RANGITAIKI DRAINAGE BOARD

THORNTON WEST DRAINAGE

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1.0 INTRODUCTION

This report documents the investigations carried out for the Thornton West drainage area in the Bay of Plenty. The investigations were initiated by the Rangitaiki Drainage Board (RDB) following the major earthquake of March 2nd 1987 which impacted on the existing drainage schemes in the Thornton West area. The brief for this investigation (attached as Appendix I) required familiarisation with existing drainage scheme layouts, development of alternative drainage scheme layouts and cost estimates, and any other related drainage aspects.

This report reviews the existing drainage schemes in Thornton West, and the design drainage standards used; assesses the impact of the March 2nd 1987 earthquake on drainage scheme capabilities to identify drainage problems caused by the earthquake, reviews post-quake drainage improvements already implemented, reviews the capacity of the Old Rangitaiki Channel (ORC), and describes options for drainage improvements in the long and medium term.

2.0 THORNTON WEST DRAINAGE AREA

The Thornton West drainage area (Figure 2.1) covers approximately 1978 ha. of lowlying land bounded by the Awaiti Canal to the west, the coastal sand dunes to the north and the Rangitaiki River to the east. Over 18% of the Thornton West area lies below mean sea level (MSL) with most of the lowest lying land located on the south side and adjacent to the Old Rangitaiki Channel (ORC). The area is farmed predominantly in pasture for dairy, cattle and deer, with some horticultural development in small pockets. Recently some horticultural plantings in Thornton West have been pulled out and the land returned to pasture. Soil types vary over the area but generally can be broadly categorised as peat or alluvium. The variable distribution of soils over the Thornton West area and with depth reflects the geomorphological development of the Rangitaiki Plains. The Thornton West area is subdivided into drainage basins separated by minor ridges. The permeability of the soils is variable with layers of silty sand having a relatively high permeability interbedded with layers of peat. The variable soil conditions affect drainage of the Thornton West area through settlement of the peat, the high permeability of the silty sand layers, and the instability of the silty sand layers when exposed in open drain excavations.

3.0 EXISTING DRAINAGE SCHEMES

3.1 Scheme Description

Eight communal drainage schemes currently serve the Thornton West area. (Figure 2.1). All schemes comprise a series of Board or Scheme open drains collecting water from

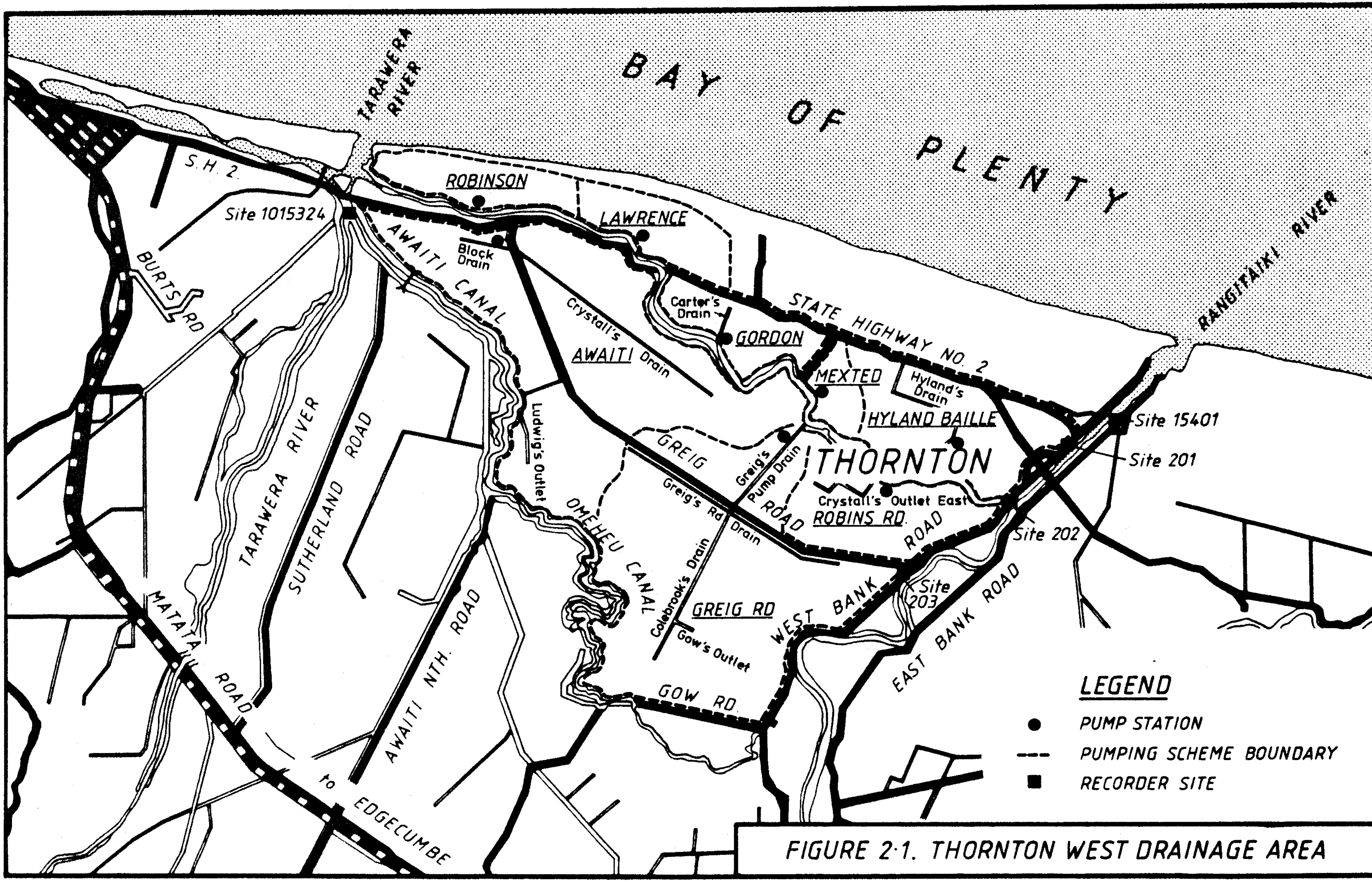


FIGURE 2·1. THORNTON WEST DRAINAGE AREA

farm drains to a scheme pumpstation discharging into the ORC. The ORC is closed at the east end adjacent to the Rangitaiki River and discharges all drainage westwards into the Tarawera River via the Matata floodgate. Prior to the March 1987 earthquake all eight scheme pumpstations were considered by the Rangitaiki Drainage Board (RDB) to have performed satisfactorily.

The pumpstation details for the eight drainage schemes are summarised in Table 3.1 and the relevant level data in Table 3.2. All Board and Scheme drains and the pumpstations within Thornton West are maintained by the RDB. Farm drains comprising open channels, timber box or slotted plastic conduits are installed and maintained by the farmers on each property, according to individual requirements and resources.

The drainage areas for the schemes north of the ORC do not include the sand dune fringe along the northern boundary as drainage from this area is apparently considered to be sufficiently delayed to not contribute significantly to peak drainage flows during heavy rain. The drainage area for the Awaiti scheme excludes the Department of Conservation (DOC) wildlife area of approximately 69 ha. Seepage from the wildlife area is drained via the Awaiti pumpstation but is apparently not considered to contribute significantly to peak drainage flows during heavy rain. Both these suppositions have been accepted in this investigation.

The elevation area distribution of each drainage scheme area are shown in Table 3.3. These distributions are based on the post-quake land survey contour plan (1:5000 scale, 0.5 m contour interval). With the exception of Robinson, Lawrence and Awaiti the drainage schemes have a significant proportion of the scheme area below mean sea level.

3.2 Drainage Design Criteria

Reference 1 sets the accepted design standards for drainage schemes in the Rangitaiki Plains. These design standards for drainage works are based on values which have historically proven to be satisfactory, and are restated below.

3.2.1 Pumpstation Capacities

A capacity of 1.1 inches (28mm) per day is required for pumping schemes and canals draining flat areas. This is the value used in the Whakatane River Major Scheme and is based on the following:

i) For dairying it is considered pumping schemes should be able to handle 5 year critical rainfalls.

TABLE 3.1 - THORNTON WEST PUMPSTATIONS

STATION NAME	DRAINAGE AREA (HA)	PUMPING CAPACITY (l/s)	PUMPING HEAD RANGE (m)	EXISTING PUMP MODEL AND MOTOR
vaiti	533	1727	1.72 to 3.33	2 x MacEwans PPF 24/30, CN+2 Impellor, 56 kw motor
ordon (HB No. 3)	97.8	317	1.25 to 2.73	1 x MacEwans PPF 15/18, B+2 Impellor, 22 kw motor
iegs Road	696.8	2258	2.30 to 4.54	2 x MacEwans PPF 24/30, CN+4 Impellor, 75 kw motor
yland Baillie No. 1	190	616	1.58 to 2.85	2 x MacEwans PPF 15/18, B+2 Impellor, 22 kw motor
awrence	75.9	246	2.47 to 2.75	2 x Flygt LL 3152, 610 Impellor, 9 kw motor
exted (HB No. 2)	49	159	1.76 to 2.98	1 x MacEwans PPF/12/14, c-4 Impellor, 11 kw motor
obins Road	194.8	631	2.55 to 3.78	1 x MacEwans PPF 18/22, 37 kw motor
obinson	72.0	233	2.17 to 2.45	2 x Flygt LL 3152, 610 Impellor, 9 kw motor
	1909.3	6187		

otes:

Pumping Capacity based on 28mm/day from drainage area.

Pumping head range based on maximum and minimum static lifts plus all friction losses.

Drainage areas are for the pre-quake drainage boundaries.

Awaiti area excludes DOC wildlife area of 69 ha.

TABLE 3.2 - THORNTON WEST PUMPSTATION LEVELS (1988)

ATION NAME	PUMP	START PROBE (RLm)	STOP PROBE (RLm)	STOP LOGS	BELL INVERT (RLm)	LOWEST EFFICIENT PUMPING LEVEL (RLm)	SUMP INVERT (RLm)	WATER LEVEL (RLm)	LOWEST 1987 GROUND LEVELS (RLm)	DISTANCE FROM PUMPS (RLm)
aiti Farms	1	-1.35	-1.84	Yes	-3.15	-2.24	-3.50	-1.84	-1.0	35000
	2	-1.64	-1.99	Yes	-3.18	-2.27	-3.50	-1.84		
rdon (HB No.	Blue HB	-1.39	-1.44	Yes	-1.87		-3.23	-1.17	-0.5	1400
)	No. 2	-1.02	-1.53	Yes	-1.84		-3.23	-1.17		
eigs Road	1	-1.91	-3.18	Yes	-4.47	-3.56	-5.00	-1.98	-1.4	500
	2	-2.10	-3.14	Yes	-4.51	-3.60	-5.00	-1.98	-0.5	2300
land Baillie	1	-1.34	-1.64	Yes	-2.88	-2.24	-3.28	-1.48	-0.6	1000
. 1	2	-1.32	-1.57	Yes	-2.88	-2.24	-3.28	-1.48		
wrence	1 Flood	-0.73	-0.75	No	-2.1		-2.4	-0.88	-1.0	500
	2 Duty	-0.88	-1.02	No	-2.1		-2.4	-0.88		
xted(HB No.2)	1	-1.35		Yes	-		-3.03	-1.29	-0.6	600
bins Road	1	-2.38	-2.64	Yes	-4.10	-3.43	-4.43	-2.39	-1.4	400
binson	1 Flood	-0.36	-0.45	Yes	-1.8	-2.1	-0.36	-0.4		800
	2 Duty	-0.34	-0.45	Yes	-1.8	-3.23	-1.17			

tes: 1) Level Datum 0.00 Moturiki
2) Level surveyed November 1987
3) Lowest 1987 ground levels identified from 1:5000 post-quake contour plan.

TABLE 3.3 ELEVATION AREA DISTRIBUTION FOR THORNTON WEST DRAINAGE SCHEMES

Scheme	Area (ha)	Percentage of Area Below Elevation (mRL)						Pump Probe Levels (mRL) Maximum	Minimum
		-1.0	-0.5	0.0	0.5	1.0	2.0	7	7
Robinson	72.0				1	68	100	-0.36	-0.45
Lawrence	75.9			0.4	17	70	99	-0.73	-1.02
Gordon	97.8			18	55	71	99	-1.02	-1.53
Mexted	49.0		1.6	32	48	58	88	-1.35	
Hyland Baillie	190.0		1.3	27	49	61	89	-1.32	-1.64
Robins Road	194.8	9.8	33	54	70	79	88	-2.38	-2.64
Greigs Road	696.8 *		4	18	29	42	74	-1.91	-3.18
Awaiti	533 *		0.1	3	36	76	97	-1.35	-1.99
Crystall's Drain	171.0 #		14	43	69	89	99		

* Based on original drainage scheme areas

\# Refers to the area now drained by Crystall's drain extension.

ii) The predominant type of farming on the Plains is dairying and the maximum period that water can lie on pasture without damage is 3 days in summer and 6 days in winter.

iii) The critical 5 year storm is one in which the following falls are recorded:

1st day	5.6 inches (143 mm)
2nd day	0.76 inches (19 mm)
3rd day	0.80 inches (20 mm)

making a total of 7.16 inches (182mm). With estimated losses of 3.8 inches (97 mm) this leaves 3.36 inches (85 mm) to be pumped, i.e. a rate of 1.1 inches (28 mm) per day.

3.2.2 Drainage Levels

A freeboard of 2 ft (600 mm) above normal winter flow is considered necessary to prevent root rot. In order to prevent over-drying of the underlying peat with consequent oxidation and settlement, it is considered that the water table during the summer months must be kept as high as possible without affecting grass growth.

3.2.3 Flood Gradients

Main canals should provide a minimum flood gradient of 10cm per kilometer (.01%). In areas where the land is rising a steeper gradient is obviously acceptable, but where the land is low-lying this provides a standard on which to base the necessity for pumping.

In the Thornton West area land gradients are very flat and flow velocities are so low that hydraulic grades in the drains are also extremely flat. For storms where the volume of flood water exceeds the pumpstation design capacity of 1.1 inches per day water levels in the lowest lying areas will pond and pumped evacuation times may exceed the 3 day design standard depending on the storm duration.

Drainage standards for horticulture exceed the standards for pasture, with a shorter period of permissible ponding and a lower everyday water table. Some small pockets of horticulture planted in Thornton West have been pulled out and at this stage there is no justification to modify drainage design standards to allow for horticulture.

In this report a distinction is made between flood drainage and "everyday" drainage. Flood drainage refers to the removal of floodwater ponded in the

drains or on the land within the 3 day design evacuation period. Everyday drainage refers to water pumped during normal or dry weather periods. Experience on the Rangitaiki Plains suggests that in a typical year everyday drainage comprises about 90% of the total drainage water pumped with the remaining 10% being floodwater.

Prolonged periods of very wet weather may result in exceedance of the design drainage criteria, in which case ponding and high water table levels may persist for longer than 3 days, with consequent damage to pasture. The lowest lying areas in each scheme are most vulnerable to flooding and high water table levels during storms when the design drainage criteria are exceeded.

4.0 THE MARCH 1987 EARTHQUAKE

The earthquake of March 2nd, 1987 had a number of effects on the drainage schemes in Thornton West due to the ground settlement that occurred over much of the Rangitaiki Plains. As shown in Figure 4.1 the major settlement occurred around the Edgecumbe Township area, with ground levels dropping by up to about 2.0 m. In the Thornton West area settlement was generally 0.3 to 0.4 m on the east side near the Rangitaiki River and typically 0.1 to 0.2m in the west near the Matata floodgate. The tilting and lowering of the plains had the following general effects on the drainage in the region:

i) The land surface settled closer to the regional watertable with the result that, relative to the ground, surface water table levels are now higher.

ii) The effective capacity in the ORC for storing pumped drainage water was reduced.

iii) The Awaiti drain and the ORC are perched and the potential for seepage of water through the stopbanks to the farmland was increased due to the increased differential head following land settlement.

iv) Bed slopes in the open drains and in the ORC were disrupted, in some cases reducing the hydraulic efficiency of the system to dispose of drainage and flood waters.

v) Differential settlement has resulted in drainage patterns being altered which in some cases has disrupted drainage scheme boundaries and reduced the capability of the pumpstations to control every day water table levels.

vi) Physical damage occurred to some of the pump- station equipment, e.g. discharge pipelines.

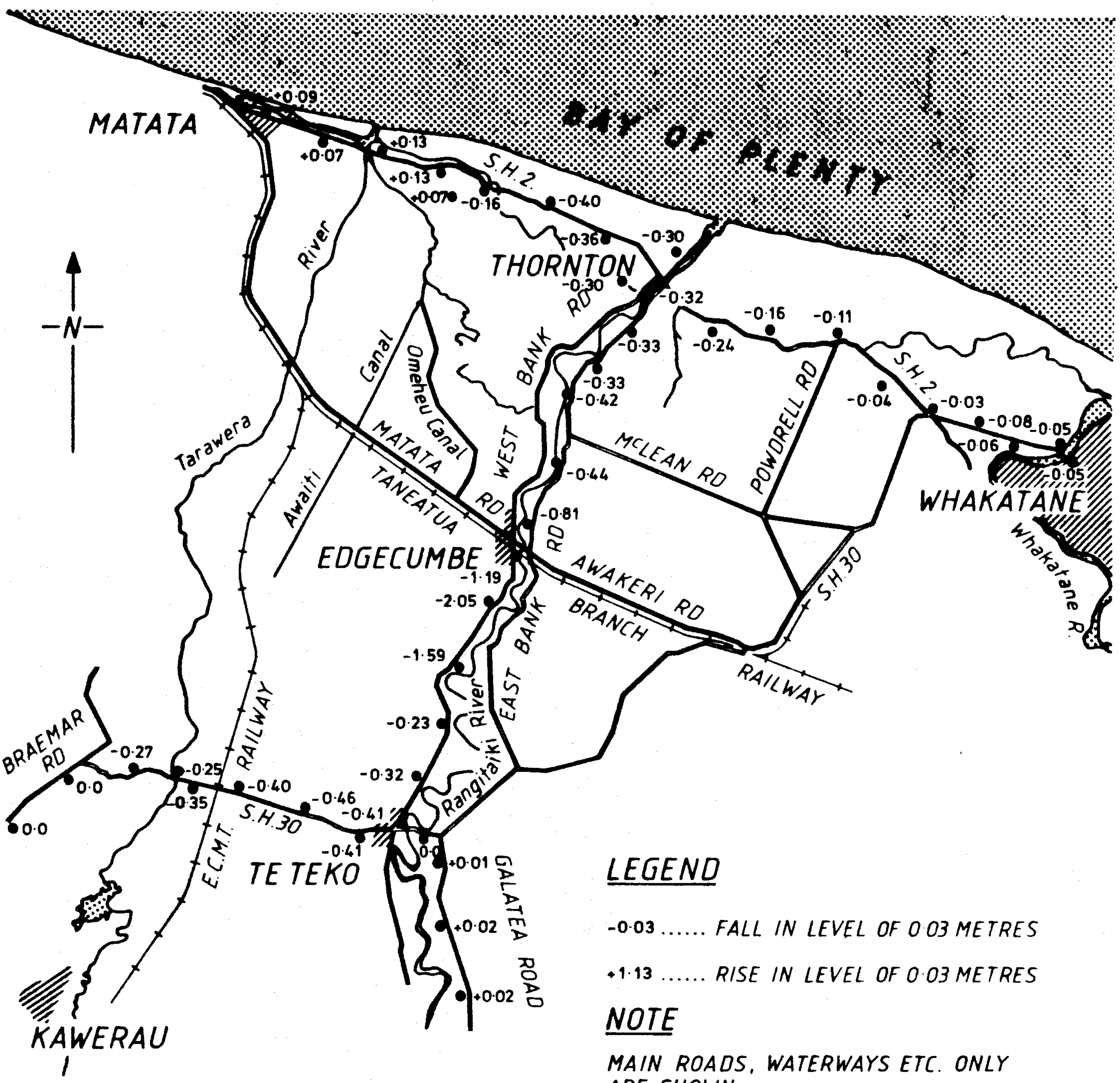


FIG. 4·1

RANGITAIKI PLAINS - LEVELS CHANGES

FOLLOWING 2nd MARCH 1987 EARTHQUAKE

vii) Stopbanks along the Tarawera and Rangitaiki Rivers were lowered resulting in increased flood risk from Tarawera and Rangitaiki River spillage.

5.0 IMPACT OF EARTHQUAKE ON DRAINAGE WORKS

The impact of the March 1987 earthquake on specific aspects of the Thornton West drainage works was reviewed as follows:

5.1 Flood Drainage

5.1.1 Pumpstations

The pumping capacity of pumpstations in Thornton West is unchanged from the pre-quake capacity. Receiving water levels in the ORC remain unaltered and to achieve the pre-quake level of flood protection all pumps would have to pump against an extra 0.1 to 0.4m head increment depending on land settlement. Inspection of the pump performance curves for each pumpstation indicates that the pumping capacity at peak operating efficiency would be reduced by typically less than 3% for an incremental head increase of up to about 0.4m. For practical purposes this has a negligible effect on the flood drainage capability of the pumpstations. Whether the pumpstation probe levels can be lowered to compensate for the reduction in land levels is discussed under everyday drainage in section 5.2.

5.1.2 Board and Scheme Drains

Land settlement as a result of the earthquake has lowered the Board and Scheme drain levels, with greater differential settlement generally in the east of Thornton West drainage area. The levels of all Board and Scheme drains and typical drain cross sections have been surveyed post-quake for all eight drainage schemes. Based on this data the hydraulic efficiency of the critical drains has been checked by calculation. The estimates indicate that for the design flows based on 28mm/day (3.2 l/s/ha drained):

- the flow velocities are low, typically less than 0.2m/s.

- the hydraulic grade (surface water slope) along the drain is very flat, typically less than 1 in 3000 (0.03%) for a drain with advanced weed growth to less than 1 in 8000 (0.01%) for a clean drain.

- head loss through clean inlet screens at the pumpstations are negligible.

The drains considered to be critical are those relatively long drains flowing generally east to

west against the general trend of differential settlement over the plain viz Crystall's drain, Greigs drain, and Hyland Baillie drain. Flood drainage via Crystall's drain has been modified by Crystall's drain extension and this is discussed in Section 6.2. Within the above calculated hydraulic grades for flood flow in Greigs drain and Hyland Baillie drain there are no obvious impediments to the hydraulic efficiency of either drain to transfer floodwater to the pumpstations. However it is important that these drains in particular be maintained in a clean condition.

5.2 Everyday Drainage

5.2.1 Pumpstations

Under everyday drainage the flows are relatively small (compared to flood flows) and hydraulic grades are much flatter, typically 0.005% or flatter. Under everyday drainage operation the Board and Scheme drains act as a headpond for the pumpstations. The efficiency of the drainage scheme in controlling everyday water level in the Board drains depends on the preset pumping levels at the pumpstations. These levels were measured during the post-quake survey together with the lowest scheme land levels and are shown in Table 3.2. The effect of the earthquake has been to lower ground levels which has meant that to achieve comparable pre-quake water table control the pumping levels need to be correspondingly lowered. Refined control of on-farm water tables is not considered in this report.

Pumping levels are controlled by individual farmers appointed as caretakers by the RDB for each drainage scheme. Pumping levels were discussed with the relevant caretakers and the following comments noted:

- The Awaiti pumpstation probe levels were lowered 0.3 to 0.45 m immediately post-quake and raised again after Crystall's drain extension was completed. Current probe levels are considered to be slightly less than pre-quake probe levels.

  Apparently during the immediate post-quake period the reduced water levels aggravated problems when pumping at lower forebay water levels caused by piping and erosion of sand in the drain banks in the immediate vicinity of the Awaiti pumpstation. This potential problem was recognised before the March 1987 earthquake and was investigated and reported on by consultants in December 1985 (Reference 6).

The lowering of the Awaiti pumpstation probes by 0.3 to 0.45 m immediately post-quake would have lowered the minimum water level in the forebay to close to the Lowest Efficient Pumping Level (LEPL) (-2.24m and -2.27m, refer Table 3.2) for the pumps. However the problems caused by piping and erosion indicate that the LEPL cannot be achieved for the Awaiti pumpstation unless remedial works as recommended by the consultants report (Reference 6) are adopted.

- At Greigs Road pumpstation no deliberate lowering of probe levels was recalled by the caretaker. However from Table 3.2 the LEPL's are 0.38m and 0.46m respectively below the present pump stop probe levels, and it is considered that further lowering of the probes would be feasible if required, although the potential for piping and erosion at lower forebay water levels is unknown and would have to be assessed at the time.

- The RDB commented that water level probes may have been adjusted on some of the other six pumpstations but there was no definite recollection of this having been done post-quake. Comparison of the stop probe levels with the LEPL's for Robins Road and Hyland Baillie pump stations in Table 3.2 indicates that probe levels could possibly be lowered further if necessary. Again any potential for piping and erosion at lower pumping levels would have to be assessed at the time.

5.2.2 Board and Scheme Drains

The post-quake survey of existing Board/Scheme drain levels and cross sections has identified a number of possible impediments to everyday drainage as follows:

i) a high spot (RL 98.08m) in Greigs drain invert at approximately 1660 m from the Greig Road pumpstation.

ii) a restriction in Secombes drain in the vicinity of three culvert crossings between 2018 m and 2196 m from Awaiti pump station, causing a rise in drain water level of approximately 0.35 m.

iii) a relatively steep rise (up to 0.5 m) in water level in the section of drain between 2902m and 3627 m upstream from the Awaiti pumpstation.

iv) a relatively steep rise (up to 0.34 m) in water level in the section of drain in Hyland Baillie No. 1 scheme on the north-east side of State Highway 2 and between 1074 m and 1455 m from the Hyland Baillie No. 1 pumpstation.

Insufficient information was available at the time of writing this report to indicate whether the above impediments were present prior to the earthquake. Without exception all the above drainage impediments can be alleviated by maintenance of the drain section and if necessary lowering some of the culverts in Secombes drain. Since it would be treated as a maintenance item no cost estimates have been made for this remedial work.

5.3 <u>Seepage</u>

Seepage into the Thornton west drainage area occurs wherever a perched water table exists at the drainage boundary with the receiving waters; viz the Tarawera River, Awaiti drain, ORC and Rangitaiki River. The rate and volume of seepage depends on the incremental head difference between the perched and drainage area water tables, the boundary length of the perched water table, and the permeability of the ground through and beneath the stopbank or levee retaining the perched water table. In this investigation no specific field tests were carried out to quantify the potential severity of seepage at the above drainage boundaries. A review of previous seepage investigations, a comparison of the Thornton West drainage scheme pumping costs, field observation of drain water levels, and observations made during the excavation of six test pits dug earlier in the year gave an indication of the relative magnitude of seepage potential as follows:

i) Reference 2 reports estimated average seepage rates under design flood conditions in the Tarawera River of between 0.002 and 0.003 l/s per metre length of stopbank for an average measured permeability of 10^{-3}cm/sec. Maximum and minimum permeabilities measured in the field ranged from 10^{-1} cm/sec to 10^{-4} cm/sec. High permeability areas were considered to be localised. Based on the average permeability of 10^{-3} cm/sec measured for the Tarawera River stopbanks an average seepage rate of typically 0.004 l/s per metre could be expected from the ORC, with possibly higher rates of up to 0.4 l/s per metre occurring in localised lowlying areas adjacent to the ORC. These estimates are only approximate and the actual seepage rates will depend on the factors mentioned earlier. On a regional basis an equivalent 'rise' in the ORC water levels of typically 0.3m due to land settlement would result in an increase in seepage from the ORC of typically 10 to 15%.

ii) Annual pumping costs are considered to comprise up to typically 90% everyday drainage with the remaining 10% being flood drainage. Pumping costs are determined by pump efficiency, pumping head and flow (drainage) rate. Annual pumping costs were calculated for each drainage scheme in Thornton West for the two years 1986/87 and 1987/88 (Table 5.1). The costs are expressed as unit cost per hectare per metre head pumped and only include energy costs. The figures indicate that the relative unit costs are very low for Greigs Road, moderate for Hyland Baillie and Mexted, Gordons, Robins Road and Awaiti, and high for Robinson and Lawrence pumping schemes.

The low Greigs Road unit costs reflect the relatively low everyday drainage of the scheme which is largely isolated from the perched water table on the Thornton West boundaries. The Lawrence and Robinson unit pumping costs are high because of the lower operating efficiency of the Flygt submersible flood pumps used (50 to 55%) and possibly because of additional seepage from the coastal sand dunes not allowed for in the drainage scheme areas originally defined.

iii) Observations reported by farmers of farm drains adjacent to the ORC in the vicinity of Crystall's drain extension suggest that continual seepage occurs from the ORC and that seepage rates are noticibly higher when the ORC water levels are high.

iv) Observations reported by farmers of farm drains adjacent to the Rangitaiki River do not identify a major seepage contribution from the Rangitaiki River, although some seepage undoubtedly does occur.

v) Observation of the Rangitaiki River bed at low tide level indicates steady seepage back into the Rangitaiki River from permeable sandy layers in the vicinity of ORC east end. These sandy layers would be recharged each tide cycle.

vi) Six test pits were excavated adjacent to the ORC and the Rangitaiki River earlier in the year by BOPCC staff. The test pit locations and logged records are held by the BOPCC. The test pits showed variable ground conditions with potentially high groundwater flow and ground instability encountered in some of the sandy layers.

The above information confirms the contribution of seepage from perched water tables into the Thornton West drainage area, although the rates of seepage are quite variable.

TABLE 5.1 - ANALYSIS OF PUMPING COSTS

Drainage Scheme	Area (ha)	Max. Pumping Head (m)	Annual Power Cost for 1986/87 ($)	($/ha)	($/ha.m)	Annual Power Cost for 1987/88 ($)	($/ha)	($/ha.m)
Awaiti	533	3.25	7007	13.1	4.0	9393	17.6	5.4
Gordons (HB No 3)	97.8	3.03	1518	15.5	5.1	2428	24.8	8.2
Greigs Road	696.8	4.33	4672	6.7	1.5	3065	4.4	1.0
Hyland Baillie No 1 & Mexted (HB No 2)	239	3.14	3516	14.7	4.7	4520	18.9	6.0
Lawrence	75.9	2.77	2987	39.4	14.2	2915	38.4	13.9
Robins Road	194.8	4.14	2498	12.8	3.1	2924	15.0	3.6
Robinson	72	2.20	2264	31.4	14.3	2224	30.9	14.0

Notes:

1. Annual power costs based on kWh charges from April to March inclusive.

2. Maximum pumping head based on estimated maximum head pumping from lowest probe level to ORC including all friction head losses.

Apparently local farmers consider the ORC in particular to be a major source of seepage. Although it was not possible to quantify accurately seepage from the ORC, increases of up to about 17% could be expected as a result of post-quake lowering of water table levels in Crystall's drain extension by 0.57m. It is impractical to attempt to reduce seepage from the Awaiti Canal or from the Rangitaiki River. Seepage from the ORC could be reduced by lowering the water levels over part or all of the channel by pumping out of the ORC into the Tarawera River. Some leakage is occurring back into the ORC through the Matata floodgate, although from visual inspection the volumes are small.

6.0 POST-QUAKE REMEDIAL WORK

6.1 Remedial Drainage Work Carried Out

The remedial works to the Tarawera and Rangitaiki River stopbanks for reinstatement of flood protection is dealt with elsewhere and is not considered in this report. Post-quake remedial works for the Thornton West drainage schemes already carried out to correct some of the problems identified in section 4 and 5 include:

i) Repairs to pump station equipment. Separation of the discharge pipeline from the pumpstation or between discharge pipes was the most common damage. Temporary repairs were undertaken immediately after the earthquake; permanent repairs are currently underway.

ii) Regrading the ORC to lower the bed level over approximately 3.5 km channel reach from the Matata floodgate eastwards. The regrading involved a maximum excavation depth of about 0.8 m at the Matata floodgate grading out at 3.5 km. The work was completed by September 1988. The purpose of the regrading was to increase the hydraulic capacity in the lower reaches of the ORC.

iii) Diversion of drainage from Overdevest, Ruiter and Smit farms, previously drained by Awaiti pumpstation, to the Greigs Road pumpstation via an extension of Crystall's drain. A flood gate in the west end of Crystall's drain extension prevents water from the Awaiti scheme draining to Greigs Road, but does permit water to discharge from the above three farms back to the Awaiti pumpstation during floods when Greigs Road pumpstation would be under capacity to handle the flood drainage from the increased drainage area. Flow back through the flood gate to the Awaiti station only occurs when the water levels in Crystall's drain extension are sufficiently high to drain westwards. A further floodgate at the east end of Crystall's drain extension prevents water from Greigs Road scheme

from draining back to Awaiti pumpstation. The intention of this remedial work was to improve the 'everyday' drainage from the Overdevest, Ruiter and Smit farms which could not be achieved by the Awaiti pumpstation and to continue to flood drain these three farms via the Awaiti pumpstation during periods of heavy rain. The Crystall's drain extension and floodgates construction was completed by April 1988.

6.2 Crystall's Drain Extension

The Crystall's drain extension has definitely improved the everyday drainage of the Overdevest, Ruiter and Smit farms. This is apparent from the lowering of the water table in Crystall's drain extension by about 0.57 m, which is greater than the 0.1 to 0.4 m overall settlement of the plains caused by the March 1987 earthquake, and by comments made by local farmers on regional water table levels achieved after construction of Crystall's drain extension was completed. During a period of wet weather in late August/early September floodwater from Crystall's drain extension was observed by one of the local farmers to flow back to Awaiti pumpstation. Flood drainage of Crystall's drain extension is unavoidably the last area in Greigs Road/Awaiti schemes to be dewatered because it is the lowest lying area furtherest from either Greigs Road or Awaiti pumpstations. Because the flood pumping capacity of Greigs Road and Awaiti pumpstations is unchanged, the post-quake flood drainage capacity is as adequate as the pre-quake capacity.

Because the separation of floodwater from everyday drainage is arbitrary both pumpstations probably share a proportion of the flood pumping from Crystall's drain extension. Whether this compromises Greigs Road flood pumping capability will have to be assessed during future wet weather periods.

7.0 ADEQUACY OF OLD RANGITAIKI CHANNEL AND THE MATATA FLOODGATES

7.1 Outlet Water Level at Matata Floodgate

The ORC receives all drainage water from the eight pumpstations in Thornton West. Drainage water is temporarily stored in the ORC and released to the Tarawera River through the Matata floodgate during low tide. The floodgates were constructed with a reinforced concrete apron, wingwalls and a headwall with five 1.2m x 1.2m openings tide locked by timber gates.

The water level in the Tarawera River at the outlet of the Matata floodgate is influenced by the tide, the river mouth conditions and the flow in the river. A recent survey carried out in November 1988 shows that at low tide the water levels between the State Highway bridge and the sea vary significantly with a fall exceeding 0.7m over a reach

of about 650m between the State Highway and the sea, and a fall of over 0.5m between the Matata floodgate outlet water level and the sea (Figure 7.1). At the time of the survey the Tarawera River was not in flood. A previous study of the Omeheu Awaiti drainage system (Reference 3) nominated a design tide peak and trough for the Tarawera River outlet of:

Spring tide peak	1.3
Wave surge and barometric pressure	0.3
Greenhouse effect	0.14
Design peak	1.74m
Minimum trough at Matata floodgate	0.35
Greenhouse effect	0.14
Design trough	0.59m

A flood in the Tarawera River in February 1988 recorded a maximum trough at the State Highway bridge of over 1.0m. Flows in the Tarawera River at the time were reported to be equivalent to about a 5 year flood event. During this flood drainage from the ORC apparently still occurred (reported by local farmers) and it is considered that the trough level at the floodgate outlet must have been substantially less than that recorded at the bridge. The significant hydraulic grade measured at low flow would support this. The design tide peak and trough above were adopted for this investigation to assess the adequacy of the ORC under design drainage conditions.

A design tide hydrograph for the Tarawera River outlet was constructed by modifying the typical tide hydrograph shape recorded at State Highway bridge to incorporate the design peak and design trough. The resultant design tide hydrograph shown in Figure 7.2 reflects the head loss across the Tarawera River bar.

Historic records of water levels in the Tarawera River at the Matata floodgate outlet reported in earlier investigations (Reference 4) vary from 97 ft (0.61m RL) for low river stage, low tide, good mouth conditions; to 103 ft (1.89m RL) for flood stage, high tide, and on-shore winds. Present conditions at the Tarawera mouth have improved because recent low tide levels measured in November 1988 were less than 0.10m RL opposite the Matata floodgate.

Table 7.1 summarises the respective levels of the ORC levees, the Matata floodgate and the design peak and trough tide levels in the Tarawera River downstream of the floodgate.

FIGURE 7·1

LOW TIDE WATER LEVEL PROFILE – TARAWERA RIVER. 24 Nov. 1988.

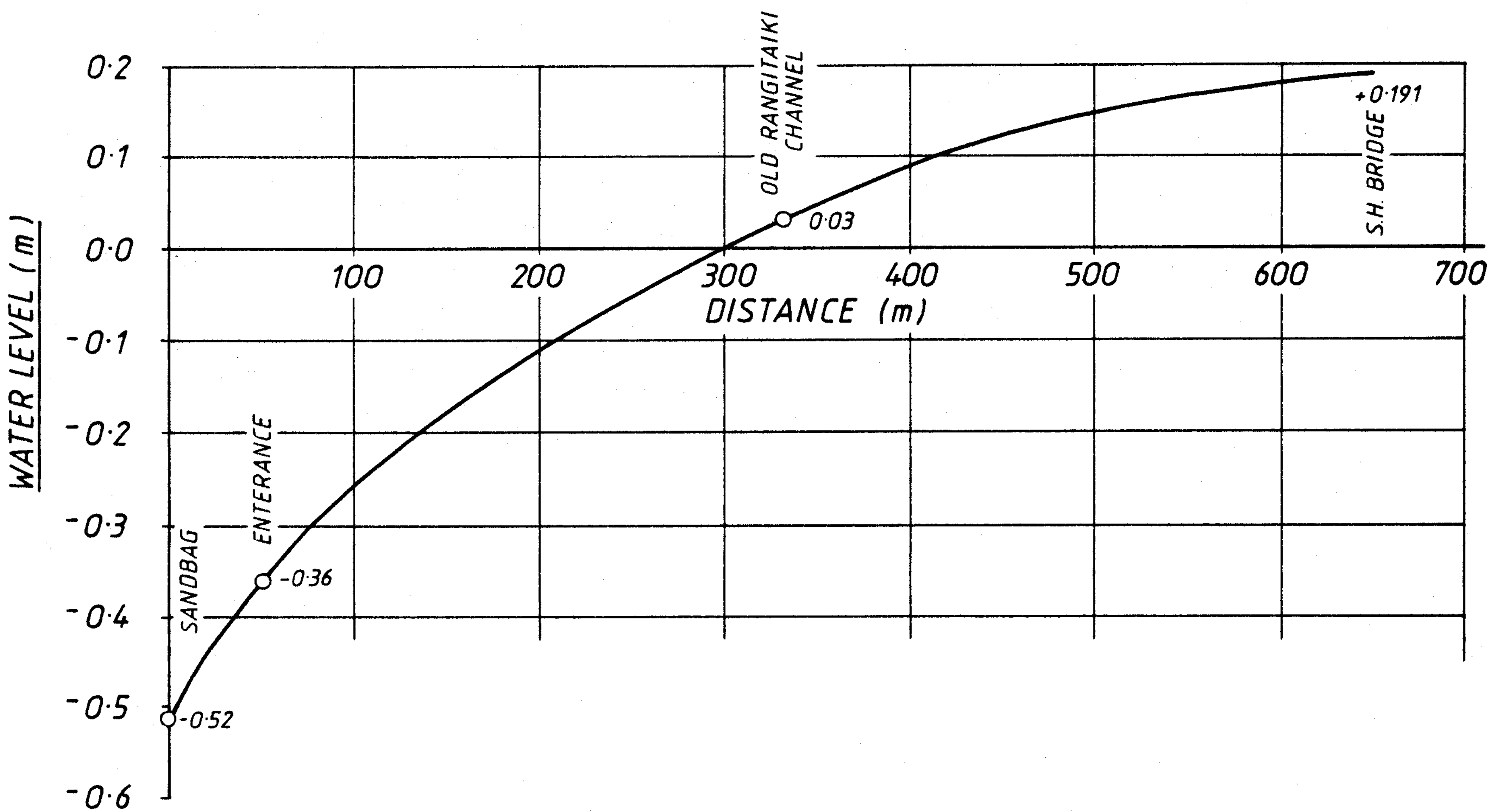


FIG 7·1

FIGURE 7·2

DESIGN TIDE HYDROGRAPH

TARAWERA RIVER MATATA FLOODGATE OUTLET

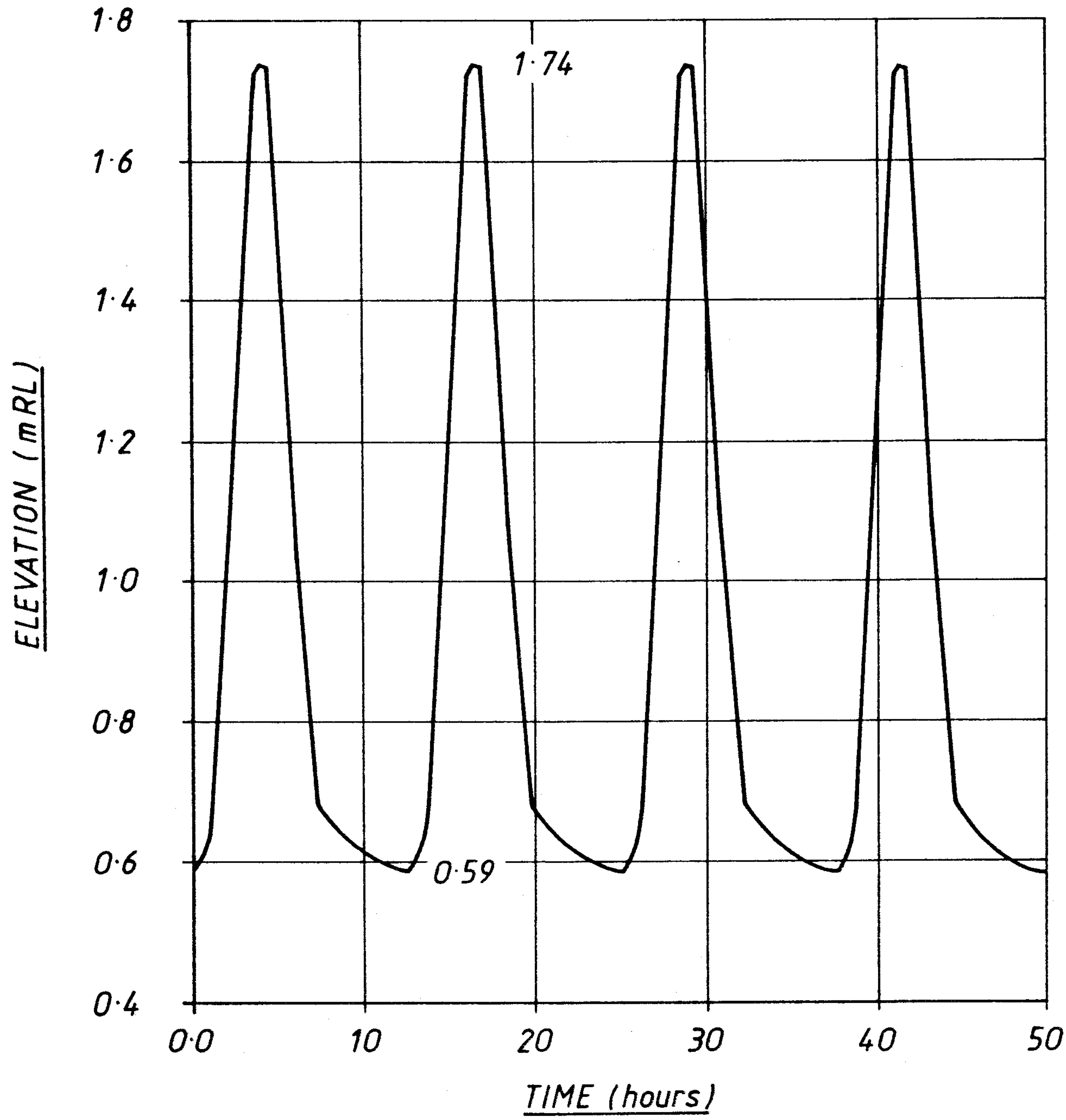


TABLE 7.1 - ORC MATATA FLOODGATE AND DESIGN TIDE LEVELS

Top of headwall	2.788
Soffit of gate opening in head wall	0.90
Invert of gate opening in head wall	-0.30
Design maximum level of ORC levees	1.50
Design peak tide water level d/s floodgate	1.74
Design trough tide water level d/s floodgate	0.59

Note: Level datum 0.0m Moturiki

7.2 Storage Capacity of Old Rangitaiki Channel

Based on a survey carried out of the ORC levees in April 1987 (RDB drawing 534, Sheet 3 dated July 1987 the maximum permissible water level considered by the BOPCB to be sustainable in the ORC is approximately 1.35m RL which allows 0.15m freeboard to the 'design' levee level of 1.5m RL. An elevation storage curve for the ORC (Figure 7.3) was plotted based on storage volumes calculated from ten post-quake cross sections surveyed at intervals along the ORC. Useful live storage within the ORC is approximately 248,000 m3 between 0.59m RL (the design tide trough) and 1.35m RL. For lower tide troughs the live storage increases to about 326,000 m3 at a tide trough level of 0.3m RL. Both these storage volumes assume a horizontal water surface in the ORC. Under real conditions of unsteady flow the water surface in the ORC will be sloping which will reduce the useful live storage capacity available.

7.3 Hydraulic Capacity of Matata Floodgate

The hydraulic capacity of the Matata floodgate depends on whether the floodgate opening is fully submerged and what head loss is developed across the gates. Figure 7.4 graphs the flow versus head loss characteristics for the Matata floodgates assuming fully submerged openings. At partial submergence the flows would be less. The hydraulic estimates in Figure 7.4 are based on velocity head loss coefficients of 0.5 at the inlet and 1.0 at the outlet.

7.4 Maximum Expected Water Levels in Old Rangitaiki Channel

Maximum pumped inflow to the ORC with all pumps running totals approximately 6.58 m3/s. Over a 12 hour cycle this gives a total inflow of about 284,000 m3. During the 12 hour period the total water stored in the ORC would be less than 284,000 m3 because water would be evacuated through the Matata floodgates when the design tide level permits. To avoid an accumulation of drainage water with successive tide cycles over the 3 day design storm, the full 284,000 m3 would need to be evacuated through the Matata floodgates during a design tide cycle. The hydraulic performance of the ORC and the Matata floodgate was checked by modelling the system using the RIVERS computer programme. The analysis takes into account pumped inflows at nominated locations along the ORC and models the unsteady flow in the ORC to compute water levels and flows at each of ten cross sections along the channel. A Mannings'n' roughness coefficient of 0.045 was used for the entire reach of the ORC. Maximum water levels modelled in the ORC for a continuous total pumped inflow of 6.58 m3/s and for a design tide hydrograph downstream of the Matata floodgate were approximately 1.17m RL at the eastern end of the ORC and approximately 0.87m RL immediately upstream of the Matata floodgate. For this maximum water level profile the flow through the floodgate was modelled as 14.75 m3/s, and

FIGURE 7·3

ELEVATION STORAGE FOR OLD RANGITAIKI CHANNEL

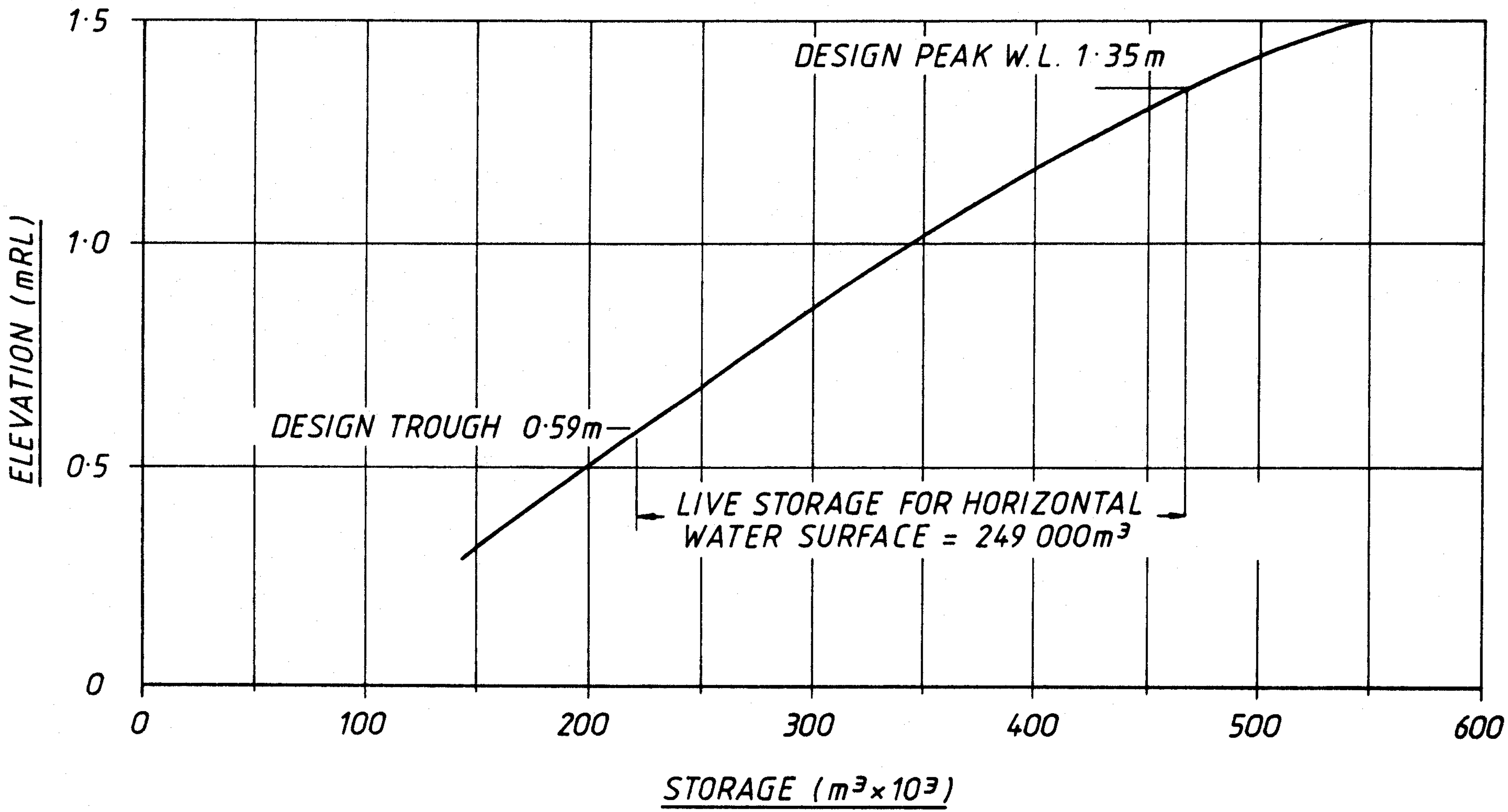
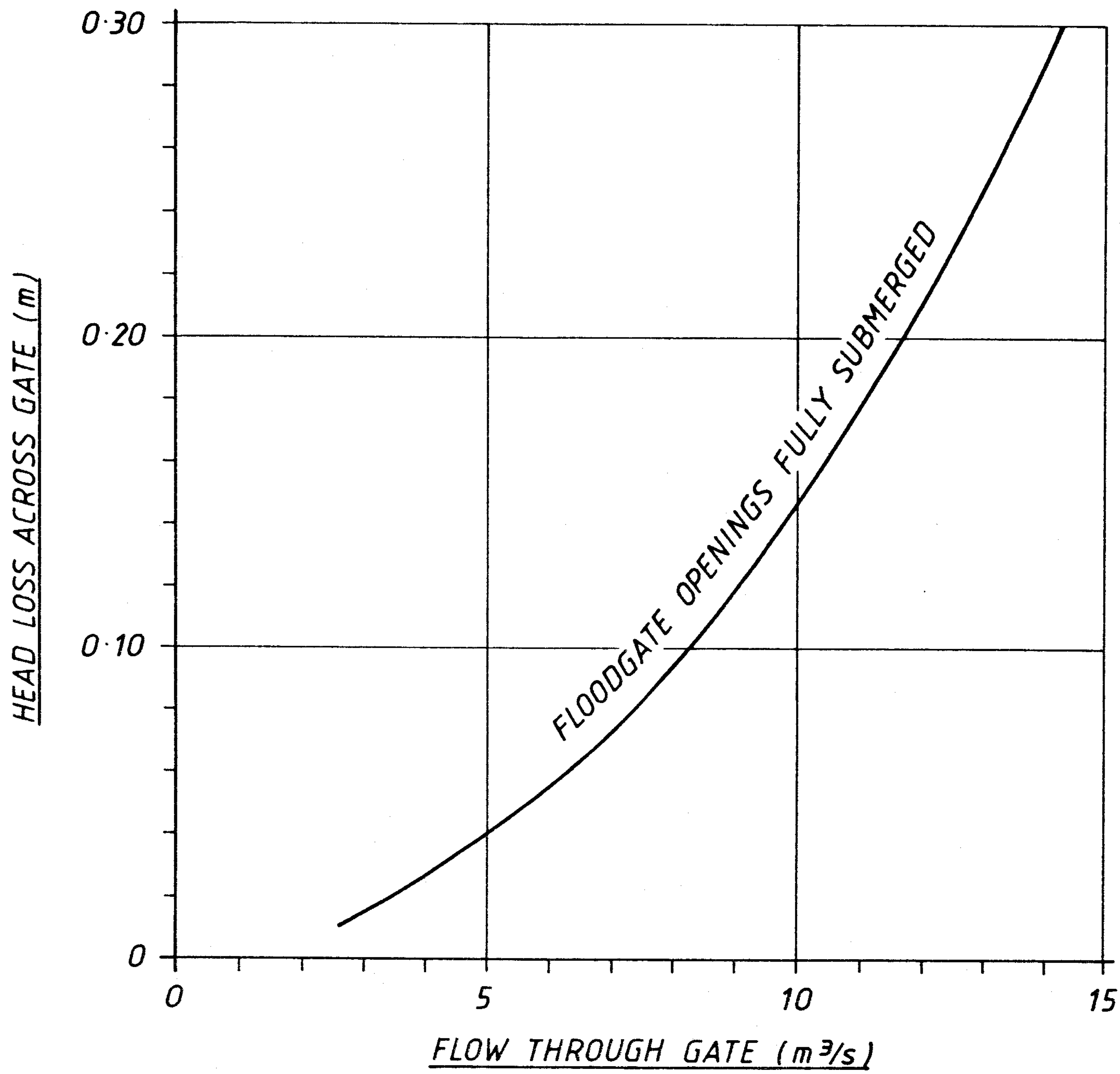


FIG 7·3

FIGURE 7·4

MATATA FLOODGATE FLOW
v's
HEAD LOSS



the flow through the Smith flood culvert was modelled as 2.9 m3/s. Higher flows of up to 3.7 m3/s were modelled through the culvert, but at lower water levels.

The RIVERS modelling analysis does not make allowance for head loss through the Matata floodgate or for head loss through the Smith Road culvert. From the flow verses head loss characteristics in Figure 7.4 about 0.3 m would be needed to pass a flow of 14 to 15m3/s through the Matata floodgates. From culvert hydraulic calculations a head loss of about 0.11m would be needed to pass the modelled flow of 2.9m3/s through the Smith Road culvert. Adding these head losses to the modelled maximum water level profile for the ORC gives the predicted design water level profile for the ORC under flood conditions and with a design tide hydrograph at the Matata floodgate outlet as shown in Figure 7.5. Limitations in the accuracy of the hydraulic analysis make it difficult to state the reliability of the conclusions drawn regarding the capacity of the ORC and Matata floodgates. These limitations affect the estimated head losses across the Matata floodgate, losses in the ORC (influenced by the Mannings'n' value used) and losses through the Smith Road culvert. Reduced head losses in some or all of these components would flatten the design water level profile, and reduce the risk of spillage in the upper reaches of the ORC. The head loss estimates in Figure 7.5 are considered to be relatively conservative.

The predicted design water level profile in the ORC immediately downstream of the Smith Road culvert would exceed 1.35m and approaches 1.47m, and approaches 1.56m in the ORC upstream of the culvert.

Within the accuracy of the analytical methods used to calculate head losses in the ORC system that:

i) Discharge of floodwater from the Thornton West drainage schemes for the design tide hydrograph and the pumping rates stated would fully extend the existing capacity of the ORC system and would necessitate minor topping up of the ORC levees over small sections.

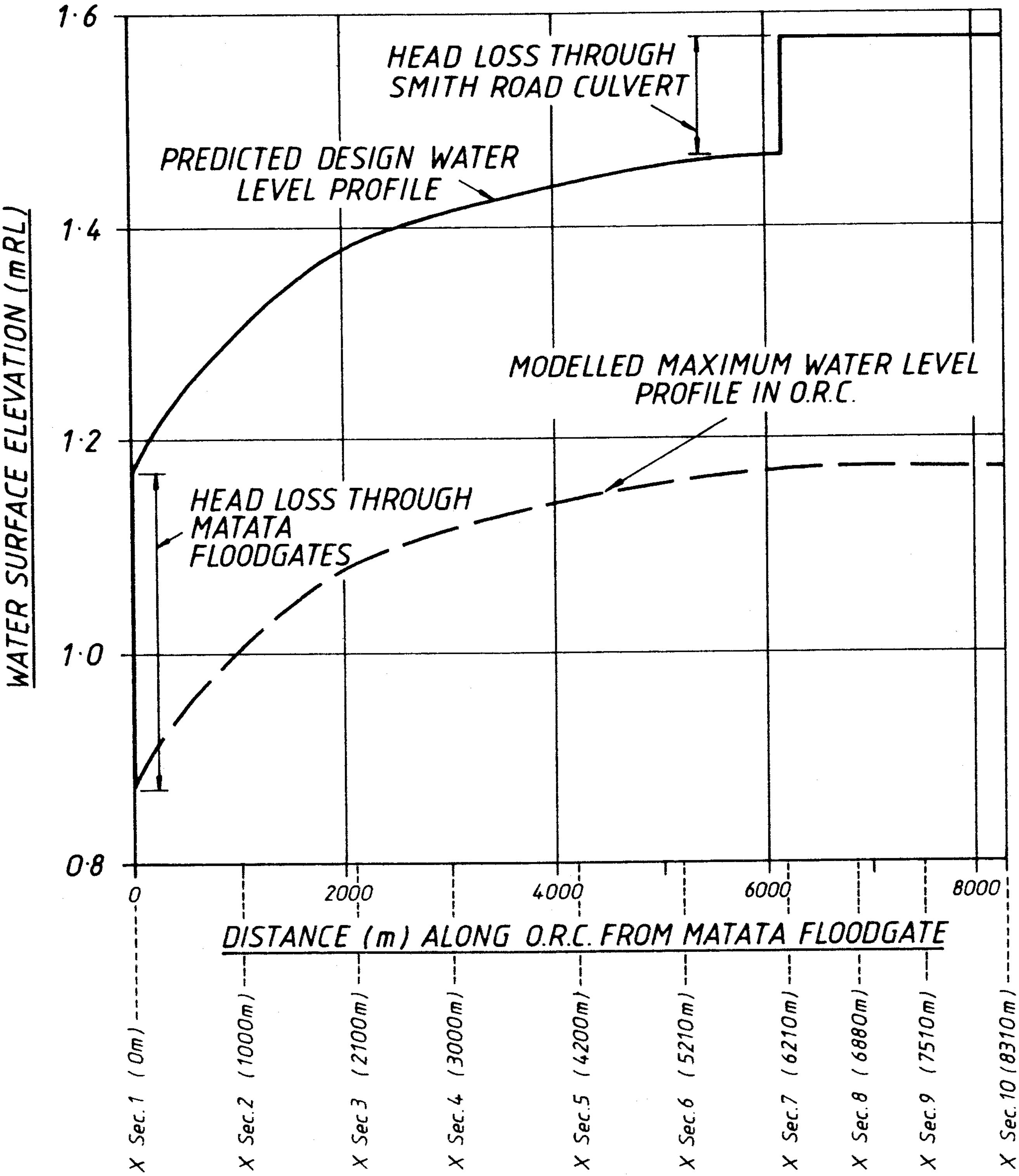
ii) It is important to maintain the Smith Road culvert entrance and exit free of obstructions.

iii) Any future increase in the Greig Road pumpstation capacity associated with possible drainage scheme upgrading would need to reconsider the capacity of the Smith Road culvert.

iv) The validity of the modelling analysis used to predict the design water level profile should be confirmed by field measurements of water levels and

FIGURE 7·5

O.R.C. PREDICTED DESIGN WATER LEVEL PROFILE



NOTE: "X Sec.1" DENOTES "CROSS SECTION 1"

flows in the ORC upstream and downstream of the Matata floodgate and the Smith Road culvert.

The measurements should be made during wet weather periods. Field measurements made by the BOPCB staff during a flood on 14 February 1988 recorded a head loss through the Smith Road culvert of only 3.9 cm. Water levels in the ORC at the time were high, exceeding 0.8m RL upstream of the culvert, but no flows were measured. Once the hydraulic characteristics of the Matata floodgate and the Smith Road culvert have been confirmed by field measurement, the predicted design water level profile in the ORC in Figure 7.5 should be reassessed.

Inspection of the long section plotted for the ORC (RDB Drawing 534, Sheet 3, dated July 1987) show that the ORC levees immediately upstream of the Smith Road culvert could be raised by about 0.3m to approximate RL 1.8 m over a total length of about 300m (Right Bank 100m, Left Bank 200m) to contain the predicted design water level profile. Preliminary estimates indicate that the volume of fill required would not exceed about 500 m3. It may be feasible to use dredgings from the ORC. Topping up the levees would be cheaper than constructing a second culvert parallel to the existing Smith Road culvert. The preliminary estimates of fill material needed for topping up the levees should be confirmed by field inspection but the estimated costs are not expected to exceed about $2000.

8.0 LONG AND MEDIUM TERM DRAINAGE DEVELOPMENT

8.1 Long Term

8.1.1 Considerations

Considerations affecting the upgrading and replacement of drainage schemes in the Thornton West area include the indemnity value of existing schemes, private ownership of schemes, seepage from the ORC, rising water levels due to the Greenhouse Effect, and further land settlement due to continued shrinkage of peat land and future seismic activity.

Other drainage principles are relevant: for example with the very flat gradients in the area it is desirable to have alternative drainage outlets available which gives greater operating flexibility. Adjacent to Thornton West lies the Kopeopeo-Orini system which fulfills the same role as ORC. It drains land between Rangitaiki and Whakatane rivers and will by 1990 have a floodgated outlet at both ends enabling water to be discharged either way depending on the relative stages of the rivers. On that system there will also be a flood pump installed at the eastern (Whakatane River) end. It is similarly desirable that at least a flood gated outlet be established on the eastern end of the ORC.

Obviously any reduction in loading of the ORC will have benefits; it is desirable to 'prune off' areas at the eastern and western end and dispose of that drainage directly into Rangitaiki River and Awaiti canal respectively. It is clear however that in the long term, excepting for massive seismic land disturbance, the ORC will be the only outlet for the central part of Thornton West drainage area.

Implementation of long term works will of course depend on their economic viability.

a) Indemnity Value of Schemes
All existing pumpstations in Thornton West were constructed with Government subsidies and as at March 1988 had a remaining economic life of between 14 and 36 years, a total replacement value of $1,104,000 and a total indemnity value of $595,505 (Table 8.1). The economic evaluation of drainage scheme upgrading or modifications must include the indemnity value of the existing schemes as a cost, with the increased production benefits anticipated for the modifications as the scheme benefit. The present indemnity values of the pumpstations are a cost to new development, but a cost which is decreasing with time. New investments, superceding the existing schemes, will become economically more attractive with the passage of time.

b) Private Ownership
The existing drainage schemes are privately owned and any modifications will require the consent of participating owners. This places some constraints on what modifications are acceptable to owners, particularly where the modifications involve a change in scheme boundaries.

TABLE 8.1 - PUMPSTATION VALUATION

Scheme	Replacement Value ($)			Approx Year Installed	Age	Remaining Life	Indemnity Value ($)
	Buildings	Plant & Equip	Total				
Robinson	42,200	17,400	59,600	1984	4	36	53,640
Lawrence	43,700	17,400	61,100	1984	4	36	54,990
Gordon	58,500	42,600	101,100	1970	18	22	55,605
Mexted	57,100	28,700	85,800	1969	19	21	45,045
Hyland Baillie	65,800	82,000	147,800	1969	19	21	77,595
Robins Road	72,900	56,600	129,500	1970	18	22	71,225
Griegs Road	123,300	150,200	273,500	1962	26	14	95,725
Awaiti	104,000	142,400	246,400	1971	17	23	141,680
	567,500	537,300	1,104,800				595,505

Source: RDB March 1988

c) Seepage

The seepage potential from the perched water tables on the boundaries of the Thornton West area has increased as a result of the March 1987 earthquake and will continue to increase with future land settlement. Seepage from the ORC adjacent to the lowlying areas adjacent to Crystall's Drain (Awaiti Scheme) and Crystall's outlet east (Robins Road scheme) are considered to be the worst affected areas. Using average field permeabilities measured for the Tarawera River stopbanks (refer section 5.3) the average seepage from the ORC over both 9 km long levees was estimated to be approximately 70 to 80 l/s. Allowing for an order of magnitude increase in field permeability gives a conservative seepage estimate of approximately 700 to 800 l/s.

The existing pumpstations recirculate this seepage as part of the overall pumped discharge into the ORC. As a proportion of the total pumping capacity of the Thornton West schemes of approximately 6200 l/s, seepage accounts for about 1.3 to 13%. Seepage from the ORC could be reduced by a reduction in water levels in the ORC.

d) Greenhouse Effect

The Greenhouse Effect is predicted to cause a rise in sea levels over the coming decades. This will result in an increase in tide levels with a consequent overall increase in water tables along the coastal boundary and at the Matata floodgate outlet. Increases up to the 0.14m considered in this investigation (section 7.1) should be able to be accommodated but greater rises may further compromise the ability of the ORC and the Matata floodgate as they currently exist to effectively discharge floodwater from the Thornton West drainage schemes.

e) Land Settlement

Further land settlement may occur as a result of continued shrinkage of peat soil areas and future seismic activity.
Borehole logs dated July 1946 and showing soil and peat strata to varying depths have been recorded for boreholes excavated over the Thornton West drainage area (records held by RDB).

Subsequent drainage reports have analysed ground settlement attributed to peat shrinkage

from surveyed ground levels between the years 1944 and 1967 (Reference 4) and from calculated shrinkage in the upper 4 feet (1.2m) soil profile based on peat soil samples tested for 'loss on ignition' by Ruakura Agricultrual Research Centre (Reference 5). The measured land settlement in the Awaiti scheme was greatest in the lowest lying ground between Greig Road and the ORC (on properties currently farmed by Overdevest, Ruiter and Smit) where up to 2.25 feet (0.69m) settlement was recorded. A further 2.39 feet (0.73m) settlement was predicted based on 'loss on ignition' tests giving an eventual settlement of over 1.4m. Calculated settlement of up to 1.7 feet (0.52m) was estimated for ground in the Robins Road scheme on a property currently farmed by Brady. Ground settlement in the Gordon drainage scheme area of up to 0.38 m has been reported by the present land owner.

No attempt has been made to predict rates of future land settlement. Land settlement as a result of peat shrinkage is likely to continue, depending on the water table levels maintained. Major earthquakes such as occurred in March 1987 are unlikely to occur more frequently than once in one hundred years.

To counteract the effects of additional land settlement due to earthquakes or peat shrinkage the pumping levels of the existing schemes would have to be reduced to maintain the accepted design drainage standard for water table control. As discussed in section 5.2.1 lowering of existing pumpstation water level probes without drain stabilisation works is not practical for the Awaiti pumpstation because of erosion of the inlet drain banks and the risk of piping under high outlet or low inlet conditions. The possibility for lowering the water level probes at the other scheme pumpstations has not been exhaustively investigated. Discussions with the RDB and some of the scheme caretakers, and comparison of the current probe levels with the LEPL's for the pumpstations are discussed in section 5.2.1 and conclude that there may be potential for lowering water level probes some pumpstations, but the risks of erosion and piping would have to be assessed at the time.

8.1.2 Proposals

Drainage of at least some of the Thornton West area via the ORC will continue for the foreseeable future. All the existing schemes currently discharge into the ORC and of these at least Robinson, Lawrence, Gordon, Mexted, Robins Road and Greig Road have no obvious alternative discharge. In the long term it is prudent to reduce the dependency on the ORC which efficiency will continue to be degraded as a result of the factors mentioned in 8.1.1 above. Long term proposals considered in this investigation included upgrading the capacity of the ORC system and diverting drainage directly to the Rangitaiki River and the Awaiti Canal. A brief description of the scheme concepts proposed and first order costs are:

a) Upgrading the ORC System

The capacity of the ORC system to discharge floodwater could be upgraded by extending the capacity of the existing Matata floodgates, opening out the east end of the ORC and constructing a new supplementary floodgate discharging into the Rangitaiki River, or by constructing a pumpstation to pump from the ORC into the Tarawera or the Rangitaiki River. Preliminary consideration of these proposals indicates that:

i) increasing the Matata floodgate capacity would reduce the predicted design water level in the ORC (Figure 7.5) by about 0.16m, and would also improve the evacuation of the ORC during a design tide. The Smith Road culvert capacity would need to be upgraded by minor stopbanking of the ORC levees upstream of the culvert. The preliminary cost estimate for the Matata floodgate upgrading and the levee top up more approximately $165,000 and $5,000 respectively.

ii) construction of a new supplementary tide gate at the east end of the ORC (site 202) would capitalise on an outlet level in the Rangitaiki River which at average low take is about 0.278 m lower than Tarawera river level. The trough level is a critical parameter in the operation of such floodgates. The site would need to be carefully investigated to avoid potential seepage problems. A new gate having a capacity of 50% of the Matata floodgate

would cost an estimated $360,000 excluding the cost of regaining ownership of the ORC east end and any channel excavation. The scheme would have the advantage of an alternative discharge for drainage from the ORC. The hydraulics of the system would need to be investigated to confirm the gate capacity and the east end channel capacity needed, and the probability of design drainage flows in ORC coincident with floods either in the Tarawera and/or Rangitaiki River.

iii) ORC Floodgate Pumpstation

A pumpstation having a capacity up to approximately 6.6m3/s installed at the Matata floodgate would discharge drainage and floodwater from the ORC into the Tarawera River. Depending on pumping levels adopted this would maintain lower water levels in the ORC reducing seepage potential from the ORC into the adjacent farm drains on either side of the channel. It would alleviate a potential future loss of channel storage capacity caused by further settlement of the ORC levees and would overcome the present limitation of the ORC and Matata floodgate capacity under design conditions (refer section 7). Pumping heads for the existing pumpstations discharging into the ORC would be reduced.

Site investigations for a pumpstation at the Matata floodgate would need to focus on the potentially difficult ground conditions to protect against potential seepage and piping.

The cost of a 6.6 m3/s pumpstation would be in the order of at least $600,000 to $700,000. Annual pumping costs for the Matata floodgate pumpstation would be partly offset by a minor reduction in seepage pumping costs from the adjacent schemes but the overall pumping costs for Thornton West would increase. At this stage the high capital cost and marginal benefits do not warrant the scheme.

b) Pumpstations Discharging to the Rangitaiki River

The presence of seepage from the ORC and the constraint of the Tarawera River bar on the

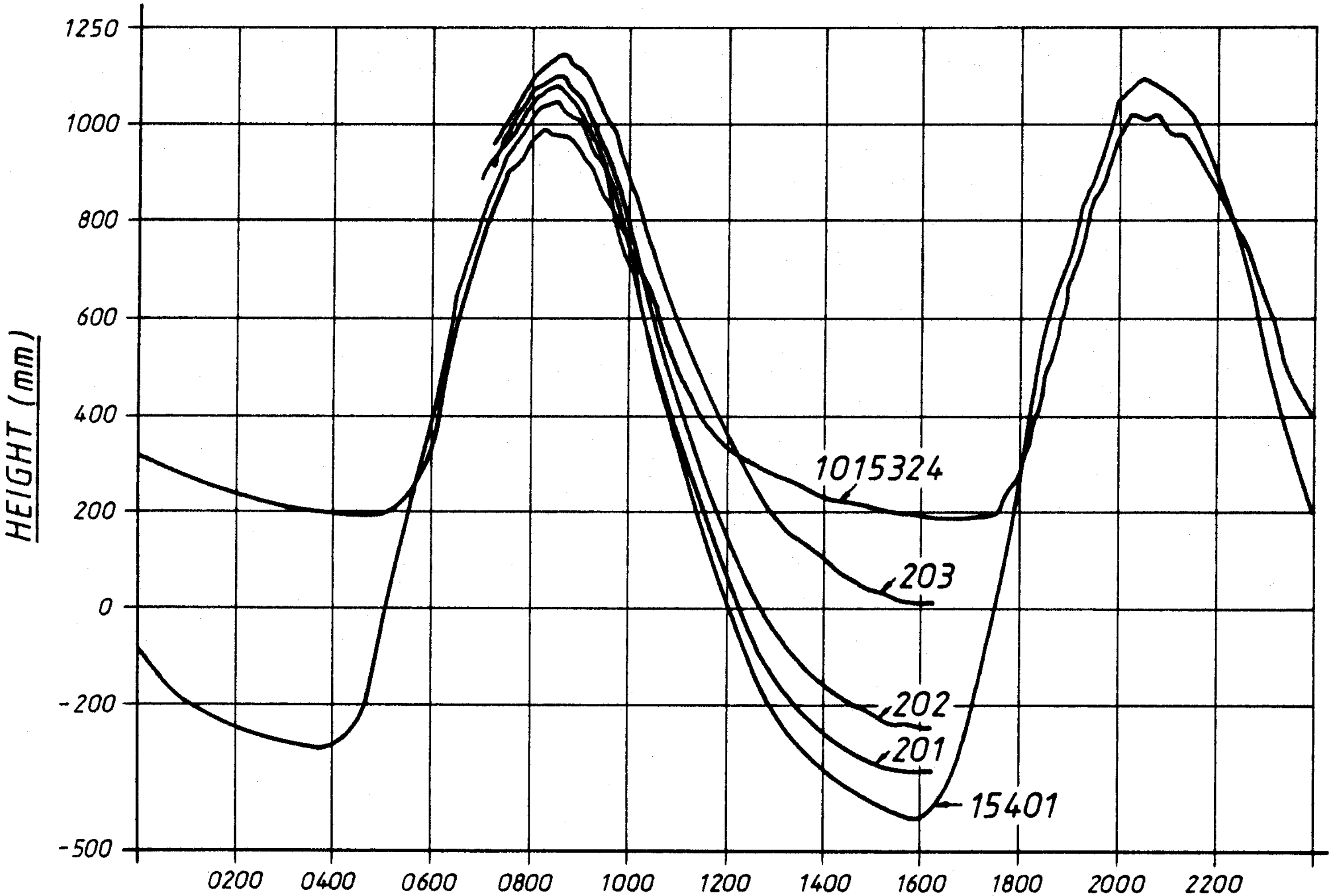
discharge of floodwater from the Matata floodgates has encouraged land owners in Thornton West to consider the Rangitaiki River as a possible outlet for the discharge of drainage water. Some preliminary investigations were carried out to assess the potential for discharging to the Rangitaiki River. Temporary staff gauge boards were erected in the Rangitaiki River at three locations considered for possible pumpstations - opposite the Hyland Baillie drain (site 201), opposite the east end of the ORC (site 202) and opposite the east end of Greig Road (site 203). These sites are shown in Figure 2.1. Water levels were recorded at each gauge board, by a water level recorder at the outlet of Reids canal (site 15401) and by a water level recorder at the State Highway bridge crossing the Tarawera River (site 1015324). The recorded water levels are shown in Figure 8.1, and indicate comparable peak water levels but lower trough water levels in the Rangitaiki River at sites 201, 202 and 203 than in the Tarawera River opposite the Matata floodgate. At the time of the survey neither the Tarawera nor the Rangitaiki River were in flood.

As with the Tarawera River, water levels in the Rangitaiki River will alter with flow. Manual inspection of selected historical tide charts for the Rangitaiki River at Thornton (site 15401) indicates peak flood levels in excess of 1.5m RL and peak trough levels also approaching 1.5m RL. During normal dry weather flow the water levels vary between about -0.2 to 1.0m RL and about 0.1 to 1.3m RL for wet weather flow. Corresponding water levels in the Rangitaiki River upstream at sites 201, 202 and 203 would be proportionally higher. In this investigation no attempt was made to assess the probability of design drainage flows in Thornton West coincident with floods in the Rangitaiki River and/or Tarawera River.

The preliminary assessment of Rangitaiki River water levels at sites 201, 202, and 203 indicates that pumpstations at these locations would need to accommodate normal tailwater levels in the Rangitaiki River of between - 0.1 to 1.33m RL, 0 to 1.35m RL, and 0.25 to 1.4m RL respectively. Considering the likely inlet water levels at each site, there is no major reduction in pumping lifts for pumpstations discharging into the Rangitaiki River compared

FIGURE 8·1 RANGITAIKI AND TARAWERA RIVER LEVELS

(IN MOTURIKI DATUM)



TIME (hrs) ON 28 SEPT 1988

SITE No.	NAME
15401	RANGITAIKI R. AT REIDS CENTRAL CANAL
201	RANGITAIKI R. OPPOSITE HYLAND BAILLIE CANAL
202	RANGITAIKI R. OPPOSITE O.R.C. EAST END
203	RANGITAIKI R. OPPOSITE GRIEG RD.
1015324	TARAWERA R. AT STATE HIGHWAY 2 BRIDGE

FIG 8·1

with the existing pumpstations discharging into the ORC.

One concept examined was for a new pumpstation at the east end of Greig Road discharging into the Rangitaiki River, and commanding drainage from all of the existing Greig Road scheme area south of Greig Road totalling 599 ha. 362 ha of the western end of Awaiti pump scheme would remain as the Awaiti scheme with 171 ha (Crystall's drain extension) routed into Greig Road scheme, which would then service 269 ha (compared to 697 at present).

The drain along Greig Road would need regrading eastwards to site 203. In this long term scenario the present Awaiti and Greig Road scheme would have reached the end of their economic lives (say by about year 2005) and therefore no indemnity write-off costs would be incurred.

The scheme would relieve the drainage load on the ORC and Matata floodgate by 29% and would have marginal benefits in reducing seepage losses from the ORC, and possibly some ponding relief for the existing low lying areas in Greig Road scheme during flooding (some ponding would be transposed to the lowlying areas adjacent to site 203).

A preliminary estimate is:

- pumpstation, design and build	$550,000
- upgrading drainage; power supply say	<u>40,000</u>
	$590,000

c) <u>Pumpstation discharging to Awaiti Canal</u>
With the construction of a new tide gate and stopbank top-up on the Awaiti Canal a cut from Ludwigs' outlet becomes a possible discharge point for drainage from the western part of Awaiti scheme. Although no detailed comparison has been made between water levels in the Awaiti Canal and the ORC, pumping heads are likely to be very similar. There is no obvious advantage in constructing a new pumpstation from the Awaiti scheme into the Awaiti Canal apart from reducing the discharge into the ORC. The capacity of the Awaiti Canal to accommodate the additional inflow would need to be assessed but since Awaiti-Omeheu catchment is about four times the size of Old Rangitaiki Channel

catchment it is likely that capacity is available.

8.2 Medium Term

8.2.1 Considerations

The major post-quake drainage considerations to be addressed in the medium term are:

i) the temporary status of the Crystall's drain extension which affects both the Awaiti and Greig Road schemes.

ii) Any investment made should as far as possible conform to the long term scenario.

Constraints affecting the upgrading of Awaiti and Greig Road schemes in the medium term include the indemnity value of both existing schemes and the private ownership of schemes.

Seepage from the ORC is not a major consideration for medium term drainage. Rising water levels due to the Greenhouse Effect and further land settlement due to continued shrinkage of peat land and future seismic activity are all long term considerations discussed in section 8.1. The options for medium term drainage improvements are discussed in the following section.

8.2.2 Options

i) Joint Awaiti-Greig Road Scheme

This is the least cost scheme since it is already in place albeit on an interim basis, (until 31/12/89) as a result of the extension of Crystall's drain. This scheme relies on the manual operation by the Drainage Board of a sluice gate during flooding to prevent water from the Crystall's drain extension (of 171 ha) entering Greig Road scheme; that water would be drawn westwards and discharged through the Awaiti scheme. The scheme has not yet been tested in floodtime.

A re-classification of both schemes as one would be required to fairly apportion benefit. Estimated costs (mainly fees) for this are $6,000. This is the preferred option.

It is recognised that the Greig Road and Awaiti schemes are privately owned, and that at 31/12/89 Greig Road participants may refuse further inflows from the Crystall's drain extension (an area which pre-quake was part of the Awaiti scheme). Therefore the following options are also proposed:

ii) Low Lift Pump, Crystall's Drain (refer Figure 8.2)

This involves the installation of a pump of capacity 550 l/s (being 28 mm/day over 171 ha) with a lift of about 0.5 to 1.0 m, pumping over a block in Crystall's drain to the existing Awaiti station. Electricity would be supplied from a new extension line from Gordons pumpstation.

Estimated costs are:

- Pump station, design and build	$195,000
- Electricity Installation	12,750
Cost say	$208,000

This option means double pumping of Crystall's drain extension water. The low head requirement would likely mean construction of a specially designed axial- flow pump. The efficiency of such a pump would likely be lower than commercially available pumps operating at higher heads as used elsewhere in the area. Overall the operating costs of the Awaiti scheme under this option would be relatively expensive, with the water still being discharged to the ORC, i.e. there are no off-site benefits for the long term scenario.

This option is not recommended.

iii) Pump Discharging Directly to ORC

This option creates a new scheme of 171 ha out of Crystall's Drain extension. It can be considered as the traditional solution. It would leave Awaiti pumpstation with overcapacity of about 32% and this can be costed as a write-off of 32% of the present indemnity value of Awaiti pump scheme. Power supply would be by extension line from Gordons pumpstation.

Estimated costs are:

- Pumpstation, design and build	$195,000
- Electricity installation	7,000
- New scheme drainage and culverting say	10,000
Cash cost say	$212,000

- plus indemnity write-off cost of $ 45,000


Figure 8.2
OPTIONS FOR MEDIUM TERM
DRAINAGE IMPROVEMENT
NOTES
1) POSSIBLE PUMPSTATIONS ARE SHOWN AT APPROX. LOCATIONS ONLY.
2) PUMP SCHEME BOUNDARY (APPROX.)
3) SCALE= 1 cm To 50 metres
N
OLD RANGITAIKI CHANNEL
SMITH ROAD
EXISTING 900 Ø FLOODGATE
PUMPSTATION OPTION II.
AWAITI PUMP SCHEME AREA
PUMPSTATION OPTION III.
C.SMIT - OWNER
CRYSTALL DRAIN EXTENSION AREA
EXISTING CRYSTALL'S DRAIN EXTENSION
EXISTING 900 Ø SLUICE GATE
H. OVERDEVEST - OWNER
S.RUITER - OWNER
Bdy.
Bdy.
PUMPSTATION OPTION IV.
EXISTING GREIG ROAD PUMPSTATION
GREIGS ROAD
GREIGS ROAD PUMP SCHEME AREA
EXISTING 900 Ø FLOODGATE

iv) <u>Pump discharging into Greig Road scheme outlet</u>
This option has the advantages of proximity of power supply and good access and known site conditions. It would have similar operating costs to option iii). Estimated costs are:

- pump station design and build	$195,000
- electricity installation	2,000
- new scheme drainage and culverting say	20,000
Cash cost say	$217,000
- plus, as for iii) indemnity write-off cost of	45,000

This scheme fits the long-term scenario of diverting some water from the ORC eastwards into the Rangitaiki River and thereby improving the utilisation of the ORC. The improvement would result in a reduction in the head losses in the ORC and a flattening of the water level profile resulting in an overall decrease in the design water level profile. Preliminary estimates suggest that the order of magnitude of the decrease in design water level profile would be typically 0.35 m, but this would have to be confirmed by hydraulic modelling.

This scheme would be a new scheme operating independently. Those participants leaving the original Awaiti scheme to form the Crystall's drain extension scheme may expect their share of Awaiti assets to be purchased by the remaining Awaiti participants. That is a matter for the individuals concerned to agree on.

The costs for option (iv) are similar to option (iii) and because of its compatibility with the long term scenario it is the preferred option after (i).

9.0 SUMMARY

i) With the post-quake remedial works that have been carried out (section 5.1), the drainage schemes are coping with everyday drainage. Some additional everyday drainage impediments have been identified in section 5.2.2. The opinions of all farmers in the Thornton West drainage area have not been canvassed and there may still be localised everyday drainage problems not addressed in this report.

ii) A modelling analysis carried out demonstrated that the post-quake capacity of the ORC, the Smith Road culvert and Matata floodgate is fully extended during design flood

conditions and will require minor works to prevent spillage from the ORC upstream of the culvert. However field measurements of water levels and flows in the ORC should be initiated to verify the modelling analysis.

iii) Crystall's drain extension is successfully controlling everyday water levels in the Overdevest, Ruiter and Smit properties adjacent to the ORC. The gates at either end of Crystall's drain extension allow the combined capacity of Awaiti and Greigs Road pumpstations to be utilised for flood evacuation from the combined scheme areas. At this stage the Crystall's drain extension into Greigs Road scheme is an interim measure which owners may not allow to continue.

Four options for the future of Crystalls drain extension were presented. The preferred Option (i) retains the situation as is but reclassifies the Awaiti and Greigs Road schemes to reapportion operating costs. Estimated cost is $6,000. Should this be unacceptable to scheme owners the next preferred option (iv) involves construction of a new pumpstation near the existing Greigs Road station. Estimated cost is $217,000 plus 45,000 indemnity write-off. Both these options are compatible with the long term drainage objectives. Obviously choice of any option should be made on the basis of economic viability.

iv) Constraints for long term drainage improvements are the indemnity value of existing pumpstations, the private ownership of the existing pumpstations, seepage from the ORC and future drainage degradation due to land settlement and rising sea levels. In the long term it is considered prudent to reduce the dependency of Thornton West drainage on the ORC although the ORC will be retained for the foreseeable future. Possible long term drainage scenarios considered and costed were pumping from the ORC (not recommended), upgrading the Matata floodgate, opening the east end of the ORC and constructing a supplementary tide gate discharging to the Rangitaiki River, diverting all the Awaiti scheme drainage to the existing Greigs Road pumpstation and diverting the Greigs Road scheme area south of Greig Road to a new pumpstation discharging to the Rangitaiki River, diverting the Awaiti scheme drainage to the Awaiti canal.

10. RECOMMENDATIONS

i) The everyday drainage impediments identified in section 5.2.2 should be corrected.

ii) Minor topping up of the ORC upstream of the Smith Road culvert should be done. Concurrently field measurements of water levels and flows in the ORC should be undertaken to verify the modelling analysis carried out for the ORC.

iii) In the medium term it is recommended the existing Crystall's drain extension be formally incorporated into Greigs Road scheme (for everyday drainage) and Awaiti scheme (for flood drainage) by way of a reclassification.

iv) Should iii above not be acceptable to scheme owners then the recommended alternative is a new pumpstation constructed near Greigs Road pumpstation.

v) Any medium term drainage improvements should conform with possible future long term investment.

Appendix I

Consultants Brief

Thornton West Drainage

CONSULTANTS BRIEF

THORNTON WEST DRAINAGE

Thornton West drainage area covers about 1400 ha. west of the lower five km of Rangitaiki River. The area is predominantly drained by seven communal pumping schemes established since 1960 and administered by Rangitaiki Drainage Board. These discharge into a collector canal, (Old Rangitaiki River channel) which flows westwards via a tidegated outlet into Tarawera River, about 400 metres upstream from its mouth.

Prior to the earthquake of 2 March 1987 a reasonable pastoral drainage standard had been achieved; however very low ground levels of some areas meant some of those areas were unable to be drained to standard. These problems were exacerbated by the earthquake which caused differential settlement ranging from small upthrusts on the western side near Tarawera River to a lowering of up to about 40 centimetres on the eastern side adjacent Rangitaiki river - i.e. these effects were against the drainage gradient of Old Rangitaiki River channel. Pre-earthquake drainage scheme boundaries are no longer appropriate and there is a need to rationalise drainage. This is likely to involve alteration to and shifting of pumps to new sites with associated new drains.

CONSULTANCY

Secondment is required of a consultant to work out of the Board's office, Quay Street, Whakatane. The work includes:

1. Familiarisation with existing pumping schemes layout.

2. Development of alternative drainage scheme layouts and costings with particular attention to rationalisation of existing equipment. The investigation may show some areas are uneconomic to drain.

3. It is expected the system will require modelling; this to be done on Board's PDP11/3 computer, likely using LATIS or RIVERS programme available in-house.

4. Other aspects which may arise as the study progresses.

5. The period for the consultancy is six weeks.

OTHER

Most information required is available at the Bay of Plenty Catchment Board, or Rangitaiki Drainage Board for which the Catchment Board provides engineering services. Surveying staff will be available for field work as the consultant requires.

An extensive drainage study on the adjacent Awaiti-Omeheu catchment has recently been completed and will be valuable for this study.

The study is for Rangitaiki Drainage Board and is likely to be funded by the Bay of Plenty Earthquake Restoration Committee.

The consultant will be responsible to the Engineering Manager, Bay of Plenty Catchment Board.

Regards

D G Pemberton
ENGINEERING MANAGER -
BAY OF PLENTY CATCHMENT BOARD

P.S. Transport provided;
Accomodation provided

<u>References</u>

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