TrustPower Ltd
Mangorei Hydroelectric Power Scheme
Monitoring Programme
Annual Report
2012-2013

Technical Report 2013–46

ISSN: 0114-8184 (Print)
ISSN: 1178-1467 (Online)
Document: 1262240 (Word)
Document:1268019 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

November 2013

Executive summary

TrustPower Ltd operates the Mangorei HEP scheme in the Waiwhakaiho River catchment to the south of New Plymouth and holds seven consents (with a total of 33 special conditions) relating to this scheme; an additional land use consent having been granted in the 2005-2006 period for an access culvert.

This report covers the monitoring activities undertaken during the 2012-2013 period by way of an annual programme. The report provides information relating to compliance performance by the consent holder in relation to lake level and residual flow maintenance, fish pass operation, and generation discharges into the lower river. It documents the performance of the residual flow device in maintaining residual flows through the 6 km reach of the river between the intake weir and powerhouse outlet. It also documents aspects of previous native fish monitoring within the catchment, the macroinvertebrate biology of the river, and continuous monitoring of river water temperatures through the middle and lower reaches of the Waiwhakaiho River.

The Council's monitoring programme included 12 compliance inspections, 11 compliance hydrological gaugings, water temperature data collection, fish passage evaluation, and liaison with the consent holder's staff. The required stakeholders' meeting was scheduled but not held as there were no issues requested for discussion by the stakeholders.

Overall, very good compliance with lake level and residual flow release requirements (400 L/sec, 600 L/sec and 700 L/sec) was achieved, principally as a result of automation of the HEP intake gates and subsequent regular maintenance of a stable operating water level at the abstraction weir, throughout the monitoring period. No non-compliance events relating to river flows were recorded during the monitoring year. Suitable compensatory systems are in place should they be required for future compliance.

The report also considers the results of impact monitoring of Waiwhakaiho River fish passage, and effects of power generation and residual flow releases on the lower river water temperatures. The establishment and maintenance of the appropriate 'summer' (600 and 700 L/sec) and 'winter' (400 L/sec) residual flows have provided improved fish passage through the 6 km reach immediately downstream of the abstraction weir, and improved water quality, particularly during critical summer months. Other fish passage facilitation measures have also been established including upgraded (mainly wooden block) substrate throughout the fishpass and the continuation of the successful transfer of elvers past the powerhouse.

A moderate number of elvers was transferred in comparison with numbers over the eleven seasons to date in this summer-autumn period when about 19,000 elvers were transferred to the main river, but far in excess of the extremely low number over the previous season. Downstream migratory adult eel passage was provided by the consent holder with manual trapping and transfer of a few migrant eels on two occasions after river fresh events in autumn 2013. With the completion of a three year fish distribution survey in 2009, further monitoring is proposed as a component of a state of the environment freshwater fish programme currently in formulation. Relatively minor remedial works to the access culvert have been identified and are to be addressed in relation to fish passage conditions.

Water temperatures in the lower river have not increased significantly, nor reached excessive levels, principally as a result of the increased spread of power generation releases during daylight hours, a condition of renewed consents.

Although lower river reaches' temperatures have apparently warmed very slightly over the fourteen year period since the 100 L/sec increase in summer residual flows, climatic changes have resulted in generally warmer water temperatures throughout the river since the renewal of consents in 1995.

The consent holder's operation of the upgraded flow release mechanism, together with appropriate monitoring, plus fish pass improvements (requirements of the renewed consents compliance), have been effective. Automated continuous monitoring has continued to be operated by the consent holder although this facility requires intensive calibration .The consent holder has adopted environmental reporting methods within the Company's Annual Report and continued to provide regular (monthly) compliance reporting during the monitoring period. The monitoring and achievement of residual flows compliance have required considerable inspectorial, remedial, and maintenance work; the latter by the consent holder during the period. This work will continue to be necessary due to flood effects on in-river structures although the frequency and timing of monitoring will be adapted to the performance of the automated system. No incidents of any significance occurred during the period. Compensatory flow release by the powerhouse by-pass valve was maintained through a one week period and three very short periods of powerhouse shutdown for maintenance work.

A variation to the diversion consent to enable flood water flow harvesting was granted late in the period. This resulted from earlier refurbishment work on the intake tunnel (to Lake Mangamahoe) which improved efficiency and permits the additional taking of up to 3 cumecs of river fresh flows, but requires bathymetric monitoring of Lake Mangamahoe and sedimentation evaluation of diverted water to the lake.

During the year, the Company demonstrated a high level of environmental performance and compliance with the resource consents directly associated with the diversion of river flows for HEP generation.

Recommendations include continued liaison between parties in relation to compliance strategies, compliance reporting, and the performance of an appropriate annual monitoring programme for the 2013-2014 period. This programme may be expanded (after consultation with the consent holder) to include sedimentation components required by a condition added to the varied consent 2053. No stakeholders' meeting is required (by a consent condition) until the 2014-2015 period.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is the Annual Report for the period July 2012-June 2013 by the Taranaki Regional Council on the monitoring programme associated with resource consents for the Mangorei Hydroelectric Power Scheme operated originally by Taranaki Energy Ltd, then by Powerco Ltd and more recently by TrustPower Ltd.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents that relate to culverting, damming and diversions of water within the Waiwhakaiho catchment.

One of the intents of the Resource Management Act (1991) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Taranaki Regional Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of the Company's use of water and is the 18th annual report by the Taranaki Regional Council for the Mangorei Hydroelectric Power Scheme.

The initial consents' monitoring report (TRC 95-71) presented a collation of the three interim reports produced by the Taranaki Regional Council in relation to the monitoring of the consents granted in mid 1991 for the Mangorei HEP scheme and New Plymouth City water supply. Monitoring of consents compliance and the effects of water abstraction and generation discharge on the Waiwhakaiho River was established by means of a programme designed to extend over a four-year period during the exercise of these five-year consents. The second report (TRC 97-92) presented further monitoring information collected over the period July 1995 to June 1997 during which consents were renewed for the Mangorei HEP scheme. The third to seventeenth reports presented annual monitoring information for the period from July 1997 to June 2012. This current report covers the period from July 2012 to June 2013.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the Resource Management Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by TrustPower Ltd, the nature of the monitoring programme in place for the period under review, and a description of the Mangorei Hydro Electric Scheme.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretation, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2013-2014 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act (1991) and monitoring

The Resource Management Act primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (e.g. recreational, cultural, or aesthetic);
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on water permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, including activity and impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods and responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the consent holder(s) during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions.

- a **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or

minor at most, or, the Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and any inconsequential non compliances with conditions were resolved positively, co-operatively, and quickly.

- **improvement desirable (environmental)** or **improvement desirable (administrative compliance)** (as appropriate) indicates that the Council may have been obliged to record a verified unauthorised incident involving measurable environmental impacts, and/or, there were measurable environmental effects arising from activities and intervention by Council staff was required and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.

- **poor performance (environmental)** or **poor performance (administrative compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or an infringement notice.

1.2 Background

The Mangorei scheme diverts waters from the Waiwhakaiho River to Lake Mangamahoe via an intake weir and tunnel (Figure 1). Water is taken from the lake for the Mangorei Power Station, and returned to the Waiwhakaiho River approximately six kilometres downstream of the intake weir. The New Plymouth Water Treatment Plant takes water from Lake Mangamahoe for the New Plymouth and Waitara water supplies.

Consents for the Mangorei Hydroelectric Power Scheme were renewed in September 1996, and expire on 1 June 2021, with reviews dated for June 2001, June 2006, June 2011 and June 2016. A variation to the consent to divert water from the river (2053) to permit an increase from 7 cumecs to 10 cumecs, for the purposes of harvesting flood flows in the river, was granted in April 2013. The re-lining work in the inlet tunnel had increased its capacity to take water, but only when a fresh flow overtops the intake weir. No changes to residual flow requirements were necessary but additional conditions on the consent include:

- the consent holder to monitor rates of sedimentation entering Lake Mangamahoe via the diversion; bathymetric surveys of Lake Mangamahoe; and reporting on effects and changes in lake bathymetry;
- a flow restriction (at higher flood flows) to minimise total sediment entering the lake; and
- an increase in the financial contribution rate for riparian planting in the catchment.

An additional land use consent for an intake access culvert was granted in March 2006 with an expiry date of June 2020 and reviews dated for June 2009 and June 2014.

Taranaki Energy Ltd who originally held consents for the scheme, merged with neighbouring Wanganui-based company Powerco Ltd on 1 October 1995. The Mangorei (and Motukawa) HEP schemes were owned and operated by Powerco Ltd until purchased by TrustPower Generation in 1998 and operated by its subsidiary, Taranaki Generation Ltd and now by TrustPower Ltd.

Considerable investigative work was required to process the earlier consent applications (granted in 1991 for a five-year period). This was performed over a relatively brief period in order to assess overall residual flow requirements (TRC, 1991a). Particular regard was given to matters raised by various parties who lodged objections or submissions to either the water right applications or the draft Waiwhakaiho River Catchment Water Management Plan (TRC, 1991b) which was also under consideration.

These investigations involved measurements of water quality, river temperature, river morphology, instream habitat and biology, and potential for flow and habitat enhancement. All parties were actively involved with the progress of the investigations and participated in the informal consultations necessary to reach agreement on the appropriate conditions for attachment to the previous consents.

It was recognised that monitoring of consents' conditions and the impacts of the operation of the various consents would be undertaken by the Taranaki Regional Council during the approximately five year term of the consents. This monitoring was reported by the Regional Council in interim reports and a final summary report (TRC 95-71).

The establishment of the initial residual flow in the 6 km reach below the river intake weir was recognised as a Taranaki Regional Council management decision requiring a balance of many factors. Investigations indicated that several flow releases between 400 L/sec and 600 L/sec would be appropriate and that in order to optimise these flows some river enhancement would be required. The establishment of the appropriate residual flow releases utilised aspects of Jowett's (1982) IFIM methodology for assessment of fish habitat and passage requirements.

In order to meet the earlier consent requirements, a residual flow mechanism and fish pass were constructed in 1992 and were operational from mid 1992. The residual flow mechanism utilised a pipe through the weir which passed water into a concrete chamber on the downstream side. A calibrated water level was maintained in this chamber prior to residual flow release via a gate which slid horizontally to allow the correct flow to be set.

The fish pass consisted of a cobbled ramp on the downstream side of the weir with a continuous flow of water (approx 10 L/sec) piped from a small tributary of the river through the pass.

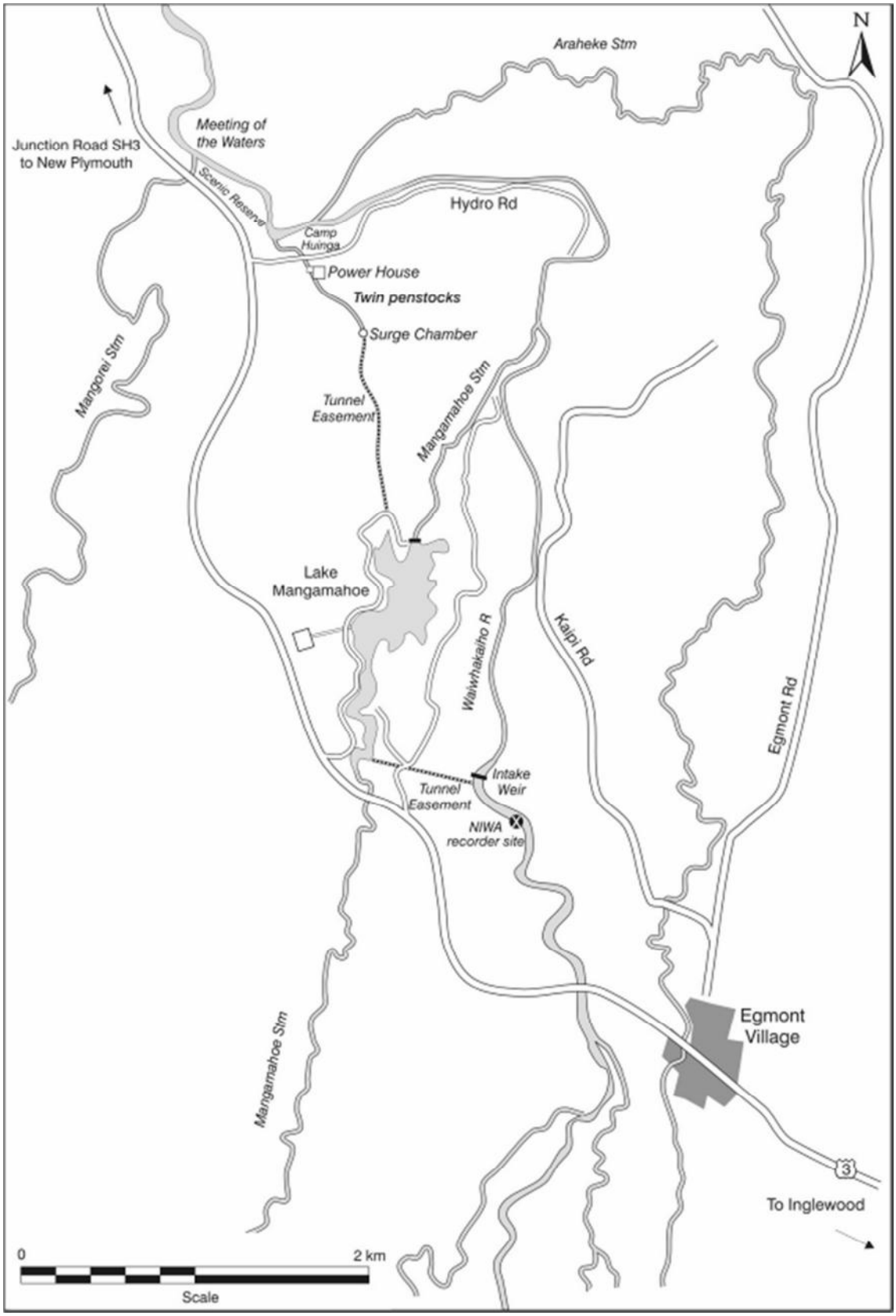


Figure 1 Lake Mangamahoe environs showing the Waiwhakaiho diversion, community water supply, and TrustPower Ltd hydroelectric power generating system

The renewals of the consents, considered under the Resource Management Act 1991 (for the first time), were granted in September 1996 following considerable

involvement of interested parties, most of whom had been involved at the time of the granting of the earlier consents in 1991. These consents and the more recently granted land use consent and variation of the diversion consent are provided in Appendix I to this report. The principal changes to consents' conditions resulting from consultation between the parties may be summarised as follows:

Residual flows
An increase in summer residual flow (700 L/sec, from January to March) required an additional 100 L/sec to be released downstream of the HEP intake weir. This increase applied from 1 January 1998.

An upgrade to the residual flow device was required to ensure compliance with consent conditions at all times.

Fish passage
Fish pass maintenance and modifications were necessary to allow for the passage of trout and native fish species whether changes to the residual flow release mechanism were required or not.
A further requirement for maintenance of the residual flow river channel below the intake weir was imposed for provision of fish passage through this reach of the river. This essentially required that work already undertaken must be maintained or additional works be performed should the river channel change to the detriment of fish passage.

General
Mitigation of the effects of flow diversion on water quality and river ecology by way of riparian management is required, as is the maintenance of a minimum water level in Lake Mangamahoe.

Five-yearly consent reviews have been provided during the 25-year term of the consent which enables environmental benefits to be achieved (e.g. automation and improved residual flows control) as a result of long-term certainty to the consent holder.

Regular meetings between interested parties provide improved communication concerning performance and monitoring results.

1.3 Resource consents

1.3.1 Water permits

The consents now held by TrustPower Ltd (after transfer from Taranaki Energy), were renewed following a series of informal hearings involving all interested parties, and a number of special conditions were altered by mutual agreement, with the consents granted in September 1996. The appropriate consents relating to the monitoring programme (see Appendix I) are summarised as follows:

- 2053: to divert up to 10000 litres/second of water from the Waiwhakaiho River via a diversion weir and associated intake structures into Lake Mangamahoe, through the Mangorei Hydroelectric Power Scheme and back into the river approximately six kilometres downstream of the diversion point at or about GR:P19: 078-298.

Special Conditions require maintenance of daily generation flows in the lower river and various residual flows below the intake weir during the year; continuous recording of residual flows; and maintenance of fish passage through the residual flow channel reach of the river. Other conditions require safety warnings downstream of the scheme; riparian management mitigation measures; regular 2-yearly meetings with submitters; monitoring by the consent holder; and provision for reviews of consent conditions.

- 2054: to dam the Mangamahoe Stream to form Lake Mangamahoe to act as a reservoir of water for hydroelectric power generation purposes at or about GR: P19: 074-312.

  Special Conditions require satisfactory operation and maintenance of the dam; maintenance of a minimum level in Lake Mangamahoe; and provision for reviews of consent conditions.

- 2056: to use up to 735 000 cubic metres/day of water from Lake Mangamahoe for hydroelectric power generation purposes at or about GR: P19: 073-312.

  A Special Condition requires the daytime spread of generation flows. The other condition provides for reviews of the consent conditions.

- 4887: to erect and maintain structures associated with the diversion of water from the Waiwhakaiho River into Lake Mangamahoe for hydroelectric power generation purposes at or about GR: P19: 078-298.

  Special Conditions require satisfactory operation and maintenance; and provide for reviews of consent conditions.

  The consents were transferred from Powerco Ltd to Taranaki Generation Ltd, a subsidiary of TrustPower, during the 1998-99 monitoring year.

An additional land use consent for an access culvert, granted in March 2006, is:

- 6810: to erect, place and maintain a culvert in an unnamed tributary of the Waiwhakaiho River for access purposes at or about GR: P19: 071-301.

  Special conditions relate to installation practice, advice and timing of works, minimisation of disturbance, limitations on effects and provision of a sediment control plan. Another condition provides for reviews of consent conditions.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the Resource Management Act sets out an obligation upon the Taranaki Regional Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

The Taranaki Regional Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders.

Monitoring is to be performed throughout the term of the consents, but annual programmes may vary from year-to-year depending upon requirements for certain forms of monitoring information and assessment of compliance performance.

An appropriate monitoring programme for the Mangorei HEP scheme was established in 1992 and annual programmes have continued since. The 2012-2013 programme consisted of five primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Taranaki Regional Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters. This continues to be the norm for the Mangorei HEP scheme consents programme.

1.4.3 Site inspections

Sites within the scheme were visited twelve times during the monitoring period mainly for the purposes of residual flow and fish pass compliance assessments and inspections. Data collected by the consent holder were provided so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council.

1.4.4 River temperature monitoring

Assessments of the impacts of residual flow provision and generation release fluctuations on water temperatures of the middle and lower reaches of the river were performed by utilisation of continuous data loggers at three sites.

1.4.5 Residual flow gaugings

The Taranaki Regional Council undertook hydrological flow gaugings on eleven of the twelve inspection occasions during the full range of residual flow release conditions of 400 L/sec to 700 L/sec.

1.4.6 Biological inspection and surveys

A field inspection of the river channel residual flow enhancement site to assess continuing suitability for fish passage was last undertaken during June 2010 (TRC, 2010). The results of the two-year fish monitoring programme were presented in an earlier Annual Report (TRC, 2009). Macroinvertebrate data have been utilised from the Council's state of the environment programme (TRC, 2013).

2. Results

2.1 Compliance issues

Consents compliance monitoring involved the supply of lake and river level data by the consent holder, and the regular inspections of the fish pass, flow release mechanism and residual flow levels during the period. A higher frequency of monitoring has been necessary in times past as problems with the operation of the residual flow release mechanism were recognised (see TRC 95-71, 97-72 and 98-76) particularly prior to the upgrading of the system. Any additional inspections to those scheduled are performed when non-compliance, residual flow calibration, or fishpass refurbishment necessitates re-inspections. No additional inspections were necessary during the 2012-2013 period. Assessments of the condition of the refurbished (wooden block substrate) fish pass are also made.

2.1.1 Lake Mangamahoe level compliance monitoring

Special Condition 2 of consent 2054 requires:

> *'that the consent holder shall maintain a minimum lake level of 750 mm below the crest of the Mangamahoe spillway except during lake weed maintenance periods'.*

The consent holder supplied the Council with records of Lake Mangamahoe water levels for compliance assessment purposes. These lake levels are illustrated for the period in Figure 2.

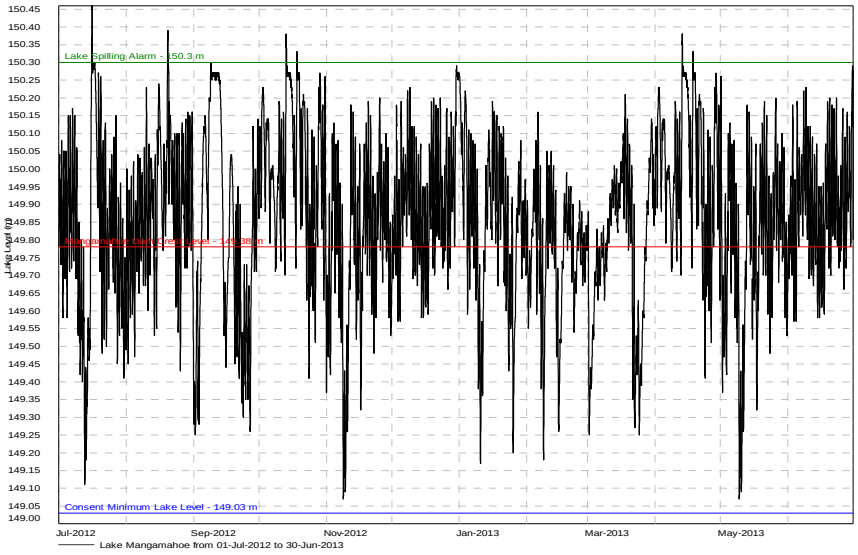


Figure 2 Lake levels (m) at Lake Mangamahoe, 1 July 2012 to 30 June 2013

The data indicates compliance with the operational minimum throughout the one year period with no breaches of the minimum lake level. No incidents of equipment malfunction occurred during this period as improvements were made to the consent holder's recording systems, particularly a more rapid response to data download problems. Relatively few lake spills occurred, mainly during a wet period in late winter-early spring 2012.

2.1.2 Residual flow compliance inspections

The residual flow mechanism's outlet gate setting and downstream water level were checked and the residual flow level through the fish pass was assessed and recorded at the time of each inspection. [Note: when natural river flows sufficient to overtop the weir (i.e. greater than 7 m^3/s) occur, these provide a satisfactory residual flow below the weir in addition to the residual flow mechanism's operation]. The gate setting was checked to ensure the correct opening in conjunction with the requisite flow level through the fish pass.

Although compliance performance prior to July 2000 has been extensively detailed in earlier reports, a summary of compliance for the 2012-2013 period is compared with the record for the entire period prior to July 2012. This summary of compliance over the entire period to date is provided in Table 1 which includes a few inspection occasions when by coincidence, river flows overtopped the weir. No inspections coincided with weir overtopping during the 2012-2013 period however, as the tendency in more recent years has been to focus inspections toward lower river flow conditions.

Table 1 Residual flow release inspection compliance for the period mid 1992 to mid 2013

Period	'Winter' (400 L/s)		'Summer' (600 L/s)		'Summer' (700 L/s)	
	No of inspections	Compliance	No of inspections	Compliance	No of inspections	Compliance
mid 1992-1993	38	74%	33	55%	-	-
mid 1993-1994	17	100%	16	93%	-	-
mid 1994-1995	18	89%	13	54%	-	-
mid 1995-1996	16	94%	17	53%	-	-
mid 1996-1997	28	93%	27	67%	-	-
mid 1996-1998	26	92%	11	66%	14	93%
mid 1998-1999	21	76%	16	81%	11	91%
mid 1999-2000	25	80%	12	92%	10	90%
mid 2000-2001	19	100%	7	100%	9	100%
mid 2001-2002	14	93%	7	100%	11	91%
mid 2002-2003	15	100%	7	86%	4	75%
mid 2003-2004	10	100%	4	80%	3	100%
mid 2004-2005	9	100%	4	100%	6	100%
mid 2005-2006	11	90%	6	84%	5	100%
mid 2006-2007	13	100%	4	100%	3	100%
mid 2007-2008	12	100%	3	100%	3	100%
mid 2008-2009	8	100%	3	100%	6	83%
mid 2009-2010	10	100%	3	100%	4	100%
mid 2010-2011	9	100%	3	100%	3	100%
mid 2011-2012	5	100%	2	100%	4	100%
Total to mid 2012	324	91%	199	75%	96	94%
mid 2012-2013	5	100%	3	100%	3	100%

Comments with respect to compliance relating to the period prior to July 2012 and for the 2012 to 2013 monitoring year are as follows:

1992 to 2012 period

Compliance with the winter residual flow requirements (400 L/sec) generally has been good with 91% of inspection visits confirming residual flow compliance, although some earlier visits also coincided with weir overtopping due to river freshes. Most non-compliance events monitored followed river freshes and, up until the 1998-1999 monitoring years, these events were mainly due to blockages of the residual flow device by debris which reduced flow through the release system. These were rectified by the consent holder immediately river conditions permitted the safe clearance of the residual flow device. During the 1998 to 2012 period, the residual flow mechanism functioned well with minimal sedimentation problems. The majority of non-compliance issues were related to blockages in the fish pass following river freshes. These were rectified by the consent holder immediately river conditions permitted safe maintenance of the fish pass.

Summer residual flow (600 L/sec) compliance has varied resulting in a relatively poorer overall performance (75% compliance) although compliance has improved considerably from 1998 onwards (when it has been 91%). Initially, considerable problems with silt build-up in the residual flow release mechanism were the cause together with low river levels upstream of the abstraction weir, which failed to provide sufficient head at the pipe inlet to the flow mechanism. Maintenance of adequate upstream water levels was subsequently provided by manual manipulation of the HEP intake gates by the consent holder. During the 1997-98 period these intake gates were automated and operated by remote telemetry to retain a requisite stable water level in the river upstream of the residual flow device. Restoration of the requisite 600 L/sec residual flow was generally undertaken within acceptable timeframes by the consent holder who acknowledged the need to regularly monitor the system in the immediate aftermath of river freshes. It was also understood that consideration of an upgrade of the flow release methodology was necessary including the incorporation of part of the flow release via the upgraded fish pass. A marked improvement followed in the 1999-2000 period when this upgrade occurred and 94% compliance has been achieved over the 2000-2012 period.

Compliance with the renewed consent condition requirement of a summer residual flow release of 700 L/sec (between January and March) has been almost totally achieved since this condition became operational on 1 January 1999 (94% compliance). Occasional non-compliance events have followed river freshes and sedimentation of the fish pass, and were rectified immediately safety considerations allowed remedial work in the river channel.

Overall, residual flow compliance occurred on 86% of the inspection occasions during the twenty year period from mid 1992 to mid 2012. Poorer compliance early in the period has significantly improved through the 2000-2011 period when all but eight inspections have noted compliance with residual flow requirements. The consent holder was fully aware that the residual flow release mechanism, in conjunction with the fish pass, could not continuously maintain residual flow requirements immediately following recessions from freshes and floods due to siltation and substrate movements. This necessitated considerable effort by the consent holder to perform remedial works as soon as safety issues permitted activity in the river channel at the abstraction weir.

2012 to 2013 monitoring year

Each compliance inspection involved recording water levels upstream and downstream of the abstraction weir, and at the entrance to the fish pass, checking the gate opening setting from the residual flow device, and assessing the state of the substrate (positioning and accumulation) within the fish pass. Checking of flow in the powerhouse outlet channel was also performed for consent compliance purposes. The flow record for the Waiwhakaiho River (at Egmont Village) during this period is provided in Figure 3.

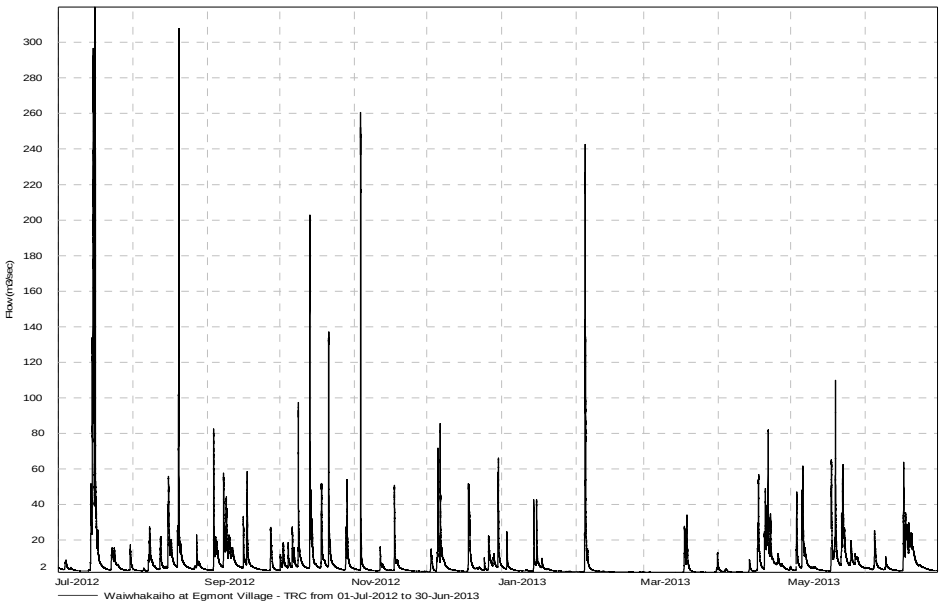


Figure 3 Flow record for the Waiwhakaiho River at the Egmont Village recorder, 1 July 2012 to 30 June 2013

Winter residual flow (400 L/sec) compliance was totally achieved with no non-compliance events despite two large freshes during July 2012 and August 2012 and several freshes in May 2013. A blockage of the fishpass followed the mid-winter flood and necessitated additional flow release through the residual flow device until the refurbishment of the fishpass was performed. A residual flow gauging and inspection performed during this period confirmed compliance with the 400L/sec residual flow.

Spring-autumn residual flow (600 l/sec) compliance was recorded on the two monthly inspection visits carried out within November to December and April months despite a very wet October 2012 month. This continued the considerable improvement in compliance over the last thirteen years, compared to the 1992 to 1999 (seven) year period.

Compliance with the 700 L/sec residual flow release (in the period from January to March) was totally achieved, with three inspections carried out within this generally very dry period (Figure 3). One gauging (March 2013) indicated a marginal residual flow (691 L/sec ± 7%) which was increased immediately by the consent holder upon notification by Council.

The residual flow mechanism functioned well during the 2012-2013 period with no reported internal sedimentation problems.

A compliance record of 100% of the total inspections (11) was achieved during the monitoring year. Compliance trends continued to show improvement in comparison with the overall compliance rate of 86% over the twenty year period up to mid 2012, since the installation of the residual flow mechanism (in mid 1992).

Summer residual flow compliance improvement also was due primarily to the continued maintenance of a stable river water level on the upstream side of the weir wherever possible by the consent holder. This was achieved by automatic lowering of the intake gates (by remote telemetry associated with electrical control of the gates) to provide the stable water level required for maintaining the operating system in the residual flow device and residual flow component through the fish pass.

The consent holder established automatic recording of the total residual flow downstream of the abstraction weir, and data continued to be provided to the Taranaki Regional Council during the 2012-2013 monitoring period (Figure 4).

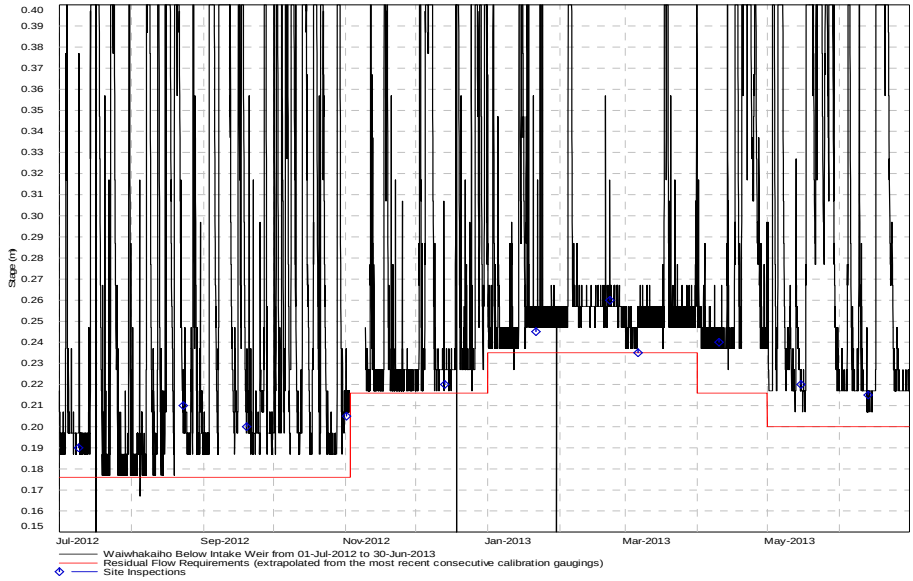


Figure 4 Residual flow immediately d/s of intake weir water level record as supplied by TrustPower Ltd for period 1 July 2012 to 30 June 2013

The continuous water level record (Figure 4) indicated very few inaccuracies with respect to ongoing correlations with actual water levels (as established by staff gauge levels), despite the frequent river freshes particularly during the late winter-early spring period. A more reliable pressure transducer system had been installed in the 2005-2006 period and was replaced after the midwinter 2009 floods and again in October 2010 after spring floods, and regular correlations of these flow recordings with field staff gauge measurements were conducted. However, general compliance was indicated with residual flow consent requirements (700 L/sec, 600 L/sec and 400 L/sec) during the period, despite considerable variability of the water level/flow ratings at this site. The water levels monitored by the consent holder required regular correlation with established staff gauge readings with particular attention given to

corrections applied to levels after significant fresh events, to avoid the differences apparent on occasions in Figure 4. Compliance gaugings were performed soon after such events. There were no indications of significant lengthy periods of non-compliance from the records illustrated in Figure 4.

The staff gauge installed immediately below the weir for rating and inspectorial purposes will continue to be monitored to assess the stability of the flow rating. This site, typical of most Taranaki ringplain river sites, is very unstable and rating changes have continued to occur since the staff gauge was installed. These ratings can only be re-established, and residual flow compliance assessed, by regular gaugings following significant river fresh events. This will continue to be the focus for future compliance monitoring in conjunction with the provision of continuous residual flow water level records by the consent holder.

The consent holder has contracted the establishment of a flow monitoring site within the HEP tailrace for the purpose of monitoring compliance with consent requirements. The consent holder advised that calibration of this site had been completed by the contractor and subsequently these levels were checked for compliance at the time of each monthly inspection.

2.1.3 Residual flow compliance gauging

In addition to the regular inspection programme, gaugings of the residual river flow were performed at intervals during the 2012-2013 monitoring period. These were provided as verification of the various residual flow release settings at the flow release device and within the fish pass and establishment of the rating (with staff gauge water levels) at this site. They were also performed to re-establish ratings following significant river freshes where necessary or upon request by the consent holder. These results are summarised in Table 2. Flows were gauged by TRC hydrological staff immediately downstream of the abstraction weir.

Table 2 Summary of residual flow gauging results for the period of July 2012 to June 2013

'Winter' (400 L/s)			'Summer' (600 L/s)			'Summer' (700 L/s)		
No of gaugings	Range (L/s)	Compliance	No of gaugings	Range (L/s)	Compliance	No of gaugings	Range (L/s)	Compliance
5	541-667	100%	3	626-789	100%	3	691-908	100%

[Note: compliance allows for gauging accuracy of $\pm$ 7%

These gauging results were indicative of correct settings of the residual flow device and partial and/or complete maintenance of flows within the fish pass on all occasions. No non-compliance events were gauged with excessive flow releases adjusted by the consent holder from time to time following gauging notification and on one occasion followed up with a confirmation re–gauging when fish pass maintenance work was necessary. Residual flow settings were more difficult to maintain during the very late winter-early spring period, but compliance was achieved at these times.

The construction of the new fish pass (April 1998) altered the mechanism for residual flow release (see section 2.1.4) established prior to this date, but experience has indicated that allowing for the judicious placement of smaller substrate in the lower section of the pass, since wooden blocks were positioned throughout the pass, a fish passage flow ranging from 150 L/sec to 200 L/sec is the most appropriate flow for

satisfactory operation. This equates to a water depth of approximately 0.25 m at the entrance provided the morphology of the pass is correct. Water depth was visually checked as a component of each inspection visit.

Visual inspections of the fish pass, gate setting, residual flow mechanism internal water level and downstream river water level provide approximate indications of actual residual flow. Familiarity with the system has reduced the need for frequent residual flow gauging downstream of the weir and this was reflected in the reduced inspection regime continued during the period. Residual flow gaugings were undertaken as calibration monitoring of the performance of the residual flow mechanism, and fish pass flow maintenance, particularly after the maintenance or adjustment of the system and following significant freshes. The maintenance of a stable summer upstream water level at the weir (see previous section) has been critical for the improvement to the performance of the residual flow device throughout the 600 L/sec and 700 L/sec release periods.

2.1.4 Operation and maintenance of fish pass

Special condition 2 of consent 4887 states:

> *"That the consent holder shall install and maintain, to the satisfaction of the General Manager, Taranaki Regional Council, a structure at the diversion weir to enable the passage of native fish, juvenile trout and adult trout"*.

The compliance inspections of the residual flow release mechanism also included monitoring of the fish pass flow and its maintenance. Construction of the new natural stream-type fish pass began in late March 1998, on the right bank side of the diversion weir, and was completed in April 1998, replacing the previous smaller fish pass (see TRC Report 98-76). This larger fish pass was a component of the consent holder's proposed upgrade intended to provide automated residual flow releases in compliance with the renewed consents.

The original intention of the consent holder was to provide for the entire residual flow releases (400, 600 and 700 L/sec) through this fish pass via the entry point cut into the weir, removing the need to use the older flow release device. However, although some rocks and stones were cemented into the base of the fish pass, trial flows during early 1998 through the pass indicated that additional placement of rocks and boulders in the pass would be necessary to reduce velocities which were too high for fish passage. Accumulation of rocks, boulders and general debris (cobbles, fines, etc) subsequently occurred during mid-winter river freshes, with the correct placement of this material to form a fish pass satisfactory for trout and native fish then determined by Mr C Mitchell (Consultant) in a report to the consent holder. After the correct placement and maintenance of this material in the fish pass, residual flow compliance incorporated the release of approximately 150 to 200 L/sec of flow through the fish pass (at a fixed water level) with the requisite flow rates achieved by adjustments to the residual flow mechanism. This generally necessitated maintenance of a minimal upstream river ('ponding') level, by telemetry and automated intake gates adjustments, particularly during the summer residual flows period (600 L/sec and 700 L/sec), and lower natural river flow conditions.

The consent holder constructed permanent wooden blocks as boulder substitutes in the first section of the fishpass in early 2005 after consultation with interested parties. This placement of the blocks was undertaken to reduce the amount of maintenance required when boulders have needed repositioning following river freshes. To date the blocks have been successful in terms of maintaining the flow patterns required in the pass to such an extent that further placement of wooden blocks in the lower section of the fish pass was undertaken in late 2006. It had been agreed in 2009-2010 that some accumulation of river gravels and material between the wooden blocks within the pass could enhance passage through this structure. Some damage was noted to a few of the blocks and where necessary, rocks had been utilised as appropriate replacements.

During the residual flow inspections of 2012-2013 the condition and flow through the fish pass were noted. As a result, one of these inspections (August, 2012) found that the fish pass required some degree of maintenance, particularly clearance of debris which had accumulated within the pass.

This inspection occurred soon after river freshes and the consent holder rectified the situation as soon as safety issues permitted activity in the river channel. Accumulation of debris had resulted in partial overflows of water across the interior dividing wall adjacent to the inlet of the fishpass. Remedial works rectifying blockages and removing debris from the fish pass were performed within timeframes acceptable to all parties. Residual flow compliance was maintained through this period, however.

Photo 1 Small breakage in wall of fish pass, August 2012

Damage to the dividing wall of the fishpass near the inlet (Photo 1), resulting in small overflows between sections, has been identified as requiring remedial work but this has yet to be rectified.

During the 2010-2011 period, after consultation with Council, the consent holder cut a small notch in the furthest downstream bend in the fishpass for the purpose of alleviating debris build-up during river floods. Debris accumulation had been considerable and frequent at this bend and large boulders had caused structural damage at this point during past flood events. An operational condition relating to the provision of the notch requires that no flows are discharged through the notch as such an attractant flow to fish passage could divert migrant fish from the opening of the fishpass under residual flow conditions. This was complied with throughout the 2012-2013 period. This proviso also requires that gravel and debris removal from this section of the fishpass is undertaken in a timely fashion to ensure that overflows under base residual flow conditions are prevented.

Areas of severe gravel accretion were removed from the true right bank of the river immediately upstream of the weir in August 2010 following several earlier floods particularly in winter 2010. This operation was monitored and was a follow-up to similar work undertaken in February 2000, January 2002, May 2003, March 2004, January 2005, June 2007, May 2008, February 2009, and January 2010 to alleviate sedimentation problems in the fishpass and to address the issue of river profile variability effects on residual flow ratings.

The consent holder's manual maintenance of the fish pass has noted the presence of elvers, eels, torrent fish and lamprey in the pass from time-to-time (G Hurlstone, pers comm.). Elvers were particularly common during early January 2001, and torrent fish, lamprey and eels were found in the pass during the 2001-2002 period. Fish pass effectiveness monitoring was a component of the fish survey monitoring programme performed in the 2006-2007 and the 2007-2009 periods with completion of the work in the 2008-2009 period (TRC, 2009a).

2.1.5 Instream channel works

Areas restrictive to fish passage within the residual flow reaches (TRC, 1991) were the subject of river engineering channelisation works early in the monitoring period subsequent to establishment of residual flows (TRC, 1993). This flow enhancement work was performed in late summer 1992 and has generally withstood the many freshes through these reaches since this date. Visual inspections of these works have been performed from time-to-time over the monitoring periods and historical information is provided in previous Annual Reports (see TRC, 2010). No issues related to fish passage have been noted at these critical areas, although the lower residual flow reaches had been re-aligned by channel control and gravel extraction activities adjacent to lower Hydro Road.

2.1.6 Lower river flow fluctuations

During the mid to late summer period river flows in the lower reaches of the Waiwhakaiho River are generally low, and extremes in water temperature can occur. To mitigate these extremes, provide recreational opportunities, and maintain water and habitat quality in general, Special Condition 1 of the original consent (2056) required the consent holder to spread power generation over daylight hours between 15 November and 15 April of each year. Spreading generation maximises the beneficial effect of artificial flows created below the power station outlet during generation. A river level recorder was established in the lower reaches at Rimu Street extension in late 1992, largely for the purpose of monitoring power generation variations, but as access to generation records was also provided by the consent holder the river level recorder was removed in October 1999, partly due to vandalism and for cost-saving purposes. However, the flow recorder was re-installed by TRC (in mid April, 2009) and has been rated for further monitoring purposes. The records have indicated that power generation was spread over daylight hours according to consent requirements. Evaluation of the effects of variable generation releases on flow travel times, river levels and water temperatures in the lower river, was undertaken using data from the summers of 1993-94 and 1994-95 (TRC 1995a and 1995b) and relevant information contained in these interim reports was summarised in Section 3.2 of TRC report 95-71. It was emphasised that the database was limited, particularly for conditions of full power generation releases (due mainly

to low natural river flows), and further evaluation of effects in the lower river is undertaken later in this report now that a larger database is available and permits the use of cumulative summers' data.

A requirement for continuous daily power generation releases of 950 L/sec to be spread over the period between 0800 hrs and 1800 hrs was included as Special Condition 1 of consent 2053 and became operative in September 1996. Perusal of Rimu Street river level records and more specifically, power generation data (supplied by the consent holder) for the period between this date and 30 June 2001, showed that this condition was substantially complied with. Similarly, compliance with this consent condition throughout the current monitoring period was confirmed by reference to regular inspections of the powerhouse outlet channel and the consent holder's power generation data. On the few occasions prior to April 2001 when the power generation releases were prevented by temporary outages (shutdowns and/or faults) of the power station between 0800 hrs and 1800 hrs, extra water was spilled over the HEP weir to compensate. These occurrences were due mainly to refurbishment or maintenance requirements and on each occasion the consent holder notified the Council of its intentions and mitigation measures. In April 2001, the consent holder installed an automatic flow valve release mechanism at the powerhouse to compensate for the need to spill residual flow over the river intake weir. This was calibrated by the Regional Council (at the request of the consent holder) and was found to discharge the 950 L/sec flow. The compensation valve release was used for a period of half an hour in late November 2001 during closure of the power station. On one occasion, in late September 2002, compensation flows were achieved by additional spillage over the intake weir, as the outage at the power station involved commissioning new hydraulic lines supplying the bypass valves on each generation machine. The consent holder requested a further calibration gauging of the powerhouse valve flow release which was found to discharge 1039 L/sec in November 2003. Outages and maintenance at the powerhouse have necessitated brief usage of the bypass valve and/or additional spillage over the weir on several occasions since mid 2003. Maintenance work at the intake necessitated an unnotified spillage of natural river flow over the weir in May 2005. Consultations with the consent holder subsequently resulted in provision of warning signs at the HEP intake and improvements in communication procedures between all parties. The powerhouse was shutdown for maintenance works on the penstocks and other equipment for a brief period in March 2011. Additional residual flow discharges were made over the intake weir to achieve consent compliance.

The lengthy extremely low flow period in late summer 2003 (March) resulted in low inflows to Lake Mangamahoe and caused difficulty for the consent holder to maintain requisite minimum lake levels, while complying with the need to provide a continuous generation flow release of at least 950 litres/second between 8.00 am and 6.00 pm daily (Special Condition 1 of consent 2053). Following discussions between the consent holder and affected parties, an emergency works direction was issued by the Taranaki Regional Council to provide for a shortened duration of daily generation release (by two hours [to 4.00 pm]) with the proviso that this temporary measure was to be documented with a return to normal operating procedures as soon as river flows improved. The consent holder advised that this amended daily generation duration release operated for only one week, prior to resumption of normal operation.

Inspections of the powerhouse outlet channel and the power station generation records indicated compliance with daytime generation flow release requirements during annual periods between 2003 and 2011. The consent holder supplied monthly generation records for compliance assessment purposes during the 2011-2012 period during which total compliance was recorded, with only minor failures in data recording due to very short duration communication failures. In March 2012 the station was shut down over a three week period for maintenance purposes and all residual flows were released over the intake weir.

Maintenance shutdowns of the station occurred over an eight day period in late March 2013, and a few hours in April, May, and June 2013 during which the by-pass valve maintained lower river residual flow compliance while residual flows were released over the intake weir.

The Council re-installed a rated, flow recording station at Rimu Street in April 2009. The record for the 2012-2013 monitoring period is presented in Figure 5 and confirms compliance with daily generation flow releases to the lower river.

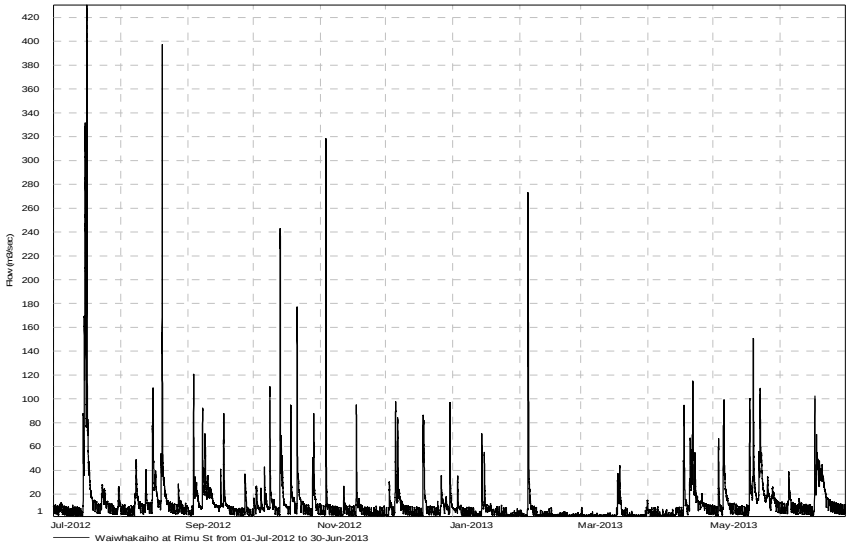
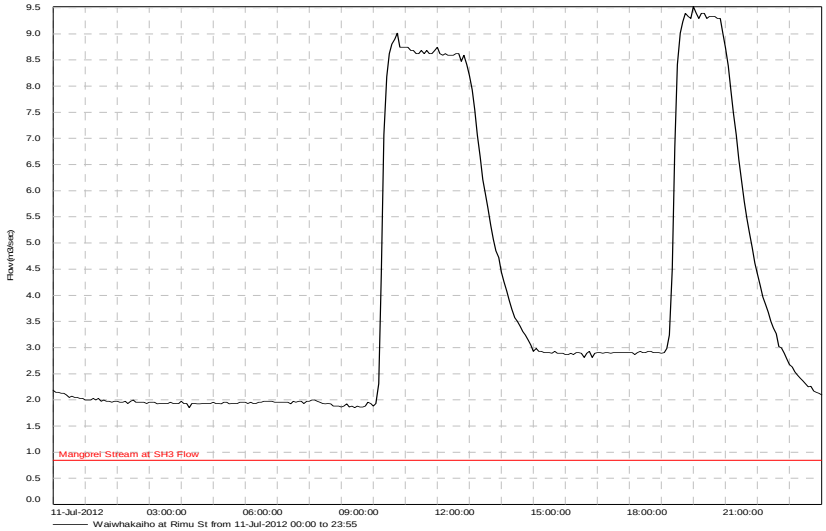


Figure 5 Flow record for the Waiwhakaiho River at the Rimu Street recorder, 1 July 2012 to 30 June 2013

Typical hydrographs for the lower river at Rimu Street are illustrated in Figure 6 under the three seasonal residual flow scenarios and indicate twenty-four hour flow variability associated with generation releases. Each of these scenarios is typical of operational flow releases and confirms compliance with the relevant consent condition. It should be noted that, apart from HEP compliance flow, the principal contribution to lower river flows is provided by the Mangorei Stream (median flow: 1.4 m^3/s).

Compliance with consents' conditions relating to timing of daytime generation releases will continue to be monitored by examination of monthly power station generation records supplied by the consent holder, reference to the Rimu Street flow records, and inspections of the powerhouse outlet channel. This outlet channel has a flow rating established and is monitored by the consent holder's hydrological contractor (TrustPower, pers com, Sept. 2012).

a



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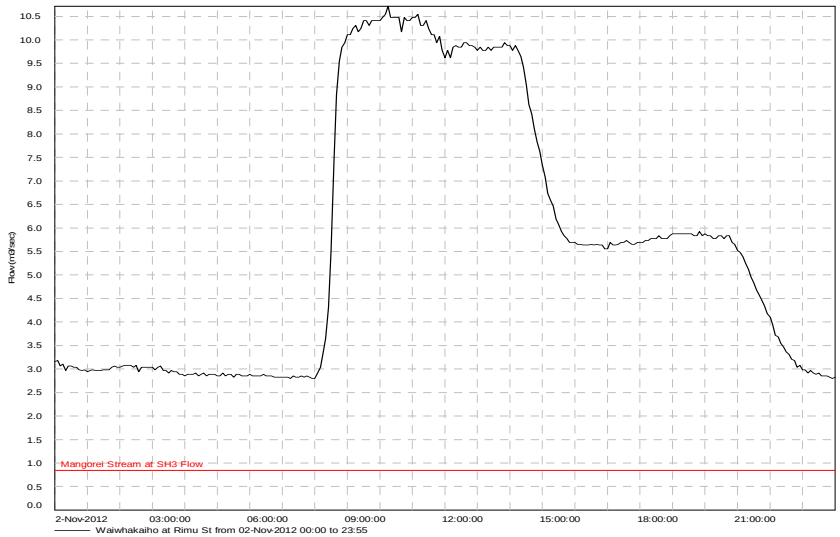

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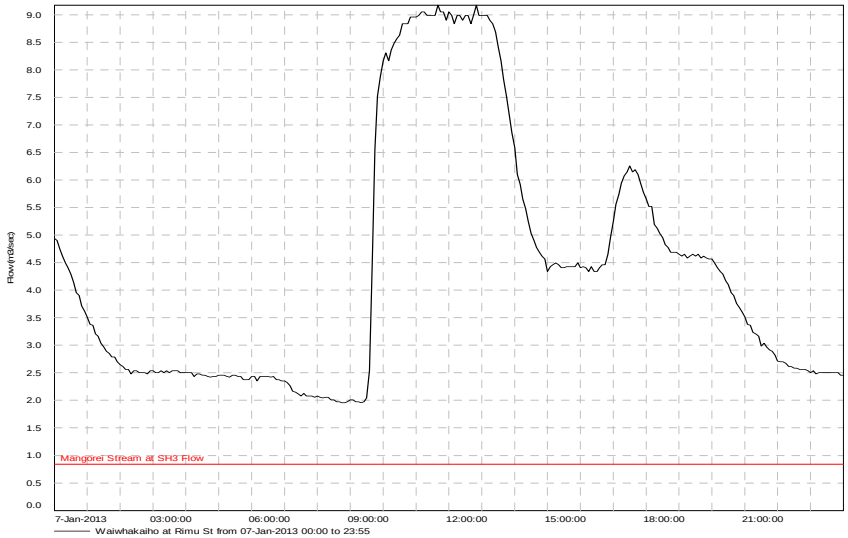

Figure 6 Examples of river flows at Rimu Street during periods of 400 L/sec (a), 600 L/sec (b), and 700 L/sec (c) residual flow releases and daylight (950 L/sec) generation flow compliance during the 2012-2013 period

2.1.7 Refurbishment of the intake tunnel

The consent holder liaised with all interested parties prior to performing maintenance work in the intake tunnel between late October and mid December 2004. This work was covered by conditions attached to consent 4887 and involved the spillage of all natural river flows over the intake weir and through the residual flow channel and lower reaches of the river. No generation therefore occurred from the HEP station over this period and for the duration of the work the level in Lake Mangamahoe was retained above its consented minimum level. Provision was made to restore inflows to the lake via the tunnel (by cessation of maintenance works) if lake levels required such action. The intake refurbishment work was completed and normal residual flow releases were restored below the intake weir by the end of December 2004. Some final work was necessary over a few days in late March 2005. An assessment by the consent holder of the effectiveness of this refurbishment work has found that the intake tunnel now has the ability to pass flows in excess of the consented abstraction rate but all compliance is achieved through the use of PLC controls and intake gate algorithms. The controls adjust the intake gate openings in relation to changing intake weir levels for compliance purposes. In April 2013 a variation to the diversion consent was granted, permitting harvesting of an additional 3 cumecs of flood water flows (see Section 1.2) as a result of the refurbishment of the intake tunnel.

2.1.8 Access culvert at the intake

In order to gain equipment access to the intake tunnel in 2004, a temporary track with a culvert across the small left bank tributary stream, was agreed to by interested parties and constructed. Some gravel lining of the culvert was required and subsequently, Taranaki Generation Ltd requested permanency of the culvert for access purposes. A consent application was received from the Company in February 2006 and a land use consent (6810) granted in March 2006. There was an issue with the timing of the installation (Special Condition 3) and subsequently additional streambed mitigation work was required to prevent sub-culvert stream flow and provide for suitable fish passage. This was remedied and further inspectorial monitoring at the intake has continued to assess culvert compliance issues.

Debris removal and substrate realignment at the culvert outlet was not necessary during the 2010-2012 or 2012-2013 periods but further substrate re-alignment may be required in the immediate vicinity of the culvert outlet from time to time. There are some concerns that there is a barrier to fish passage created at the downstream outlet of the culvert through the descent to the river, under normal river level conditions which prevents migrant fish access to the stream beyond the culvert. This barrier and sub-culvert seepage flow issues may be addressed by relatively uncomplicated remedial works which are to be addressed by way of a recommendation attached in Section 4 of this report. This consent has an optional review for June 2014 (see Section 3.7).

2.1.9 General comments

The residual flow release mechanism performed well during the monitoring period. Monitoring and maintenance after freshes and floods in the river will continue to be necessary to ensure compliance with residual flow requirements. The continuous water level monitoring system installed immediately downstream of the intake weir

will also continue to require rating by judicious timing of flow gaugings following significant river freshes, in order to calibrate and authenticate residual flow releases. It also requires regular calibration by the consent holder to maintain the accuracy of the record between residual flow gaugings. Maintenance work on the fish pass has continued to be required after river freshes in order to ensure compliance with fish passage and residual flow consent conditions. Some minor repairs to the dividing wall remain to be performed. Maintenance of the fishpass substrate may not be as extensive as previously required, with the provision of fixed laminated wooden blocks in both sections of the pass although recent damage to those blocks has occurred and required remedial work including some rock reinstatement. A minor modification to the fishpass to alleviate debris retention will require maintenance to ensure residual flows meet fish passage design requirements. Daily power generation requirements for spreading flow releases have been very good, particularly since the provision of automatic release of compensation flows in the event of powerhouse outages. Compliance monitoring utilising inspections, gaugings and inspection of river and lake levels and generation records supplied by the consent holder, has proved effective throughout the 2012-2013 monitoring period. The consent holder has maintained environmental reporting methods within the Company's annual reporting system.

2.1.10 Meeting of stakeholders

Special Condition 7 of consent 2053 requires:

> *"That the consent holder and staff of Taranaki Regional Council shall meet as appropriate, and at least once every two years, with submitters to the consent to discuss any matter relating to the exercise of this resource consent":*

Meetings have been held in July 2002, March 2005, and July 2007 with the issues and outcomes summarised in TRC, 2010. The latest meeting was held on 22 November, 2011 in New Plymouth in conjunction with a similar meeting required by consents for the TrustPower Motukawa HEP scheme and was reported in TRC, 2012. The consent holder canvassed all parties in advance of a proposed meeting for the 2012-2013 period but no issues were identified which necessitated the convening of such a meeting.

2.2 Assessment of effects monitoring

The consents' monitoring programme includes a component of effects assessment which to date has focused on impacts of residual flow releases and generation flow discharges on aspects of river physicochemical water quality and biology. In the 2012-2013 period this assessment involved the continuation of instream measurements (e.g. water temperatures) and assessments of impacts on river biology. Effects assessments will continue to form components of future consents' monitoring activities.

2.2.1 River water temperatures

Continuous river water temperature measurements have been performed throughout the term of the consents at three sites on the Waiwhakaiho River – one site upstream of the weir, one site within the residual flow reach of river between the

weir and the power station outlet, and one site below the power station outlet. The sites' locations are shown in Figures 7 and 8.

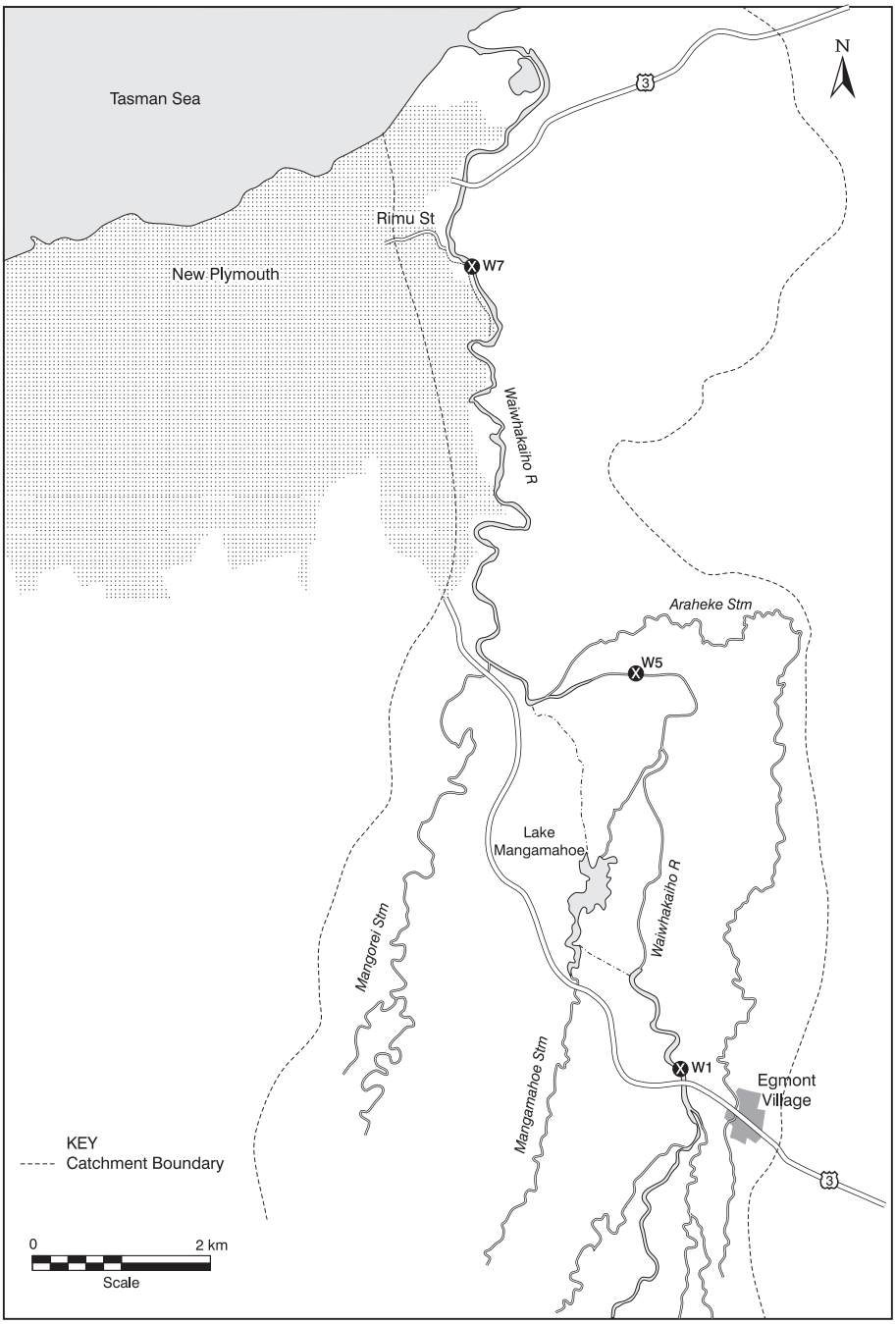

Figure 7 Water temperature monitoring sites (W1, W5, W7) in the lower Waiwhakaiho River catchment

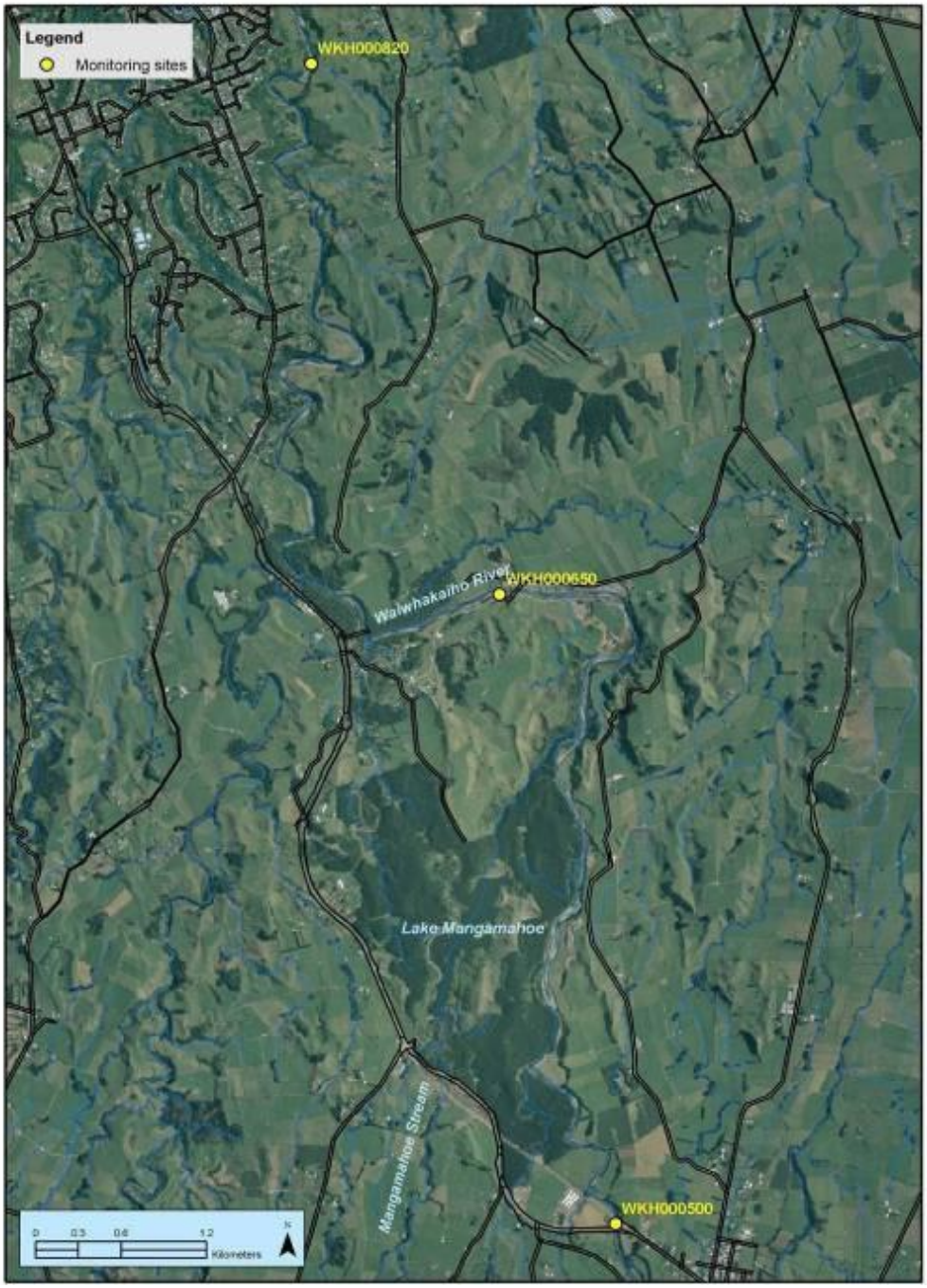

Figure 8 Aerial location map of monitoring sites

Details of these sites are provided in Table 3.

Table 3 Water temperature monitoring sites in the Waiwhakaiho River

Site	Location	GPS Location	Site code
W1	State Highway 3 (approximately 2 km upstream of weir)	E1698297 N5666893	WKH000500
W5	Hydro Road (within residual flow reach, approximately 5 km downstream of weir)	E1697474 N5671435	WKH000650
W7	Rimu Street track extension (approximately 13 km downstream of weir)	E1696149 N5675261	WKH000820

The water temperature data loggers that operated in the river were regularly calibrated and maintained throughout the monitoring period. Although the data loggers currently in use required less frequent calibration and servicing than the original recorders, site records do not always encompass the full monitoring period because of occasional malfunctions and damage due to river freshes and/or vandalism. This has affected the loggers at all sites on various occasions, despite an increased frequency of maintenance by the Council. Improvements to the housing of data loggers has resulted in greater efficiency of these units in the longer term. Analysis of results has been provided in previous monitoring reports with a compilation of data for the period from 1992 to mid 2002 provided in the principal monitoring report (TRC 95-71) and all subsequent reports (see Bibliography).

The continuous river water temperatures monitored at each of the three river sites are illustrated in Figure 9 as a complete record for the period from 1 July 1992 to 30 June 2013. Monthly average river temperatures for these sites have been presented in TRC, 2009a for the 1995-2009 period, and for annual monitoring periods in subsequent reports (TRC, 2010 TRC, 2011, and TRC 2012), and in Table 4 for the 2012-2013 period.

Table 4 Monthly statistical water temperature (°C) data for the three Waiwhakaiho River sites for the period mid 2012 to mid 2013

		2012						2013					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Max	SH3	11.3	11.3	14.3	16.4	17.9	21.1	20.7	20.5	18.3	15.9	13.8	11.6
	Hydro Rd	11.8	12.9	16.9	19.7	21.2	25.4	25.1	25.0	22.2	18.8	15.5	12.6
	Rimu St	12.2	12.5	14.2	17.1	20.0	23.2	23.4	23.4	21.8	18.7	15.0	12.2
Mean	SH3	8.3	9.3	9.8	10.9	12.7	15.2	16.3	16.4	15.2	13.0	11.0	9.3
	Hydro Rd	9.0	10.3	10.9	12.3	14.8	17.3	18.7	18.7	17.2	14.2	11.7	10.0
	Rimu St	10.0	10.9	11.1	12.4	15.6	18.0	19.2	19.9	19.0	15.2	12.4	10.5
Min	SH3	5.3	7.0	5.9	7.5	8.1	10.3	11.1	11.1	11.6	9.1	6.8	6.4
	Hydro Rd	5.9	8.1	7.0	8.2	9.5	11.5	13.4	12.6	13.0	9.8	6.9	7.2
	Rimu St	7.8	9.5	8.7	10.0	11.7	14.2	15.6	15.4	15.9	13.1	9.3	8.5

[Note: * = incomplete data for month]

These data indicate that upstream (SH3) natural river flow reached a higher maximum water temperature (21.1°C) during the 2012-2013 period compared to the maximum for the previous period. The maximum water temperature recorded at this site, upstream of the intake weir, since monitoring began, has been 23.3°C (February 2005) with a highest monthly average water temperature of 18.0°C in January 1999, whereas the highest monthly average in the 2012-2013 period was 1.6 C lower than this temperature. The widest monthly water temperature range measured at this SH3 site has been 14.7°C in February 2003, whereas the January and February 2013 temperature ranges were a moderate 9.6°C and 9.4°C respectively during low recession flow conditions.

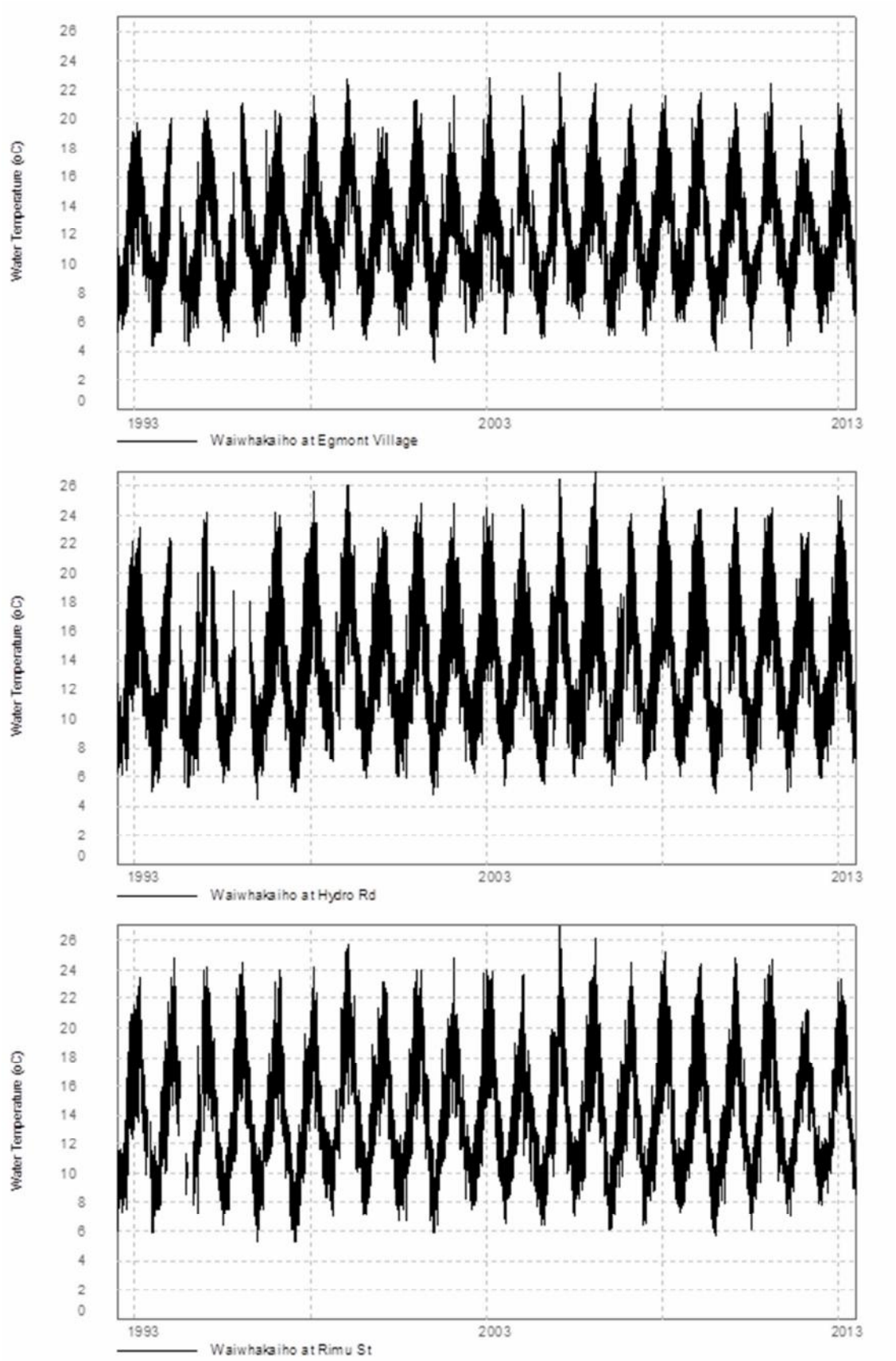

Figure 9 Water temperature (°C) in the Waiwhakaiho River (Egmont Village – SH3 (upper), Hydro Road (centre), and Rimu Street (lower)), for the period 1 July 1992 to 30 June 2013

Maximum water temperature recorded in the lower residual flow reach (at Hydro Road) during the 2012-2013 period was 25.4°C in December 2012, about 2°C lower than the previous maximum (recognising the absence of the summer 1995-96 and January 1998 records). Maximum water temperatures reached 25°C at this site in December 2012, and January and February 2013. The monthly January and February 2013 averages were 1.3°C below the highest monthly average (20.0°C) recorded to date (in January 1999). The widest water temperature range (15.3°C) at this site to date was measured in January 2006, 1.4°C higher than the range measured in December 2012. Temperatures in the 2012-2013 monitoring year were generally typical and within the range of those of previous years in this lower residual flow reach (at Hydro Road).

During the monitoring year, the lower river site at Rimu Street, with the greatest variation in flow regime, had a maximum water temperature of 23.4°C (January and February 2013) which was nearly 3.5˚C lower than the maximum water temperature recorded at this site since mid 1995 (27.0°C in February 2005). The highest monthly average has been 21.4°C in February 2005 and the widest water temperature range of 11.9°C in November 2002, whereas the highest monthly average (19.9°C) in the 2012-2013 period was recorded in February 2013 with the widest monthly temperature range (9.0°C) during the year recorded in December 2012.

Monthly statistical data (Table 4) for the 2012-2013 monitoring period indicate that monthly average water temperature differences between the natural river flow at the intake weir and end of the residual flow reach (Hydro Road) ranged between an increase of 0.7˚C and 1.4˚C (during the 400 L/sec residual flow release period); increases of 1.2°C to 2.1°C (during the 600 L/sec residual flow release period); and increases of 2.0°C to 2.4°C (during the 700 L/sec residual flow period). Instantaneous water temperature differences between these sites (Figure 10) peaked at a downstream increase of about 5.3°C, with the minimum difference in the one year period between 1 July 2012 and 30 June 2013 being a decrease of 0.2˚C between sites (in August 2012 and May 2013).

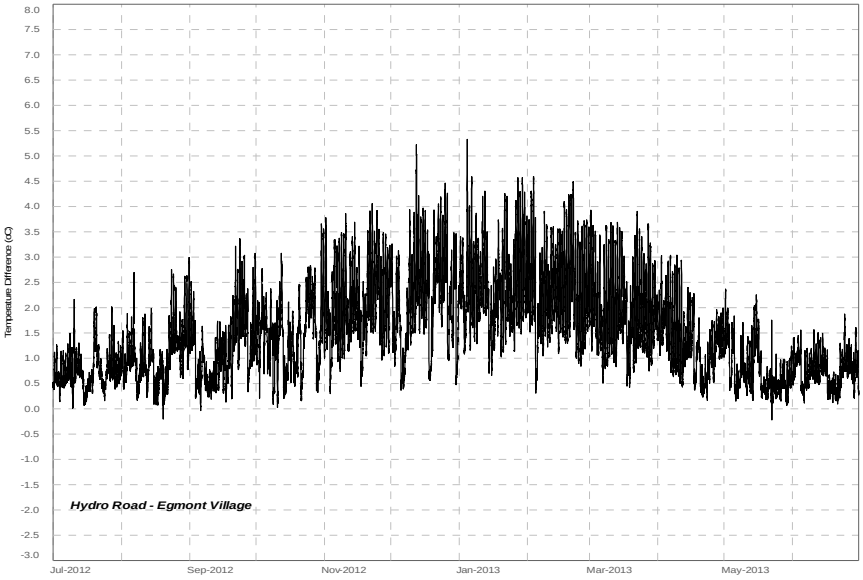

Figure 10 Instantaneous water temperature differences (˚C) between Waiwhakaiho River sites during the monitoring period – SH3 and Hydro Road sites

Average monthly water temperature differences between the lower end of the residual flow reach (Hydro Road) and the lower river reaches (Rimu Street) ranged between increases of 0.1°C to 1.0°C (during the 400 L/sec residual flow release period); and increases of 0.7˚C to 1.0°C (during the 600 L/sec residual flow release period); and increases of 0.5°C to 1.8°C (during the 700 L/sec residual flow release period). Instantaneous water temperature differences between these sites (Figure 11) peaked near a downstream increase of 4.0°C with the minimum difference in the one year period between 1 July 2012 and 30 June 2013 being a decrease of 2.8˚C between sites in late October 2012. Water temperatures often cooled in a downstream direction between these sites but generally by no more than 2°C (e.g. maximum monthly water temperatures ranged from 0.4°C higher to 2.7°C lower at the lower river site during the monitoring year (Table 4)), while minimum monthly water temperatures were always higher at the lower river site (ranging from 1.3˚C to 3.1˚C warmer).

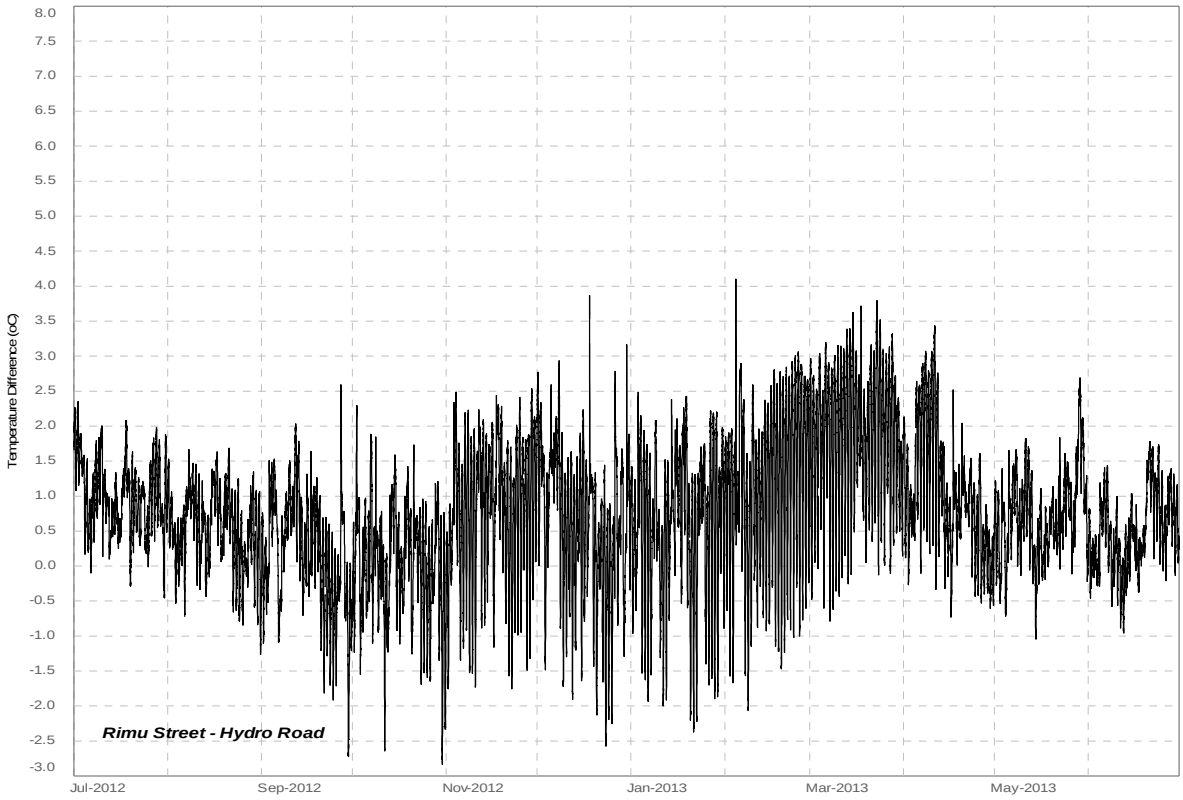

Figure 11 Instantaneous water temperature differences (˚C) between Waiwhakaiho River sites during the monitoring period – Hydro Road and Rimu Street sites

Similar comparative water temperature data analysis for the natural river flow site (SH3) and the lower river site (Rimu Street) during the 2012-2013 period showed that average monthly water temperatures increased in a downstream direction by 1.2°C to 1.7°C (400 L/sec flow releases); 2.2°C to 2.9°C (600 L/sec flow releases); and 2.9°C to 3.8°C (700 L/sec flow releases), typical of results for most earlier monitoring years. Instantaneous water temperature differences between these sites (Figure 12) reached a maximum downstream increase of 5.4°C during summer-autumn with a minimum difference during the monitoring period being a downstream decrease of 0.6˚C between sites in late September, 2012.

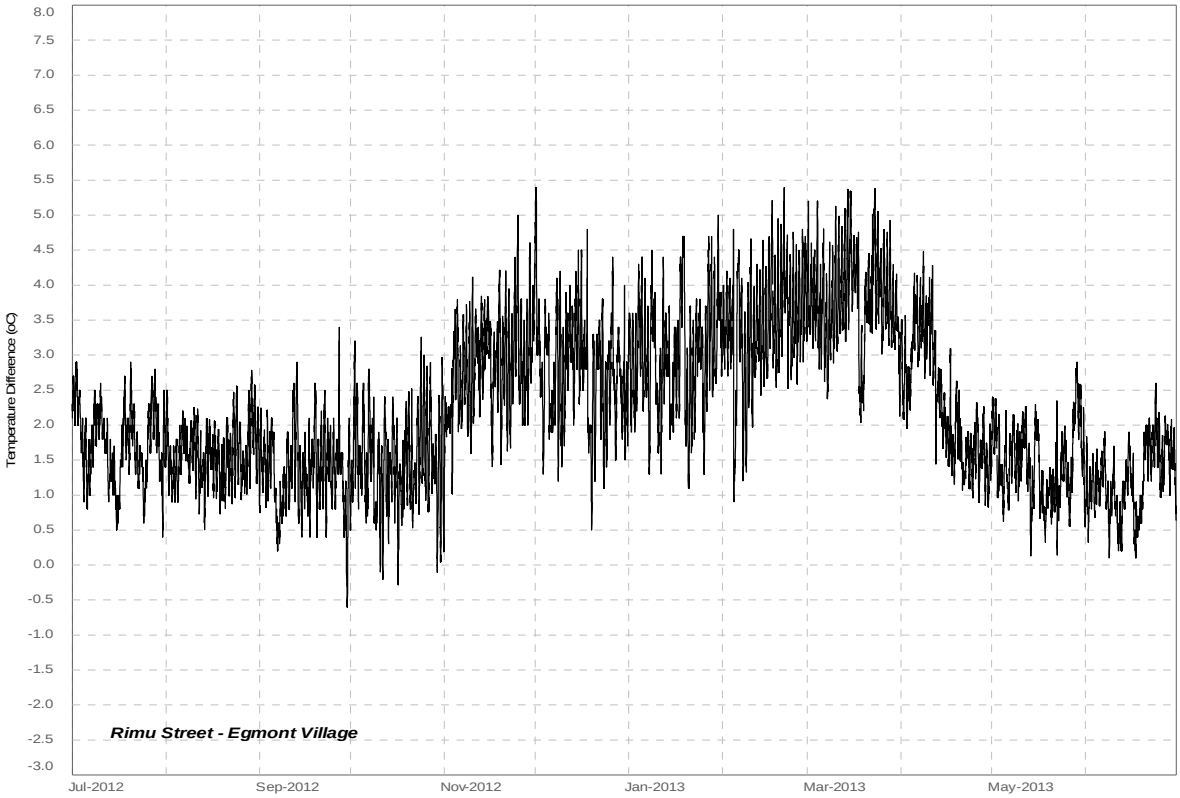

Figure 12 Instantaneous water temperature differences (˚C) between Waiwhakaiho River sites during the monitoring period – SH3 and Rimu Street sites

The river water temperature records for the one-year monitoring period and the entire twenty-one year period to mid 2013 have been statistically evaluated to provide percentages of time that specific temperatures were exceeded at each site. These results are presented in Tables 5 and 6 and provide comparative data for each of the three sites over periods when all three data loggers were operative simultaneously during the monitoring year (Table 5) and the entire period (Table 6).

Table 5 Comparative exceedance times (%), means, and ranges of water temperatures (°C) recorded at the three sites in the Waiwhakaiho River for periods when all sites were simultaneously operative from 1 July 2012 to 30 June 2013

Site	Exceedance time (%)								Temperature (°C)		
	10°C	12 °C	14 °C	16 °C	18 °C	20 °C	22 °C	24 °C	Min	Mean	Max
SH3	70	48	31	15	4	<1	0	0	5.3	12.2	21.1
Hydro Rd	81	59	44	30	17	7	2	<1	5.9	13.7	25.4
Rimu St	91	62	49	36	25	10	1	0	7.8	14.5	23.4

Table 6 Comparative exceedance times (%), means, and ranges of water temperatures (°C) recorded at the three sites in the Waiwhakaiho River for periods when all sites were simultaneously operative from July 1992 to June 2013

Site	Exceedance time (%)								Temperature (°C)		
	10°C	12 °C	14 °C	16 °C	18 °C	20 °C	22 °C	24 °C	Min	Mean	Max
SH3	69	47	29	14	4	<1	<1	0	3.3	12.1	23.3
Hydro Rd	79	58	41	26	14	6	2	<1	4.4	13.4	27.0
Rimu St	84	64	47	32	19	8	2	<1	5.3	14.1	27.0

The comparative record for the twenty-one year period to mid 2013 (Table 6) indicates an average water temperature increase in a downstream direction of 1.3°C at the Hydro Road site (in the lower residual flow reach) and a further 0.7°C at the

Rimu Street site in the lower river. Maximum river water temperature to date has been 23.3°C at SH3 upstream of the HEP intake weir increasing to 27.0°C at Hydro Road and remaining at 27.0°C downstream at Rimu Street. During the 2012-2013 monitoring period, slightly higher mean water temperatures (within 0.4°C of those in recent years) compared to the long term record were recorded at SH3, Hydro Road, and Rimu Street (Table 5). There was a downstream increase of 2.3°C in average water temperature between SH3 and Rimu Street recorded in the 2012-2013 period, compared to 2.0°C for the entire monitoring period (1992-2013).

The entire record (Table 6) also indicates that river water temperatures exceeded 20°C for less than 1% of the twenty-one year monitoring period at the SH3 site, 6% of the period at the Hydro Road site, and 8% of the period in the lower river at Rimu Street. River water temperatures exceeded 22°C for no more than 2% of the period at the site in the lower reaches of the river.

During the recent one-year monitoring period, average water temperatures were 0.1°C higher at the SH3 site above the hydro scheme, and 0.3 to 0.4°C higher at the two lower sites, than those over the twenty-one year period. Maximum temperatures throughout the river in 2012-2013 were lower than maxima recorded over the twenty-one year period by 2.2°C at SH3, 1.6°C at Rimu Street, and by 3.6°C at the residual flow, Hydro Road site.

2.2.2 Comparative river water temperatures in Taranaki

Water temperature records from dataloggers in two other ringplain Taranaki rivers are presented for comparison with data collected from the Waiwhakaiho River. The two rivers are the Kaupokonui River in southern Taranaki and the Kapoaiaia Stream in western Taranaki. Both are sourced in the National Park, and have significant reaches in open developed farmland, but are not used for hydroelectric power generation purposes. The sites and extent of the data record are summarised in Table 7.

Table 7 Taranaki sites used for water temperature comparative purposes

River	Site	Elevation (masl)	Distance from Nat Park boundary (km)	Distance from coast (km)	Data record
Waiwhakaiho River	SH3	175	10.6	18.4	February 1991 – June 2013
	Rimu Street, NP	40	25.2	4.7	February 1991 – June 2013
Kaupokonui River	Upper Glen Road	50	25.9	5.6	September 1978 – June 2013
	Near beach	5	31.0	0.6	July 1999 – June 2013
Kapoaiaia Stream	Wataroa Road	140	13.5	12.7	August 2000 – June 2013
	Near coast	20	25.2	1.0	May 1998 – June 2013

masl = metres above sea level

A summary of comparative water temperature data is presented in Table 8. It must be noted that the length of record varies between sites and for various reasons some records are incomplete (i.e. gaps in the continuous record).

Table 8 Water temperature data for selected Taranaki ringplain rivers (for periods listed in Table 7)

River	Waiwhakaiho River		Kaupokonui River		Kapoaiaia Stream	
Site	SH3	Rimu St	U Glenn Rd	Near Coast	Wataroa Rd	Near Coast
Maximum (°C)	23.3	27.0	29.0	26.8	24.3	27.7
Minimum (°C)	3.3	5.3	2.7	3.5	4.3	2.8
Mean (°C)	12.0	14.1	14.4	14.5	13.3	14.5
% exceedance						
>25°C	0	<1	<1	<1	0	<1
>23°C	<1	<1	2	2	<1	2
>20°C	<1	8	11	10	<3	9
>15°C	21	40	44	44	33	44
>10°C	69	84	82	85	80	88

Water temperatures in the lower reaches of all three rivers show relatively similar mean temperatures ranging from 14.1°C to 14.5°C with maximum temperatures ranging from 26.8°C to 27.7°C. The Waiwhakaiho River mean temperature was the lowest of the three lower river sites while the two other, more open rivers' catchments were comparatively warmer, exceeding 20°C for up to 2% more of the recording period in the lower reaches (Table 8). Generally, more riparian cover in the Waiwhakaiho River catchment compared to the more open nature of the other river catchments, maintained slightly lower water temperatures throughout the river length. Very limited exceedances of 25°C occurred in any of the three rivers over the various recording periods, averaging no more than the equivalent of 3 days duration in any single year i.e., on average, less than one hour per day during any summer period.

These records will continue to be updated in future monitoring reports including state of the environment reporting (e.g. TRC, 2009).

2.2.3 Impact of increased summer residual flow regime on river water temperatures

An assessment of any impacts of the residual flow increase from 600 L/sec to 700 L/sec (during the January-March period) on river water temperatures, particularly at the Hydro Road site in the lower residual flow reach, is provided from the several summers' data collected prior to 1998 (pre 700 L/sec releases) and from 1998 to 2013. The principal proviso applying to this assessment is the gap in data records at the SH3 and Hydro Road sites prior to 1998 (explained in section 2.2.1). Prior to the summer of 1997-98, all residual flows during the January to March period were of 600 L/sec. Subsequent to this date, renewed consent conditions required a residual flow of 700 L/sec over these three months of summer. A comparative statistical summary of river water temperature data is presented in Table 9.

Table 9 Waiwhakaiho River water temperature data at three sites prior to, and after, the requirement for the 700 L/sec summer (3-month) residual flow

River	SH3		Hydro Rd		Rimu St	
Site	**1992-97**	**1998-2013**	**1992-97**	**1998-2013**	**1992-97**	**1998-2013**
Maximum (°C)	21.1	23.3	25.6	27.0	24.8	27.0
Minimum (°C)	9.2	8.2	9.4	10.2	10.8	10.7
Mean (°C)	15.3	15.8	17.2	17.8	18.0	18.7
Std Devn (°C)	2.0	2.1	2.6	2.5	2.3	2.3
% exceedance						
>25°C	0	0	<1	<1	0	<1
>23°C	0	<1	1	3	1	3
>20°C	<1	3	13	20	21	29
>18°C	10	14	37	45	50	61
>16°C	37	45	66	76	79	88
>14 °C	74	80	88	95	96	98
>12 °C	95	97	98	99	99	99
>10 °C	>99	>99	>99	100	100	100
Data record (percentage of period)	80	99	60	99	100	99

Note: 600 L/s residual flow at Hydro Road: 1992-97 and 700 L/s residual flow at Hydro Road: 1998-2013

The data indicate that average water temperatures were higher by 0.6°C at the residual flow (Hydro Road) and 0.7°C at the lower (Rimu Street) reaches subsequent to the 100 L/sec increase in residual flow over the three month summer periods. However, upstream (ambient) average river water temperature has also increased (by 0.5°C) over the same period, indicating that the increases downstream may predominantly be due to natural climatic variability. Warmer waters from Lake Mangamahoe discharged through the powerhouse may also have accentuated lower river temperature increases. A confounding factor has also been the significant loss of mid-summer data prior to 1998 (40% of data) for the Hydro Road site (due to vandalism of the loggers etc), thereby depressing the true average water temperature at the site before the summer residual flow releases were increased, and some loss of similar data from the upstream SH3 site (20% of data).

The percentages of the total time that river temperatures were above various temperatures within the range of 16°C to 20°C have generally increased by about 8 to 11% since the implementation of higher residual flow at both sites downstream of the intake weir (Table 9), but the influences of natural upstream river temperature increases (4 to 8% over the same range), absence of critical data, and warming of Lake Mangamahoe waters must also be taken into account. Periods of exceedances of 23°C at the two lower reach sites have increased by 2% with no significant increase in exceedances of 25°C which have remained at less than 1% of the period.

Changes in downstream water temperatures between the intake weir and each of the two lower river monitoring sites (Hydro Road in the lower residual flow reach, and Rimu Street in the lower river) are summarised in Table 10 for the 600 L/sec and 700 L/sec summer residual periods and compared for the different residual flow regimes in Figure 13.

Table 10 Comparative exceedance times for water temperature differences (°C) between sites in the Waiwhakaiho River prior to, and after, the requirement for the 700L/sec summer (3 months) residual flow

Sites	Period	% exceedance time									Difference (°C)		
		10	20	30	40	50	60	70	80	90	Min	Mean	Max
Hydro Rd – SH3	1992-97	3.3	2.8	2.4	2.1	1.8	1.6	1.3	1.0	0.6	-1.5	1.9	7.3
	1998-2013	3.6	3.0	2.6	2.3	2.0	1.7	1.5	1.2	0.8	-2.4	2.1	7.6
Rimu St – SH3	1992-97	3.7	3.3	3.0	2.7	2.4	2.2	1.9	1.6	1.2	0.6	2.5	6.4
	1998-2013	4.4	3.9	3.5	3.3	3.0	2.7	2.4	2.1	1.6	-1.7	3.0	9.3

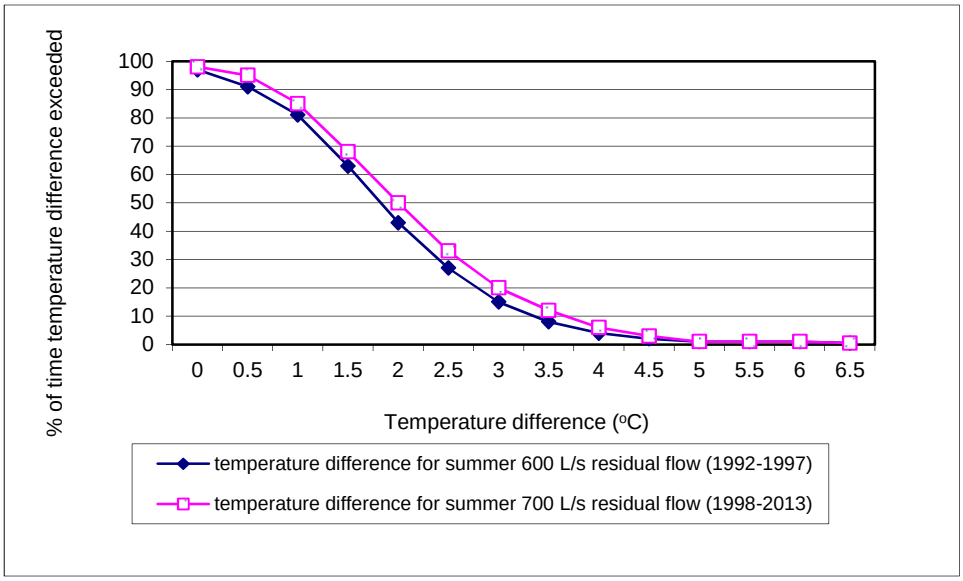

Figure 13 Exceedance time (%) for the temperature difference between natural flow upstream of weir (SH3) and residual flow downstream at Hydro Road prior to and after the summer residual flow was increased by 100 L/s

The magnitudes of the rises in average river temperature have increased slightly (by 0.2°C in the residual flow reach and 0.5°C in the lower river) since the instigation of the additional 100 L/sec residual flow between January and March of each summer. However, significant gaps in the records prior to 1998 (referenced earlier) may have influenced the results during the 600 L/sec residual flow period. Median (50% exceedance) records also indicate similar trends (but a narrower range) of increased temperatures of 0.2°C and 0.6°C at these sites. These rises have been calculated from records only when all three dataloggers have been operating simultaneously and therefore differ slightly from the increases referenced in relation to the entire water temperature records (Table 9).

The temperature differentials between the natural and residual flow reaches (Figure 13) exhibit the same trend with a 3% increase in frequency of exceedance of 1.5°C, 6% increase in 2.5°C exceedance, reducing to a 2% increase in 4°C exceedance under the higher residual flow conditions. No significant differences in temperature differentials above 5°C were recorded, but the same provisos (as earlier) apply to this statistical summary of date.

The trends in mean monthly water temperature differentials over the 21 year period to date are illustrated in Figures 14 and 15.

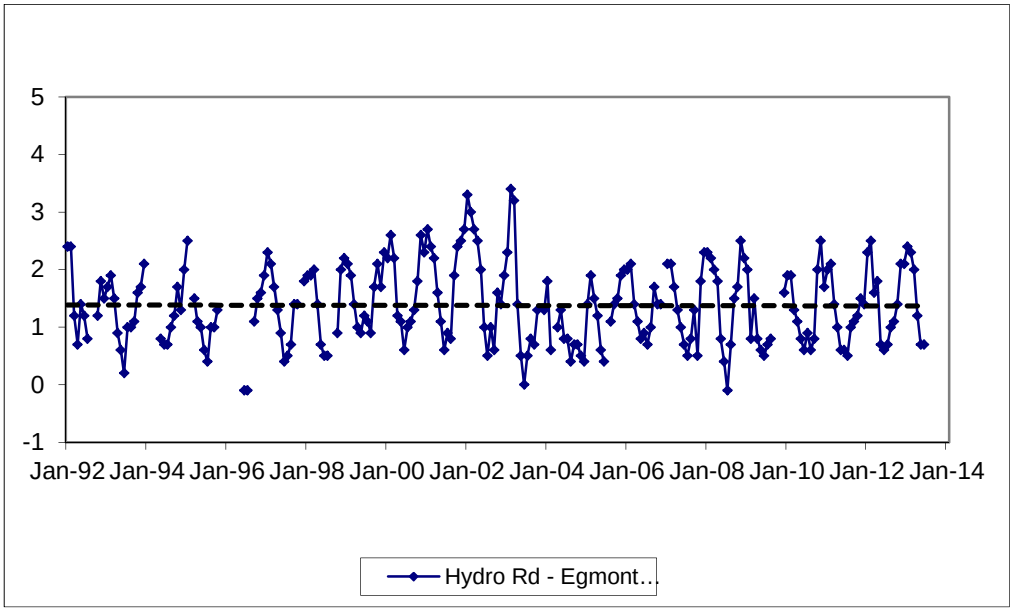

Figure 14 Trend in mean monthly water temperature differences over the period January 1992 to June 2013 between Egmont Village and Hydro Road

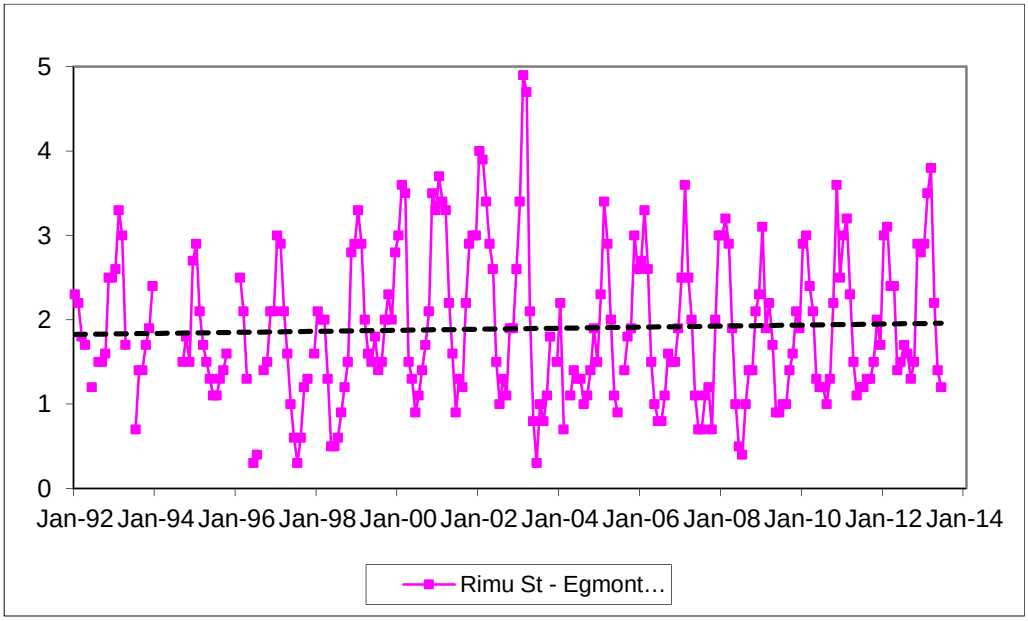

Figure 15 Trend in mean monthly water temperature differences over the period January 1992 to June 2013 between Egmont Village and Rimu Street, New Plymouth

There has been minimal change in average monthly water temperature differentials (fall of <0.1˚C) through the residual flow reach of the river (Figure 14) and in the lower river (Figure 15) (rise of 0.1˚C) over the twenty-one year period.

It should be noted that past physicochemical water quality surveys (TRC, 2001) have not indicated any detrimental effects upon residual flow or lower river dissolved oxygen concentrations as average water temperatures have risen. Also, the additional residual flow release may be expected to have had more subtle beneficial effects in terms of provision of greater areas of wetted biological habitat and improved fish passage throughout the lower river, but particularly in the 6 km residual flow reach between the intake weir and 'Meeting of the Waters'.

2.2.4 Impacts on biological aspects of the river

2.2.4.1 Macroinvertebrate fauna

In previous monitoring periods, macroinvertebrate surveys have been performed as components of other consent holders' programmes and for state of the environment monitoring (SEM) purposes. These were used to provide biological information for the Mangorei HEP scheme, as well as specific surveys for scheme monitoring performed during the spring residual flow (400 L/sec) and summer residual flow (700 L/sec) to assess the effects of residual flows on macroinvertebrate communities during the 1999-2000 period (TRC 2000-51). No specific HEP scheme macroinvertebrate surveys were programmed for the 2012-2013 period. However, state of the environment monitoring data to date for four sites in the Waiwhakaiho River (TRC 2011b, TRC 2012b, and 2013), applicable for consent monitoring purposes, are summarised beneath.

The number of macroinvertebrate taxa found in each sample is used as an indicator of the richness of the community at each site while the Macroinvertebrate Community Index (MCI) is used as an indicator of river 'health'.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

Rates of MCI change have been calculated for the catchment where several sites have been surveyed based upon recent updated G.I.S. river/stream length information incorporated into the Council's 'SITES' database system and relationships developed between MCI, site altitude, and distance from the National Park boundary (Stark and Fowles, 2009).

A gradation of biological water quality conditions based upon MCI ranges has been adapted for Taranaki streams and rivers (TRC, 2006b) from Stark's classification (Stark, 1985 and Boothroyd & Stark, 2000). This 'generic' gradation which provides more resolution within the upper and lower gradings is as follows:

Table 11 Generic MCI gradation of biological water quality conditions adapted for Taranaki streams and rivers

Grading	MCI	Code
Excellent	>140	
Very Good	120-140	
Good	100-119	
Fair	80-99	
Poor	60-79	
Very Poor	<60	

Following the establishment of relationships between MCI scores and ringplain stream altitude and distance from source (Stark & Fowles, 2009), biological 'health' may also be graded against predictive values recognising the degree of degradation between the National Park and the coast. These 'predictive' gradings which may be applied throughout the length of ringplain streams, range from 'better than expected' through 'expected' to 'worse than expected' (see TRC, 2013b). Both systems of grading sites ('generic' and 'predictive') biological 'health' have been utilised in the following discussion.

The Waiwhakaiho River was one of several selected for the SEM programme as examples of waterways with large catchments and multiple impacts from human land uses including plantation forestry, rural, urban and industrial.

The Waiwhakaiho River and its headwater tributaries arise above the tree line on the north face of Mount Taranaki. Upon leaving the National Park, the river flows north through agricultural and industrial land for 27 kilometres to the sea. The river passes under State Highway 3 near Egmont Village, nine kilometres downstream of the National Park boundary. The sites at Constance Street and adjacent to Lake Rotomanu are included in the lower Waiwhakaiho River industrial monitoring programme. This allows the State of the Environment monitoring programme to better synchronise with the industrial monitoring programme.

An additional site was established in the upper reaches of the Waiwhakaiho River for the 2002-03 SEM programme, to complement the three sites in the central to lower reaches of this large ringplain river, in recognition of its importance as a water resource and particularly its proximity to New Plymouth city. The site was established a short distance inside the National Park boundary at an elevation of 460 m asl. No macroinvertebrate data had been collected for this reach of the river inside the National Park prior to 2002.

The results from the 2012-2013 surveys are presented in Tables 12 and 13 for the four sites in the Waiwhakaiho River at the sites located at National Park boundary, State Highway 3 (Egmont Village), Constance Street (New Plymouth), and the riffle adjacent to Lake Rotomanu, respectively.

Table 12 Macroinvertebrate fauna of the Waiwhakaiho River: spring SEM survey sampled 28 November 2012

Taxa List	Site Code	MCI score	WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB12460	FWB12461	FWB12462	FWB12464
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	R	A
	Lumbricidae	5	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	-	A
CRUSTACEA	Ostracoda	1	-	-	-	R
	Paracalliope	5	-	-	-	R
	Paratya	3	-	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-	-	-
	Austroclima	7	-	R	-	-
	Coloburiscus	7	-	A	C	C
	Deleatidium	8	XA	XA	XA	VA
	Nesameletus	9	C	-	-	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	R	-	-
	Austroperla	9	-	R	-	R
	Megaleptoperla	9	A	R	R	-
	Zelandobius	5	R	R	R	R
	Zelandoperla	8	VA	A	-	-
HEMIPTERA (BUGS)	*Saldula*	5	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	A	A
	Hydraenidae	8	-	-	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R	R	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	C	A	VA
	Costachorema	7	A	A	A	R
	Hydrobiosis	5	C	C	C	R
	Hydrochorema	9	R	-	-	-
	Orthopsyche	9	R	-	-	-
	Plectrocnemia	8	-	C	-	-
	Psilochorema	6	C	R	-	-
	Beraeoptera	8	C	-	R	-
	Olinga	9	R	-	-	R
	Oxyethira	2	-	-	-	A
	Pycnocentrodes	5	R	A	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A	C	VA
	Eriopterini	5	C	-	-	R
	Maoridiamesa	3	C	A	A	VA
	Orthocladiinae	2	-	C	A	VA
	Polypedilum	3	R	R	-	-
	Tanytarsini	3	-	-	R	C
	Empididae	3	-	-	-	C
	Ephydridae	4	-	-	R	R
	Muscidae	3	-	-	-	R
	Austrosimulium	3	-	R	-	C
		No of taxa	21	22	17	30
		MCI	133	112	108	96
		SQMCIs	7.6	7.4	7.3	4.3
		EPT (taxa)	14	14	8	10
		%EPT (taxa)	67	64	47	33

'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 13 Macroinvertebrate fauna of the Waiwhakaiho River: summer SEM survey sampled 1 February 2013

Taxa List	Site Code	MCI score	WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB13033	FWB13034	FWB13035	FWB13037
NEMERTEA	Nemertea	3	-	-	R	R
NEMATODA	Nematoda	3	-	-	R	C
ANNELIDA (WORMS)	Oligochaeta	1	R	R	A	A
MOLLUSCA	*Potamopyrgus*	4	-	R	C	A
CRUSTACEA	*Paracalliope*	5	-	-	-	R
	Paratya	3	-	-	-	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	R	R
	Coloburiscus	7	R	C	-	C
	Deleatidium	8	XA	XA	VA	R
	Nesameletus	9	C	R	-	-
	Zephlebia group	7	-	-	-	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-
	Megaleptoperla	9	A	-	R	-
	Stenoperla	10	-	R	-	-
	Zelandobius	5	R	-	-	-
	Zelandoperla	8	VA	R	R	R
COLEOPTERA (BEETLES)	Elmidae	6	XA	VA	VA	A
	Hydraenidae	8	R	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA	VA	XA
	Costachorema	7	C	A	R	R
	Hydrobiosis	5	C	A	A	C
	Hydrobiosella	9	R	-	-	-
	Neurochorema	6	-	C	-	-
	Plectrocnemia	8	-	R	-	-
	Psilochorema	6	R	R	-	-
	Olinga	9	C	-	R	-
	Oxyethira	2	-	-	A	A
	Pycnocentria	7	R	-	-	-
	Pycnocentrodes	5	-	R	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C	VA
	Eriopterini	5	C	-	-	-
	Maoridiamesa	3	R	VA	R	C
	Orthocladiinae	2	-	A	VA	VA
	Polypedilum	3	R	R	-	R
	Tanypodinae	5	R	-	-	-
	Tanytarsini	3	-	R	A	VA
	Empididae	3	-	R	C	R
	Ephydridae	4	-	R	C	-
	Muscidae	3	-	C	C	R
	Austrosimulium	3	-	-	-	R
	Tanyderidae	4	-	-	R	R
		No of taxa	22	27	24	26
		MCI	125	112	96	89
		SQMCIs	7.1	6.4	4.6	3.7
		EPT (taxa)	14	14	9	8
		%EPT (taxa)	64	52	38	31

'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

2.2.4.1.1 National Park site (WKH000100)

2.2.4.1.1.1 Taxa richness and MCI

Twenty surveys have previously been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and April 2012. These results are summarised in Table 14, together with the results from the current period, and illustrated in Figure 16.

Table 14 Results of previous surveys performed in the Waiwhakaiho River at National Park together with spring 2012 and summer 2013 results

Site code	SEM data (1995 to Apr 2012)					2012-2013 surveys			
	No of surveys	Taxa numbers		MCI values		November 2012		February 2013	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000100	20	4-29	19	115-147	129	21	133	22	125

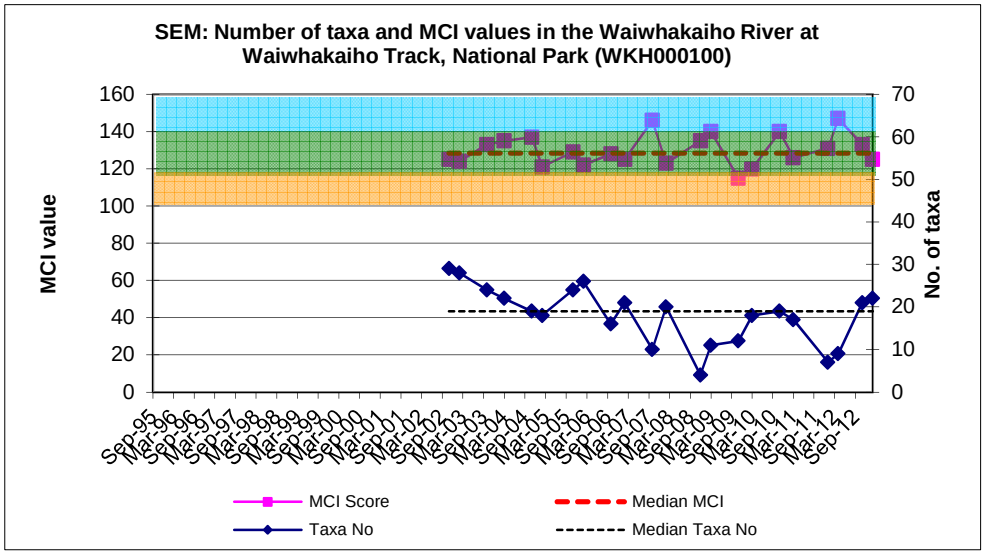

Figure 16 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont National Park

A wide range of richnesses (4 to 29 taxa) has been found; wider than might be expected, due to headwater erosion effects over the 2008-2009 period in particular, with a median richness of 19 taxa, significantly lower than typical richnesses (28 taxa) in ringplain streams and rivers near the National Park boundary. During the 2012-2013 period spring (21 taxa) and summer (22 taxa) richnesses were slightly above this median richness following continued recent post-headwater erosion recovery, with minimal evidence of siltation remaining at this site.

MCI values have had a wider range (32 units) at this site than typical of a National Park boundary site, due in part to an atypically very high value in 2008 following a marked drop in richness and low values after the 2008-2009 headwater erosion period. The median value (129 units) has been slightly lower than typical of upper reach sites elsewhere on the ringplain (TRC, 1998b (updated, 2012) and 2012b), and the spring, 2012 (133 units) and summer, 2013 (125 units) scores were 4 units higher and 4 units lower than the historical median respectively. They categorised this site as having 'very good' (spring and summer) health generically and, in terms of predictive relationships, 'expected' health for the upper reaches of a ringplain stream

on both these occasions with taxa richnesses indicative of continued post-headwater erosion recovery. The historical median score (129 units) placed this site in the 'very good' and 'expected' categories for generic and predictive methods of assessment respectively (see 2.2.4.1.1.3 below).

2.2.4.1.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2012-2013 period are listed in Table 15.

Table 15 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the National Park between 1995 and April 2012 [20 surveys], and by the spring 2012 and summer 2013 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2012	Summer 2013
EPHEMEROPTERA	*Coloburiscus*	7	2	10		
	Deleatidium	8	20	100	XA	XA
	Nesameletus	9	4	20		
PLECOPTERA	*Megaleptoperla*	9	6	30	A	A
	Zelandoperla	8	15	75	VA	VA
COLEOPTERA	Elmidae	6	18	90	VA	XA
TRICHOPTERA	*Aoteapsyche*	4	1	5		
	Costachorema	7	1	5	A	
	Hydrobiosella	9	1	5		
	Beraeoptera	8	5	25		
DIPTERA	*Aphrophila*	5	8	40		A
	Eriopterini	5	3	15		
	Maoridiamesa	3	1	5		
	Orthocladiinae	2	2	10		

Prior to the current 2012-2013 period, 14 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', five 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream although numerically fewer dominant taxa than are typical in the upper reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa [mayfly (*Deleatidium* on every sampling occasion) and stonefly (*Zelandoperla*)]; one 'moderately sensitive' taxon [elmid beetles]; but no 'tolerant' taxa. Five of these taxa were dominant in the spring 2012 community and four of these same taxa were again dominant in the summer 2013 community. No 'tolerant' taxa were dominant on either sampling occasion coincident with minimal periphyton substrate cover at this site. All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 75% to 100% of past surveys.

2.2.4.1.1.3 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is just inside the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 131 (altitude) and 132 (distance) for this site. The historical site median (129 units) is only 2 units lower than the altitude

prediction and 3 units lower than the distance predictive value, while the spring, 2012 survey score (133 units) was within two units of both predictive values and the summer, 2013 score (125 units) was insignificantly 6 to 7 units lower than both predictive values. Of the 22 surveys to date at this site, 55% of MCI scores have been less than 131 units while 41% have been greater than 132 units.

2.2.4.1.1.4 Temporal trends in 1995 to 2013 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site in the Waiwhakaiho River at the National Park. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 17.

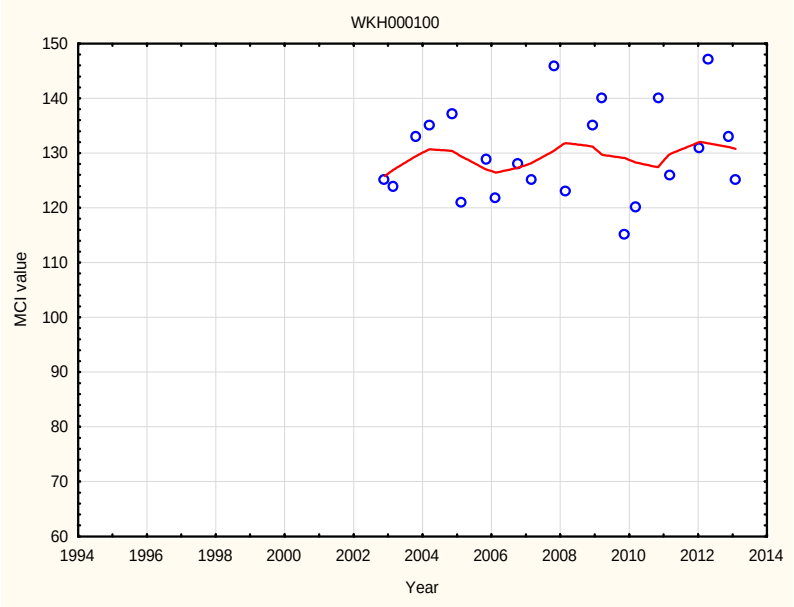

Figure 17 LOWESS trend plot of MCI data at the National Park site

No significant temporal trend in MCI scores has been found over the eleven year monitoring period at this site within the National Park. Smoothed scores consistently have indicated 'very good' generic river health over the period but, in terms of predictive relationships for a site in the upper reaches of a ringplain river at the boundary of the National Park, river health has remained as 'expected'. Some individual scores indicative of 'worse than expected' health have followed headwater erosion events during the eleven year period.

2.2.4.1.2 Egmont Village site (WKH000500)

2.2.4.1.2.1 Taxa richness and MCI

Thirty-four surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village (above the Mangorei Power Scheme) between October 1995 and April 2012. These results are summarised in Table 16, together with the results from the current period, and illustrated in Figure 18.

Table 16 Results of previous surveys performed in the Waiwhakaiho River at Egmont Village, together with spring 2012 and summer 2013 results

Site code	SEM data (1995 to Apr 2012))					2012-2013 surveys			
	No of surveys	Taxa numbers		MCI values		November 2012		February 2013	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000500	34	14-32	23	87-122	109	22	112	27	112

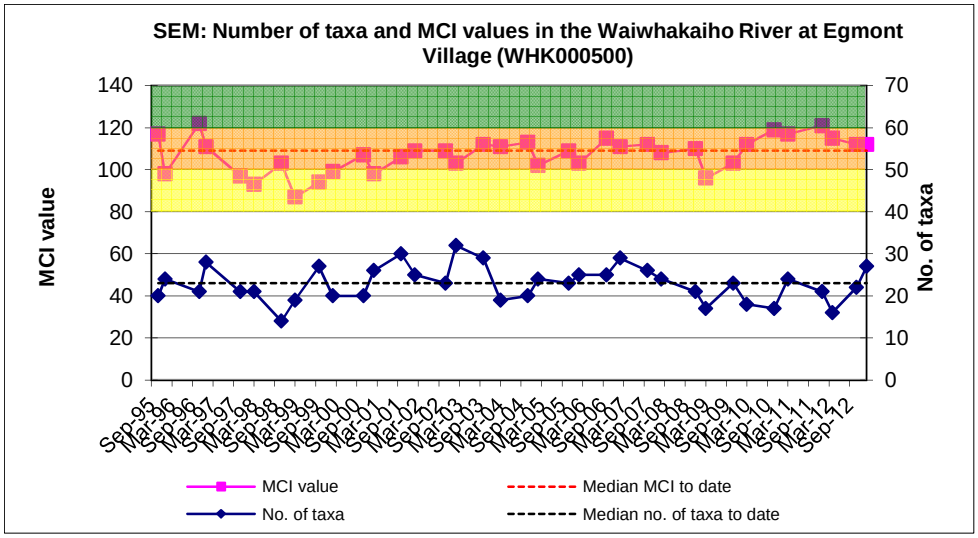

Figure 18 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richnesses (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 23 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2012-2013 period spring (22 taxa) and summer (27 taxa) richnesses were relatively different (by 5 taxa) but near or above the median taxa number to date.

MCI values have had a slightly wider range (35 units) at this site than typical of sites in the mid reaches of ringplain rivers. The median value (109 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, with the spring, 2012 (112 units) and summer, 2013 (112 units) scores typical for such a site and 3 units higher than the historical median. These scores categorised this site as having 'good' (spring and summer) health generically and, in terms of predictive relationships 'expected' (spring and summer) health for the mid reaches of a ringplain river. The historical median score (109 units) placed this site in the 'good' and 'expected' categories for generic and predictive methods of assessment respectively.

2.2.4.1.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2012-2013 period are listed in Table 17.

Table 17 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at Egmont Village between 1995 and April 2012 [34 surveys], and by the spring 2012 and summer 2013 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2012	Summer 2013
NEMATODA	Nematoda	3	1	3		
ANNELIDA	Oligochaeta	1	8	24		
EPHEMEROPTERA	*Coloburiscus*	7	9	26	A	
	Deleatidium	8	27	79	XA	XA
	Nesameletus	9	3	9		
PLECOPTERA	*Zelandoperla*	8	1	3	A	
COLEOPTERA	Elmidae	6	20	59	A	VA
MEGALOPTERA	*Archichauliodes*	7	2	6		
TRICHOPTERA	*Aoteapsyche*	4	22	65		VA
	Costachorema	7	11	32	A	A
	Hydrobiosis	5	5	15		A
	Neurochorema	6	5	15		
	Beraeoptera	8	1	3		
	Oxyethira	2	8	24		
	Pycnocentrodes	5	3	9	A	
DIPTERA	*Aphrophila*	5	27	79	A	A
	Eriopterini	5	2	6		
	Maoridiamesa	3	29	85	A	VA
	Orthocladiinae	2	32	94		A
	Tanytarsini	3	10	29		
	Empididae	3	2	6		
	Muscidae	3	4	12		
	Austrosimulium	3	1	3		

Prior to the current 2012-2013 period, 23 taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and in comparison with the National Park site, a (downstream) increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Eight of the historically characteristic taxa were dominant in the spring, 2012 and summer 2013 communities. These comprised two 'highly sensitive' taxa, five 'moderately sensitive' taxa, and one 'tolerant' taxon in spring, whereas one 'highly sensitive', four 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community i.e. fewer 'sensitive' and more 'tolerant' taxa in summer. Five of these eleven taxa were dominant in both spring and summer communities (Table 17). The predominant taxon [mayfly (*Deleatidium*)] remained the same in both surveys resulting in relatively high $SQMCI_s$ values (7.4 and 6.3 units).

Of the predominant taxa in the 2012-2013 period, the 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' elmid beetles, and 'tolerant' caddisfly (*Aoteapsyche)* and orthoclad midges have characterised this site's communities on 59% to 85% of survey occasions to date.

2.2.4.1.2.3 Predicted stream 'health'

The Waiwhakaiho River site at Egmont Village is 10.6 km downstream of the National Park boundary at an altitude of 175 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 102 (altitude) and 105 (distance) for this site. The historical site median (109) is 7 units higher than the altitude prediction and 4 units higher than the distance predictive value while the spring, 2012 and summer, 2013 survey scores (112 units) were higher than both predictive values by 7 to 10 units. Of the 36 surveys to date at this site, 22% of MCI scores have been less than 102 units while 64% have been greater than 105 units.

2.2.4.1.2.4 Temporal trends in 1995 to 2013 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the seventeen years of SEM results collected to date from the site in the Waiwhakaiho River atEgmont Village. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 19.

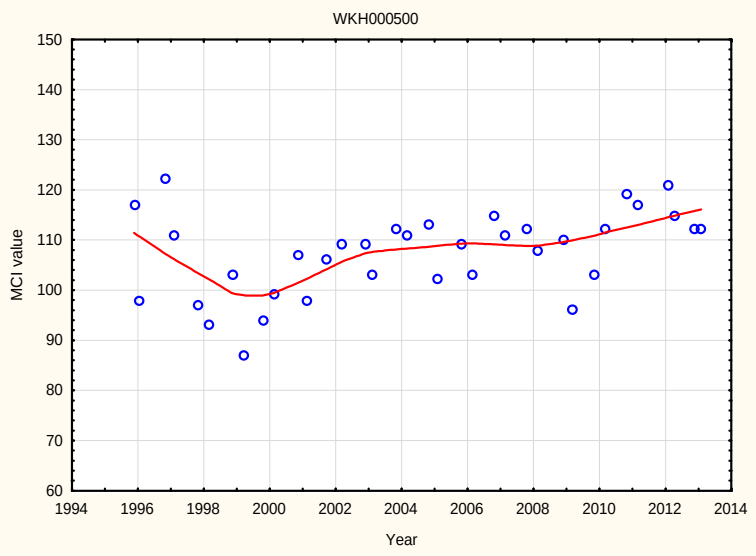

Figure 19 LOWESS trend plot at the Egmont Village site

An overall significant trend in MCI scores has been found during the eighteen year period. After some initial deterioration in scores, there has been a steady improvement since 1999. The change in the LOWESS-smoothed range (19 MCI units) has been of ecological significance over the period. While the smoothed scores were indicative of 'good' to 'fair' generic river health over the first five years, river health has consistently remained 'good' since 2000. In terms of predictive relationships for a

site in the mid reaches of a ringplain river, health has been 'expected' for most of the period, improving to 'better than expected' more recently.

2.2.4.1.3 Constance Street site (WKH000920)

2.2.4.1.3.1 Taxa richness and MCI

Thirty-five surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth (below the Mangorei Power Scheme) between 1995 and March 2011. These results are summarised in Table 18, together with the results from the current period, and illustrated in Figure 20.

Table 18 Results of previous surveys performed in the Waiwhakaiho River at Constance Street, New Plymouth together with spring 2012 and summer 2013 results

Site code	SEM data (1995 to Apr 2012)					2012-2013 surveys			
	No of surveys	Taxa numbers		MCI values		November 2012		February 2013	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000920	35	12-29	20	71-110	95	17	108	24	96

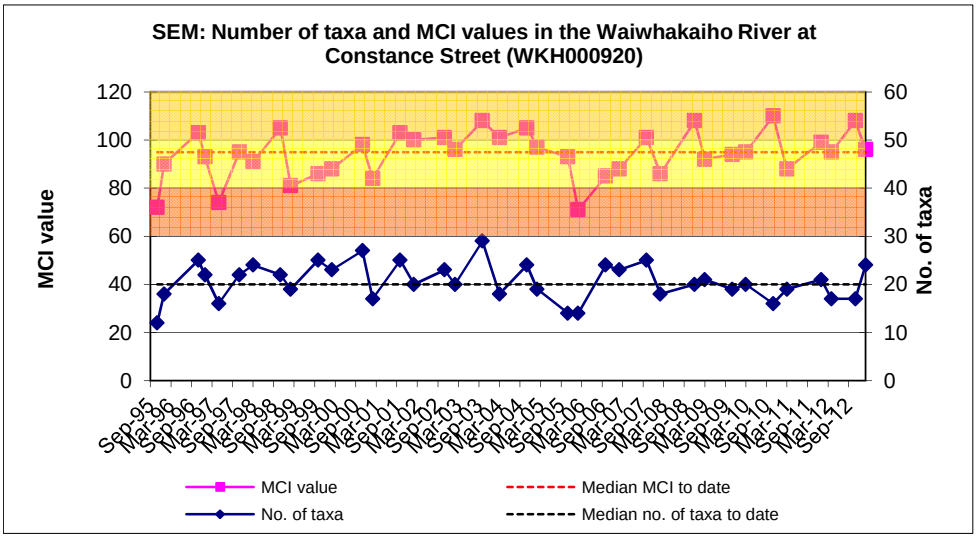

Figure 20 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richnesses (12 to 29 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2012-2013 period spring (17 taxa) and summer (24 taxa) richnesses were relatively different but within four taxa of the median richness on both occasions.

MCI values have had a wide range (39 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain however (TRC, 1998). The spring, 2012 (108 units) and summer, 2013 (96 units) scores were significantly different (Stark, 1998), although relatively typical of scores for such a site. They were significantly higher than the historical median in spring when the score was within 2 units of the historical maximum and very similar to the median in summer. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically and, in terms of predictive relationships 'better than expected' health in spring and 'expected' health in summer for the lower reaches of a

ringplain river. The historical median score (95 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

2.2.4.1.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2012-2013 period are listed in Table 19.

Table 19 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at Constance Street between 1995 and April 2012 [35 surveys], and by the spring 2012 and summer 2013 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2012	Summer 2013
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	20	57		A
MOLLUSCA	*Potamopyrgus*	4	2	6		
CRUSTACEA	*Paratya*	3	1	3		
EPHEMEROPTERA	*Austroclima*	7	1	3		
	Coloburiscus	7	5	14		
	Deleatidium	8	17	49	XA	VA
COLEOPTERA	Elmidae	6	9	26	A	VA
	Staphylinidae	5	1	3		
TRICHOPTERA	*Aoteapsyche*	4	27	77	A	VA
	Costachorema	7	5	14	A	
	Hydrobiosis	5	6	17		A
	Neurochorema	6	1	3		
	Oxyethira	2	10	29		A
DIPTERA	*Aphrophila*	5	8	23		
	Maoridiamesa	3	17	49	A	
	Orthocladiinae	2	34	97	A	VA
	Tanytarsini	3	15	43		A
	Muscidae	3	2	6		
	Austrosimulium	3	4	11		

Prior to the current 2012-2013 period, 20 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increased proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa; no 'moderately sensitive' taxa; but three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Aoteapsyche*), and orthoclad midges]. Only six of the historically characteristic taxa were dominant in the spring, 2012 community. These comprised one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and three 'tolerant' taxa, whereas one 'highly sensitive', two 'moderately sensitive', and five 'tolerant' taxa comprised the dominant taxa of the summer, 2013 community. Four of these ten taxa were dominant in both spring and summer communities (Table 19). Increases in summer seasonal dominances by 'tolerant' taxa and a reduction in the abundance of the 'highly sensitive' mayfly (*Deleatidium*) were reflected in the significant decrease (2.7 units) in the summer $SQMCI_s$ score (Tables 12 and 13).

The 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' elmid beetles, and 'tolerant' caddisfly (*Aoteapsyche*) and orthoclad midges which were pre- dominant in spring and/or summer surveys, had characterised this site's communities on 26% to 97% of past survey occasions.

2.2.4.1.3.3 Predicted stream 'health'

The Waiwhakaiho River site at Constance Street, New Plymouth is 26.6 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 86 (altitude) and 95 (distance) for this site. The historical site median (95) is 9 units higher than the altitude prediction and equal with the distance predictive value. The spring, 2012 survey score (108 units) was significantly 22 and 13 units higher than the altitude and distance predictive values respectively while the summer, 2013 score (96 units) was 10 units higher than the predictive altitude value and one unit above the predicted distance value. Of the 37 surveys to date at this site, 17% of MCI scores have been less than 86 units while 43% have been greater than 95 units.

2.2.4.1.3.4 Temporal trends in 1995 to 2013 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2009) has been performed on the seventeen years of SEM results collected to date from the site in the Waiwhakaiho River at Constance Street . The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 21.

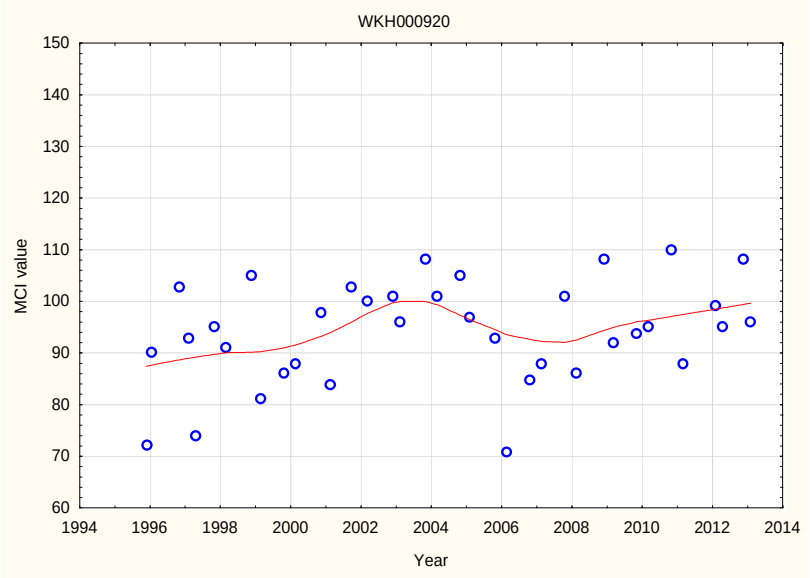

Figure 21 LOWESS trend plot at the Constance Street site

The overall trend in MCI scores has not been statistically significant for the period, due mainly to some decline in scores after 2005. The LOWESS-smoothed range of scores (12 units) indicates variability of some ecological significance. Smoothed MCI scores indicated 'fair' generic river health improving toward 'good' health (after a

small increase in summer residual flow releases by the TrustPower Mangorei HEP scheme) before returning to 'fair' health over recent years. In terms of predictive relationships for a site in the lower reaches of a ringplain stream, river health improved from 'expected' early in the period to 'better than expected' for a brief period before returning to 'expected' more recently.

2.2.4.1.4 Site adjacent to Lake Rotomanu (WKH000950)

2.2.4.1.4.1 Taxa richness and MCI

Thirty-three surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between March 1997 and April 2012. These results are summarised in Table 20, together with the results from the current period, and illustrated in Figure 22.

Table 20 Results of previous surveys performed in the Waiwhakaiho River the site adjacent to Lake Rotomanu, together with spring 2012 and summer 2013 results

Site code	SEM data (1995 to April 2012)					2012-2013 surveys			
	No of surveys	Taxa numbers		MCI values		November 2012		February 2013	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000950	33	12-28	21	70-111	88	30	96	26	89

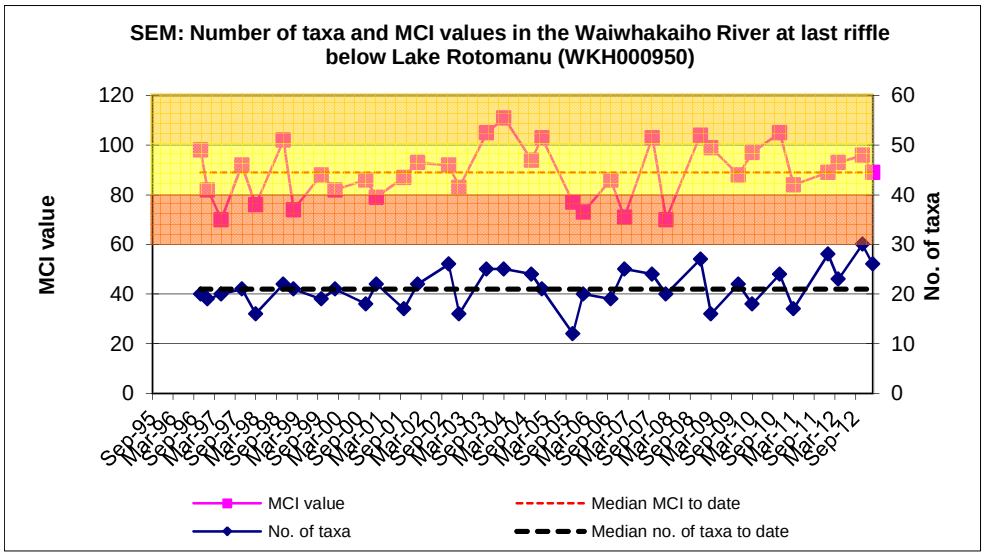

Figure 22 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richnesses (12 to 28 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the 2012-2013 period, the spring richness (30 taxa) was 4 taxa higher than found later in summer and both were higher than of the median richness, with the spring richness two taxa above the historical maximum.

MCI values have had a wide range (41 units) at this site but typical of sites in the lower reaches of ringplain streams. The median value (88 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 1998b (updated 2012)). The spring 2012 (96 units) and summer, 2013 (89 units) scores, although typical for such a site, were very similar (in summer) and eight units higher in spring than the historical median. These scores categorised this site as having 'fair' (spring and

summer) health generically and, in terms of predictive relationships 'expected' health in spring and in summer for the lower reaches of a ringplain river. The historical median score (88 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

2.2.4.1.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2012-2013 period are listed in Table 21.

Table 21 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the site adjacent to Lake Rotomanu between 1995 and April 2012 [33 surveys], and by the spring 2012 and summer 2013 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2012	Summer 2013
NEMERTEA	Nemertea	3	3	9		
ANNELIDA	Oligochaeta	1	27	82	A	A
MOLLUSCA	*Physa*	3	1	3		
	Potamopyrgus	4	9	27	A	A
CRUSTACEA	*Paratya*	3	6	18		A
EPHEMEROPTERA	*Coloburiscus*	7	1	3		
	Deleatidium	8	9	27	VA	
COLEOPTERA	Elmidae	6	5	15	A	A
TRICHOPTERA	*Aoteapsyche*	4	22	67	VA	XA
	Costachorema	7	2	6		
	Hydrobiosis	5	3	9		
	Oxyethira	2	13	39	A	A
DIPTERA	*Aphrophila*	5	10	30	VA	VA
	Maoridiamesa	3	16	48	VA	
	Orthocladiinae	2	33	100	VA	VA
	Tanytarsini	3	14	42		VA
	Empididae	3	1	3		
	Muscidae	3	1	3		
	Austrosimulium	3	1	3		

Prior to the current 2012-2012 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', five 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a minority of 'sensitive' taxa and a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa; no 'moderately sensitive' taxa; but three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Aoteapsyche*), and orthoclad midges]. Nine of the historically characteristic taxa were dominant in the spring, 2012 community. These comprised one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and six 'tolerant' taxa. No 'highly sensitive', two 'moderately sensitive', and seven 'tolerant' taxa comprised the dominant taxa of the summer, 2013 community. Seven of these eleven taxa were dominant in both spring and summer communities (Table 21). The absence of the 'highly sensitive' mayfly taxon from the dominant summer taxa was reflected in the drop of 0.6 unit in $SQMCI_s$ scores between spring and summer (Tables 12 and 13), with this decrease

also being due to a summer increase in abundance of one 'tolerant' taxon [caddisfly (*Aoteapsyche*)] in particular.

The 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' cranefly (*Aphrophila*), and 'tolerant' net-building caddisfly (*Aoteapsyche*) and *Maoridiamesa*, tanytarsids, and orthoclad midges have characterised this site's communities on 27% to 100% of past survey occasions.

2.2.4.1.4.3 Predicted stream 'health'

The Waiwhakaiho River at the site adjacent to Lake Rotomanu is 28.4 km downstream of the National Park boundary at an altitude of 2 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 (altitude) and 94 (distance) for this site. The historical site median (88) is 3 units higher than the altitude prediction and 7 units lower than the distance predictive value. The spring 2012 survey score (96 units) was slightly above both of these predictive values while the summer score (89 units) was midway between the predictive altitude and the distance values. Of the 35 surveys to date at this site, 31% of MCI scores have been less than 85 units while 29% have been greater than 94 units.

2.2.4.1.4.4 Temporal trends in 1995 to 2013 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2009) has been performed on the seventeen years of SEM results collected to date from the site in the Waiwhakaiho River adjacent to Lake Rotomanu . The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 23.

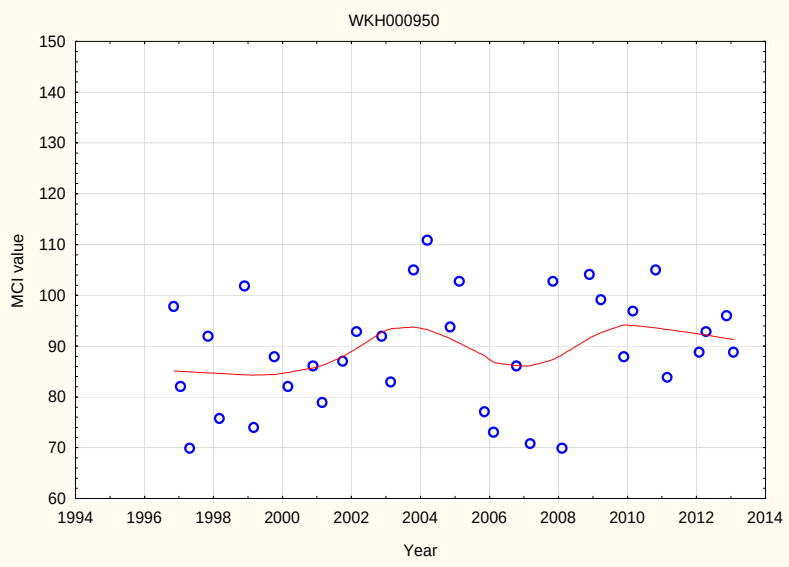

Figure 23 LOWESS trend plot of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend, despite a significant improvement during the first nine years of the programme (TRC, 2006b). Since 2004, there has been a steady decline in scores toward scores typically found in the first two years of the programme, followed by a more recent improvement, a similar trend found at the nearest upstream site (Constance St). The LOWESS-smoothed range of scores (20 units) is ecologically significant with more marked variability over the 2002 to 2010 period. Smoothed MCI scores have indicated 'fair' generic stream 'health' throughout the period, where it currently remains. In terms of predictive relationships for a site in the lower reaches of a ringplain stream, river health has improved from 'expected' toward 'better than expected' between 1996 and 2005, before returning to 'expected' over the last eight years.

2.2.4.1.5 Discussion

Seasonal MCI values typically deteriorated between spring and summer at three sites by 8, 12, and 7 units respectively in a downstream direction whereas scores at one site atypically remained identical in summer at the mid-catchment site. Seasonal communities shared 48% of 29 taxa present at the upper site, 58% of 31 taxa at the mid reach site, and in the lower reaches, 54% of 28 taxa at Constance Street and 56% of 36 taxa at the furthest downstream site. The typical decrease in seasonal faunal similarities in a downstream direction, as might be anticipated given wider variability in seasonal substrate periphyton coverage and water temperatures in the lower reaches, was not so apparent between seasons in the 2012-2013 period, particularly at the upper site.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 37 units in spring and 36 units in summer, over a river distance of 28.7 km. These seasonal falls in MCI scores equated to rates of decline of 1.3 units/km (spring) and 1.3 units/km (summer), compared with a predicted rate of 1.3 unit/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). This was atypical of the trend of past summer seasonal rates of decline which have usually been higher.

Between the upper and mid-reach sites, the spring (2.0 unit/km) and summer (1.2 units/km) rates of decline were lower in spring and far lower in summer than the predicted rate (2.6 units/km) for the equivalent river reach. For the mid-reach to lower reach sites, spring (0.9 unit/km) and summer (1.3 units/km) rates of decline were slightly higher (spring) and well above (summer) the predicted rate of 0.6 unit/km.

Using the long-term median SEM MCI scores for each site, the rates of decline between upper and mid catchment and between mid catchment and lower river sites have been about 1.4 and 1.1 units per km respectively with an overall average rate of decline of 1.3 MCI units/km over the river's length. Therefore overall rates of decline over the 2012-2013 period were identical in both spring and summer to the typical rate prior to 2012, but in the upper to mid reaches, spring MCI rate of decline was well above the typical rate.

Community composition varied markedly through the length of the river surveyed. A total of 41 taxa was recorded in spring of which only eight taxa were present at all four sites. These included one 'highly sensitive', six 'moderately sensitive', and one

'tolerant' taxa with only the 'highly sensitive' mayfly (*Deleatidium*) and 'moderately sensitive' elmid beetles abundant at all four sites. One other 'moderately sensitive' taxon was abundant at three sites and one of the 'tolerant' taxa was abundant at three sites (mid and lower reaches of the river). A similar total of 42 taxa was found along the river's length by the summer survey of which only nine taxa were present at all four sites. These were relatively similar to the eight widespread taxa in spring with the addition of one 'highly sensitive' taxon, loss of one 'moderately sensitive' taxon, and addition of one 'tolerant' taxon. Only the one 'moderately sensitive' taxon (elmid beetles) was abundant at all four sites. These dissimilarities in spatial community structure along the length of the Waiwhakaiho River were less pronounced between seasons than usual.

2.2.4.2 Fish species distribution

2.2.4.2.1 Introduction

Fish species distribution surveys have assessed the effectiveness of both the residual flow, for fish passage purposes, and the new upgraded fish pass on the intake weir, and programmes have also included surveys of the fish pass to determine usage. Although no fish distribution work has been included in recent annual programmes prior to the current period, previous data have been summarised in the 2003-2004 Annual Report (TRC, 2004) for reference purposes. Fish survey methods were reviewed by TRC staff and discussed with all parties to the consents prior to the performance of the agreed survey monitoring programmes.

The purpose of fish surveys in relation to the Mangamahoe diversion weir has been to determine whether or not the fish pass constructed over the weir in April 1998 and the maintenance of residual flows, have been effective in providing passage for migrating fish within the river. The results of previous monitoring surveys indicated in general terms that the fish pass on the Mangamahoe weir provides upstream passage for all native migratory fish present in the Waiwhakaiho catchment, at the altitude of the weir, and passage for trout.

2.2.4.2.2 NZ freshwater fish database

In recent years, Department of Conservation surveys for galaxiid native fish species, particularly in the upper reaches of Taranaki ringplain rivers and streams, have enhanced the records for galaxiid distribution. A search of the NZ freshwater fish database has provided distribution data for four galaxiid species (shortjaw, giant and banded kokopu, and koaro) in the upper reaches of the Waiwhakaiho River catchment (Figure 24).

Most of these records have been from the Mangorei Stream catchment, the major tributary entering the Waiwhakaiho River downstream of the Mangorei HEP Scheme. The agreed survey programme (performed over the 2006–2009 period) has increased the records of galaxiid and other species' distributions within the Waiwhakaiho catchment.

2.2.4.2.3 Results of the fish distribution survey performed during the 2006-2009 period

Electric fishing and spotlighting methods were used to identify fish species present at four mainstream Waiwhakaiho River sites and seven tributary sites in the catchment upstream of the Mangorei HEP intake weir, and one mainstream river site and eight tributary sites in catchments entering the lower river downstream of the Mangorei HEP intake weir. The presence of freshwater crayfish and shrimp was also recorded by these surveys in April-May 2007 (Table 22). During October 2007 the fishpass at the intake weir was trapped for identification of fish species using the pass.

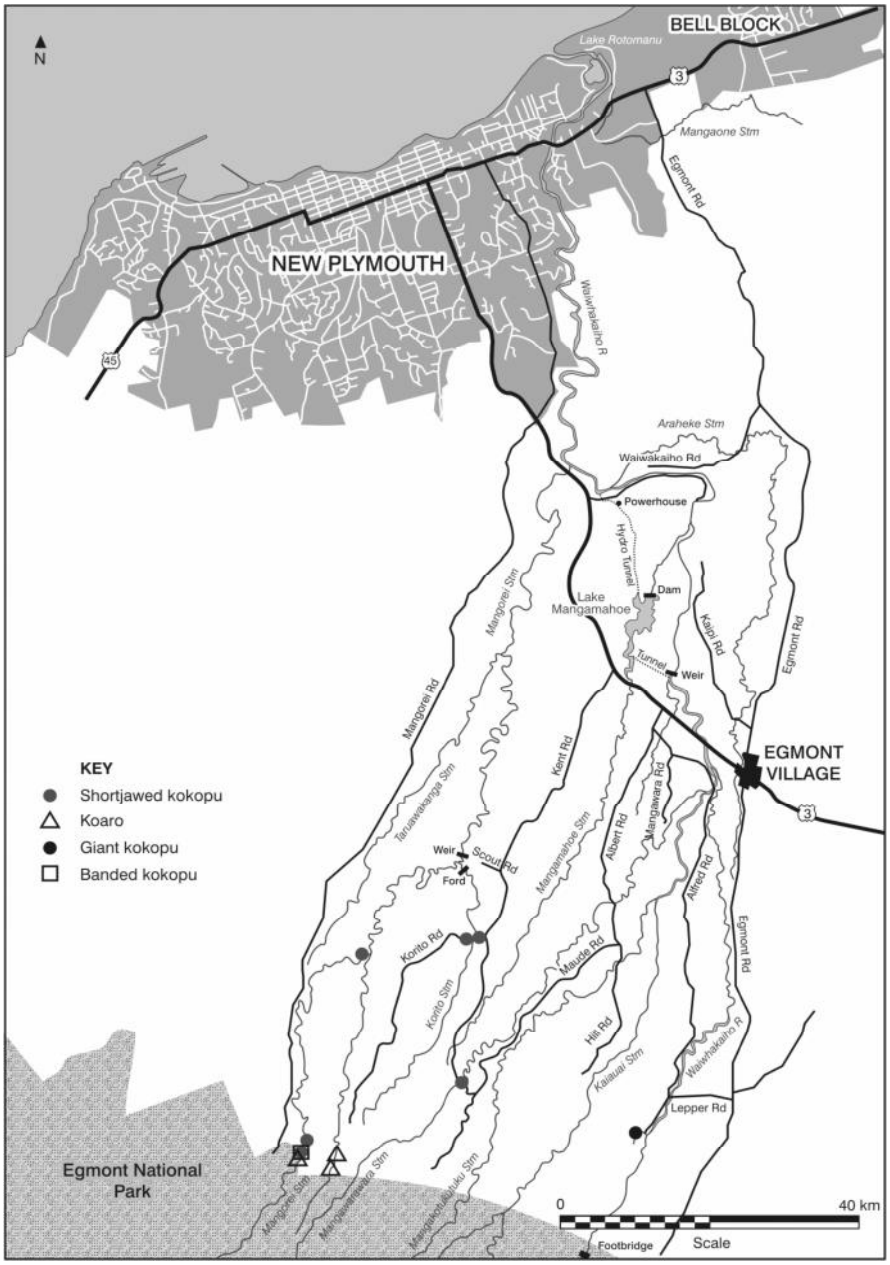

Figure 24 Galaxiid records for the Waiwhakaiho catchment

Table 22 Summary of fish (and two macroinvertebrate) species in relation to the Mangorei HEP intake weir, surveyed in April-May 2007 [uid = unidentified]

		Sites	
Species		Upstream of weir	Downstream of weir
Key indicator	Redfin bully	✓	✓
	Torrent fish		✓
	Koaro	✓	
Other indicator	Inanga		✓
	Shortjaw kokopu	✓	
Other	Longfin eel	✓	✓
	Elver	✓	✓
	Brown trout	✓	✓
	Bully (uid)	✓	✓
	Galaxiid (uid)	✓	
	Eel (uid)	✓	✓
	Crayfish	✓	✓
	Shrimp		✓

The final phase of the survey, which was concentrated on the residual flow reach of the Waiwhakaiho River, was performed during the 2008-2009 period. The completed fish distribution programme was collated and presented in the report attached as Appendix II in TRC, 2009a. In summary, this survey found:

- the diadromous fish community found upstream of the HEP intake weir closely resembled that predicted by the Leathwick et al (2009) model
- the fish pass provides adequate passage for those diadromous fish which reach the intake weir
- there is some evidence suggesting a lack of recruitment of shortjaw kokopu and banded kokopu to the headwaters
- this lack of recruitment may be due to the absence of an adult population providing attractant pheromones
- trout are able to negotiate the fish pass, although whether a significant number do so is uncertain.

Recommendations arising from the outcomes of the survey include the incorporation of appropriate sites in the Waiwhakaiho catchment in the proposed TRC state of the environment freshwater fish monitoring programme, with these sites to be monitored at a frequency of at least five-yearly intervals. Any additional monitoring proposals (e.g. trout tagging, native fish headwater stocking) will be considered and discussed for their appropriateness to the consents compliance monitoring programme.

2.2.4.3 Adult eel migration

2.2.4.3.1 Prior to the 2012-2013 period

A transfer procedure has been operative for many years with the co-operation of the consent holder and Mr G Williams, the latter providing a record of the transfers.

In autumn 2002 after a heavy rain event in the catchment, adult migrant eels were netted and transferred by Mr G Williams (commercial eel fisherman) from the forebay in Lake Mangamahoe, beyond the power station to the tailrace near the confluence with the Waiwhakaiho River. A total of about 100 migrant females (in excess of 2 kg in weight) of which nearly 60% were short-finned eels, were transferred (G Williams, pers comm). Similar weather conditions five weeks prior to this event, resulted in only one migrant at the forebay. The migrants were thought to have been both residents in the lake and from the Mangamahoe Stream catchment. Heavy rain early in April 2003 produced river and lake conditions suitable for triggering adult eel migration. A day later, large migratory eels were seen swimming in the forebay area of Lake Mangamahoe and netting by Mr G Williams retrieved nearly 90 eels (each in excess of 2 kg in weight), which were released below the power station. Migrant eels in the main Waiwhakaiho River should have moved downstream over the intake weir during autumn river freshes.

Extensive, prolonged flooding throughout February and into early March 2004 plus several floods in early April and through May 2004, provided a number of opportunities for migrant eels to move over the intake weir in the main river. Eel fisherman, Mr G Williams reported no adult migrants caught from the lake in March 2004 following a series of floods.

Although several significant freshes during May 2005 (and two in late March) would have provided flows for adult migrant eels to move downstream over the HEP intake weir in the main river channel, power station staff reported no migrant eels from the forebay of Lake Mangamahoe during the autumn of 2005.

At least ten significant freshes in the main river channel during the period from late March to the end of May 2006 provided suitable flow conditions for the passage of adult migrant eels over the HEP intake weir. Power station staff reported no migrant eels in the forebay of Lake Mangamahoe during this period. The consent holder commissioned a consultant to investigate the feasibility of a trap and transfer programme for adult migrant eels from the Lake Mangamahoe component of the HEPS.

The consultant's investigation concluded that "*any migrant eels are best left in the dam undisturbed until a sufficient flood occurs to cause spilling at night. The eels can then proceed over the spillway and down the Mangamahoe River channel to the Waiwhakaiho River. Excluding eels from the intakes with an appropriately sized screen, keeping the screen clean and ensuring that the eels flushed over the spillway during fresh flows are not injured, are all that is required to ensure adult eel passage at this site.*"

The consultant also considered that "*if it is a dry autumn and eels are observed to have accumulated in large numbers above the intake screen, then a deliberate spill to release them could be initiated after a trigger rainfall event by throttling back generation after 10pm, until spilling occurs. Eels could then be expected to move over the spillway unaided and into a river system in fresh*".

Despite up to five significant river freshes between late March to the end of May 2007, no migrant eels were reported in the Lake Mangamahoe forebay in this period. Two spillway overflows were recorded during late May 2007 (see Figure 2) which

may have provided downstream migration opportunities via the Mangamahoe Stream.
The consent holder subsequently advised that a locally operated manual trap and transfer system was intended for migrant adult eels for implementation at the time of the autumn 2009 migration period.

Wet weather in late March 2009 followed a very dry summer-autumn period, coincident with the initial migration of adult eels. One hundred and ten eels were manually trapped (in fyke nets) in the forebay area of Lake Mangamahoe on the first night in early April, 2009 by consent holder staff. Two eels were trapped on the following night and two eels in mid-April 2009. All migrant eels were released successfully into the Waiwhakaiho River at the 'Meeting of the Waters'.

A moderate fresh in late April, 2009 followed a relatively low flow period of seven weeks (Figure 3). Over a three day period (27 to 29 April), 57 migrant eels were manually trapped (in fyke nets) in the Lake Mangamahoe forebay by consent holder staff and released into the Waiwhakaiho River at the 'Meeting of the Waters'.

Very few adult migrant eels (four) were seen and trapped during early May 2010 in the lake forebay for release into the river, while again only a few (seven) were trapped and transferred during May, 2011.

In the 2011-2012 period only seven adult migrant eels were trapped and transferred from the lake forebay to the river over two occasions (early March and mid May 2012).

2.2.4.3.2 2012-2013 period

Few adult migrant eels were trapped and transferred from the forebay in the lake into the river. A total of 21 eels in total was trapped, over six occasions between mid April (12 on the one occasion) and mid May 2013 following several moderate river freshes.

2.2.4.4 Elver passage

Elvers entering the powerhouse outlet canal (from the main river) were caught in the trap (established in 2002), situated within the power station. The trap is a smaller version of the one used at the Patea hydro dam. Elvers were weighed before transfer to the Waiwhakaiho River residual flow reach upstream of the 'Meeting of the Waters'. Numbers of elvers were calculated from a calibration exercise performed at the trap (in late January 2003) when it was determined that 1 kg equated to 1200 elvers, although subsequent calibration exercises in mid December 2005 and late January 2009 found that 1kg equated to 760 and 1030 elvers respectively at these times. This trapping and transfer programme commenced in the 2002-2003 period with these and subsequent results summarised in Table 23.

Table 23 Estimation of numbers of elvers trapped and transferred at the Mangorei HEP scheme powerhouse in the monitoring years to date [( ) = limited period]

Monitoring year	Transfer period	Total number of elvers	Peak daily number	Peak month
2002 – 2003	9 Jan 03 – 25 Apr 03	18160	1020	(Jan 2003)
2003 – 2004	4 Dec 03 – 25 Mar 04	19445	1715	Jan 2004
2004 – 2005	14 Jan 04 – 21 Mar 05	9780	600	Jan 2005
2005 – 2006	30 Nov 05 – 20 Mar 06	19965	1140	Feb 2006
2006 – 2007	3 Jan 07 – 26 Apr 07	25230	1910	Jan 2007
2007 - 2009	30 Nov 07 - 26 Mar 08	29668	940	Jan 2008
2008 - 2009	2 Dec 08 – 16 Mar 09	38040	1140	Jan 2009
2009 – 2010	18 Dec 09 - 25 Feb 10	8566	237	Jan 2010
2010 – 2011	8 Nov 10 – 28 Feb 11	18776	525	(late) Dec 2010
2011 - 2012	21 Jan 12 – 31 Mar 13	640	96	Feb 2012

Numbers of elvers trapped and transferred during the 2012-2013 period are summarised in Table 24 from a report supplied by the consent holder. The trap was operative from 1 November 2012 but, similar to several earlier years, no elvers were trapped until late December 2012. The trap was shut down in mid April 2013.

Table 24 Numbers of elvers transferred during the 2012-2013 period

Date	Elver numbers		Cumulative total
	Interval	Per day	
1 November 2012	0	0	0
15 November 2012	0	0	0
29 November 2012	0	0	0
14 December 2012	0	0	0
21 December 2012	960	137	960
27 December 2013	1620	270	2580
4 January 2013	1200	150	3780
11 January 2013	1020	145	4800
18 January 2013	1104	158	5904
26 January 2013	2160	270	8064
1 February 2013	1164	194	9228
8 February 2013	864	123	10092
15 February 2013	1140	163	11232
22 February 2013	1500	214	12732
8 March 2013	648	46	13380
15 March 2013	324	46	13704
22 March 2013	840	120	14544
28 March 2013	300	50	14844
5 April 2013	792	99	15636
12 April 2013	336	48	15972

The elver trap and entrance way from the powerhouse outlet was inspected and operated in normal fashion by the consent holder (Trustpower, pers, comm).

During the six month period (November 2012 to mid April 2013), a moderate number of elvers (approximately 16,000) was caught and transferred from the outlet channel of the powerhouse to the residual flow reach of the main Waiwhakaiho River. The trap commenced operation in early November 2012 but no elvers were found in the trap until later in December and no elvers were trapped after mid April 2013. The majority of numbers were recorded over the period from late December

2012 to late February 2013. Although these numbers were low compared with numbers trapped and transferred at the Patea hydro station (TRC, 2010b), it should be noted that a significant proportion of upstream elver movements would be expected to follow the main channel of the Waiwhakaiho River rather than the smaller outlet channel of the powerhouse outlet canal. In this instance adequate passage through the residual flow reach is provided by the summer-autumn residual flow conditions and past the intake weir by the in-channel fish pass. No freshwater shrimps (*Paratya*) were trapped and no freshwater crayfish or galaxiids were recorded in the trap during the period.

The total number of elver numbers trapped in the monitoring period was much higher than over the 2011-2012 period but was slightly lower than the median number trapped over the ten preceding monitoring periods (Table 24) possibly indicative of a more typical season for elver migration. The peak daily number (270 elvers/day) was in the lower range of those found in the ten previous periods which have ranged from 96 to 1910 elvers/day (median: 980 elvers/day).

2.3 Riparian planting within the catchment

Special condition 6 of consent 2053 requires

> *'that the consent holder shall mitigate the effects of the diversion through riparian management in the Waiwhakaiho River catchment…'.*

The consent holder has made financial contributions to the Taranaki Tree Trust for riparian management purposes since the issue of the consent. A total of $55,176 has been received from the consent holder by the Taranaki Tree Trust to June 2013, of which approximately $39,800 has been spent on riparian enhancement work, mainly in the Mangorei Stream. In the 2012–2013 period $2,561 was spent on the completion of further planting and fencing in this catchment. The entire Waiwhakaiho catchment was targeted for riparian plans in early 2004. Currently 87 properties in the catchment have riparian plans (Figure 25) representing an increase of one property since the previous year. These property plans cover nearly 590 km of the total riverbanks of which a length of 410 km (69%) is considered adequately protected by means of suitable stock-proof fencing and appropriate vegetation either exists or has been planted. The remaining 180 km (31%) requires either fencing or planting or both to be implemented. Total length of riverbanks in this catchment exceeds 700km.

Properties with 100% of stream margins adequately protected total 18% of those with riparian plans, while 6% of properties have less than 25% of stream margins adequately protected.

It should be noted that the recent variation to consent 2058 (see Section 1.2 and Appendix I) now requires an increase in mitigation financial contributions to riparian initiatives in the Waiwhakaiho Catchment (Special Condition 8).

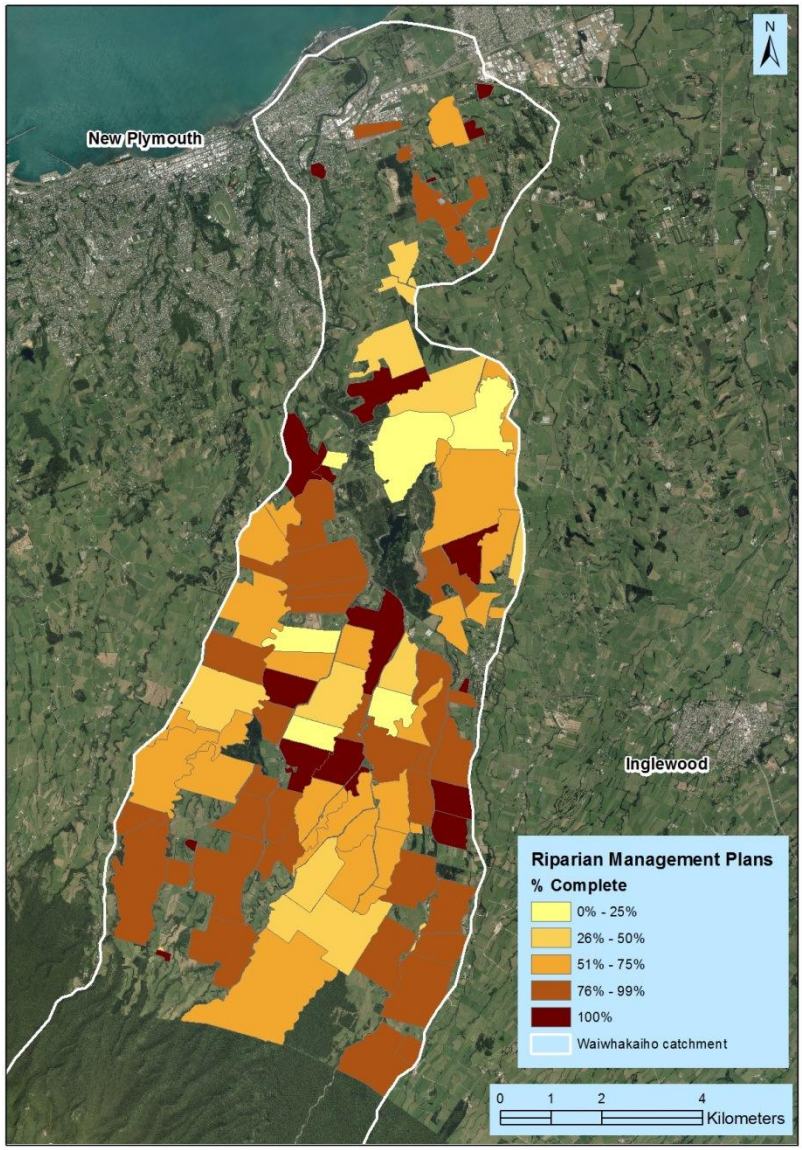

Figure 25 Riparian plans in the Waiwhakaiho catchment at 30 June 2013

2.4 Lake Mangamahoe silt monitoring

Special Condition 6(b) of varied consent 2053-3 now requires that surveys are undertaken by the consent holder to record the change in bathymetry of Lake Mangamahoe between winter 2013 and 31 December 2017. The initial survey was 'performed' by BTW Company over 28 and 29 May 2013 (see Appendix II).

In essence this survey has established the baseline sediment conditions in the lake for referencing against future surveys.

2.5 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council eg provision of advice and information, or investigation of potential or actual courses

of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Taranaki Regional Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Unauthorised Incident Register (UIR) includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2012-2013 year, there were no incidents reported or recorded by the Council that were associated with the Mangorei HEP Scheme.

3. Conclusions

3.1 The Resource Management Act 1991

The Resource Management Act primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (eg, recreational, cultural, or aesthetic);
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents.

3.2 National perspective

The Parliamentary Commissioner for the Environment (PCE) (July 2006) released a report entitled *Electricity, energy, and the environment: environmental performance assessment 1 July 2004-30 June 2005 (PCE, May 2006).*The report examined the present and future environmental performance and effects of the electricity generation and transmission sector in New Zealand. It included a focus upon the environmental performance and resource consent compliance of generators.

One of the recommendations in the PCE report was as follows:

'13. Improve the transparency in reporting of resource consent compliance and monitoring

At present there is a lack of transparency in the monitoring and reporting of resource consent compliance by electricity generators…

Based on the information provided by the large electricity generators in their environmental and sustainability reports, most companies breach their resource consent conditions several times a year. These breaches are often reported as minor, or as having no detrimental environmental effects. It is impossible to verify the actual effects of these breaches from the available reporting methods.

The PCE recommends that MFE work with electricity generators to develop a robust, transparent, and verifiable system of reporting on resource consent compliance and the environmental effects of electricity generation.'

The report commented on possible roles for the Ministry for the Environment. It states:

'MFE has limited involvement in the electricity sector, but the PCE believes it should have a broader role in the development of energy policy. Key areas where MFE could play an important role are:

- *……*
- *establishing a nationally consistent method for electricity generators to report on compliance with resource consent conditions and the environmental impacts of electricity generation;*
- *working with electricity generators to reduce the number of breaches of resource consent conditions;*
- *….*

In many cases these national-level environmental issues are not effectively dealt with by regional councils or territorial authorities.'

The report also examined the consent compliance reporting record of each company. It concluded:

'General comments on sustainability reporting

With the exception of TrustPower, none of the electricity generators detail the number of times they breach their agreed resource consent conditions. Some generators argue that compliance may not be a reasonable measure of their environmental performance. In general, it seems that it is not uncommon for electricity generators to breach their agreed resource consent conditions several times a year.

The PCE is seeking to quantify the number of non-compliance events in order to compare numbers for different generation plant and generators. The purpose is to identify any trends, which may be relevant.

Resource consent conditions for some plants are significantly more onerous than others, and sometimes this difference is based on the timing of the last resource consent rather than the local environmental effects.

National consistency in categorizing the breaches would be useful for this assessment report and for other purposes. We intend to look at this area in more detail in the next assessment period. This will include the extent to which these companies are reporting what they are doing to promote a robust demand-side sector in the electricity market, at both the wholesale and retail levels. (See Recommendation 13.)'

The Taranaki Regional Council notes that it is the long-standing practice of the Council to report publicly on environmental performance and consent compliance (including non-compliance events) in each annual compliance report. It has done so

since compliance reports were first prepared. In the case of Trust Power Company's Mangorei power generation facility, the record of reporting covers nineteen years.

The reader is referred particularly to sections 2-1, 2-4, and 3-3 in this report for more information.

3.3 Discussion of 2012-2013 results

The monitoring period (mid 2012 to mid 2013) encompassed the renewed consents' operations for the Mangorei HEP station involving the continuation of the adjusted residual flow release regime and fifteenth year following the provision of the larger fish pass. Essentially, monitoring has concentrated on the provision and maintenance of the requisite residual flow releases below the HEP abstraction weir and operation of the improved, larger fish pass at the abstraction weir and effects of residual flows on river water temperatures.

Automation of the HEP intake gates which provided for telemetered maintenance of constant water levels upstream of the abstraction weir (particularly during the summer-autumn lower flow periods), and maintenance of monitored residual flow levels below the intake, has continued the good overall performance of the residual flow release mechanism which functioned very well throughout the monitoring period due, in part, to remote monitoring of downstream water levels by the consent holder.

Residual flow release compliance continued to be of a high standard. No non-compliance events were recorded, although river freshes continued to cause sedimentation of sections of the fish pass requiring maintenance to restore both the requisite flow and the correct configuration of the substrate essential for fish passage. The installation of fixed wooden blocks throughout the fishpass reduced maintenance requirements and improved the functionality of the structure, although removal of accumulated substrate material following river floods remained an issue and some damage to the wooden blocks has required replacement with boulders in recent years. Facilitation of debris movement through the pass during flood flows (by construction of a notch in the fishpass wall) must ensure that no spillage of residual flow releases occur through the notch and no such spillage was noted during the period. However, minor spillage over the wall between the two sections of the fishpass required remedial work in the past and there remains an issue of remedial work required on this wall near the fishpass entrance. The existing system for residual flow compliance, particularly the provision of calibrated residual flow level records, will continue to require frequent monitoring, and also maintenance by the consent holder, recognising the significant impact that river freshes have on the fish pass and on rated downstream residual flows.

Daily minimum powerhouse generation releases 950 L/sec during daylight hours were successfully maintained by the consent holder throughout the period. The automatic compensation valve at the powerhouse, which removed the need for spillages via the intake weir during power station outages, was required on four occasions one of which was coincident with a one week period of station maintenance shutdown during the period but no spillages over the intake weir (in excess of residual flow requirements) were necessary during the period.

The spreading of daily power generation flows over longer daylight periods has benefits for water quality and ecology in the lower river, as well as providing recreational opportunities in reaches commonly used by the public near and within the city boundaries.

Compliance with Lake Mangamahoe minimum lake levels was also achieved throughout the period, with few lake spillages following very wet weather.

The establishment and maintenance of the winter and summer residual flow regimes has had beneficial effects on general river water quality and ecology, especially from comparisons of monitoring results with information collected prior to the implementation of these residual flows. Continuous monitoring of residual flow maintenance and generation release timing will therefore continue to be a prime focus of future consents' compliance assurance procedures. Provision of telemetered water level monitoring immediately downstream of the intake weir, by the consent holder continues to provide a more appropriate continuous record for consent compliance purposes reducing the need for frequent manual inspections. However, this telemetry system requires frequent calibration particularly following significant river fresh events. The provision of a calibrated recording station by the consent holder's contractor within the powerhouse tailrace has been completed for compliance purposes.

From time-to-time the large trout and native fish pass required substrate refurbishment in order to achieve its functions of fish passage and as a component of the residual flow release system. Originally designed to carry the entire range of residual flows (400 to 700 L/sec), the correct placement of rock, boulder and stone substrate along the pass necessitated that a critical flow (150 to 200 L/sec) was maintained, with augmentation of the requisite residual flows from the original flow release mechanism. This strategy was applied relatively successfully throughout the monitoring period with documented problems (mainly with fish pass flows and substrate) following significant river freshes, but with some reduction in maintenance due to the substitution of fixed wooden blocks throughout the structure. Fish pass maintenance work was performed by the consent holder within timeframes considered acceptable for consent compliance purposes. The larger fish pass has provided for improved passage of all fish species, including all native migratory species present in the relevant river reaches, and adult trout, which have been shown to be capable of negotiating the pass. Provision has also been made by the consent holder for the passage of elvers past the power station during the migration period. This was functional during the season with moderate numbers of elvers transferred to the river compared to numbers over the ten previous seasons. This was more typical of past elver migration seasons and a large increase over the previous poor season which had been the lowest to date. The consent holder had completed an investigation into the feasibility of adult eel transfer from the Lake Mangamahoe sub-catchment past the HEP station during critical migratory periods and implemented a very successful netting and transfer system during the autumn 2009 migratory period and again in the autumn of 2009.

However, very few migrants were seen or trapped (on two occasions) in autumn of 2013. The results of the three-year fish distribution survey (completed in 2009) suggest that the diadromous fish community found upstream of the intake weir fishpass resembles that predicted to be present in similar habitats, and that the fish

pass provides adequate passage for those fish species which reach the weir via the residual flow reach.

River water temperature records have illustrated the impacts of residual flow releases on the lower river reaches and have also indicated a general trend of a very small rise in water temperatures along the length of the river in more recent years, despite the increase in the summer residual flow release (600 to 700 L/sec) following consents' renewals in 1995. This has probably been attributable to warmer weather. In the lower Waiwhakaiho River, water temperatures continued to be comparable with, and slightly cooler than, those recorded in the lower reaches of the Kaupokonui River and Kapoaiaia Stream elsewhere on the Taranaki ringplain.

The consent holder is required by a condition of one renewed and recently varied consent to mitigate the effects of the diversion of the river flow by means of judicious riparian management elsewhere in the Waiwhakaiho catchment. This continues to be achieved by (increased) financial contributions to the Taranaki Tree Trust, which provide for the implementation of appropriate riparian planting. More recently priority has been given to the promotion of riparian planting initiatives in the Waiwhakaiho catchment as a whole and progress has been significant with 87 property plans at various stages of implementation. The latest requisite meeting of stakeholders was organised but not convened as there were no issues relating to compliance monitoring and/or reporting raised by any interested parties.

The recent variation of the diversion consent (to allow some additional harvesting of flood flows), requires the consent holder to undertake additional sediment and lake bathymetric monitoring. The initial bathymetric survey of Lake Mangamahoe was commissioned by the consent holder and performed in mid 2013.

The complexities of the monitoring requirements and supply of compliance data now associated with the various consents for this HEP scheme suggested that reporting by the consent holder at regular intervals would contribute to improvements in annual reporting and timely liaison between parties. The consent holder began monthly reporting of compliance data during the latter half of the 2005 –2006 period and has maintained this reporting throughout the 2012-2013 period.

3.4 Evaluation of performance

A tabular summary of the Company's compliance record for the year under review is set out in Tables 25 to 30.

Table 25 Summary of performance for consent 2053 (prior to variation): to divert water from the river into Lake Mangamahoe

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Continuous daily generation lower river flow release	Supply of data by consent holder	Yes
2. Seasonal residual flows released over the weir	Inspections, gaugings (TRC), and automatic flow recording (by consent holder)	Yes
3. Maintenance of residual flow recording device and supply of records	Supply of levels by consent holder	Yes (but regular calibration necessary)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
4. Provision of suitable fish passage in residual flow channel	Inspections	Yes
5. Provision of public safety notices	Liaison with consent holder and inspections	Yes
6. Mitigation by riparian management	TRC Land Management records	Yes
7. Stakeholders bi-annual meetings	Consent holder liaison	Yes (not required)
8. Optional review provision	Not scheduled for consideration until June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

[N/A = not applicable]

Table 25b Summary of performance for varied (April 2013) consent 2053-3: to divert water from the river into Lake Mangamahoe

Condition requirement	Means of monitoring during period under review	Compliance achieved?
3. Cessation of diversion at high flow	Supply of data	N/A (not full year)
6. Provision of sediment/lake bathymetry monitoring programme by the consent holder	Consent holder to undertake and provide data	Part (initial bathymetric survey performed)
8. Riparian management mitigation annual payments	TRC Land Management records	N/A (not full year)
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A (3 months)**

Table 26 Summary of performance for consent 2054: to dam the Mangamahoe Stream for HEP generation purposes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Operation and maintenance by grantee	Liaison with consent holder	Yes
2. Maintenance of minimum level in Lake Mangamahoe	Supply of data by consent holder	Yes
3. Notification if lake level to be lowered for weed maintenance purposes	Liaison with consent holder	N/A
4. Optional review provision	Not scheduled for consideration until June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 27 Summary of performance for consent 4886: to erect and maintain structures in, and dam, the Mangamahoe Stream for the formation of Lake Mangamahoe for HEP generation purposes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Maintenance and operation	Liaison with consent holder	Yes
2. Optional review provision	Not scheduled for consideration until June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 28 Summary of performance for consent 4887: to erect and maintain structures associated with the diversion of Waiwhakaiho River water into Lake Mangamahoe for HEP generation purposes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Operation and maintenance	Inspections and liaison with consent holder	Yes
2. Installation and maintenance of fish pass	Inspections and liaison with consent holder	Yes
3. Maintain residual flow device	Inspections and liaison with consent holder	Yes
4. Optional review provision	Not scheduled for consideration until June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 29 Summary of performance for consent 4888: emergency discharge of Lake Mangamahoe water to the Mangamahoe Stream

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Optional review provision	Not scheduled for consideration until June 2016	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 30 Summary of performance for consent 6810: to erect, place and maintain a culvert for access purposes, in an unnamed tributary of the Waiwhakaiho River

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Silt discharge and riverbed disturbance minimisation	Liaison with TRC by consent holder	N/A
2. Exercise in accordance with documentation	Inspections	N/A
3. Notification of installation and maintenance works	Notification by consent holder	N/A
4. Timing of works	Inspections	N/A
5. Riverbed disturbance limits	Inspections	N/A
6. Limits to effects on receiving waters	Inspections	N/A
7. Removal of structure	Liaison with consent holder	N/A
8. Flow and fish passage restrictions	Inspections	In part (with remedial work to be addressed)
9. Ponding restrictions	Inspections	Yes
10. Erosion and sediment control plan	Provision by consent holder	N/A
11. Lapse of consent	Inspection	N/A
12. Optional review provision	Scheduled for consideration in June 2014	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

During the year, the consent holder demonstrated a high level of environmental performance with all the resource consents. Maintenance works which were necessary, particularly following river freshes, were performed by the consent holder within acceptable time frames allowing for safety issues with personnel working within the river channel and/or compensated by alternative flow release methods.

It is re-emphasised that an accurate and comprehensive telemetry record of residual flow compliance immediately downstream of the intake weir requires regular calibration of the system by the consent holder, if the Council is to maintain its current frequency of monitoring.

Regular and timely liaison between the consent holder's operational staff and Regional Council staff is essential in maintaining the appropriate level of compliance.

3.5 2011-2012 Report recommendations

The previous Annual Report (2012-37) made the following recommendations:

1. THAT the consent holder liaises with the Council in matters of compliance with the residual flow release and calibrated, telemetered continuous monitoring of the system.

2. THAT regular compliance reports continue to be supplied by the consent holder during the monitoring year.

3. THAT consents monitoring be performed during the 2012-2013 period with the following components included in a suitable programme:

    - inspections of residual flow compliance measures appropriately timed to demonstrate acceptable continuous compliance monitoring taking into account the existence of a calibrated, telemetered residual flow compliance system .
    - the inspection and flow gauging programme to be timed to provide additional calibration of this system;
    - appropriate flow gaugings to calibrate downstream water levels and confirm each of the three requisite residual flow release rates;
    - inspection of the continuing effectiveness of all critical river channel enhancement works.

Recommendation 1 was achieved with appropriate liaison between Council staff and the consent holder resulting in the good compliance record achieved for the period. Monthly compliance reporting was continued by the consent holder and the monitoring programme reported in this Annual Report encompassed the components contained in the third recommendation with additional river water temperature data evaluations continued within the current report.

3.6 Alterations to monitoring programmes for 2013-2014

In designing and implementing the monitoring programmes for consents in the region, the Taranaki Regional Council has taken into account the extent of

information made available by previous authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring discharges and effects, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki utilising the region's water resources.

In the case of the Mangorei HEP scheme, it is proposed that the programme for 2013-2014 remains the same as the programme performed in the 2012-2013 period with a proviso that there may be additional components added in relation to the very recently varied consent 2053 after consultation with the consent holder.

3.7 Exercise of optional review of consents

Conditions of resource consents 2053, 2054, 4886, 4887, and 4888 do not provide for an optional review of each consent until June 2016. Consent 6810 (culvert) provides for a review in June 2014. Based upon the monitoring inspections since this consent was granted and taking into account Recommendation 4 in Section 4 it is considered that there are no grounds requiring this review to be pursued. There are no further reviews provided before the June 2020 expiry date.

4. Recommendations

As a result of the 2012-2013 monitoring programme in relation to the consents for the Mangorei HEP scheme, the following recommendations are made:

1. THAT the consent holder liaises with the Council in matters of compliance with the residual flow release and calibrated, telemetered continuous monitoring of the system.

2. THAT regular compliance reports continue to be supplied by the consent holder during the monitoring year, particularly additional records required by the variation to consent 2053.

3. THAT consents monitoring be performed during the 2013-2014 period with the following components included in a suitable programme:

    - inspections of residual flow compliance measures appropriately timed to demonstrate acceptable continuous compliance monitoring taking into account the existence of a calibrated, telemetered residual flow compliance system.
    - the inspection and flow gauging programme where necessary, to be timed to provide additional calibration of this system;
    - appropriate flow gaugings to calibrate downstream water levels and confirm each of the three requisite residual flow release rates;
    - inspection of the continuing effectiveness of all critical river channel enhancement works.

4. THAT the consent holder liaises with Council staff to ensure:

    - that all additional monitoring required by Special Condition 6 of the recently varied consent 2053 is undertaken by the consent holder;
    - that remedial works are evaluated and addressed to ensure adequate fish passage through the consented culvert is provided as required by Special Condition 8 of consent 6810.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

biomonitoring	assessing the health of the environment using aquatic organisms
cumec	a volumetric measure of flow - 1 cubic metre per second ($1m^3 s^{-1}$)
diadramous	fish with life-cycles encompassing fresh and salt water stages
elver	young eel after entry to freshwater from the sea
fresh	elevated flow in a stream, such as after heavy rainfall
g/m^3	grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm)
incident	an event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred
intervention	action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring
investigation	action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident
l/s	litres per second
macroinvertebrates	aquatic insects, snails, worms and other invertebrate animals visible to the naked eye
MCI	Macroinvertebrate Community Index (a biological index of stream health)
physicochemical	measurement of both physical properties(e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
residual flow	flow required to maintain fish passage and/or aquatic habitat
resource consent	refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 including all subsequent amendments
UI	Unauthorised Incident
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan

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Appendix I

Resource consents held by Trustpower Ltd for the Mangorei HEP Scheme

Water Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA 3143
Decision Date (Change):	19 April 2013
Commencement Date (Change):	19 April 2013 (Granted: 4 September 1996)

Conditions of Consent

Consent Granted:	To divert up to 10 cubic metres per second of water from the Waiwhakaiho River via a diversion weir and associated intake structures into Lake Mangamahoe through the Mangorei Hydroelectric Power Scheme and back into the river approximately six kilometres downstream of the diversion point
Expiry Date:	1 June 2021
Review Date(s):	June 2016
Site Location:	Lake Mangamahoe Junction Road New Plymouth
Legal Description:	Adjacent to Pt Sec 56 Blk X Paritutu SD (Site of divert)
Grid Reference (NZTM)	1697719E-5668051N
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

(i) the administration, monitoring and supervision of this consent;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain a continuous generation flow release of at least 950 litres/second between 8:00 am and 6:00 pm each day.

2. That the consent holder shall maintain, each 12-month period, the following minimum residual flows in the Waiwhakaiho River below the diversion weir:

i) at least 700 litres/second between 1 January and 31 March, effective from 1 January 1998;

ii) at least 600 litres/second between 1 January and 31 March, until 31 December 1997;

iii) at least 600 litres/second between 1 November and 31 December and during April; and

iv) at least 400 litres/second between 1 May and 31 October.

3. No water shall be diverted when the flow in the Waiwhakaiho River is greater than or equal to 85 cubic metres per second.

4. That the consent holder shall install and operate, to the satisfaction of the Chief Executive, Taranaki Regional Council, a measuring device capable of measuring the residual flow to be maintained in the Waiwhakaiho River downstream of the diversion weir, and shall provide records of such measurements to the Chief Executive, Taranaki Regional Council, upon request.

5. That the consent holder shall maintain, as far as reasonably practicable, the river channel below the diversion weir to the `Meeting of Waters' for the purpose of enhancing available fish passage and habitat, to the satisfaction of the Chief Executive, Taranaki Regional Council; and, the Taranaki Regional Council will inspect the fish passage device and river channel for compliance after any significant river fresh.

6. The consent holder shall ensure a monitoring programme is undertaken that includes:

   a) sediment sampling that relates the flow in the Waiwhakaiho River to the rate of sediment entering Lake Mangamahoe via the diversion;
   b) bathymetric surveys that record the change in bathymetry of Lake Mangamahoe between winter 2013 and 31 December 2017; and
   c) a report assessing the effects of this application and any significant change in bathymetry.

7. That the consent holder shall erect and maintain notices and other warnings as may be required, to the satisfaction of the Chief Executive, Taranaki Regional Council, for adequate protection of public safety to warn the public using the river downstream of the scheme of fluctuations in river flow and of the extent of those fluctuations.

8. The consent holder shall mitigate the environmental effects of the diversion by making annual payments of $5,000 (GST exclusive) to the Taranaki Regional Council as a financial contribution for the purpose of providing riparian planting and management in the Waiwhakaiho River catchment. The amount to be paid shall be adjusted annually according to the consumer price index, or similar index, to account for the effects of inflation, and be made no later than 1 September each year.

9. That the consent holder and staff of the Taranaki Regional Council shall meet as appropriate, and at least once every two years, with submitters to the consent to discuss any matter relating to the exercise of this resource consent.

10. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the diversion on the environment.

Signed at Stratford on 19 April 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number on all correspondence

Land Use Consent

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA
Consent Granted Date:	4 September 1996

Conditions of Consent

Consent Granted:	To dam the Mangamahoe Stream in the Waiwhakaiho Catchment to form Lake Mangamahoe to act as a reservoir of water for hydroelectric power generation purposes at or about 2607400E-6231200N
Expiry Date:	1 June 2021
Review Date(s):	June 2001, June 2006, June 2011, June 2016
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Legal Description:	Pt Sec 53 Hua & Waiwhakaiho Hundred Blk X Paritutu SD
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

(a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

(b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

(c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

(i) the administration, monitoring and supervision of this consent;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the dam and associated structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the consent holder shall maintain a minimum lake level of 750 mm below the crest of the Mangamahoe spillway except during lake weed maintenance periods.

3. That the consent holder shall notify the Chief Executive, Taranaki Regional Council, of its intention to temporarily lower Lake Mangamahoe for weed management purposes at least seven days prior to commencing lake dewatering.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the dam on the environment.

Transferred at Stratford on 31 July 2007

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 4886-1

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
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Please quote our file number on all correspondence

Land Use Consent

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA
Consent Granted Date:	4 September 1996

Conditions of Consent

Consent Granted:	To erect and maintain structures in the Mangamahoe Stream in the Waiwhakaiho Catchment to dam the stream to form Lake Mangamahoe for hydroelectric power generation purposes at or about 2607400E-6231200N
Expiry Date:	1 June 2021
Review Date(s):	June 2001, June 2006, June 2011, June 2016
Site Location:	Lake Mangamahoe Junction Road New Plymouth
Legal Description:	Pt Sec 53 Hua & Waiwhakaiho Hundred Blk X Paritutu SD
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

(a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

(b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

(c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

(i) the administration, monitoring and supervision of this consent;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the structures on the environment.

Transferred at Stratford on 31 July 2007

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 4887-1

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
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Please quote our file number on all correspondence

Land Use Consent

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA
Consent Granted Date:	4 September 1996

Conditions of Consent

Consent Granted:	To erect and maintain structures associated with the diversion of water from the Waiwhakaiho River into Lake Mangamahoe for hydroelectric power generation purposes at or about 2607800E-6229800N
Expiry Date:	1 June 2021
Review Date(s):	June 2001, June 2006, June 2011, June 2016
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Legal Description:	Lot 5 DP 4414 Pt Secs 13 &166 Hua & Waiau SD
Catchment:	Waiwhakaiho
Tributary:	Lake Mangamahoe

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

(a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

(b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

(c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

(i) the administration, monitoring and supervision of this consent;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special conditions

1. That the consent holder shall maintain and operate the structures, to the satisfaction of the Chief Executive, Taranaki Regional Council.

2. That the consent holder shall install and maintain, to the satisfaction of the Chief Executive, Taranaki Regional Council, a structure at the diversion weir to enable the passage of native fish, juvenile trout and adult trout.

3. That the consent holder shall maintain a device capable of meeting the residual flow requirements of the consent, to the satisfaction of the Chief Executive, Taranaki Regional Council.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the structures on the environment.

Transferred at Stratford on 31 July 2007

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
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NEW ZEALAND
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Please quote our file number on all correspondence

Discharge Permit

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA
Consent Granted Date:	4 September 1996

Conditions of Consent

Consent Granted:	To discharge up to 150,000 litres/second of water from Lake Mangamahoe via a spillway into the Mangamahoe Stream in the Waiwhakaiho Catchment under emergency conditions associated with hydroelectric generation purposes at or about 2607400E-6231200N
Expiry Date:	1 June 2021
Review Date(s):	June 2001, June 2006, June 2011, June 2016
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Legal Description:	Pt Sec 53 Hua & Waiwhakaiho Hundred Blk X Paritutu SD
Catchment:	Waiwhakaiho
Tributary:	Mangamahoe Lake Mangamahoe

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

(a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

(b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

(c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

(i) the administration, monitoring and supervision of this consent;
(ii) charges for the carrying out of the Council's functions under section 35 in relation to this consent; and
(iii) charges authorised by regulations.

Special condition

1. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 2001, June 2006, June 2011 and/or June 2016 for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the discharge on the environment.

Transferred at Stratford on 31 July 2007

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 6810-1

TARANAKI
REGIONAL
COUNCIL

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
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Please quote our file number on all correspondence

Land Use Consent

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	TrustPower Limited Private Bag 12023 TAURANGA
Consent Granted Date:	6 March 2006

Conditions of Consent

Consent Granted:	To erect, place and maintain a culvert in an unnamed tributary of the Waiwhakaiho River for access purposes at or about GR: P19:071-301
Expiry Date:	1 June 2020
Review Date(s):	June 2008, June 2014
Site Location:	Lake Mangamahoe, Junction Road, New Plymouth
Legal Description:	Lots 3 & 4 DP 20530
Catchment:	Waiwhakaiho

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to avoid or minimise the discharge of silt or other contaminants into water or onto the riverbed and to avoid or minimise the disturbance of the riverbed and any adverse effects on water quality.

2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 4114. In the case of any contradiction between the documentation submitted in support of application 4114 and the conditions of this consent, the conditions of this consent shall prevail.

3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the commencement and upon completion of the initial installation and again at least 48 hours prior to and upon completion of any subsequent maintenance works which would involve disturbance of or deposition to the riverbed or discharges to water.

4. Any instream works shall take place only between 1 November and 30 April inclusive, except where this requirement is waived in writing by the Chief Executive, Taranaki Regional Council.

5. The consent holder shall ensure that the area and volume of riverbed disturbance shall, so far as practicable, be minimised and any areas which are disturbed shall, so far as practicable, be reinstated.

6. After allowing for reasonable mixing, being a mixing zone extending seven times the width of the surface water body at the point of discharge, the discharge shall not give rise to any of the following effects in any surface water body:

   a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effects on aquatic life.

7. Except with the written agreement of the Chief Executive, Taranaki Regional Council, the structure[s] authorised by this consent shall be removed and the area reinstated, if and when the structure[s] are no longer required. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to structure[s] removal and reinstatement.

8. The exercise of this consent shall not alter the natural flow of the river or restrict the passage of fish.

9. The exercise of this consent shall not result in the significant ponding of water upstream of the culvert.

10. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, a site erosion and sediment control management plan.

11. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

12. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2008 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 6 March 2006

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Lake Mangamahoe
silt monitoring survey report
May 2013

btw company
surveyors . planners . engineers . land & g·i·s services

6th June 2013 Ref: 13197

TrustPower Ltd
Private Bag 12023
TAURANGA

Attn: Ryan Piddington

Dear Sir,

RE: Lake Mangamahoe – Silt monitoring Survey Report

The following is a brief report on the Silt monitoring survey carried out on the 28th and 29th May 2013.

Please find enclosed with this report:

- Appendix A – BTW Drawing 13197-01 – Sht 1 Contour plan
  Sht 2 Contour Plan with Aerial image

Purpose:

The purpose of this survey was to undertake the initial base survey to establish current silt levels within the upper reaches (southern end) of Lake Mangamahoe. Additional conditions to resource consent 2053-3 require a comparison survey to be carried out six months prior to the five year anniversary of the varied consent date.

The fifth year survey will establish a comparison plan, and a volumetric analysis of silt buildup or displacement will be undertaken.

Personnel:

- Ross Gunn; - Surveyor
- Toby Dixon; - Surveyor
- Tim Verry; - Captain
- Leif Lauchlan; - 1st Mate

Equipment used:

- Leica 1205 Robotic Theodolite – used to measure and record the silt levels of the lake electronically, and establish vertical control (reduced levels).
- Leica Viva RTK GPS – used to establish horizontal control marks.
- 10ft aluminium dingy
- 5m extending level staff with Leica 360° prism attached.

Weather and Lake Conditions:

The survey was carried out over two days. Both days were fine with light winds. It was observed over the two days, the continuous lowering of the water level.

It is recommended, that the next survey be carried out with sufficient water levels deep enough to enable a small craft to travel over the shallows without grounding. While walking the shallows in waders was possible this time, it was very slow going.

Methodology:

Reduced levels have been obtained from survey marks used for the saddle dam deformation survey (Opus drawing 2N5242.03) first established in 1996.
(Level origin for this survey was BM 5A R.L 153.58)

Survey control points have been established in suitable locations around the lake edge and should be used or referenced in future surveys to ensure continuity of methodology. Control point IT 3 should be used as the height origin point for the next survey.

A 5m extendable levelling staff was lowered from a dingy until it rested on the lake bed. Direct observations were then taken to a Leica 360° optical prism mounted on the top.

Most of the surveyed lakebed was clear of aquatic vegetation. In places where weed was encountered, the staff was pushed through until silt disturbance was observed; this was generally accompanied with a change in required downward pressure.

A general grid spacing of 5m between points was achieved for the most part, with closer observations taken around the lake edge and identified channels.

While we endeavoured to obtain levels up to the lake edge, it was impossible at some locations due to dense overhanging vegetation.
It is envisaged this problem will be encountered next time in the same locations so should reproduce a survey with similar extremities.

Contour Plan; BTW drawing 13197-01

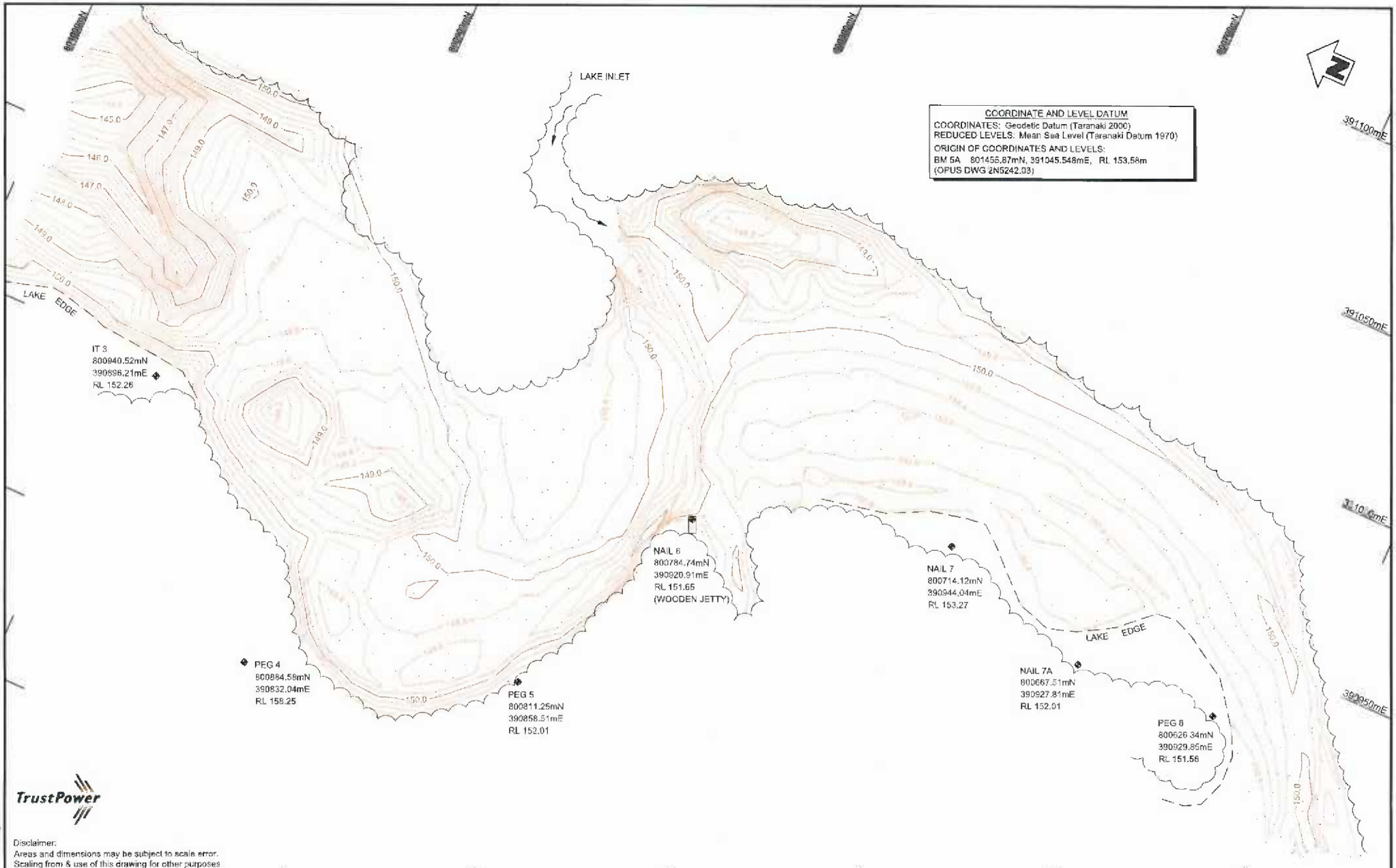
Sheet 1 drawing shows contours at 0.2m intervals and survey control points for future reference.
Sheet 2 was produced to show an aerial underlay obtained from the NPDC GIS Boost website. Areas of silt deposits and deeper channels are clearly shown in the image and generally confirms the results from this survey.

If you have any further questions, please do not hesitate to contact me.

Regards

Ross Gunn
Surveyor
BTW Company Ltd

Appendix A – Contour Plan Sheets 1 & 2



COORDINATE AND LEVEL DATUM

COORDINATES: Geodetic Datum (Taranaki 2000)
REDUCED LEVELS: Mean Sea Level (Taranaki Datum 1970)
ORIGIN OF COORDINATES AND LEVELS:
BM 5A 801455.87mN, 391045.548mE, RL 153.58m
(OPUS DWG 2N5242.03)

TrustPower

Disclaimer:
Areas and dimensions may be subject to scale error.
Scaling from & use of this drawing for other purposes is at the users risk.

btw company
. surveyors
. planners
. engineers
. land & g-i-s services

BTW Company Ltd
Cnr. Courtenay & Eliot Sts.
P.O Box 551, NEW PLYMOUTH 4340
Ph (06) 759 5040
Ph 0800 289787 Fax (06) 759 5049
E-mail survey@btwcompany.co.nz
Web www.btwcompany.co.nz

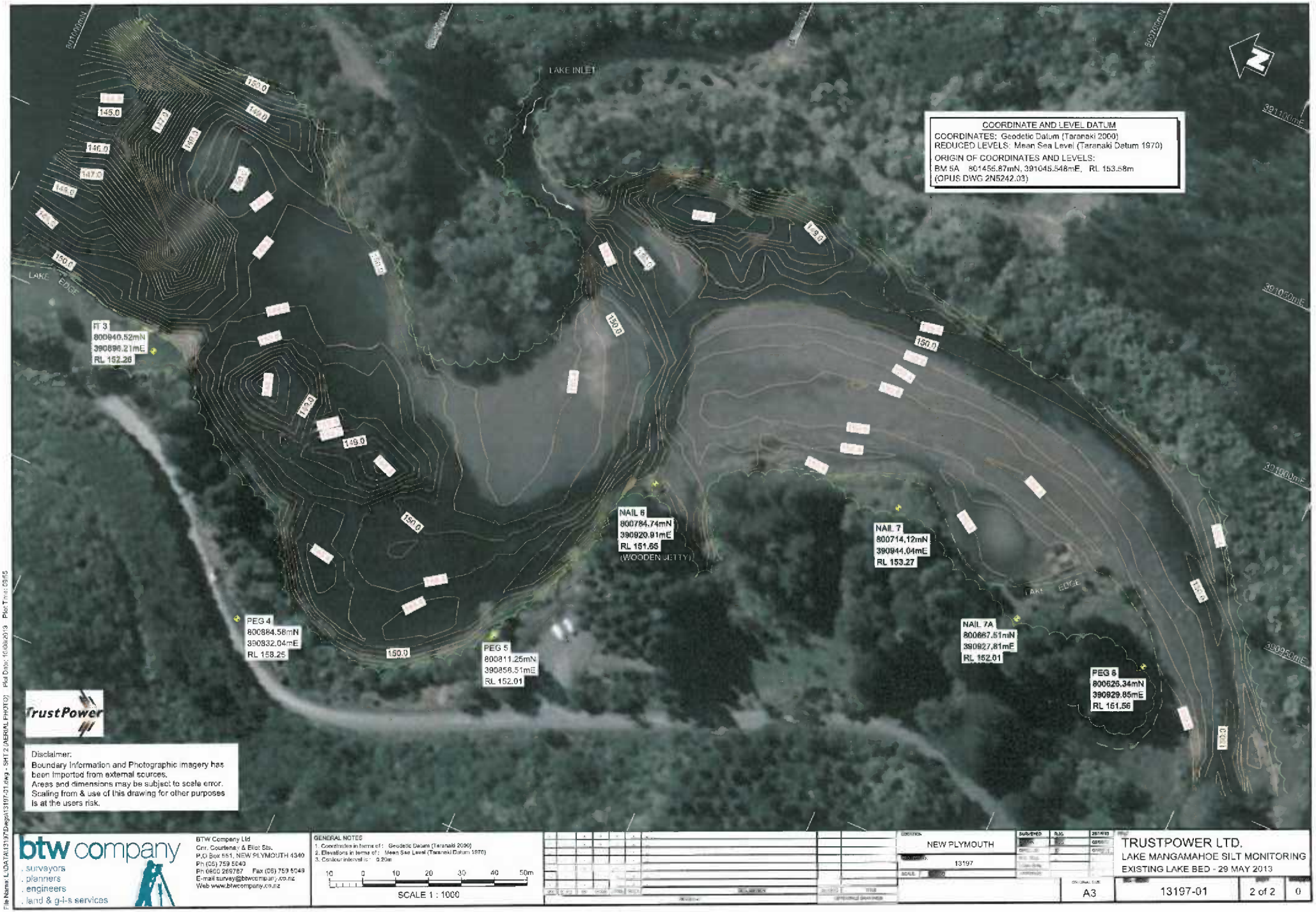
GENERAL NOTES
1. Coordinates in terms of : Geodetic Datum (Taranaki 2000)
2. Elevations in terms of : Mean Sea Level (Taranaki Datum 1970)
3. Contour interval is 0.20m

10 0 10 20 30 40 50m
SCALE 1 : 1000

NEW PLYMOUTH
13197
TrustPower
A3

TRUSTPOWER LTD.
LAKE MANGAMAHOE SILT MONITORING
EXISTING LAKE BED - 29 MAY 2013
13197-01
1 of 2
0

File Name: L:\DATA\13197\Dwgs\13197-01.dwg - Sht1 Plot Date: 10/06/2013 Plot Time: 09:45


LAKE INLET
LAKE EDGE
LAKE EDGE
COORDINATE AND LEVEL DATUM
COORDINATES: Geodetic Datum (Taranaki 2000)
REDUCED LEVELS: Mean Sea Level (Taranaki Datum 1970)
ORIGIN OF COORDINATES AND LEVELS:
BM 5A 801456.87mN, 391045.548mE, RL 153.58m
(OPUS DWG 2N5242.03)
IT 3
800940.52mN
390896.21mE
RL 152.26
NAIL 6
800784.74mN
390920.91mE
RL 151.65
(WOODEN JETTY)
NAIL 7
800714.12mN
390944.04mE
RL 153.27
NAIL 7A
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RL 152.01
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RL 151.56
391100mE
391050mE
391000mE
390950mE
150.0
149.0
148.0
147.0
146.0
145.0
TrustPower
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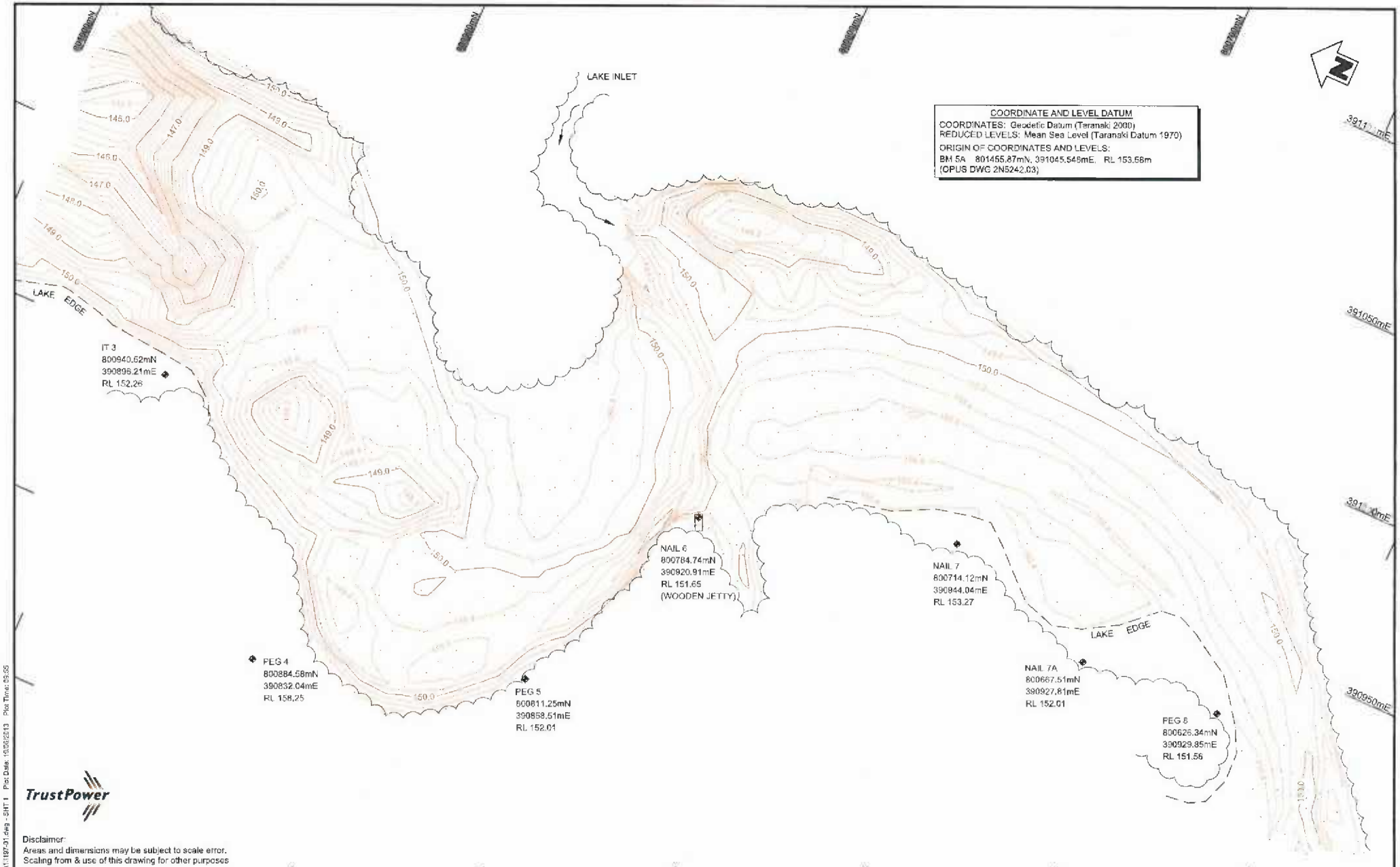
Areas and dimensions may be subject to scale error.
Scaling from & use of this drawing for other purposes is at the users risk.
btw company
. surveyors
. planners
. engineers
. land & g-i-s services
BTW Company Ltd
Cnr. Courtenay & Eliot Sts.
P.O Box 551, NEW PLYMOUTH 4340
Ph (06) 759 5040
Ph 0800 269767 Fax (06) 759 5049
E-mail survey@btwcompany.co.nz
Web www.btwcompany.co.nz
GENERAL NOTES
1. Coordinates in terms of : Geodetic Datum (Taranaki 2000)
2. Elevations in terms of : Mean Sea Level (Taranaki Datum 1970)
3. Contour interval is : 0.20m
10 0 10 20 30 40 50m
SCALE 1 : 1000
LOCATION: NEW PLYMOUTH
PROJECT NO: 13197
SCALE
ORIGINAL SIZE: A3
TRUSTPOWER LTD.
LAKE MANGAMAHOE SILT MONITORING
EXISTING LAKE BED - 29 MAY 2013
13197-01
2 of 2
0
File Name: L:\DATA\13197\Dwgs\13197-01.dwg - SHT 2 (AERIAL PHOTO) Plot Date: 16/08/2013 Plot Time: 09:55



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. surveyors
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. land & g-i-s services

BTW Company Ltd
Cnr, Courtenay & Eliot Sts,
P.O Box 551, NEW PLYMOUTH 4340
Ph (06) 759 5040
Ph 0800 289787 Fax (06) 759 5049
E-mail survey@btwcompany.co.nz
Web www.btwcompany.co.nz

GENERAL NOTES
1. Coordinates in terms of : Geodetic Datum (Taranaki 2000)
2. Elevations in terms of : Mean Sea Level (Taranaki Datum 1970)
3. Contour interval is : 0.25m

10 0 10 20 30 40 50m
SCALE 1 : 1000

NEW PLYMOUTH
13197
TrustPower
ORIGINAL SIZE A3

TRUSTPOWER LTD.
LAKE MANGAMAHOE SILT MONITORING
EXISTING LAKE BED - 29 MAY 2013
13197-01 | 1 of 2 | 0

File Name: L:\DATA\13197\Dwgs\13197-01.dwg - SHT 1 Plot Date: 10/06/2013 Plot Time: 09:55

COORDINATE AND LEVEL DATUM

COORDINATES: Geodetic Datum (Taranaki 2000)
REDUCED LEVELS: Mean Sea Level (Taranaki Datum 1970)
ORIGIN OF COORDINATES AND LEVELS:
BM 5A 801455.87mN, 391045.548mE, RL 153.58m
(OPUS DWG 2N5242.03)

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GENERAL NOTES
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2. Elevations in terms of : Mean Sea Level (Taranaki Datum 1970)
3. Contour interval is : 0.20m

10 0 10 20 30 40 50m
SCALE 1 : 1000

LOCATION: NEW PLYMOUTH
JOB NO: 13197
SCALE: 1:1000
SURVEYED: 29/5/13
DRAWN: RJC 05/6/13
ORIGINAL SIZE: A3

TRUSTPOWER LTD.
LAKE MANGAMAHOE SILT MONITORING
EXISTING LAKE BED - 29 MAY 2013

13197-01 | 2 of 2 | 0

File Name: L:\DATA\13197\Dwgs\13197-01.dwg - SHT 2 (AERIAL PHOTO) Plot Date: 10/06/2013 Plot Time: 06:55