata whenua in order to identify other items of cultural significance in order that protection can be afforded where appropriate.

5.4 RESOURCE MANAGEMENT ACT

In achieving the purpose of the RMA, resource users have a positive obligation under section 6(e) to recognise and provide for the protection of ancestral land, water, sites, waahi tapu (sacred sites) and other taonga (treasure). In addition, section 7(a) of the RMA requires that particular regard be given to kaitiakitanga to manage the use, development and protection of natural and physical resources. Furthermore, under section 8 of the RMA, there is a fundamental requirement to take into account the principles of the Treaty of Waitangi. Some well established principles of the Treaty include consultation and shared decision making. Consultation should be ongoing and in accordance with tikanga Maori and provision should be made for the participation of tangata whenua in decision making.

Section 1 of this AEE has described the direct involvement of both Ngati Tuwharetoa Geothermal Assets Ltd and Putauaki Trust interests in the power station and through consultation and joint decision making, Mighty River Power have reached agreement with these parties on the project with respect to recognising cultural interests in Kawerau's geothermal and water resources and other items of cultural significance. This cultural assessment has also identified sites and features of cultural significance, and potential adverse effects on these sites and features have been assessed in relation to the proposed power station.

Mighty River Power therefore considers that it has recognised the matters of national importance in section 6(e) of the RMA particularly as they have sought to protect taonga. For example, there will be no contaminated discharges that will affect the geothermal resource, the mauri of water bodies and the proposal is not considered to have any adverse effect on the relationship of Maori with other matters of cultural heritage. Regard has also be had to tangata whenua's kaitiaki status in section 7(a) and Mighty River Power has taken Treaty of Waitangi principles into account in accordance with section 8 of the RMA, by undertaking to consult with the iwi/hapu of the region. Overall therefore, it is considered that Mighty River Power has fulfilled its obligations under section 6(e), 7(a) and 8 of the RMA.

6 EFFECTS ON THE GEOTHERMAL RESOURCE AND SUBSIDENCE

Increased production from the Kawerau geothermal reservoir will have effects on both reservoir temperatures and pressures and cause some low levels of subsidence. Section 2.5 describes the historical subsidence levels observed at Kawerau which has been monitored since 1976. This measured subsidence has been characterised as a field-wide subsidence bowl, centred 1km to the north west of the Tasman site. Geothermal abstraction may also affect the seismicity of the Kawerau area.

Mighty River Power has commissioned Industrial Research Limited (IRL) to model the effect of increased geothermal take at Kawerau. The full report is titled *Production Scenarios on the Kawerau Geothermal Field*, Industrial Research Limited, 2005. Mighty River has commissioned a further report on subsidence, titled *Subsidence Interpretation*, by Geothermal Engineering Limited, 2005. A report by GNS, titled *Induced Seismicity at Kawerau*, July 2005, has also been prepared. All reports are included on the attached CD-ROM and form part of this AEE

6.1 RESERVOIR AND SUBSIDENCE MODELLING

The modelling exercise employed an existing IRL simulation model for predicting the change in reservoir temperatures and pressures, and Geertsma's "buried disk" model to predict subsidence. Changes in pressure result in compaction of subsurface material within the reservoir. The compacting rocks are modelled as a subsurface disk and subsidence at any distance from the centre of the disk can then be calculated based on the geometry of the disk.

The levelling data from the period 1970-1982 and the modelled pressure drawdown data were used to calibrate the Geertsma disk model and to calculate a compaction constant (the relationship between pressure change and compaction). For this period the buried disk was determined to be of radius 1.75 km, at a depth of about 600 m and the compaction constant was estimated to be in the range of 250 to 400 mm/bar[9]. Figure 6.1 depicts the buried disk underlying the geothermal field, centred to the north west of the Tasman site.

The same method was employed using the more recent levelling data from the period 1982 to 2005. The model is similar to that used for previous predictions of temperature, pressure and subsidence for geothermal development in Kawerau and will be familiar to Environment Bay of Plenty.

The predicted model subsidence rates and tilt rates are generally similar to the values which have been measured in successive levelling surveys over the past 33 years. The

[9] The square brackets indicate an estimated value of 300 mm/bar with upper bound 400 mm/bar.

validation of the subsidence model provided by these results suggests that it may be used with some confidence to predict the subsidence response to future production from the Kawerau geothermal field.

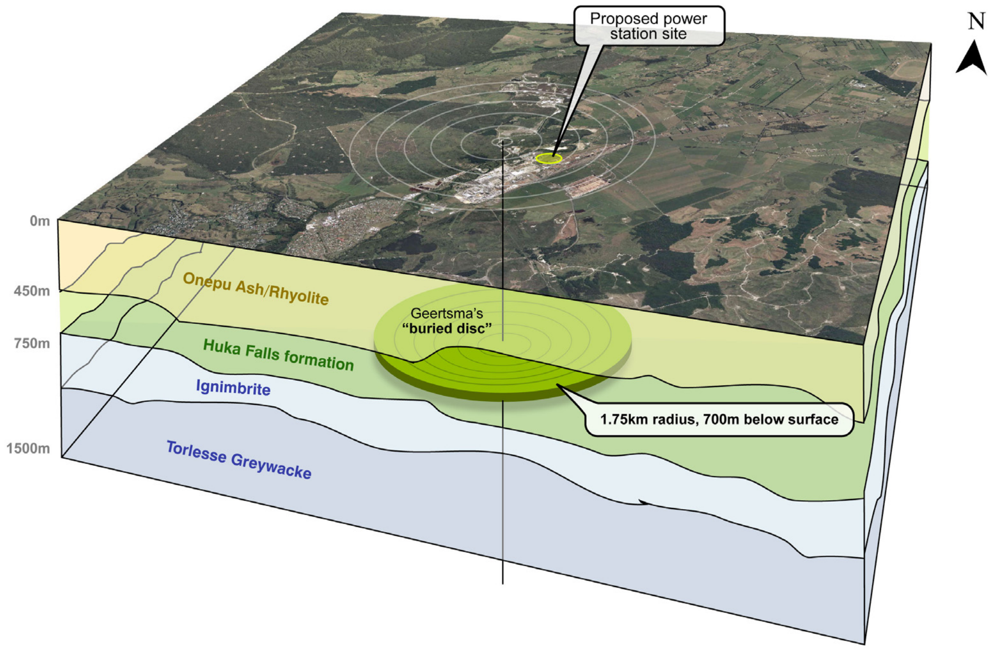


Figure 6.1: Diagram of Geertsma's "Buried" Disk Underlying the Kawerau Geothermal Field.

6.1.1 SCENARIOS MODELLED

The production scenario modelled assumes that the new Mighty River Power production wells increase the fluid production from the reservoir by an average of 45,000 t/d. All of the spent geothermal fluid is reinjected. The consented takes of up to 44,400 t/d by NGTA and up to 5,280 t/d by OEC are assumed to be fully exercised. All of the OEC fluid is reinjected and 50% of the NGTA fluid is reinjected (which reflects the existing resource consent requirements).

6.2 PRODUCTION SCENARIO RESULTS

The model simulated pressure and temperature responses and the associated computed subsidence give an indication of the likely impacts of producing/reinjecting an additional 45,000 t/d. The scenario has been modelled for 45 years (2005-2050) which is considered to be a reasonable period for the predictive range of the model.

6.2.1 TEMPERATURE & PRESSURE CHANGES

The modelled temperature drops at the production wells are similar in magnitude to those already experienced in the historical period with the most affected wells showing a slow decline of about 1°C per year between 2005 and 2050. At the final (2050) temperatures, these wells are still expected to be viable as production wells. Figure 6.2 depicts the temperature drawdown contours in the production area at a depth of 1375 m for the period 2005 to 2050. The cooling in the most affected wells is probably due to reinjection returns.

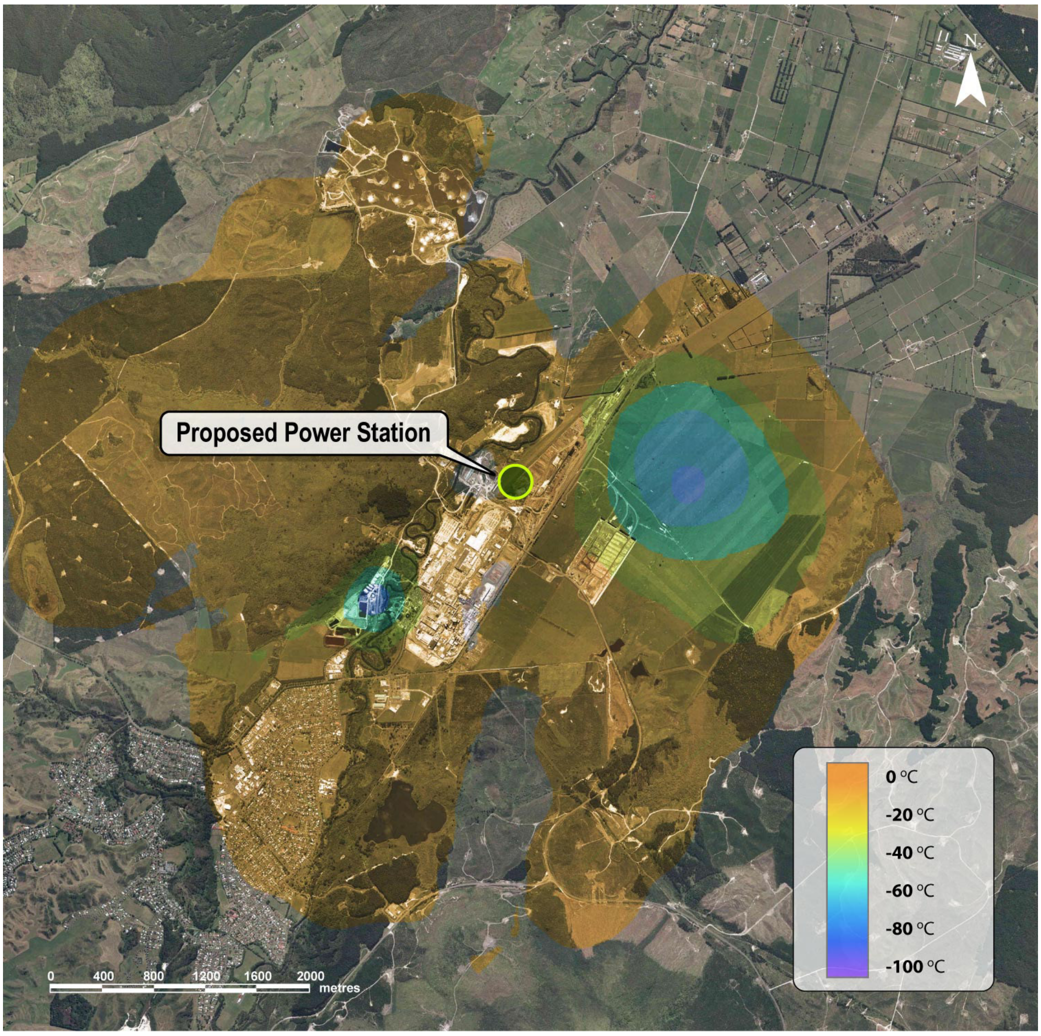


Figure 6.2: Predicted Temperature Drawdown in Production Area at 1375 m depth (2005-2050)

Similarly, few wells show any pressure decline. At the new production wells, pressures generally fall with production onset with the greatest modelled pressure drop being about 20 bars but thereafter level out. Figure 6.3 depicts the pressure drawdown contours for the reservoir at a depth of 1375 m for the period 2005 to 2050. The contours indicate drops of up to 12 bars are possible, but an average reservoir pressure drawdown estimated from the contours is less than 4 bars.

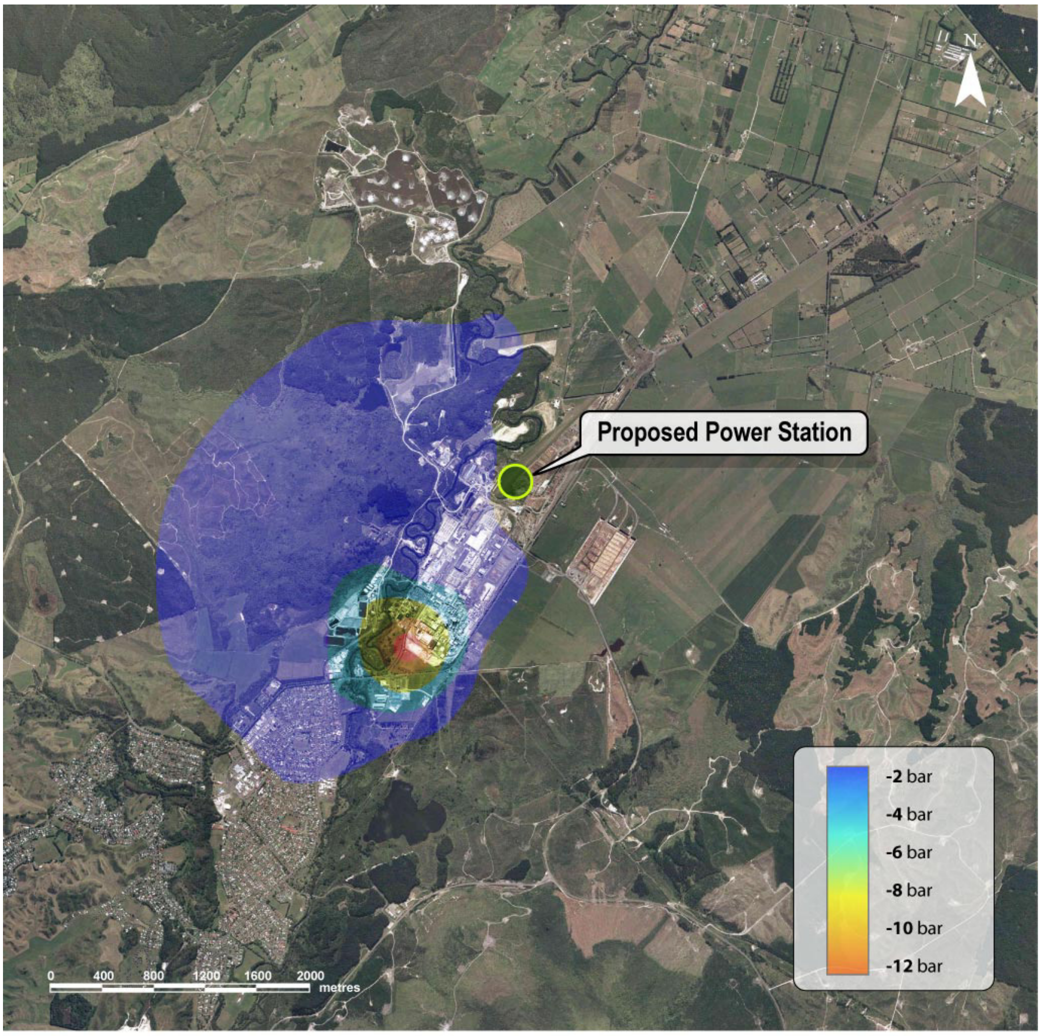
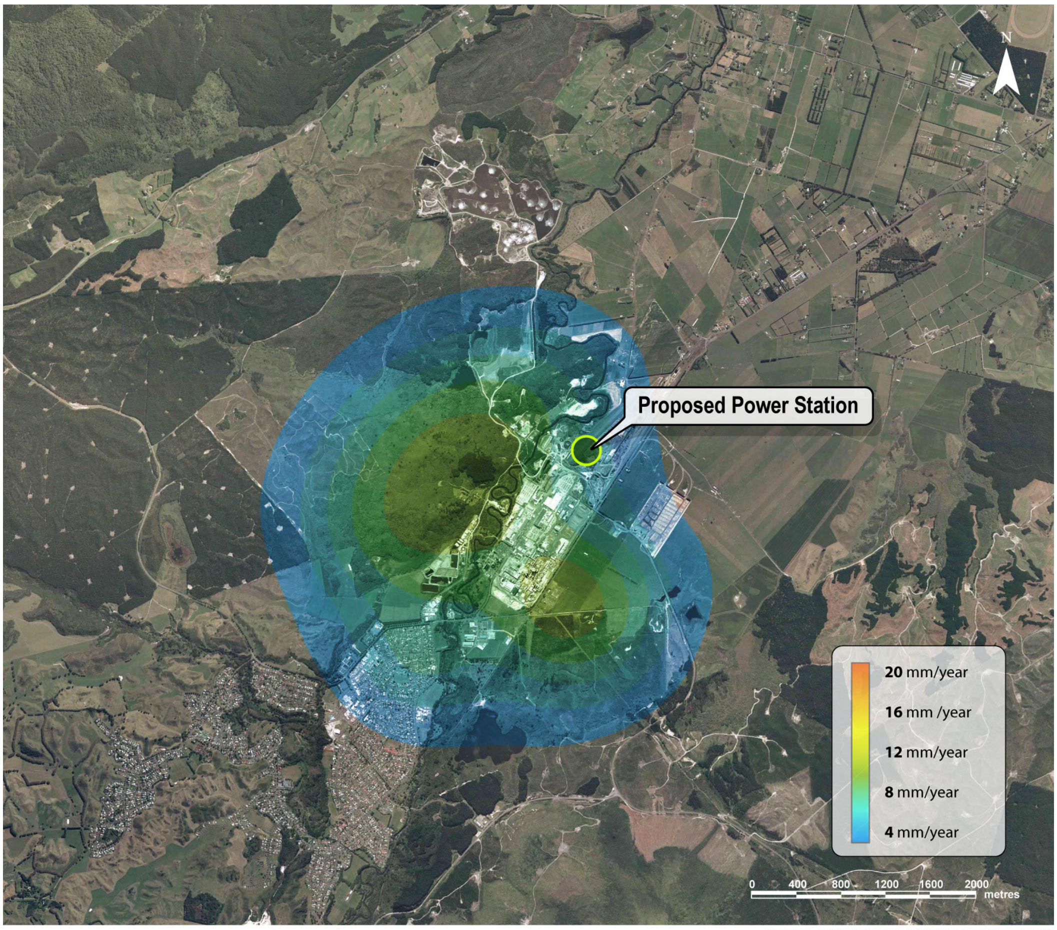


Figure 6.3: Predicted Pressure Drawdown over Production Area at 1375 m depth (2005-2050)

6.2.2 SUBSIDENCE

The decline in reservoir pressures in the compacting disk determines the resulting subsidence shown in Figure 6.4. The subsidence rates vary from 10-12 mm/yr in the centre of the disk to between 4 mm/yr and 8 mm/yr for a wider area. The subsidence will be quite gradual, and the average (maximum) rate is about 8.5 mm/year over the period 2005-2050. This is low by comparison with some recent measured values and continues the longer term trend established since 1950. Similarly worst case results for tilt in the vicinity of the mill are between 4mm/km and 8mm/km per year. These tilt rates are lower than currently measured tilt values for the mill.



SOURCE: DATA FROM INDUSTRIAL RESEARCH LIMITED

Figure 6.4: Predicted Geothermally Induced Subsidence (2005-2050).

6.3 EFFECTS ON SUSTAINABILITY OF THE GEOTHERMAL RESERVOIR

The utilisation of the energy contained within geothermal reservoir for the purposes of generating electricity results in some depletion of that energy source. The extent of depletion will depend on the size of generation relative to the size of the resource. What is ultimately considered to be sustainable management of the resource will depend on the interpretation of Section 5 of the RMA, the guidance provided by the regional planning documents and the balancing of current economic, social and cultural well being of the community with that of future generations.

Sustainable management does not mean that the resource needs to be managed on a continuously renewable basis (i.e. that the utilisation at any time is limited by the heat entering the resource from deeper strata). However, it does mean that where reasonable measures to extend the life of the resource are available, then they should be taken in order to achieve sustainable management. In this regard experience with geothermal energy development over the last 50 years has demonstrated that by reinjecting the used geothermal fluid, the field remains economically viable for a larger period of time. The reinjection of fluid maintains the heat transfer mechanism and pressure within the field. Full reinjection of remaining geothermal fluid is a fundamental tenet of this project.

The conclusions of the independent studies on the proposal to abstract an average of 45,000 t/d are that while there will be some temperature and pressure loss, at the end of the power station lifetime at 2050, the field will remain viable for further electricity generation or alternate uses. In addition, the studies conclude that there is sufficient resource to accommodate further development of the resource although this is not currently being contemplated by Mighty River Power. This conclusion is based on the results of a modelling exercise which necessarily involves some uncertainty or risk. However, the RMA consents process does not require that there be 'no risk' to the environment in granting a consent. This matter has been considered in a number of cases as diverse as landfills, marine farms and cell phone towers. As noted above, all remaining geothermal fluids will be reinjected to mitigate the effects of abstraction.

Section 5 of the Act requires that the development of the resource takes into account the needs of future generations, which has been addressed above. Section 5 also refers to safeguarding the life supporting capacity of natural resources and avoiding, remedying or mitigating adverse effects. The two environmental effects that are relevant in this context are the cultural values of the geothermal resource and the potential for subsidence. These matters have been addressed in this AEE.

Geothermally active areas are usually notable for their surface features. In Kawerau, as at Rotorua, Wairakei and Ngawha the geothermal resource is manifested as surface features such as hot pools and geysers that have become taonga for local tangata whenua. The surface features are less evident at Kawerau than other locations, yet local tangata whenua have a strong cultural connection to the geothermal resource. Section 1 above has described the direct involvement of both Tuwharetoa Ki Kawerau and the Putauaki Trust interests in the power station project. Through reaching agreement with these parties on the project, Mighty River Power considers that it has recognised the matters of national importance in section 6(e) of the RMA and the tangata whenua's kaitiaki status in section 7(a). Further assessment of the sustainable management of the resource in terms of the regional planning documents is made in Section 10 of this AEE.

6.4 POTENTIAL SUBSIDENCE IMPACTS

There are a number of possible effects of ground subsidence. The actual effects will depend on the magnitude and extent of the subsidence, but also on the nature of the structures or facilities in the affected area.

6.4.1 INUNDATION

The greatest cost of subsidence internationally arises from inundation or flooding of low-lying areas near water bodies, usually as a result of groundwater extraction.

At Kawerau, areas alongside the Tarawera River have the potential to be affected, if subsidence becomes much greater than it has been to date. However, the total measured subsidence of around 0.5 metres or less has not caused any reported effect and is unlikely to do so in the future.

6.4.2 TILTING AND DIFFERENTIAL MOVEMENT

Most structures can absorb significant tilt without damage. Exceptions are structures or facilities where a true level is important, such as swimming pools, gravity drains and some machinery installations, such as paper machines.

Curvature or differential tilt within a structure has a greater potential to cause structural damage. This is recognised in building codes, but is usually expressed in terms of allowable sag over a given span. For example, the New Zealand loading code, NZS 4203, has limits on structural components to protect non-structural elements, to prevent ponding of water on flat roofs, or for appearance. The limits are placed on deflections of beams and the like and are typically given as span/150 to span/500. Expressing the limit as a deflection, although pragmatic, causes confusion about what the significant effect is. The deflection limits are sometimes considered to be actual subsidence limits, whereas the damage potential is highly dependent on the horizontal distance over which the deflection occurs.

Taking the more conservative figure above, a subsidence of one metre over a bowl 500 m wide would be seen as acceptable. In practice, considerably more subsidence than that would be required to initiate damage as most structures have a much smaller footprint and would primarily be subject to non-damaging tilt and only small differential movement.

6.4.3 HORIZONTAL STRAINS

Extension or compression of the ground, or horizontal strain, has the potential to cause damage, but in practice it only affects long structures and only in areas of very high subsidence. In particular, high ground strains occur on the shoulders and at the toes of a subsidence bowl, but only when the maximum subsidence is very high, such as at Wairakei or Ohaaki.

Typical buildings, with much smaller longitudinal dimensions, are not affected, even in areas of high strain. For example, the steam vent house at Wairakei shows no signs of distress even though located in an area of high ground strain.

6.5 POTENTIALLY AFFECTED PARTIES

6.5.1 INDUSTRIAL BUSINESSES

The key industrial businesses located in the vicinity of the proposed power station are NST, Carter Holt Harvey Tasman, Carter Holt Harvey Woodproducts and Svenska Cellulosa Aktiebolaget (SCA). The potential effects of subsidence on these businesses has been a prime focal point for our analysis and consideration since the project inception.

In particular, extensive analysis and peer review jointly commissioned by Mighty River Power and NST on the effects of subsidence on the NST operation, and by proxy, on other industrial parties, has been undertaken. The high-speed NST paper machines are considered to be some of most level-sensitive equipment in Kawerau and are very close to the areas of maximum historical subsidence. A fundamental element of the NST and Mighty River Power decision to participate in this development was an assurance that the potential effects and risk of subsidence on the NST operations were acceptable in all respects. Early in 2005 these assessments were completed, and NST chose to proceed with this project. Accordingly Mighty River Power considers that subsidence and any associated impacts will not adversely affect the operation of the industrial businesses in Kawerau.

Furthermore, the proposed Mighty River Power geothermal power station will be located close to the centre of the historical subsidence bowl. Mighty River Power has assessed the risk and impact of potential subsidence and has concluded that the risks are acceptable to the operation of its business.

Mighty River has engaged directly with SCA, CHH Tasman and CHH Woodproducts in relation to subsidence. To date, SCA has not identified any difficulties in the anticipated levels and CHH Tasman, CHH Woodproducts and Mighty River Power are currently jointly undertaking assessments to provide confirmation that potential impacts on their businesses are acceptable.

6.5.2 TRANSIT NZ: HIGHWAYS

Roads constructed to normal New Zealand standards are relatively flexible structures so are unlikely to be damaged by even quite substantial subsidence. They are also constructed with substantial camber or crossfall to ensure good drainage; crossfall on a typical sealed road is 3% and on an unsealed road it is 5%. Such slopes are similar to the highest tilts at Wairakei and more than an order of magnitude greater than the past and expected tilts at Kawerau. For anticipated rates of subsidence at Kawerau there is expected to be no observable effect on roads in the area, either State Highways or local roads. Consultation with Transit in relation to this issue is described in section 9.6.

6.5.3 NEW ZEALAND RAILWAYS CORPORATION (NZRC): RAIL TRACK

Since June 2004, rail infrastructure has been owned by the NZ Government through the NZRC, also known as Ontrack. Like roads, rail tracks are flexible structures so are unlikely to be damaged by moderate area-wide subsidence. They are constructed such that the ballast can be recompacted or replaced to make up for local track movement caused by loads or by subsoil movement. The main rail lines at Kawerau run outside the 10mm/y subsidence contour, although spur lines run across the area of highest past subsidence. For anticipated rates of subsidence at Kawerau there is expected to be no observable effect on any of the existing rail tracks. Consultation with Ontrack in relation to this issue is described in section 9.6.

6.5.4 TRANSPOWER: POWER TRANSMISSION LINES

There are not expected to be any effects on high voltage transmission lines at Kawerau. The reasons are twofold: lines do not pass near the areas of maximum subsidence and the maximum estimated subsidence at Kawerau is very small. High voltage lines run east of Tamarangi Drive and are outside the 10 mm per year contour for past subsidence and well outside the 10 mm per year contour for predicted subsidence through to 2050. In addition, Transpower have a substation near to the NST mill site which is not expected to be affected by subsidence. Consultation with Transpower in relation to this issue is described in section 9.6.

6.5.5 KAWERAU AND WHAKATANE DISTRICT COUNCILS' INFRASTRUCTURE

District roads have the potential to be affected as described above for state highways. However, based on experience at Wairakei and Ohaaki, and with the small subsidence at Kawerau, no adverse effects are envisaged.

Pipelines may be affected by tilt or by horizontal strains. Tilt can affect gravity sewers by reducing the gradient and so the flow capacity or the self-cleaning ability. (Conversely, it may also assist drainage if in the right direction). Horizontal tensile strain may pull apart pipe joints while compressive strain may cause pipe buckling.

Such infrastructure has not been identified at Kawerau near to the centres of maximum subsidence, but noting that significant horizontal strains only occur at Wairakei within or close to the 100mm per year contour. At Kawerau there are no areas with comparable subsidence rates and only very limited areas where the subsidence has exceeded 10 mm per year. Consequently likely effects are negligible. Future subsidence is predicted to be of the same order as past subsidence rates. Consultation with Kawerau District in relation to this issue is described in section 9.2.

6.5.6 ENVIRONMENT BAY OF PLENTY: RIVER AND DRAINAGE INFRASTRUCTURE

At Kawerau, areas alongside the Tarawera River have the potential to be affected, if subsidence becomes much greater than it has been to date. However, the total measured subsidence of around 0.5 metres or less has not caused any reported effect and is unlikely to do so in the future. Consultation with EBoP's river and drainage infrastructure managers in relation to this issue is described in section 9.6.

6.5.7 NATURAL GAS CORPORATION: GAS TRANSMISSION LINES

High pressure gas lines, being long structures, would be susceptible to strain damage if located near to an area of maximum subsidence with consequent high horizontal strains.

The gas mains in the Kawerau area are located east of the mill and Tamarangi Drive, roughly along the predicted 100mm total subsidence contour for 2005-2050 (or about 2 mm per year). This area has seen subsidence of between 5 and 10 mm per year in the past. Horizontal movements or strains are perpendicular to subsidence contours and are highest when subsidence rates are changing most rapidly with horizontal distance. Strains are near zero along the subsidence contours, even in areas of greatest horizontal movement. Consequently the natural gas pipeline at Kawerau will be subject to negligible strain. There has been no observable effect on the steam mains at Kawerau. These pipelines are over a kilometre long that run near to the area of highest measured subsidence. Consultation with NGC in relation to this issue is described in section 9.6.

6.5.8 COMMERCIAL BUSINESSES

There are few commercial businesses located in an area of more than background subsidence (5 mm per year). Buildings at Wairakei, such as the Information Centre, next to the Wairakei Service Station have subsided by three to four metres and tilted as much as 7mm/metre without noticeable effects. The maximum estimated subsidence at Kawerau, over 45 years, is one tenth of this. No commercial buildings are near the maximum subsidence area.

6.5.9 RESIDENTS

Most Kawerau residences are in areas of background subsidence only, so there are no material subsidence impacts anticipated. Further, as with commercial buildings, residential buildings are flexible structures and are not susceptible to small differential ground movements. (Such movements, resulting from inadequate soils, are not uncommon). Because the maximum past and expected future subsidence at Kawerau is small and occurs over hundreds of metres, differential settlement over a typical building is negligible and no noticeable effects are expected.

6.6 INDUCED SEISMICITY

Induced seismicity (or micro-earthquakes triggered by man-made subsurface pressure and temperature changes) has occurred at some geothermal fields. Generally, the magnitudes of these induced micro-earthquakes are not sufficiently large to cause damage to surface facilities. As noted in Section 2.2, the Kawerau area lies within the TVZ, where there is a naturally high number of earthquakes. Most of these earthquakes are related to normal faulting (with mostly vertical displacements) along north-east trending faults distributed across the zone. Earthquakes near Kawerau frequently occur with an episodic or swarm-like behaviour which is typical of earthquakes in the TVZ.

Figure 3.1 depicts the proposed production and reinjection areas for the proposed power station. Injection wells are located at the north-eastern periphery of the production area where temperatures are cooler. These wells will be relatively deep, penetrating the greywacke basement, and relying on faults to disperse the injected fluid. There is a possibility of induced seismicity accompanying pressure or temperature changes caused by injection or extraction of fluids. Factors that influence the likelihood of induced seismicity include the regional stress field, the volume and rate of injected fluid, and the stress redistribution associated with pressure changes and temperature changes.

There is no evidence that the commencement of shallow reinjection of fluids in 1997 at Kawerau has affected the level of seismicity and experience from the majority of geothermal fields around the world suggests that induced earthquakes of sufficient magnitude to cause concern are unlikely to occur at Kawerau. There is however some theoretical probability, although still small, that induced seismicity involving an increase in the number of relatively small events may accompany injection of fluids into the north-eastern peripheral sector of the Kawerau resource.

7 EFFECTS ON WATER RESOURCES AND ECOLOGICAL VALUES

7.1 SURFACE AND GROUNDWATER EFFECTS

The Kawerau industrial area has two main water resource receiving environments located in close proximity to the proposed power station. These are the Tarawera River, which runs along the north western boundary of the site and the shallow groundwater system beneath the site.

It is proposed that the power station will be constructed on the eastern bank of the Tarawera River within the existing NST site. Although no take from or discharge to the river or other surface waterways is proposed for the new power plant, geothermal fluid could potentially spill into surface waters during some hazard events or failure scenarios (such as pipeline bursts or system failures), due to the site's proximity to the river, although the risk is considered to be low. The water management assessment has therefore considered both discharges to groundwater as well as the environmental risk of spills to surface water.

The potential effects of the proposed power station in terms of water management are:

- The potential effects on surface water (Tarawera River) and groundwater as a result of potential spills of geothermal fluid;
- Potential effects of run-off and storm water flows; and
- The potential effects of sedimentation and erosion during construction.

Mighty River Power commissioned Kingett Mitchell Limited to undertake an assessment of the potential environmental effects on surface and groundwater. The full report *Kawerau Geothermal Power Station: Water Management* Kingett Mitchell Limited, March 2005 is included on the attached CD-ROM and forms part of this AEE.

In identifying the potential environmental effects of installation of a power plant, the effects have been discussed based on the worst case scenario of the three possible technologies and two cooling system options.

7.1.1 HAZARD AND RISK ANALYSIS

The Tarawera River and local groundwater have been described above in Section 3 and are currently highly modified and degraded. This is due to a number of factors including natural geothermal discharges, industrial discharges and rural land use activities.

Construction and operation of a proposed power station introduces risks in terms of spills and leaks of geothermal fluid. These risks have been identified and ranked according to the likelihood (frequency) of each risk occurring, and the potential consequential environmental effects if they did occur. The risks were evaluated by adopting the recommended approach to risk management as outlined by the Australian and New Zealand Standard, Risk Management, AS/NZ 4360:1995. The likelihood of occurrence was determined by considering both the likelihood of such a failure scenario and the likelihood of the geothermal spill reaching surface water or groundwater, while the consequence was determined by considering the effect that the temperature and water quality of the geothermal fluid would have on groundwater and surface water systems.

The highest risk results of the hazard and risk analysis demonstrate that the large majority of scenarios have a low environmental risk in terms of overall likelihood and consequence. The more significant scenarios identified in the risk evaluation all relate to spills to surface water and still only have environmental risk rankings at the lower end of the moderate classification (up to 8 in a scale of 1 to 25).

Although these risks will only have minor environmental effects if they occur, there is a number of design and management measures that have been incorporated into the power station and geothermal field operation as described in Section 4 which will further reduce the likelihood and effect of consequences. These include:

- Design of pipelines for seismic scenarios;
- Design of separator, accumulators and cooling system supports to high seismic standards;
- Design of onsite storm water reticulation to direct any spills from ruptures and leaks to the storm water ponds to avoid discharge to surface waters;
- Design the pipeline crossing of SH34 such that the pipeline is protected from direct impact of over sized trucks hitting the bridge; and
- Warning signs on pipelines to keep people clear and other health and safety warning signs.

7.1.2 SITE WATER MANAGEMENT

The proposed power station is located outside the area that is serviced by the existing NST storm water system and will therefore require collection and treatment under a new resource consent. The proposed storm water system and measures for sediment control has been described in Section 3. Provided that discharges to groundwater are managed appropriately and the proposed mitigation measures for erosion and sediment control are implemented, it is considered that the proposed power station will have no more than minor adverse effects on the surface water (Tarawera River) and shallow groundwater receiving environments.

7.2 ECOLOGICAL EFFECTS

As discussed in Section 2, the natural environment in the vicinity of the proposed power station mostly consists of low scrub and bush-covered hills. There are a number of geothermal sites in the area, and the Tarawera River and associated riparian margin is located directly to the west of the proposed plant and the already established NST site. A number of lakes and wetlands are also located near the proposed facility.

When assessing the effects on ecological values, it is important to note that the Kawerau District consists of two ecological districts, those being the Rotorua Lakes and Te Teko Ecological Districts. Protected Natural Area surveys and assessments have been undertaken on both ecological districts and a number of reports have described them. Of particular importance are the Parimahana Scenic Reserve and the Parimahana Extension Recommended Area for Protection (RAP). These areas contain plant species that thrive in geothermal environments and are sensitive to changes in geothermal activity temperature.

Mighty River Power commissioned Kingett Mitchell Limited to assess the potential effects of the proposed geothermal power plant on ecological values. The full report *Kawerau Geothermal Power Plant Ecological Assessment* Kingett Mitchell, March 2005 is included on the attached CD-ROM and forms part of this AEE.

7.2.1 GENERATION PLANT SITE

The generation plant will be located in an area between Kawerau Airstrip and the NST timber yard. In this area, vegetation mainly consists of weed field, rank grass and mown pasture and is described as being 'heavily modified or degraded'. There are not anticipated to be any significant ecological effects in this area.

7.2.2 SITE CLEARANCE AND EXCAVATION

During site construction, areas of vegetation on the airstrip terrain will be required to be cleared. The area to be cleared lies a distance of approximately 50 m to 300 m from the Tarawera River Riparian Zone and 200 m from the Kanuka RAP. There is adequate distance between the clearance areas and the two natural areas, and therefore effects from sediment runoff and dust is expected to be insignificant, although a temporary dusting of vegetation may result which will not be detrimental to the health of the vegetation providing the soil is not contaminated.

Sediment traps will be built to ensure that sediment is not entrained into runoff water and consequently discharged into the Tarawera River. In the unlikely event that any sediment should happen to enter the river, adverse effects of this are not expected to be significant due to the high sediment loads currently found in the river.

7.2.3 PRODUCTION PADS

There are currently four locations proposed for production pads for the geothermal power station. The pad proposed to be located adjacent to the generation power plant, and the two proposed on the Putauaki Trust land (mainly consisting of pasture) are not located close to any significant natural area and are not anticipated to have any effects on the ecological environment. It is noted that Mighty River Power has undertaken exploration drilling on the Putauaki Trust land and all potential effects associated with drilling have previously been considered. Other production pads are contemplated at the southern end of the NST site. Those in proximity to the Tarawera River riparian zone will be lined or other measures undertaken to ensure there will be no adverse effects on riparian vegetation or in-stream ecology of the river.

7.2.4 REINJECTION PADS AND PIPELINES

A number of reinjection pads and pipelines are proposed to be located within the Putauaki steamfield which is predominantly covered in pasture. As such, the structures are not expected to have any potential effects on local ecological values within this area.

7.2.5 GEOTHERMAL EXTRACTION

Effects on plant ecology are particularly important when considering geothermal extraction, especially since the Kawerau steamfield underlies the Parimahana Scenic Reserve, Parimahana Extension and the Tarawera Kanuka RAPs. All these areas contain flora that establishes in areas of geothermal activity. It is the soil temperatures that enable such species such as the prostrate kanuka, which is endemic to New Zealand geothermal areas, to survive in these areas. If soil temperatures are cooled in response to changes in subsurface hydrology, the flora of these areas may change.

A report by GNS 2005 (included on the attached CD-ROM) concluded that the net withdrawal and reinjection of steam and water from the Kawerau Field by the mill over the past 15 years has produced negligible long-term pressure changes at production depths in the field. It also concluded that changes to heated ground, such as that which supports geothermal vegetation in Parimahana Scenic Reserve, Parimahana Extension and the Tarawera Kanuka RAPs, can occur naturally in response to changes in subsurface hydrology. However, provided appropriate reservoir management is undertaken, which will reduce the impact on shallow aquifers and groundwater, the effects of geothermal extraction on specialised geothermal vegetation are expected to be insignificant in nature.

7.2.6 EFFECTS ON ECOLOGY FROM DISCHARGES TO AIR

Discharges to air from the geothermal power generation plant proposal include minor dust emissions during construction and emissions of hydrogen sulphide during production as well as low levels of mercury. The level of hydrogen sulphide in the air is not expected to increase significantly as it has been reported by Endpoint Consulting Partners (Endpoint) that the Kawerau township already has an elevated concentration of hydrogen sulphide in the atmosphere due to existing natural sources. All of the minor emissions will make negligible contributions to expected existing levels in the atmosphere around the site. Based on the outcomes of this report no significant effects from air emissions on vegetation or wildlife are perceived either.

7.2.7 EFFECTS ON FRESHWATER ECOLOGY

With regard to freshwater ecology and the flora and fauna within the Tarawera River, the geothermal power station will not be discharging any contaminants into the River, except for minimal amounts of surface runoff during the construction phase. The taking of geothermal water and steam from the ground is not expected to alter river levels or have any adverse effects on the freshwater ecological communities in the area.

7.2.8 CONCLUSION

Having regard to the above assessment, it is considered that the potential adverse effects on significant terrestrial and fresh water ecological values on the site and surrounding environment as a result of construction activities and the operation of the power station will be no more than minor.

8 EFFECTS ON AMENITY VALUES AND TRAFFIC

8.1 AIR QUALITY EFFECTS

In general terms, the proposed power station extracts geothermal energy from the ground in the form of steam and uses this to generate electricity. An inevitable part of this process is the release of gases within the steam. In particular carbon dioxide (CO_2) and hydrogen sulphide (H_2S) and some other minor contaminants are released. These contaminants are natural in the sense that they are emitted from numerous existing fumaroles and vents around the region. There are also the potential effects of dust emissions generated during the power station construction period and the road safety implications of steam plumes on SH34.

Having regard to the above, the potential environmental effects of air discharges from the proposed power station are considered to arise from:

- Potential effects of hydrogen sulphide on surrounding residential areas, including cumulative effects on the receiving environment; and
- Potential effects of minor contaminants and dust;

Mighty River Power commissioned Endpoint to undertake an assessment of the potential effects of discharges to air from the proposed geothermal power station. Their full report, *Assessment of Effects of the Air Discharges from the Proposed Kawerau Geothemal Power Station*, (Endpoint, 2005) is included on the attached CD ROM and forms part of the AEE. Factors considered in assessing the environmental effects of air quality include:

- Existing emissions from significant dischargers in the surrounding area;
- Existing contaminant levels and air quality guidelines which apply to the Bay of Plenty Region;
- Meteorological factors; and
- Dispersion modelling approaches.

Cumulative effects have also been considered in order to assess how the emissions from the proposed power station affect the overall air quality of the surrounding environment. The modelling carried out to assess the cumulative effects considers the ground level concentrations of contaminants that are expected due to the power stations emissions alone and their relationship to other sources and existing levels of contamination in the locale. The existing air quality has been established and is described in Section 3 of this report.

8.1.1 MODELLING APPROACHES

Due to the complex meteorological conditions in the head of the Kawerau-Edgecumbe valley, the Calpuff dispersion model was used to predict ground level concentrations on both flat and elevated terrain within 16 km of the Kawerau area. The Calpuff model is a non-steady state model that allows for more complex fumigation and mountain-valley slope flows, calm conditions and variation of the meteorology over the modelling domain.

As meteorology forms the single biggest effect on the dispersion of contaminants, a meteorological data set has been produced for the year 2001 using the Calmet model, which is the meteorological processor of the Calpuff air dispersion model. The Calpuff dispersion model used this meteorological data set to provide detailed ground level concentrations for the region, for the main contaminants.

The parameters used in the Calmet-Calpuff modelling system are described in Section 5 of the appended Endpoint Report.

8.1.2 AIR QUALITY GUIDELINES AND STANDARDS

The air discharge assessment has taken into account the Ministry for the Environment Ambient Air Quality Guidelines (2002). These guidelines address a number of potential contaminants of which only H_2S and Hg are relevant.

It is noted that the proposed Air Quality Standards that come into force in September 2005 do not prescribe limitations on the key emissions relevant to this project.

8.1.3 EFFECTS FROM PROPOSED POWER STATION

Hydrogen Sulphide (H_2S)

A full air dispersion modelling assessment was undertaken for the air cooled condenser and cooling tower options at the proposed site. Different building configurations and discharge characteristics have been assessed and the results are presented in Section 6 of the appended Endpoint Report. The results detail the worst, or highest predicted 1-hour H_2S ground level concentrations (glc) from either of the two options.

Power Station and Cumulative Effects

A summary of the 99.9% percentile level of 1-hour H_2S ground level concentrations are shown in Table 8.1. The table firstly shows the effects from existing industrial emissions. Secondly, the effects from the power station alone are shown. The results illustrate that the power station alone results in concentrations that are not as high as those from existing mill operations in locations close to the station (Kawerau Road). However, the effects are slightly more noticeable at greater distances, such as Te Teko and Edgecumbe. Table 8.1 also demonstrates the cumulative effects for the combined H_2S concentrations from the proposed power station and existing emissions. Again, this demonstrates that there are negligible effects due to the addition of the power station at locations within a few kilometres of the site, although concentrations increase slightly at locations further away.

An important aspect of peak H_2S concentrations is the frequency of occurrences. Table 8.2a below shows the predicted frequency of peak concentrations of H_2S air discharges from the existing plants while the effects of adding the proposed power station are shown in Table 8.2b. For instance, at present, the maximum concentration occurring at Edgecumbe is 13 μg m^{-3} and the 99.9 percentile is 8 μg m^{-3}. That is, for 99.9% of the year (all except 9 hours) the concentration is below 8 μg m^{-3}. Similarly, at Te Teko the maximum concentration is 30 μg m^{-3} and the 99.9 percentile is 16 μg m^{-3}. That is, for 99.9% of the year (all except 9 hours) the concentration is below 16 μg m^{-3}. The higher concentrations are generally at night, or in the early morning. A comparison of Tables 8.2 a and b indicates the marginal increase in emissions for the affected areas.

Table 8.1: Predicted 1-hour H_2S 99.9th Percentile Level Ground Level Concentrations for the Power Station and Existing Emissions[1].

Location	Existing Industrial Emissions	Maximum Power Station Alone	Power Station and Existing Industrial Emissions
Highest 99.9 percentile	932	519	932
Site boundary (Kawerau Road)	308	151	311
Marae (lower)	225	75	225
Kawerau residential	152	49	165
Te Teko residential	16	21	29
Edgecumbe residential	8	9	13

[1] All units are in μg/m^3

Table 8.2a: Statistics of Predicted H_2S Ground Level Concentrations for Existing Emissions [1].

	Kawerau	Kawerau Rd	Marae (lower)	Te Teko	Edgecumbe
Max	206	431	316	30	13
99.9	152	308	225	16	8
99.0	72	86	99	6	2
95.0	34	28	32	1	1
90.0	14	11	8	0	0
80.0	3	2	1	0	0

[1] All units are in μg/m^3

Table 8.2b: Statistics of Predicted H_2S Ground Level Concentrations for Existing Emissions plus Power Station[1].

	Kawerau	Kawerau Rd	Marae (lower)	Te Teko	Edgecumbe
Max	220	431	316	52	30
99.9	157	287	221	27	13
99.0	83	125	103	10	5
95.0	49	49	44	3	2
90.0	25	27	17	1	1
80.0	4	9	2	0	0

[1] All units are in µg/m^3

Figure 8.1 illustrates the total number of days per year that residents in Kawerau, Te Teko and Edgecumbe would experience H_2S concentrations greater than the 7 µg m^{-3} guideline when the existing discharge sources and the proposed power station (using the worst-case dry option) are operational. The figure shows that for all three residential areas, the increase in total time that this guideline is exceeded is very small.

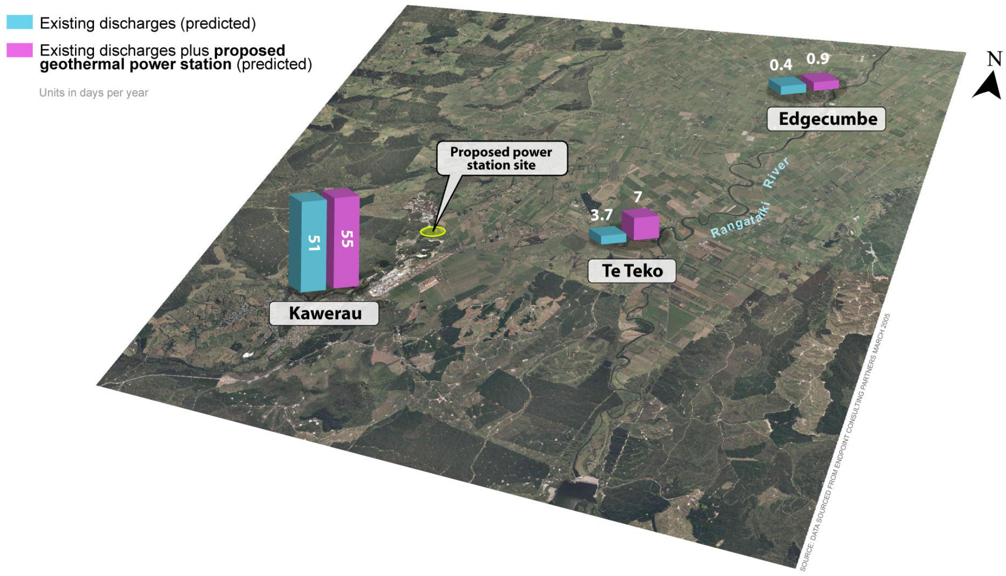


Figure 8.1: Days per Year H_2S concentrations greater than 7 µg m^{-3}.

8.1.4 ASSESSMENT OF H_2S EFFECTS

Generally speaking, health effects are not evident until H_2S concentrations reach several thousand µg m^{-3} and it is apparent that such concentrations will never be reached in the immediate vicinity of the site. Thus there are unlikely to be direct health effects associated with the power station discharges, nor any cumulative effects with other sources.

Conversely, odour nuisance effects are more subjective. The odour perception threshold is typically considered to be 7 μg m^{-3} for non-geothermal areas. Concentrations of 7 μg m^{-3}, which occur in an urban area unfamiliar with H_2S, would probably result in a few complaints. However a level of 70 μg m^{-3} occurring almost anywhere in Rotorua for example would probably be regarded as a clean, refreshing day. As such, a guideline level of 70 μg m^{-3} is considered more appropriate for geothermal areas.

Around the Kawerau power station the modelling shows that relatively high H_2S concentrations are likely to be experienced in the immediate vicinity of the site, and locales nearby such as along Kawerau Road and at the lower marae. However, as these locations already experience elevated concentrations, the increment of concentration due to the power station will be low and is likely to be unnoticed. As noted above, there is very little difference in the statistics of Tables 8.2a and 8.2b or the incremental time that concentrations will exceed 7 μg m^{-3}.

Current peak concentrations decrease rapidly with distance from the sources (Table 8.2a) and the percentage of time that Te Teko and Edgecumbe experience concentrations above the odour threshold is very low. While these percentages increase significantly in absolute terms they are still a very low percentage of the time with the introduction of the power station (Table 8.2b).

In summary, for most locations the concentrations will still be within the nominal guidelines and it is probable that those who are regularly exposed to the odour will become accustomed or desensitised to the concentrations and will be unable to detect the small increases which will occur. As is well known to the residents of Rotorua, people become accustomed to the H_2S odour if exposed to it regularly. Not only do people cease to notice it, they become desensitised to the absolute concentration and can detect only very large increases in concentration – that is, they may not detect an increase from 10 μg m^{-3} to 50 μg m^{-3}, but may detect an increase to say 500 μg m^{-3} a level still well below the threshold for direct health effects.

8.1.5 OTHER EFFECTS

Minor Contaminants

There are contaminants other than H_2S in the non-condensable gas stream, including mercury (Hg) carbon dioxide (CO_2), ammonia (NH_3), hydrogen (H_2), methane (CH_4), nitrogen (N_2), radon (Rn), and other minor contaminants. None of these have been directly modelled for the purposes of the assessment. The concentrations however can be estimated for these contaminants by scaling the predictions for H_2S by the relative emission rate. An assessment has been carried out for the following two cases, the predicted highest concentrations from the power station alone; and cumulatively with other discharges and natural background.

The analysis undertaken shows that all of the minor emissions (non-H_2S) will have negligible contributions to expected existing levels in the atmosphere around the site. Each of these contaminants has a nominal 'safety margin' of at least a factor of 100 (or

1000). That is the maximum annual concentrations expected are 1/100th (or 1/1000th) of the value that might cause concern.

Mercury concentrations, even with all sources, will be well below the Ministry for the Environment (2002) air quality guideline of 0.33 μg m^{-3} by at least three orders of magnitude. The mercury concentrations can also be compared to expected background levels, due to a range of other sources. For a very clean background annual average mercury concentrations are of the order of 0.0007 μg m^{-3}, and would thus be increased by a factor of two with the peak station effect of 0.0014 μg m^{-3}. However natural concentrations in the geothermal areas around the proposed power station site are likely to be at least an order of magnitude higher at up to 0.007 μg m^{-3}. Thus the increase in mercury due to the power station in a clean environment would be of the order of 20% at most, but still of the order of only 3% of the guideline.

Dust

Once the station is commissioned, there will be no source of dust associated with power generation. Related traffic on unsealed portions of access roads may create some dust, but any resultant effects will be confined to immediate neighbours and will not be any worse than currently experienced, as the traffic volumes are not expected to increase significantly.

During the construction phase however, there is substantial potential for dust creation, both from equipment and traffic using the unsealed roads, and from the site earthworks. Although these effects have not been modelled or explicitly assessed, measures can be taken to mitigate and minimise adverse effects that may arise from excess dust during construction. Such measures may include protocols for:

- Minimizing dust from roads by controlling vehicle speeds;
- Watering of roads, earthworks and stockpiles;
- Reduced operations in high winds (not common at this site);
- Restricted activity in certain wind directions if required; and
- Post works remediation through vegetation planting and screening.

Steam plumes

The potential for steam plumes to affect road safety on SH 34 and local roads has been assessed. There are no significant discharges of steam required by the power station operation in close proximity to SH34 or any local road. Based on the volume of steam and location of emissions from the proposed plant and taking into account the incidence of steam plume interference at other places such as Wairakei, it is considered that there is unlikely to be any significant increased road safety consequences resulting from the project.

8.1.6 CONCLUSION

The results show that ambient H_2S concentrations in the general Kawerau area are currently well above the guideline value of 7 μg m^{-3}due to natural sources. Additional emissions from the power station in the Kawerau area will result in small increases in ambient levels, however the increment is unlikely to be noticeable. H_2S concentrations at residential locations, such as Te Teko and Edgecumbe will show slight increases but remain well below the 7 μg m^{-3} guideline level for the vast majority of the time.

Minor gases in the emissions have been assessed and the station discharges will not have any significant effect. In particular, mercury concentrations will be well below the Ministry for the Environment guidelines. Where appropriate measures will be taken to manage any dust emissions associated with power station construction earthworks..

Overall therefore, discharges to the air are likely to only have minor effects on the environment and should not lead to any significant loss of amenity beyond the immediate vicinity of the site.

8.2 NOISE EFFECTS

The potential noise effects of the proposed power station are primarily the effects on surrounding residential areas associated with its construction and operation.

Mighty River Power commissioned Kingett Mitchell Limited to undertake an assessment of the potential effects of the power station in relation to noise. The full Noise Report, Kawerau Geothermal Power Station *Assessment of Noise Effects*, (Kingett Mitchell Limited, April 2005) is included on the attached CD Rom and forms part of the AEE. This section reports the findings of the noise assessment where operational noise levels have been calculated based on field test measurements at the Mokai (Stage 1) geothermal power station (55MW).

8.2.1 PERFORMANCE CRITERIA

As previously referred to, the proposed power station is located within the Industrial Area 1 Zone of the Kawerau District and is therefore subject to the noise provisions contained within the Operative Kawerau District Plan 1999. As most of the production and reinjection wells are within Whakatane District, the construction noise standards contained in the Proposed Whakatane District Plan are also of relevance for these activities.

In accordance with Rule 2.3.7 of the Kawerau District Plan, there are no specific noise standards for activities undertaken in the Industrial Zone and noise is managed through the excessive noise provisions of the RMA. In measuring and assessing noise the provisions of NZS 6801:1991 (Measurement of Sound) apply.

While there are no specific controls on construction noise in the Kawerau District Plan, the Whakatane District Plan requires that noise generated during the construction stage be controlled according to the recommendations of *New Zealand Standard NZS 6803:1999 – Acoustics – Construction Noise.* In the absence of any specified standards, Mighty River Power will apply NZS 6803:1999 as a guide to the control of construction noise within the Kawerau District.

As the construction works are planned to last for some 18 months the applicable noise limits for long-term duration works are as follows:

Construction Noise Limits

- Monday to Friday 06:30-07:30 – L_{eq} 55 dB(A) and L_{max} 75 dB(A);
- Monday to Saturday 07:30-18:00 – L_{eq} 70 dB(A) and L_{max} 85 dB(A);
- Monday to Friday 18:00-20:00 – L_{eq} 65 dB(A) and L_{max} 80 dB(A);
- Sundays and public holidays 07:30-18:00 – L_{eq} 55 dB(A) and L_{max} 85 dB(A); and
- At all other times - L_{eq} 45 dB(A) and L_{max} 75 dB(A).

8.2.2 SENSITIVE RECEIVERS

In assessing the potential adverse effects of noise on the surrounding environment it is necessary to identify potentially sensitive receivers and their proximity to the subject site. The dwellings of the nearest receivers and their respective distances from the site are listed below.

A – 1km to the south-west across the Tarawera River;
B – 450m to the north across the Tarawera River;
C – 450 – 900m to the north-east along the western side of Onepu Springs Road;
D – 600m to the north on the eastern side of Onepu Springs Road;
E – 420 – 550m to the east across SH34; and
F – 1.5km to the south.

8.2.3 CONSTRUCTION NOISE LEVELS

The only residential properties within 300 m of construction works will be those located at receiver E, to the east of SH 34. These will be some 150-200 m from the production and reinjection pads and at least 50-75 m to the west of the pipelines and new power transmission pylons. Mighty River Power has entered into a formal agreement with Putauaki Trust in relation to the acceptance of the proposed activities. In addition, Mighty River Power has undertaken exploration drilling on the Putauaki Trust land where noise effects were previously considered.

Depending upon the construction equipment and methodologies used, screening may be required to ensure that all daytime works remain compliant with the noise limits at the nearest receivers. Noise from construction vehicles is unlikely to be distinguishable from general road traffic noise at any of the identified receivers and will not, therefore, generate any adverse effects.

8.2.4 OPERATIONAL NOISE LEVELS

The main noise sources at Kawerau have been identified to be the generator, turbines and fin/fan coolers if used. The steam turbine generator for the proposed power station will be housed in a building and any outdoor turbine generators can be insulated and/or screened to provide sufficient attenuation to achieve the required night-time noise levels.

The noise level at the most exposed receiver from the fin/fan coolers is predicted to be about 60 dB(A) during the day. Similar noise levels are likely at the properties on the eastern side of SH 34, but survey data indicates that these dwellings are already exposed to night time noise levels of up to 70 dB(A) from road and rail traffic.

8.2.5 MITIGATION MEASURES

The construction works will be undertaken at distances of 300-450 m from the nearest sensitive receivers. At these distances, the noise from all daytime activities will be attenuated to compliant levels, without the need for any additional mitigation measures.

The proposed approach to mitigating adverse operational noise effects involves specifying in project design documents best practicable option mitigation measures such that all noise sources must achieve a night time design standard of L_{10} 50 dB(A) at a distance of 500 m. This design criteria will apply irrespective of the cooling option employed.

The implementation of the L_{10} 50 dB(A) design standard will be sufficient to attenuate the noise levels at all receivers to acceptable levels. The noise levels at the receivers on the eastern side of SH 34 will be slightly lower than those at an equivalent distance in other directions as a result of the partial screening provided by the log yards. It is proposed that additional noise attenuation will be offered to the receiver on a case by case basis if sufficient noise attenuation can not be achieved by the plant.

Operational noise from the production and reinjection pads and the brine/steam pipelines will be limited, not least because of the thermal insulation required for the system. The only receivers that might be affected by noise from these areas are the properties along the eastern side of SH 34, however steam noise is unlikely to be audible at the receivers over the existing high levels of road and rail noise.

8.2.6 CONCLUSIONS

On the basis of the above assessment, the anticipated noise levels associated with the construction phase will achieve compliance with the New Zealand Standards NZS 6803:1999.

In terms of operational noise levels, the main source of noise has been identified to be the fin/fan coolers if this design is used. A design performance standard has been selected to limit noise at all potentially affected receivers. In this regard, the aural effects associated with the operation phase will not result in any significant loss of amenity beyond the immediate vicinity of the site.

8.3 VISUAL AND LANDSCAPE EFFECTS

The potential environmental effects of the proposed power station in relation to visual matters are effects on the amenity and landscape values of the Kawerau locality.

Mighty River Power commissioned Kingett Mitchell Limited to undertake an assessment of the potential effects of the power station in relation to visual impacts. The full Report, Kawerau Geothermal Power Station Landscape and Visual Assessment, (Kingett Mitchell Limited, April 2005) is included on the attached CD Rom and forms part of the AEE.

A key consideration in this assessment, as in other assessments relating to land use matters, is that the construction of a power station is a permitted activity under the Kawerau District Plan provided that the proposal meets the required standards. In addition, it is noted that Mighty River Power has entered into agreements with Ngati Tuwharetoa Geothermal Assets, NST and the Putauaki Trust for the proposal.

The existing visual amenity, characterised by the predominance of industrial structures, and the broader landscape, featuring the plains to the east and Putauaki to the south-east have been described in Section 2.

Boffa Miskell (1993) identified broad landscape types for the district, to which different management principles could be applied. Landscape units were then identified, the visual character assessed and an overall sensitivity rating applied.

Conclusions reached for the Rangitaiki Plains landscape unit the following classification:

Visual Quality:	Moderate
Visual Absorption Capability:	Low-moderate
Visibility:	High
Overall Sensitivity:	Moderate

The evaluation concluded that the siting of large scale industry within the plains area is appropriate where the existing mill site is situated. Further, that significant views of outstanding natural features (such as Putauaki), *"should be protected while generally enframing the view from the road."*[10]

8.3.1 LANDSCAPE CONTEXT AND CHARACTER

The Whakatane District Plan contains descriptions of landscape types in the District, two of which are relevant for this proposed power station. The steamfield activities which are within the Whakatane District fall under the description given for the Plains Landscape Type. The wider landscape context is described by the Plateau Landscape Type.

[10] Assessment of Visual Effects Kawerau Pulp and Paper Mill, Boffa Miskell October 2002

The wider landscape context of the proposed power station incorporates a combination of industrial, pastoral and natural landscapes. The development is to be sited on the flat area of the Kawerau plains with a backdrop of the outstanding features of Putauaki and other maunga. The Whakatane Proposed District Plan schedules Putauaki as an outstanding natural feature and landscape.

Despite Putauaki being outside of the immediate zone of the proposal, the relevant statutory documents require consideration of it not only as an outstanding natural feature but also for its cultural importance. Section 6(e) of the RMA requires that the relationship of Maori with their ancestral lands, sites and waahi tapu be recognised and provided for as a matter of national importance.

8.3.2 VISUAL CATCHMENT

Wider Catchment

The Kawerau industrial site has been described generally in Section 2, however, in landscape terms, the site sits on the flat land where the plains open out from the central valley of the Tarawera River, immediately northwest of the 821m cone of Putauaki, and north of the Kawerau township.

The foothills, including the smaller maunga of Onepu, Otukoiro and Tirotiro Whetu form a backdrop on the western side of the site, with Putauaki looming on the eastern boundary. To the south-west, Tarawera maunga is a similarly distinctive and significant landscape feature.

The plains of the Putauaki land stretch out in front of the site in a north eastern direction, bounded by the two significant rivers – Tarawera and Rangitaiki. The Tarawera River winds down from the mountainous area south of the site, takes a loopy path along the western boundary of the site then straightens out as it stretches between the plains and Lakes Rotohipaki, Rotoroa and Tamurepuhi.

In contrast, the straight edge of the eastern boundary lies parallel to, and just beyond the stretch of State Highway 34 and the adjacent railway line.

Local Catchment

The existing mill site is characterised by its dense mix of buildings and tall structures associated with the pulp and paper processing plant. Again, there is a proliferation of industrial features such as the pipelines, conveyors and isolated structures amongst close knit groups of buildings that are offices, workshops and the like.

Despite the density of the structures and buildings that preclude any views from the midst of the site, Putauaki remains dominant, and the forested hills provide a welcome textural and colour contrast to the dusty, hard surfaced and blocky forms of the site. On the other hand, the complex also contains attractive gardens, planted with mature native plants, within the building groupings that serve to soften the interior of the complex.

Vegetation cover is reasonably sparse in the plains area, consisting of exotic grasses in the pastured areas, while the foothills and mountains have densely planted (and some wilding) pine cover with some remnant and regenerating/rehabilitated native tree and scrub cover.

The existing airstrip, being the proposed site, protrudes from the northern end of the mill site, bounded by the margins of the Tarawera River on the eastern side, the timber yard area on the western side, and Onepu Springs Road at its southern end.

8.3.3 VIEWPOINT ASSESSMENT

View points of the proposed power station were chosen to be representative of those views most likely to be obtained and also of its effects on visual amenity and landscape character. These view points were as follows:

- Residents of Onepu Springs Road travelling past the northern end of the airstrip;
- Residents of the Putauaki land; and
- Those travelling on Kawerau Road/SH34.

Other audiences may include tangata whenua and visitors on the Hauhuru and Tohia o te Rangi marae.

Viewpoint 1: From North End of Airstrip

The current view from this point is a framed perspective of the mill site, except that the site is so far in the distance that it is really only the steam plumes and tallest structures that are visible. Steam (and perhaps dust and other industrial discharge) create a haze that blurs the vanishing point, but the maunga frame each side of the flat, mown line of the airstrip. It is an attractive view that combines the features, forms and lines of the natural and industrial landscape.

From this point on the boundary, between the airstrip and Onepu Springs Road, the audience will obtain a clear 'end-on" view of the cooling technologies. This view is most easily obtained by residents travelling Onepu Springs Road, rather than from the actual residences themselves, which are either side of the corners of the straight part of the road directly facing the end of the strip.

The cooling structures will be the most clearly visible. The visual effect of these structures will be low to moderate, in that the residents have been used to a clear, mown strip, with a distant view of the industrial plant at the far end (some 1250 m away). However, the longest of the two cooling tower systems will reach less than halfway up the strip from the site.

The insertion of another industrial structure into the northern end of the mill site could have the effect of extending the flat area of the dense industrial 'landscape', but given the distance and the haze effect, this will not be significant from this point.

Viewpoint 2: From approximately 1,500m Northwest of Tarawera Road on Putauaki Trust Land

This viewpoint is one obtained by the residents of the Putauaki Trust land. In the absence of specific site positioning of the transmission lines and steam pipes, this view will be analysed in a general way, rather than focussing on specific elements.

The effects the proposal will have on this land are the installation of:

- A new transmission line, which includes poles, lines and insulators; and
- Well pads, drilling waste ponds, production lines, reinjection lines, steam separators and brine accumulators.

The new transmission line will run from the power station, crossing the railway line and SH34; then proceed south-west, parallel to the road reserve to switchgear located alongside the Transpower Kawerau substation. The line will run adjacent to the existing line, with the new poles placed parallel to the existing poles.

The 16 m high poles will be clearly obvious in this flat terrain. The effect however is mitigated by the presence of the existing poles and lines, amongst which the new poles and lines will not be noticed so much as individual elements, but rather a slight increase to the horizontal and vertical linear patterning that exists across the plains in this area.

Similarly, the new pipelines will be incremental to the existing industrial activity within Putauaki Trust land, and will be seen as an increase to the existing structures, rather than as a new element in the landscape. However, additional pipelines will change the relationship, or balance, within the existing landscape patterning, and as such could be viewed by those in close proximity or residence as an adverse effect.

The additional industrial elements associated with the wells and ponds will have a higher visual impact in that they will be new, isolated elements in this landscape. As there are already similar isolated structures existing in this specific landscape, the overall effect is less than moderate.

Views from SH34

State Highway 34 is a loop road off State Highway 30 between Rotorua and Whakatane. The main travellers on the road are those working at, or having businesses on the mill site or travellers to or from Kawerau, and the road is also used by tourists to access the Tarawera Falls.

The road is typical of those in rural/plains areas: wide, flat, with long stretches of straight lengths, the absence of footpaths and kerbs, minimal and open fencing, with open pasture land running adjacent and wide open views either side, and ahead.

Both the power station area and the steamfield area to the east of SH34, will be partially visible from several points along this road, as is much of the existing mill site. Existing planting along the edge of the SH34 and the presence of the timber yard serve to partially screen the site, and will therefore do so for the power station component of the proposal. However, the effectiveness of any existing screening will depend on the option chosen for the cooling structures, with the higher Type 2 towers being more visible.

The new transmission lines, pipelines and well pads, plus associated structures will be visible on the Putauaki Trust land, but this view will be more one of an incremental nature overall. However, the pipelines crossing over the road and the railway will be more or less obvious, depending on whether the lines are taken over or under the crossing.

The visual impact of the transmission lines will be similar to that noted from viewpoint 2.

8.3.4 CONCLUSION

As with any predominantly or historically industrial site, the issue of additional industrial activity can be considered appropriately incremental.

The landscape of this and similar environments has evolved its particular character because of the nature of the industrial activity; but importantly, it is the natural processes and systems that gave rise to the industry that have created the 'natural' character of the landscape.

Therefore, the relationship between the visual effects of the activities on the landscape, and the appearance and existence of the natural features and elements, already has a common basis, in this case the forestry and geothermal activity.

Certain elements, both natural and man-made, may be more dominant than others as individual elements. Others may have significance as being part of a visual collection, mass or field. Such dominance or significance may exist in relation to other elements, or simply stand alone. For instance, Putauaki has dominance as a single entity despite the proliferation of industrial activity at its base, but with the other maunga it provides a frame by which the mill site is enclosed. Further, its significance is enhanced by the flatness of the plains that extend from it in a northwards direction. Similarly, the expanse of the plains is exaggerated by the 'insertion' of isolated groups of or individual vertical elements, whether they are mountains, pylons or conveyor towers.

Any requirement for mitigation measures is, most appropriately considered not so much as a method of attempting to hide or block views of individual or groups of industrial structures, but should be assessed in terms of the visual balance of this landscape.

Overall, and with respect to the appropriate assessment criteria, it is considered that the elements of the power station that are located within the steamfield area:

- Will not generate any adverse effects on the surrounding environment or to the scheduled outstanding natural features identified;

- Are in keeping with the general, local, landscape character;
- Will generate no more than minor effects on landform or vegetation;
- Are of a scale that is in keeping with the scale of other similar activities in the area and integrates into existing landscape features; and
- Represent site sharing of network utilities, therefore reducing cumulative effects.

This assessment concludes that the siting of large scale industry within the plains area is appropriate due to existing industrial activity. The visual quality, visual absorption and visual rating of outstanding and significant landscape units as reported in the Boffa Miskell Ltd (1993) report has been used as a basis for this assessment.

8.4 TRAFFIC EFFECTS

The potential traffic effects of the proposed power station relate to potential traffic capacity, access and safety issues associated with construction, operation and maintenance activities.

Mighty River Power commissioned Traffic Design Group to undertake assessments of the potential environmental effects on traffic. The full report Kawerau Geothermal Power Station Transportation Assessment, (Traffic Design Group April 2005) is contained on the attached CD-ROM and forms part of this AEE.

8.4.1 CONSTRUCTION EFFECTS

Traffic Generation

The bulk of all vehicle trips to the site will occur during the 18-month construction phase when up to 100 staff will be employed on site and in the order of 1500 truck visits are anticipated. The most intensive period of work will be during the construction of foundations and which will generate up to 120vpd with staff generating approximately 200vpd.

Light and heavy traffic associated with construction of the power station will use the access point off SH34 immediately south of the private overbridge. Traffic flows at that access currently consist of about 400 truck movements, or around 1,800 ECM[11] per day. Against this background, the anticipated maximum traffic flow of 600 ECM per day will not cause any more than minor adverse effects on road safety or efficiency.

Additionally, the average traffic generation of 200 car and 4 truck movements per day will be noticeable but will have a negligible effect on existing road users.

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[11] The Kawerau District Plan refers to "Equivalent Car Movements" (ECM) whereby one concrete truck entering or exiting the site is three ECM. Using this scale, the maximum traffic generation is not expected to exceed about 600 ECM per day.

Furthermore drilling will also take place in the vicinity of the existing NST carpark occupying an area of over 1 hectare. Apart from 200 movements to deliver and remove the drill rig at the start and finish of drilling, there are not expected to be more than six external truck movements per day associated with this.

Large Loads

Special deliveries are likely to include overdimension cylindrical towers, cooling stacks or large transformers. With an existing clearance under the overbridge of 5.15m and a currently certified load limit of 80 tonnes, some of the large loads are likely to need to use an alternative temporary access at the northern end of the site, via Onepu Springs Road.

As an initial overview, it is likely that these components will arrive at Tauranga Port and be transported along via SH2, and SH34 to the site, which are well established over-size load routes. Bridges on the route should be capable of supporting the 150 tonne gross vehicle weight of the transformer but will be supervised by structural engineers where necessary in any event.

Parking

In order to accommodate the expected 100 construction staff, it is proposed to construct a temporary 100-space car park at the power station site. This will provide the necessary parking ratio of one space for every construction worker to meet the requirements of the Kawerau District Plan.

Site Access

For the majority of vehicles, primary access to the site will be obtained via the existing heavy vehicle access on SH34 and across the overbridge. Some over dimension or over-height vehicles may access the construction site via a temporary access from Onepu Springs Road and down the air strip, while the production well in the vicinity of the NST car park will be accessed via Fletcher Avenue.

The primary access on SH34 adequately accommodates existing and proposed traffic flows and maintains good sight distances in both directions such that roading capacity and traffic safety is not compromised. The physical separation (220m) between the primary access and the nearest driveway to the intersection also removes any potential conflict between these access points.

Consideration has been given to two other potential access points, namely Fletcher Avenue and Onepu Springs Road. The Fletcher Avenue access is proposed to be used by vehicles associated with drilling in the southern parts of the NST site, where there will be noticeable effect on the performance of the signalised intersection. A new temporary access onto Onepu Springs Road at the northern end of the mill would involve creating a new internal road along the airstrip to connect the power station site with the public road for overweight loads that cannot cross the bridge. However, there are no simple options to bring the intersection of Onepu Springs Road and SH34 up to the standard of the preferred access by the overbridge. As such, it is recommended that the existing site access on SH34 be used by managed construction and operational traffic for the power station.

Steam and Water Pipes

Three pipes carrying water and steam of various temperatures and pressures around 200ºC and 1,600KPa will connect the wells on the eastern side of SH34 with the power station. It is currently proposed that these pipes will be attached to the side of the private overbridge. Alternative options, including the culverting of the pipes with a bridge over the pipes to allow inspection, as has been done on SH1 north of Taupo, are also being considered. A risk analysis has been undertaken on pipes passing both over and under SH34 which has concluded that attaching the pipes to the private bridge is the preferable option. This is a detailed design matter which is being progressed with Transit NZ and the final option and design will be confirmed in consultation with Transit NZ.

Road Safety

In comparing the road safety performance of the last five years with the expected additional traffic resulting from the power station, it is not expected that the development will unduly increase the safety risk to users of the surrounding road network.

8.4.2 OPERATIONAL EFFECTS

Traffic Generation

Regular traffic will consist of shifts of maintenance and operations staff and occasional deliveries. It is expected that the number of daily vehicle movements on or off the site will not exceed 15 vpd.

Given the location of the power station at an operational mill, adjacent to a busy logging yard, it is not intended that public access or tours to the site would be provided. As such, the 15 vpd represents the long-term total trip generation of the power station. Periodic maintenance of the power station will generate a small level of heavy traffic from time to time, but will be negligible compared to existing heavy traffic flows to and from the site.

Site Access

Long term access for operational and maintenance vehicles will occur via the same access points that will be utilized by vehicles during construction as specified in Section 8.3 above.

8.4.3 CONCLUSION

The traffic assessment has found that:

- The additional volumes of heavy traffic that will be generated during the construction and operational phases can be adequately accommodated on the surrounding road network without compromising its function, capacity or convenience to road users;

- The existing high standard intersection on SH34 provides appropriate access to the site in a manner which will have no discernable effect on the safe and efficient operation of the surrounding road network;
- All parking demand is accommodated on site;
- Being located adjacent to the state highway network, the site is well placed to receive overweight and over-dimensioned loads via established transport routes; and
- Mighty River Power is currently engaged with Transit NZ in relation to the development of specific designs for steam pipes and transmission lines that will cross SH34 in order to ensure that the safest option to meet all of the current standards is selected.

Overall it is concluded the construction, operation and on-going maintenance of the proposed power station can be undertaken in a manner whereby the consequential traffic effects will be no more than minor.

9 CONSULTATION

9.1 CONSULTATION PRINCIPLES AND APPROACH

Consultation is an important aspect of the proposed Kawerau geothermal project because of the range of parties who are interested in the future of this area. In preparing the consultation programme, the project team adopted the following consultation principles and approach:

- To recognise consultation as an on-going and integral part of the whole Kawerau geothermal project, both prior to and after the formal lodging of the applications and Assessment of Environmental Effects;
- To prepare a summary consultation brochure (appended) explaining the scope of the Kawerau geothermal project to interested and/or affected parties;
- To prepare a range of technical, environmental and resource studies prior to discussing any detail of the actual or potential effects of the Kawerau geothermal project with the interested parties (i.e. to establish information and the factual position from independent experts prior to engaging in discussions with other parties on detailed matters);
- To be readily available throughout the course of the project to members of the public or interested parties who wish to meet to discuss any issues; and
- To respond to matters of concern raised by parties.

Consultation has been undertaken with a number of possibly affected and interested parties. The key parties and the results of the consultation undertaken are set out below.

9.2 DISCUSSION WITH COUNCILS

Environment Bay of Plenty

Mighty River Power met with staff of the Environment Bay of Plenty in May 2005 in relation to the Kawerau geothermal project. Matters discussed included an overview of technical assessments undertaken and various process-related issues.

Copies of draft documentation were provided to Council in early August 2005.

Kawerau District Council

Mighty River Power met with representatives of the Kawerau District Council in May and June 2005 in relation to the Kawerau geothermal project. Matters discussed included an overview of technical assessments undertaken and various process-related issues. Kawerau District Council is generally supportive of on-going development within their district.

Copies of draft documentation were provided to Council in early August 2005.

Whakatane District Council
Mighty River Power met with staff of the Whakatane District Council in June 2005 in relation to the Kawerau geothermal project. Matters discussed included an overview of technical assessments undertaken and various process-related issues.

Copies of draft documentation were provided in early August 2005.

9.3 CONSULTATION WITH OTHER STATUTORY AGENCIES

Department Of Conservation
Mighty River Power met with staff from the Department of Conservation in May 2005 in relation to the Kawerau geothermal project. Matters discussed included the approach to sustainable management of the geothermal resource and the potential impacts of the operation on geothermal surface features and ecosystems, including those on the Parimahana Reserve. Discussions will be ongoing..

Bay Of Plenty Health
As a result of discussions with Dr Phil Shoemack, Medical Officer of Health for Bay of Plenty Health, a copy of the summary consultation document was provided on 1 August 2005. Discussions will be ongoing.

9.4 CONSULTATION WITH TANGATA WHENUA

Mighty River Power has consulted for over two years with representatives of tangata whenua on commercial and cultural issues and this has resulted in the signing of formal agreements between Mighty River Power and both Ngati Tuwharetoa Bay of Plenty Settlement Trust and the Putauaki Trust. Constituent members of the Putauaki Trust largely affiliate with Ngati Awa and constituent members of the Ngati Tuwharetoa Bay of Plenty Settlement Trust clearly affiliate with Tuwharetoa Ki Kawerau.

Specifically, more recent consultation on cultural issues has been focussed to identify places, values and relationships of significance to tangata whenua and to assist Mighty River Power to identify methods to avoid, mitigate, or remedy adverse environmental effects resulting from the establishment of its proposed power station. In addition, Trustees of these groups have provided guidance and assistance to Mighty River Power to ensure that Maori with a relationship with the subject land are consulted appropriately.

9.5 CONSULTATION WITH TASMAN INDUSTRIALS

Carter Holt Harvey Tasman and Woodproducts

Initial meetings were held with CHH representatives in June 2005 in relation to the Kawerau geothermal project. Ongoing dialogue has considered beneficial effects of localised power generation and potential impacts of geothermal development on their operations.

Discussions and assessments are continuing at time of writing.

Svenska Cellulosa Aktiebolaget (SCA)

A meeting was held with SCA representatives in June 2005 in relation to the Kawerau geothermal project. Matters discussed included beneficial effects of localised power generation and potential impacts of geothermal development on their operations.

9.6 CONSULTATION WITH LOCAL INFRASTRUCTURE/UTILITY MANAGERS

Transit

Meetings were held with Transit in relation to the wider Kawerau geothermal project in March and May 2005. A letter dated 7 July 2005 confirms that all RMA considerations of relevance to Transit have been addressed.

Ontrack

A teleconference was held with Ontrack representatives in May 2005 in relation to the Kawerau geothermal project. Matters discussed included potential impacts of operation on local rail infrastructure, management of storm water and traffic efficiency surrounding SH34 level crossing. Further information was provided to Ontrack in July 2005 and discussions are continuing at time of writing.

Copies of the summary consultation document were provided to **Toll NZ** and **Transfield Services** as operators and service providers on the local rail network

Natural Gas Corporation

A teleconference was held with NGC representatives in May 2005 in relation to the Kawerau geothermal project. Matters discussed included potential impacts of operation on local gas network and effects of air discharges on above ground infrastructure. A letter dated 2 August 2005 confirms that all RMA considerations of relevance to NGC have been addressed.

EBoP Drainage Group

A teleconference was held with an EBoP river and drainage representative in July 2005 in relation to the Kawerau geothermal project. Matters discussed included potential impacts of operation on Tarawera River. Further information was provided to the EBoP river and drainage department in July 2005.

Transpower
A meeting was held with Transpower representatives in April 2005 in relation to the Kawerau geothermal project. Matters discussed included potential impacts of operation on high voltage transmission network and grid connection issues.

Horizon Energy Distribution Ltd
A meeting was held with Horizon Energy representatives in May 2005 in relation to the Kawerau geothermal project. Matters discussed included potential synergies with respective operations.

Bay Of Plenty Electricity
A meeting was held with BoP Electricity representatives in June 2005 in relation to the Kawerau geothermal project. Matters discussed included potential synergies with respective company operations.

9.7 CONSULTATION WITH ADJOINING LANDOWNERS

On 1 August 2005 a copy of the summary consultation document was provided to parties with landholdings overlying and around the Kawerau geothermal resource as shown on Table 9.1 and Figure 9.1. Parties were invited to contact Mighty River Power if further interested in the Kawerau geothermal project.

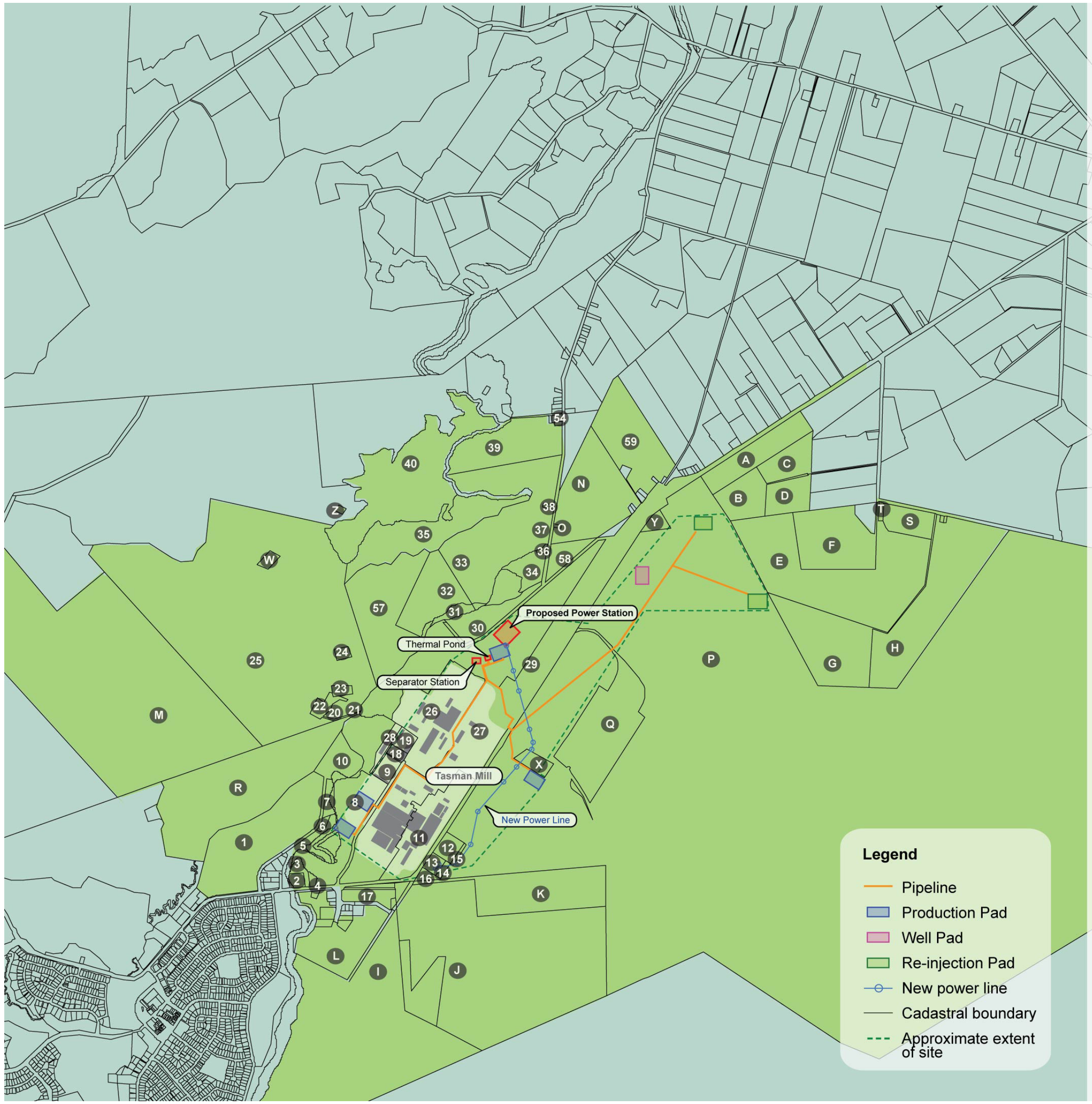
Table 9.1: Parties with Landholdings overlying and around the Kawerau Geothermal Resource

Id	Block	Name	Address
32	Allot 39A sec 2	B Adlam	The Owners Lot 39A c/- B Adlam 82 Westridge Dr Bethlehem TAURANGA
33	Lot 39A2B2B2A Matata	B Adlam	The Owners Lot 39A2B2B2A Matata c/- B Adlam 82 Westridge Dr Bethlehem TAURANGA
N	Sec 12A1C Block IX Rangitaiki upper SD	H Hiraka	H Hiraka 447 Onepu Springs Rd RD2 WHAKATANE

59	Sec 12B2D Block IX Rangitaiki Upper SD	H Hiraka	The Owners 12B2D c/- H Hiraka 447 Onepu Springs Rd RD2 WHAKATANE
36	Lot 1 DPS 15826	B Adlam	The Owners Lot 1 DPS 15826 c/- B Adlam 82 Westridge Dr Bethlehem TAURANGA
34	Pt Lot 3 DPS 2476	B Adlam	The Owners Lot 3 DPS 2476 c/- B Adlam 82 Westridge Dr Bethlehem TAURANGA
O	Sec 12A1A Block IX Rangitaiki upper SD	J&T Hudson	J&T Hudson Onepu Springs Rd KAWERAU
39	Allot 39A2B1B2B	T Fox	The Owners Lot 39A2B1B2B c/- T Fox PO Box 158 KAWERAU
L		Manukorihi Trust	Manukorihi Trust c/- J Aratema 3 Westminster Drive ROTORUA
M	Kawerau A5B	B Adlam	The Owners Kawerau A5B c/- B Adlam 82 Westridge Dr Bethlehem TAURANGA
25	Kawerau A8D	T Fox	Chairman A8D Trust c/- PO Box 186 KAWERAU
40	Pt Allot 39A4 Matata	Kawerau A8, 39A4 & A11 Trust	Chairman 39A4 Trust c/- PO Box 186 KAWERAU
35	Kawerau A11	Kawerau A8, 39A4 & A11 Trust	Chairman A11 Trust c/- PO Box 186 KAWERAU

38	Allot 39A2B2A	B Adlam	The Owners Lot 39A2B2A 82 Westridge Dr Bethlehem TAURANGA
A	Lot 1 DPS 47339	S van Ameringen (owner)	32 Endeavour Ave Welcome Bay TAURANGA
A	Lot 1 DPS 47339	Linda Clarke (occupier)	L Clarke Park Rd RD2 WHAKATANE
B	Lot 2 DPS 47339	T&M McCauley	T&M McCauley Park Rd RD2 WHAKATANE
C	Lot 3 DPS 47339	L Conway & V O'Brien	L Conway & V O'Brien Park Rd RD2 WHAKATANE
D	Lot 4 DPS 47339	D Jackson & F Hennessey	D Jackson & F Hennessey Park Rd RD2 WHAKATANE
E	Lot 2 DPS 78379	CJ Park	CJ Park Park Rd RD2 WHAKATANE
F	Lot 1 DPS 62518	RD Park	RD Park Park Rd RD2 WHAKATANE
G	Allotment 59B2D2C1 Matata Parish	JP Edwards	JP Edwards Park Rd RD2 WHAKATANE
H	Allotment 59B2D2C2C Matata Parish	JP Edwards	JP Edwards Park Rd RD2 WHAKATANE
I	Pt Allotment 59B2C	Cathy Burgess	The Owners Lot 59B2C c-/ C Burgess PO Box 87 TE TEKO
J	60B Matata	V Thompson	V Thompson SH30 RD2 WHAKATANE
K	Lot 59B2C2B1	P Wetini	The Owners Lot 59B2C2B1 c/- P Wetini

			132 Valley Road KAWERAU
	MT	E&K Lambert	E&K Lambert 133 Lambert Rd RD2 WHAKATANE
	MT	R Hunia	R Hunia PO Box 312 KAWERAU
		Colin Hammond	C Hammond Onepu RD2 WHAKATANE



Key	Legal Description
1	Matata Parish Allotment 1198
2	DPS5539 LT1
3	DPS10187 LT1
4	DPS53920 LT1
6	Matata Parish Allotment 1364
7	Matata Parish Allotment 1363
8	DPS87801 LT2
9	DPS4706 LT2
10	Matata Parish Allotment 1362
11	DPS90818 LT1
12	Matata Parish Allotment 59B2D4
13	Matata Parish Allotment 59B2D4
14	Matata Parish Allotment 59B2D4
15	Matata Parish Allotment 59B2D4
16	Matata Parish Allotment 59Z1
17	DPS40870 LT1-3
18	DPS4706 LT1
19	DPS12743 LT3
24	Matata Parish Allotment 39A4
25	Kawerau A8D
26	DPS87786 LT1
27	DPS90818 LT2
28	DP12743 LT4
30	DPS2476 LT4
31	DPS2878 LT2
32	Matata Parish Allotment 39A2A
33	Matata Parish Allotment 39A2B2B2A
34	DPS2476 LT3
35	Kawerau A11
36	DPS15826 LT1
37	Matata Parish Allotment 39A2B2B2A
38	Matata Parish Allotment 39A2B2A
39	Matata Parish Allotment 39A2B1B2B
40	Matata Parish Allotment 39A4
54	Matata Parish Allotment 39A3D2A
57	DPS2878 LT1
58	DPS2476 LT2
69	Rangitaiki Upper SD Section 12B2D Block IX
A	DPS 47339 LT1
B	DPS 47339 LT2
C	DPS 47339 LT3
D	DPS 47339 LT4
E	DPS 78379 LT2
F	DPS 62518 LT1
G	Matata Parish Allotment 59B2D2C1
H	Matata Parish Allotment 59B2D2C2C
I	DPS76506 LT3 Lot 59B2C
J	DPS92247 Flat 2 60B Matata
K	Matata Parish Allotment 59B2C2B1
L	DP79599 LT2
M	SAPR69A/342 Kawerau A5B
N	Rangitaiki Upper SD Section 12A1C Block IX
O	Rangitaiki Upper SD Section 12A1A Block IX
P	DPS308053 LT3
Q	DPS87786 LT1
R	Matata Parish Allotment 927
S	DPS78379 LT1
T	Matata Parish Allotment 59B2D2B1
X	DPS63847 LT1
Y	Matata Parish Allotment 59Y
Z	Matata Parish Allotment 39A4

Figure 9.1: Landholder Information in Kawerau Area

9.8 CONSULTATION WITH OTHER PARTIES

Forest and Bird

A copy of the summary consultation document was sent to Forest and Bird c/- Mark Fort for the information of local members on 1 August 2005.

Wider Community

A series of public information days have been advertised in local media during August and September 2005 providing opportunity for the wider community to talk to Mighty River Power staff about the proposed Kawerau geothermal project.

10 RESOURCE MANAGEMENT ACT REQUIREMENTS

10.1 RESOURCE MANAGEMENT FRAMEWORK

This section reviews in detail the current statutory context relevant to the proposed power station, geothermal extraction and associated activities. The governing statutes are the provisions of the RMA and the operative and proposed policy statements and plans for each consenting authority being Environment Bay of Plenty (EBoP), Kawerau District Council (KDC) and Whakatane District Council (WDC).

10.1.1 NEED FOR RESOURCE CONSENTS

The purpose of the Resource Management Act is to promote the sustainable management of natural and physical resources. This is achieved through regulating the use and development of natural resource, principally through the resource consent process. Part III of the RMA details the duties and restrictions under the Act. Various activities associated with the proposed power station are restricted under the RMA, *"...unless expressly allowed by a rule in a regional plan and in any relevant proposed regional plan or a resource consent."*

Given the nature of the proposed power station and the fact that many of the activities are not provided for by the relevant Regional and District Plans, a number of activities will require authorisation from EBoP, KDC and WDC in the form of resource consents. The resource consents required are summarised in Table 10.1 below.

Table 10.1: Summary of Resource Consents Required

Power Plant Construction & Well Drilling and Testing	Relevant Plan	Status of Activity
Land use consent – vegetation removal and earthworks	PRWLP	Discretionary
Water Permit – take of water for construction and dust suppression purposes[12]	PRWLP	Discretionary
Discharge Permit – disposal of storm water (to ground and/or surface waters)	PRWLP	Discretionary
Construction, alterations and maintenance of geothermal production, reinjection and monitoring wells.	PRWLP	Discretionary
Steamfield and Power Plant Operation	Relevant Plan	Status of Activity
Water Permit to authorise the take of geothermal water and energy for power production and other downstream uses	PRWLP & TRCP	Discretionary
Water Permit – take of water for station operation and cooling purposes[13]	PRWLP & TRCP	Discretionary
Discharge Permit – discharge of geothermal water and energy and drilling additives to ground (via soakage and/or reinjection)	PRWLP	Discretionary
Discharge Permit – discharge of steamline condensate and geothermal residues onto or into land associated with operational, construction and maintenance activities	PRWLP	Discretionary
Discharge Permit – discharge of abatement chemicals into the ground (via wells)	PRWLP	Discretionary
Discharge Permit – discharge of geothermal vapour and gases to the atmosphere from the steamfield and power plant.	RAP	Discretionary
Discharge Permit – to authorise the disposal of storm water (to ground and/or surface waters)	PRWLP	Discretionary
Ancillary Matters	Relevant Plan	Status of Activity
Land Use Consent – Height of Transmission Lines	KDP	Discretionary
Land Use Consent – Hazardous Substances	KDP	Discretionary
Land Use Consent – to authorise the use, construction and maintenance of geothermal wells and associated earthworks.	WDP	Discretionary
Land Use Consent – to authorise the construction of well head structures.	WDP	Discretionary

[12] Authorised by existing consent 02 4226 held by NST. Expiry 31.12.12 but will require a variation to the purpose for which water is taken.
[13] See note 1

Note: PRWLP – Bay of Plenty Proposed Regional Water and Land Plan
RAP – Bay of Plenty Operative Air Plan
KDP – Kawerau Operative District Plan
TRCP – Tarawera River Catchment Plan
WDP – Whakatane District Plan

10.1.2 MATTERS TO BE CONSIDERED

A resource consent application must have regard to Part II and Sections 104 and 107 of the RMA. The RMA requirements are described in more detail in Section 10.1.3 below. As already noted in Section 1, the background and technical information in this report is provided to meet the requirements of the Fourth Schedule and Section 88(2) of the RMA which requires that the application include:

b. an assessment of environmental effects in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

In making a decision in relation to the proposed activity both the Bay of Plenty Regional Council and Kawerau District Council, must have regard to Part II of the RMA (refer 104(1)); that is, the sustainable management of resources. In Section 5(2) of the RMA, sustainable management is defined as:

…"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. . . "

Section 104 of the Resource Management Act (RMA) provides consent authorities with a framework for considering applications for resource consent. Section 104(1) is reproduced below:

104. Consideration of applications

104(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part II, have regard to–

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

(b) any relevant provisions of:
   (i) a national policy statement;
   (ii) a New Zealand coastal policy statement;
   (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.*

In accordance with Sections *104(1) (b) (iii) and (iv),* the following policy and planning documents are considered to be relevant to the application for which resource consent is being sought:

- Bay of Plenty Operative Regional Policy Statement (1 December 1999);
- Bay of Plenty Transitional Regional Land Management Plan (1 Feb 2002);
- Bay of Plenty Proposed Regional Water and Land Plan (4 May 2004);
- Bay of Plenty Operative Regional Air Plan (15 December 2003);
- Bay of Plenty Operative Regional Plan for the Tarawera River Catchment (1 Feb 2004);
- Kawerau District Plan (Operative 8 June 1999); and
- Whakatane Proposed District Plan (5 November 2004).

The relevant sections of the statutory documents are discussed in turn below.

10.2 ENVIRONMENT BAY OF PLENTY REGIONAL POLICY STATEMENT

Environment Bay of Plenty's Regional Policy Statement (RPS) became operative in December 1999. The full text of the relevant objectives and policies of the RPS are contained in Appendix 3 and the sections below address the key matters raised in relation to the power station:

10.2.1 LAND

The key objectives and policies on land as contained in Appendix 3 relate to the protection of soils and water resources for rural production. A number of well pads and pipelines are on rural land. However rural production on the Putauaki land will continue largely unaffected and the applicant intends to adopt sustainable land use and management practices in order to protect land and water from degradation and to enable to Kawerau community and wider Bay of Plenty Region to provide for their social, economic and cultural wellbeing.

10.2.2 AIR

As identified in Section 8 of this report, concentrations of H_2S and minor emissions will be within the nominal guidelines and are unlikely to lead to any significant loss of amenity beyond the immediate vicinity of the site. In particular, effects of H_2S discharges in Kawerau do not increase appreciably as the area already experiences elevated concentrations of H_2S due to natural sources and existing discharges. With respect to minor gases discharged from the proposed power station, and in particular mercury, will be insignificant with concentrations well below the Ministry for the Environment guidelines. In terms of dust, the implementation of appropriate mitigation measures will ensure that dust disturbance is minimised during the construction phase. On this basis, the proposed power station is consistent with the objectives and policies as contained in Appendix 3 as there will be no resultant significant adverse effects on people and the environment as a result of discharges of chemical, odorous and particulate contaminants into the air.

Section 4 also explains how the use of geothermal energy to generate electricity results in much lower emissions of CO_2 per output. The Kawerau power station will enable the avoidance of higher CO_2 providing thermal emissions through substitution in the market place and also through avoidance of transmission losses.

10.2.3 WATER RESOURCES

As described in Sections 3 and 7 of the AEE, the proposed power station has no direct effect on the Tarawera River or other surface water body through takes or discharges. Storm water discharges, water in well pad ponds and the risk of spillages will be managed so as to avoid or minimise any adverse effects on both ground and surface waters. Accordingly, the proposal meets the objective and policies (Appendix 3) with respect to water quality, In particular, the Region's existing water quality will be maintained thereby ensuring that aesthetic and cultural values associated with water are protected and that the resource is sustained for future generations.

10.2.4 GEOTHERMAL RESOURCES

The proposed power station is consistent with the objectives and policies contained in Appendix 3 of the AEE. It is considered that the geothermal features valued in the region will be protected and the use, development and protection of the region's geothermal resources will be managed in a safe and sustainable manner. In particular:

- The further development of the field is to be undertaken pursuant to a steamfield management plan which has as its goals a sustainable and efficient development of the geothermal resource;
- Reinjection of the spent geothermal fluid is proposed;
- The geothermal resource modelling of the increased abstraction demonstrates that the proposed level of abstraction is sustainable over the consented period in terms of the resource still being viable in 2050;
- The extent of subsidence is at a level which will have only negligible effects on the area's infrastructure and plant;
- The proposed development adopts accepted practices of hazard avoidance particularly where plant or pipelines interface with the public; and
- There will be no significant effects on existing geothermal features or ecosystems.

10.2.5 HAZARDOUS SUBSTANCES & WASTE MANAGEMENT

As outlined in Section 3 of the AEE, hazardous substances associated with the operation of the proposed power station will be stored in a safe and appropriate manner to avoid and minimize the risk of hazardous spills. In addition, the proposed power station will not release unacceptable concentrations of contaminants into the environment as further described in Section 7 of the AEE. On this basis, it is considered that the proposal meets the relevant objectives and policies of the RPS (Appendix 3) with respect to the storage and use of hazardous substances.

10.2.6 PHYSICAL RESOURCES/BUILT ENVIRONMENT

In general terms the proposed power station will be managed appropriately to enable the efficient use, development and protection of natural and physical resources in the vicinity of the subject site whilst also protecting existing transportation and utility infrastructure. Additionally, an efficient and safe land transport network will be maintained during the construction and operational stages of the proposed power station as described in Section 8 of the AEE. Overall therefore, it is considered that the relevant objectives and policies relating to physical resources and the built environment will be achieved.

10.3 ENVIRONMENT BAY OF PLENTY REGIONAL LAND MANAGEMENT PLAN

As the Environment Bay of Plenty Water and Land Plan is still proposed, regard must be given to the Transitional Regional Plan. Within the Transitional Plan there are certain rules that still apply until the relevant rules within the Regional Water and Land Plan become operative. The rules in the Operative Plan that still apply in relation to the proposed power station are limited to earthworks for which restricted discretionary activity consent is sought, and vegetation removal, also requiring restricted discretionary activity consent. It is considered that these matters are adequately covered in the following section.

10.4 ENVIRONMENT BAY OF PLENTY TRANSITIONAL REGIONAL PLAN

As aforementioned in Section 10.3, the Environment Bay of Plenty Water and Land Plan is still proposed. Accordingly, regard must also be given to the Transitional Regional Plan (TRP). Under General Authorisation 4 of the TRP, the discharge of water containing waste onto or into the ground associated with well drilling activities is permitted.

10.5 ENVIRONMENT BAY OF PLENTY PROPOSED REGIONAL WATER AND LAND PLAN

Council's decisions on the Proposed Regional Water and Land Plan (PRWLP) were publicly notified on May 2004 and appeals to the Environment Court are currently being assessed. Once operative, the PRWLP will supersede the Transitional Regional Plans and the Proposed Regional Plan for the Tarawera River Catchment (TRCP).

As referred to in Section 1.4 of this report, NST holds a number of resource consents relating to the current operation on the industrial site including a storm water discharge permit, a water permit to take water from the Tarawera River and an air discharge permit.

NTGA also holds a number of resource consents relating to the current operation at the industrial site. These include water and discharge permits for the existing geothermal operations and for ongoing well drilling and well maintenance.

Mighty River Power has entered a formal agreement with NST whereby water for any use associated with the power station can be supplied from the NST water take under Permit 02-4226. This permit currently provides for 160,000m^3 per day whereas the NST site operations only utilise a maximum volume of 130,000m^3 per day. The spare capacity is more than enough to provide for the volume required by Mighty River Power for power station purposes. Utilising the NST water permit will avoid the need for any additional allocation from the river.

While Mighty River Power will be utilising existing water permits for the take and use of water for drilling purposes, a separate consent is sought for the construction and drilling of the geothermal wells on both NST and Putauaki Trust land. However, in doing so, there will be no requirement to obtain additional permits to authorise the take and use of water from the river that is associated with well drilling activities.

Under the PRWLP consents will be required for the following activities:

10.5.1 LAND DISTURBANCE ACTIVITIES

Earthworks and Vegetation Disturbance

Earthworks associated with the construction of the proposed power station and well drill pads will be in excess of the 10,000m^3 limit for a permitted activity. Consent for a discretionary activity is therefore required pursuant to Rule 1 of the PRWLP.

No vegetation, other than pasture will be disturbed for the proposed power station, well heads or pipelines.

10.5.2 DISCHARGES TO WATER AND LAND

Mighty River Power proposes to discharge storm water to storm water ponds and drilling waste and geothermal fluid to well ponds during drilling/well testing activities. It is also proposed to discharge steamline condensate and geothermal residues onto or into land at various points in the system. Consequently, storm water, drilling waste and geothermal fluids may enter groundwater during both construction and operation of the proposed power station. In the case of extreme rainfall events, discharges to the Tarawera River may occur.

Rule 30, in relation to discharges to surface water has the effect of limiting the total impervious surface of the site of a permitted activity to 5000m^2. As the power station site will exceed this limit, a discretionary activity consent will be required pursuant to Rule 37. A discretionary activity consent is also required for the discharges to ground from any storm water pond or well pond.

10.5.3 GEOTHERMAL WATER, HEAT OR ENERGY

The proposed power station depends on the take and use of geothermal water, heat and energy. The Kawerau geothermal field is located in a Geothermal Management Group 4 Area. Consequently, these activities are discretionary activities pursuant to Rules 72 and 77 of the PRWLP. The discharge of geothermal water to ground by reinjection may also include antiscalants. It is noted that the installation of geothermal bores in Geothermal Management Group 4 and the take and use of geothermal water, heat or energy for bore testing or use is permitted in accordance with Rule 75, and it is intended that the specified conditions listed (a) to (f) will be met.

The sustainable management of the geothermal resource has been addressed above in relation to the RPS. It is considered that the proposal is consistent with the provisions of the PRWLP.

10.6 ENVIRONMENT BAY OF PLENTY REGIONAL AIR PLAN

The Regional Air Plan (RAP) became operative on 15 December 2003 with all provisions having been through the submission, hearing and appeal process.

Rule 17 *Permitted Activity – Venting of Geothermal Gas and Steam,* provides for the discharge of geothermal gases and steam into air as a permitted activity up to a maximum take of 1,000 tonnes per day. Consequently, discretionary activity consent is sought pursuant to Rule 20 of the RAP as the proposed power station cannot comply with conditions 4 and 6 above for the reasons specified below:

The application is to be assessed against the anticipated environmental results that are outlined in Section 7 of the RAP and the criteria for permitted activity applications.

These results and criteria have been considered with respect to discharge of contaminants into air from the proposed power station and are assessed within Section 7. In particular;

- Best practicable options have been utilised at the power station to minimise the concentration of H_2S at sensitive receiving points in Kawerau, Te Teko and Edgecumbe;
- Cumulative effects of the discharges have been assessed and the conclusions are that there will be some minor deterioration in the air quality of Kawerau, Te Teko and Edgecumbe but that this will be limited to a small number of hours each year;
- The existing air quality of the Kawerau area will not be compromised to the extent that there would be consequential adverse effects on human health and well being;
- There will be no discernible decrease in visibility as a result of the discharge of steam;

- Appropriate management practices will be implemented during the construction phase to avoid, remedy or mitigate adverse effects arising from dust particulates; and
- The proposed power station will contribute to the social and economic well being of the local communities. It is considered that the identified discharges to air are reasonably consistent with the above assessment criteria.

10.7 ENVIRONMENT BAY OF PLENTY TARAWERA RIVER CATCHMENT PLAN

The Tarawera River Catchment Plan (TRCP) became operative on 1 February 2004 with all provisions having been through the submission, hearing and appeal process. These provisions will be superseded by the PRWLP when it becomes operative, but currently remain in force.

Chapter 17 of the TRCP contains provisions that relate to drilling and the construction of geothermal wells and the taking and discharge of geothermal fluid, whereby the proposed power station requires discretionary activity consent pursuant to the Rules 17.4.4(a) to authorise the take of geothermal mass, water, heat or energy from the Kawerau geothermal field, and Rule 17.4.4(d) to authorise the reinjection of geothermal fluid into the Kawerau geothermal field.

The TRCP requires that the application is assessed against the anticipated environmental results that are outlined in Section 17.4.6. These relate mainly to the discharge of geothermal water to the Tarawera River (which is not being proposed) and the sustainable management of the take and discharge, which has been assessed in Section 10.5 above.

10.8 KAWERAU DISTRICT PLAN

The Kawerau District Plan (KDP) became operative on 8 June 1999 and is therefore the primary statutory document in determining what aspects of the proposal require consent under Kawerau District Council's jurisdiction.

10.8.1 LAND USE ZONING

The subject site lies partially within the Industrial Area 1 Zone of Kawerau District. More specifically, the components of the power station that fall within the Industrial Area 1 Zone include:

- The power station including the cooling facilities;
- The production pad located in the vicinity of NST car park on the south west side of the mill;
- Production pads on the north-east side of the mill;

- The pipelines that connect production and reinjection well pads to the power station; and
- The initial section of the transmission line.

10.8.2 INDUSTRIAL ZONE RULES

The proposed power station and the majority of activities associated with the power station meet the standards contained in Chapter 2 of the KDP and are therefore permitted within the Industrial Area 1 Zone pursuant to Rule 2.2.1. The following table summarises the key aspects of the proposal which are permitted activities under this Rule:

Table 10.2: Compliance with Relevant Performance Standards

Industrial Zone Rules	Performance Standards	Compliance
2.3.1 Height	No maximum height for buildings and structures in Industrial 1 Zone (but note height restriction on transmission lines in Rule 9.1 (3)(b) below.	N/A
2.3.2 Yards & Landscaping	Minimum distance between any building and structure and the front boundary of the site shall be 6.0m; and - For sites adjoining SH34, a minimum 3.0m-wide landscaped strip shall be provided along entire site boundary except within 3.0m of any vehicle access point.	Complies[14] Complies
2.3.3 Signs	The maximum signage on any site shall not exceed: - Maximum area (12m^2) - Maximum height (5m) - Off–site signs which are located so as to be visible from SH34 are an exception	Complies
2.3.4 Traffic Management	The Rules in Appendix C shall apply as follows: - Parking requirements for the pulp and paper mill: 1 parking space per maximum number of employees on the site at any one time. - All parking spaces must comply with the 90 Percentile Car Tracking Curve Minimum Radius. - All permitted activities shall provide at least one loading space - Access points must be located to ensure safe entry or egress.	Complies Complies Complies Complies
2.3.5 Hazardous Substances	Rules set out in Chapter 10 Hazardous Substances shall apply as follows: When any activity is determined to be a permitted activity after screening under the HFSP procedures, it must also comply with the following:	Does not comply. See section 10.8.3

[14] The above-ground pipeline structures do not fall within the KDP definition of "building", as they are less than 1m in height.

	- All other relevant rules in the Plan - The development controls in clause 6 including: Site design and management; waste management and signage.	below Complies
2.3.6 Heritage	The Rules in Chapter 8 Heritage shall apply as follows: - No tree or wetland identified in Appendix D or any other significant indigenous ecosystem shall be cut, damaged, altered, injured, destroyed or partially destroyed or any earthworks, clearance of indigenous vegetation, storage of materials, vehicles, machinery, discharge of any toxic substance or any use, construction or other activity be undertaken within the tree's dripline or the extent of the wetland or any other recognised indigenous ecosystem. - No geological feature (including geothermal surface features) listed in Appendix D shall be destroyed or altered in any manner. - No building or object listed in Appendix D shall be destroyed, removed, added to, altered or damaged. - No Maori Heritage site or Archaeological site shall be destroyed or altered in any manner.	N/A Complies Complies Complies
2.3.7 Noise	There is no specific noise standard in the industrial zones. Any noise produced by activities in the industrial zone shall be managed through the excessive noise provisions of the RMA 1991	Complies

10.8.3 HAZARDOUS SUBSTANCES

The hazardous substances which are required for the power station operation have been described in Section 4. These include the isopentane and ammonia to operate the turbines, the acid and caustic biocide and dispersant used in ancillary operations. The measures to use and store these substances safely in accordance with the KDP requirements have been described in Section 4 also.

10.8.4 UTILITY SERVICES RULES

Chapter 9 of the KDP contains provisions applying to network utilities. The rules for network utilities relate to transmission lines associated with the proposed power station.

In particular, a new 110kV transmission line of approximately 1000m in length will connect the power station into 110kV switchgear at Transpower's Kawerau Substation. The line will leave the power station site and proceed directly to the State Highway where it will then cross the railway line and road and proceed south-west parallel to SH34 to the Transpower substation.

The new single circuit 110kV interconnection line will be constructed using standard Transpower pole configurations and will be designed to comply with all Transpower standards. Conductors for the three phases of line have a diameter of approximately 26mm. Due to the proximity to the substation, an earthwire of approximately 10mm diameter would be installed over the full length of the interconnection line.

Octagonal concrete poles would be used throughout and would typically extend some 16m above the ground. Typical spans would be 160m in length. Insulators would be the composite post type, will be mounted almost horizontally, extend over a length of 1200mm and will be attached to short 2600mm-long cross arms. The bottom cross arm will be approximately 13m above the ground, with the second arm 3300m higher. A steel pole extending some 2600mm above the top of the concrete pole will be supporting the earthwire.

In accordance with Rule 9.1(3)(b), the proposed transmission lines exceed a height of 8.0m and therefore require consent as a discretionary activity. When assessing an application to construct and operate this network utility, Council shall have regard to the assessment criteria contained under section 9.8.1 through to 9.8.4 of the KDP which refer to visual impact, noise, lighting and pollution by petroleum products (transformers etc.) The visual impact of the lines has been assessed in Section 6 as being minor and the lines are well separated from any residential or recreational land. The lines do not have any noise, lighting or pollution implications. It is considered that the network utilities associated with the proposed power station are consistent with the relevant assessment criteria.

10.9 PROPOSED WHAKATANE DISTRICT PLAN

The relevant statutory document from Whakatane District Council under which the proposed power station should be considered is the Proposed Whakatane District Plan (WDP), dated 5 November 2004 (as amended by Council's most recent decisions). The WDP has made sufficient advances through the public notification and hearing process in order that a governing degree of weight can be placed on its controls, rather than those controls contained within the Transitional Whakatane District Plan (1991).

10.9.1 GENERAL PROVISIONS

While the WDP does not expressly provide for geothermal well drilling in the Rural 1 Zone it is considered appropriate to deal with such activities under Rule 3.8.1.3 (5b) contained within Chapter 3 - *General Provisions,* of the Plan[15]. This Rule requires discretionary activity consent in the Rural 1 Zone for *"exploration which is not a permitted activity in accordance with Rule 4.1.3.2"* where Rule 4.1.3.2 – *Exploration for Aggregate, Sands, Gravel or Pumice* requires that:

i) The period of exploration does not exceed one month in duration;
ii) No explosives are to be used;

[15] Whakatane District Council has deemed that well drilling activities in the Rural Zones are best considered as a discretionary activity under 5b of General provisions 3.8.1.3.

iii) Compliance with Rules 4.1.1.7 (Property Access), 4.1.2 (Earthworks and Site Restoration), 4.1.5 (Protection of Flood Control Stopbanks and Drains), 4.3.15 (Nuisance Performance Controls), 4.3.19 (Traffic Sight Lines at Railway Crossings) and 4.3.20 (Whakatane and Galatea Airport Approach Path); and
iv) Indigenous vegetation shall be protected from disturbance by exploration activities except for such disturbance as is unavoidably necessary and in compliance with any rule in this Plan relating to the protection of indigenous vegetation.

Although well drilling activities wholly comply with conditions ii) and iv), compliance with condition i) is unable to be achieved as the well drilling operations are anticipated to occur over a duration of several weeks.

Additionally, the proposed well drilling operations, which involve large diesel engines and mechanical noise from drill pipe handling and the rotating drill string, are unlikely to comply with Rule 4.3.15 *Nuisance Performance Standards* as required by condition iii). However, it is noted that the noise effects associated with drilling were previously considered acceptable in conjunction with the land use consent for exploration drilling on Putauaki Trust land, which is currently held by Mighty River Power. Mighty River Power also has written approval from the Putauaki Trust in relation to the acceptance of the proposed activities. With the exception of Rule 4.3.15, all other aspects of condition iii) are deemed to be satisfied.

Consent for a discretionary activity is therefore required in relation to the term of the activity and noise pursuant to Rule 3.8.1.3 (5b).

10.9.2 NETWORK UTILITIES

Under the PWDP, network utilities are defined as follows:

(k) All structures and incidental facilities such as lines, support structures, pipes, pumping stations, aerials and similar structures which directly form part of a network.

The General Provisions relating to Rural Zones also contains site-specific rules. In particular, Rule 3.8.1.3 (28) relates to Activities involving Works and Network Utilities, examples of which include geothermal well heads, pipelines, plant and associated activities. Under this Rule, cross reference is made to Section 4.8 *Works and Network Utilities*.

Although well heads are a component of the proposed power station and are referred to in Rule 3.8.1.3 (28), they are not specifically included within the activity table in Section 5.8.1 and therefore require discretionary activity consent pursuant to 4.8.1 (39) which relates to *"all other works or network utilities not included in this list, or a network utility that does not comply with the performance standards listed"*.

The production and reinjection pads north-east of the mill and their respective connecting above-ground pipelines that are routed through Putauaki land east of SH34 are also located within Whakatane District's Rural Plains Zone. Above-ground pipelines conveying geothermal water are listed as a permitted activity within the Rural 1 Zone in the activity table under Section 4.8.1.

Transmission lines may in part transgress slightly into Whakatane District Council's jurisdiction.

11 ENVIRONMENTAL OUTCOMES

The proposed Kawerau geothermal power station generates a number of environmental and economic outcomes that are consistent with the principles of sustainable management. This is achieved by enabling of people and communities to provide for their social and economic and cultural well-being whilst having regard to the efficient use and development of natural and physical resources.

In terms of environmental outcomes the proposed power station will not generate any adverse effects on water, ecological values, amenity values and traffic that are more than minor in nature. The proposal recognises and protects matters of cultural significance through consultation and partnership with tangata whenua. In addition, the ongoing sustainable management and integrated development of the Kawerau geothermal resource will be achieved through a steamfield management plan that has been agreed by Mighty River Power, NST and NTGA.

There are also a range of national and regional economic benefits that can be identified from the proposed Kawerau geothermal power station which also contribute to the concept of sustainable management. Such economic benefits include reduced carbon emissions, the avoidance of transmission line losses, and improved security of supply for the Kawerau and the eastern Bay of Plenty. Direct local benefits can be expected during both the construction of the project and throughout its operating life through opportunities for employment, contracting and provision of local services.

While the information presented in this document represents the most up to date resource information for the Kawerau geothermal field it is important to recognise that Mighty River Power will continue to undertake on-going environmental monitoring and reporting to increase understanding of behaviour of geothermal systems, to ensure the on-going sustainable management of the project and the protection of the environment.