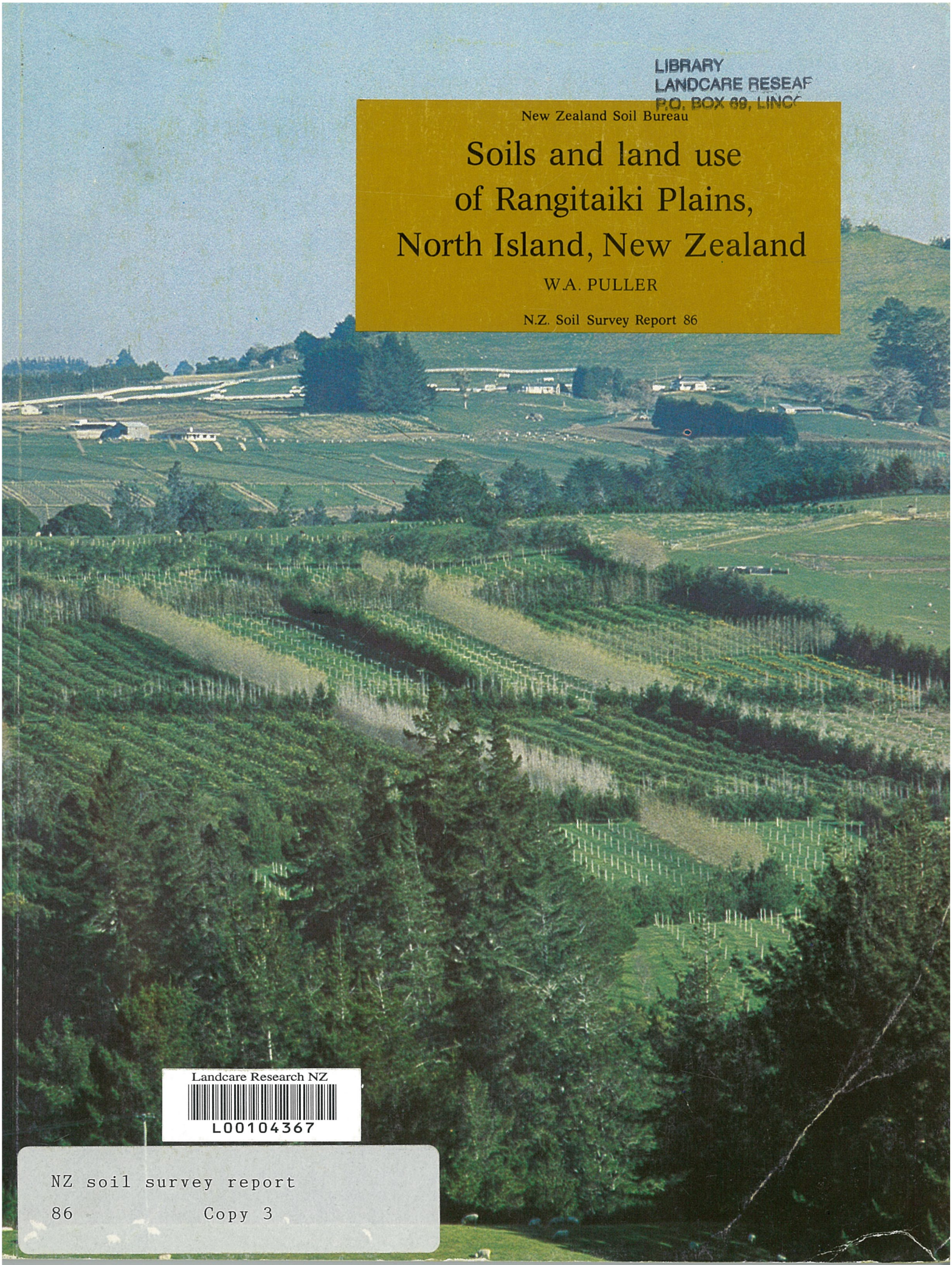
New Zealand Soil Bureau

Soils and land use of Rangitaiki Plains, North Island, New Zealand

W.A. PULLER

N.Z. Soil Survey Report 86



SOILS AND LAND USE OF RANGITAIKI PLAINS, NORTH ISLAND, NEW ZEALAND

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CONTENTS

Tables

Figures *page*

SUMMARY

The Rangitaiki Plains is a lowland of about 40 000 ha which borders the Bay of Plenty coast from Whakatane to Matata, a distance of 22.5 km, and extends inland for a distance of up to 20 km; it is part of the Whakatane graben within the Taupo volcanic zone and is bounded by prominent north–south fault scarps. The Plains today consist of inland and coastal dunes, drained peat swamps and present and former flood plains largely of mixed pumiceous with minor greywacke alluvium. Since the lowland was formed, about 7000 years ago, the shoreline has prograded about 10 km, while over the last 5000 years the area has been showered with volcanic ash. The Plains are formed mainly from the products of the larger volcanic showers, the Whakatane Ash eruption (5000 years ago), the Taupo Pumice eruption (1800 years), the Kaharoa Ash eruption (900 years) and the Tarawera Ash eruption of nearly 100 years ago; the material being transported by the Rangitaiki, Whakatane and Tarawera Rivers. The land now ranges from sea level to nearly 30 m in elevation.

At the time of European settlement, manuka and cabbage trees grew on the better drained soils of the flood plains and kahikatea, titoki, toetoe and flax on the poorer drained soils. Stunted manuka and rushes were noted on the peat swamps, and fern and mingimingi on the coastal dunes.

Most of the soils on the Plains are naturally poorly drained, but with extensive artificial drainage, including ground water pumping, the soils have become moderately well drained. However, if the system is not maintained, the soils will soon revert to the poorly drained category. Thirty-four soil mapping units are shown on the soil map accompanying this report, within which twenty-three soil series are recognised, classed in seven soil groups comprising, in order of decreasing area, recent soils, gley soils, composite recent soils on yellow brown pumice soils, organic soils, composite recent soils on yellow-brown sands, yellow-brown pumice soils, and composite yellow-brown pumice soils on podzolised yellow-brown sands. A large area contains subsurface peat (mineral soils on peat) which must not be underestimated when the land is considered for horticulture. By and large, the more silty soils occur on the eastern side of the Plains and the sandier soils on the western side. The finest-textured soils occur around Whakatane, where the Whakatane River has deposited greywacke silt. During periods of drought the sandy soils tend to dry out but, paradoxically, some of them on the former Tarawera River flood plain are excessively wet in winter due to a high water table.

Virtually all soils on the lowland have proved to be highly suitable for dairy farming but the soils that are suitable for horticulture occur in a somewhat intricate pattern. The imperfectly and poorly drained recent and organic soils of the Plains are not the same as the well drained and friable yellow-brown loams on the terraces at Te Puke and around Opotiki.

INTRODUCTION

THE SOIL SURVEY PROGRAMME

The soil survey of Rangitaiki Plains was commenced in 1960, as part of the general N.Z. Soil Bureau policy to carry out detailed soil surveys on flat land in New Zealand as base support for scientific agriculture. The objective was to map the soils on a scale of 1 inch to 40 chains (1:31 680), to furnish a report on the soil properties and to describe land use based on the soil mapping units. The field work was to be done in two stages, (a) north of the Whakatane–Rotorua highway and (b) south of this highway.

The mapping programme, however, was not adhered to. The eastern portion of the Plains from Powdrells Road east to Port Ohope on Ohiwa Harbour was mapped first, to accommodate a town planning exercise as to the most desirable direction for Whakatane Borough to expand. A soil map of Whakatane Borough and Environs was published in 1964 and soil survey reports were prepared for the Whakatane Borough Council and the Bay of Plenty Catchment Commission. The Borough was mapped in more detail (1 inch to 20 chains, 1:15 840), with a map published in 1970. Two maps, together with an extended legend and explanatory statement, were published as *N.Z. Soil Bureau Publication 515* (Pullar 1972). A very detailed account of the soils and land use of the eastern area was published five years later as *N.Z. Soil Bureau Bulletin 38* (Pullar *et al.* 1978).

The western part of the Plains proved more difficult to map than the eastern part and the work was delayed by interruptions, including the soil survey of the Maketu basin for the Catchment Commission and the mapping of volcanic ash

deposits over a wide area in the central North Island. Nevertheless, a report giving some information about soils on the western half of the Plains was prepared for the Catchment Commission in 1969 (Bay of Plenty Catchment Commission 1970). In 1971, the soil survey office was shifted to Rotorua but the field work remained uncompleted until 1976. Preparation of maps and text for publication was completed by Dr Pullar after his retirement in 1977. Later editing was carried out by G.E. Orbell and J.D. Cowie of N.Z. Soil Bureau. It is unfortunate that Dr Pullar died before this work was completed. The original section on climate was rewritten by R. Aldridge and the section on soil limitations for land use was added by W.C. Rijkse.

THE AREA SURVEYED

The Rangitaiki Plains (Fig. 1) is a lowland of 342 km² (40 000 ha) which borders the Bay of Plenty coast from Whakatane to Matata, a distance of 22.5 km, and extends inland for a distance of up to 20 km. The present soil survey maps only the flat land west of the previous soil survey of Whakatane Borough and Environs (Pullar *et al.* 1978). The scale of the soil map as originally planned has been retained at 1:31 680, so that it can be matched with the Whakatane Borough survey. Some of the soil names in the Whakatane Borough survey have, however, been changed. These are indicated in Table 10, p.15.

Whakatane Borough, the principal town on the Rangitaiki Plains, has a population of 11 500, but it lies just outside the present survey area. Smaller towns within the present area include Edgecumbe (1600), Te Teko (600) and Matata (500). Kawerau Borough, (7800) on the south-west corner of the Plains, is more directly associated with the pulp and paper industry than with agriculture. The total population of the Plains today is about 15 000 and the area is well roaded with sealed surfaces.

HISTORY OF THE RANGITAIKI PLAINS

Vegetation at the time of European settlement

At the time of European settlement, swamp land west of the Rangitaiki River was densely covered with raupo and rushes (see Appendix 1 for botanical names), and peat land east of this river was in stunted wiwi rush. Higher land at Te Teko, Onepu and Kawerau became a desert after the Tarawera eruption of AD 1886 but clumps of white manuka survived. Cabbage trees and teatree flourished on natural levées of rivers and streams, with kahikatea, titoki, toetoe and flax on back-swamp lowlands. Bracken fern, mingimingi and manuka grew on the coastal dunes and small teatree and cabbage trees on the inland dunes.

Buried stumps in the Piripai and Omeheu localities indicate that totara was growing in these parts well before the Kaharoa Ash eruption of 900 years ago. On inland dunes, soil profiles suggest that podocarp trees flourished before the Taupo Pumice eruptions of 1800 years ago.

Historical development of the Plains

The Tarawera Ash eruption of AD 1886 deposited volcanic ash to a depth of up to 30 cm and, consequently, land in the Kawerau, Onepu and Te Teko localities became a desert. In the bed of the Kokohinau swamp, the ash covered fallen manuka stems and made subsequent ploughing very difficult. Agriculture on the Plains was impeded, also, by pumice boulders up to 2 m diameter that were deposited by the Kaharoa Ash eruption about 900 years ago; these boulders can be seen at the surface and in the soil along a line north of the Whakatane–Rotorua highway at the Kawerau turnoff as far as the Otakiri railway station.

In the late nineteenth century, there were populous Maori settlements at Te Teko and Matata. Kumaras and potatoes grew well on higher land at Te Teko, particularly so in the Tarawera Ash, and between Matata and Awakaponga. Gardens were also cultivated on the banks of the Rangitaiki River from Te Teko to Edgecumbe.

In 1890–91, swamp land west of the Rangitaiki River from Te Teko north to near Matata was surveyed into 20 ha sections. Some holdings were taken up by Canterbury settlers, who soon abandoned them after the wet year of 1891 when the Rangitaiki River was flooded and the land became waterlogged. Higher land at Awakeri, however, was successfully sown to pasture for dairy farming.

By 1900 flax mills had been set up at Matata, Otakiri, Thornton, Edgecumbe, Awakeri and Whakatane but the industry was waning by 1912 and settlers then took up cattle farming. Small flour mills operated at Matata and Whakatane.

By 1902 the need for fully coordinated land drainage was clear, so in that year a drainage board was formed.

In 1904, the river outlet from Lake Tarawera burst, causing the Tarawera River to aggrade rapidly with pumice alluvium. Pumice-laden floodwaters filled in the drains.

The Omeheu Drain, an important drain in the Kokohinau and Omeheu localities, was dug in 1906. By that year, the Orini and Awaiti Streams were dammed at their confluence with the Rangitaiki River, so that all river water in this north-western part of the Plains flowed westwards towards Matata. The consequent reduction of water in the former Orini Stream bed may have caused shoaling in the Whakatane River estuary.

The drainage problem caused by the aggraded Tarawera river became particularly serious during flooding in 1909, when the Onepu locality became a lake and floodwaters overflowed through the sand hills (seen at the Kawerau turnoff and along the Whakatane–Rotorua highway) into low-lying land between Kawerau and Te Teko. At this time, the

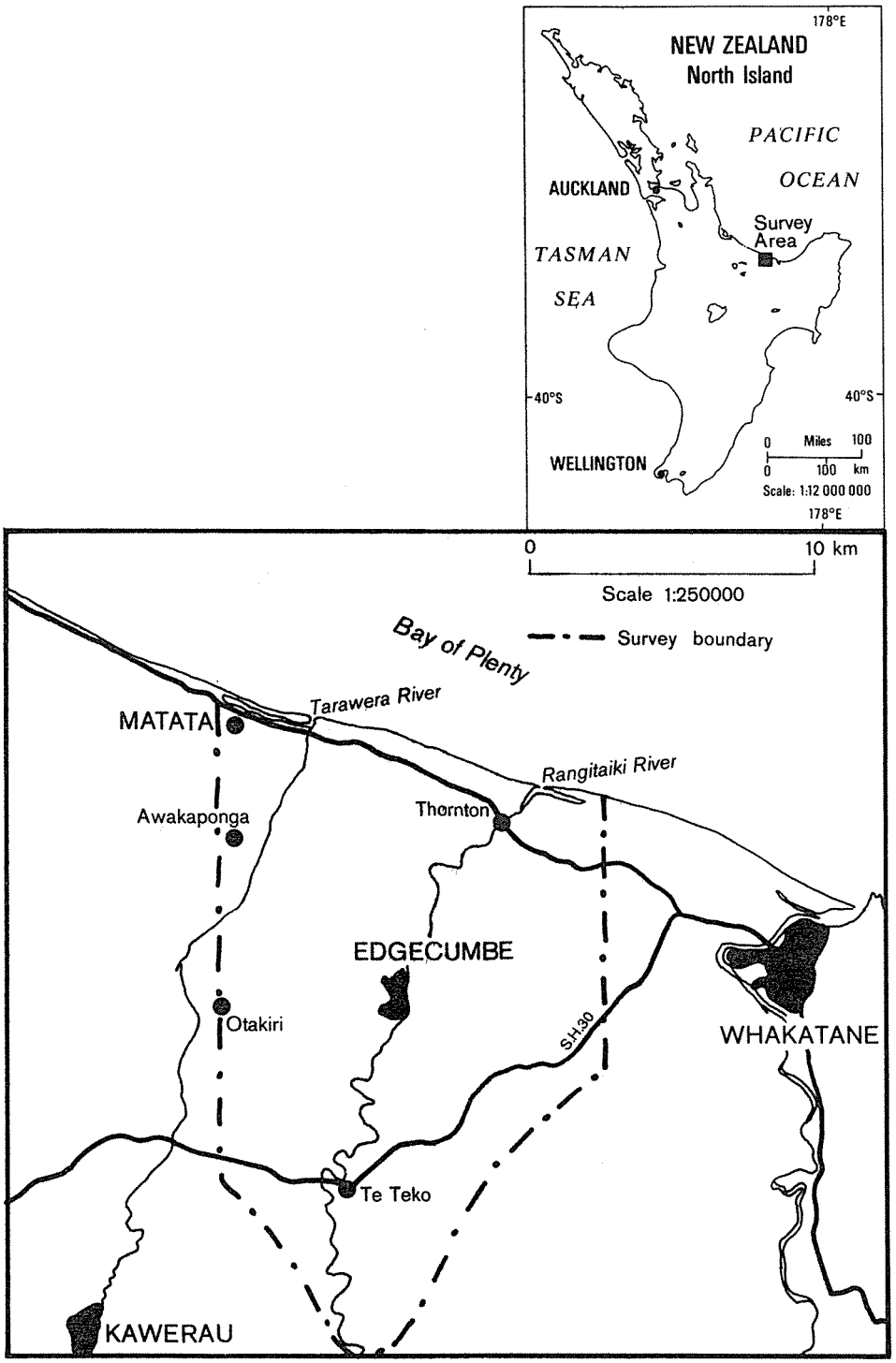

Figure 1 Location maps

Rangitaiki river flooded also, overflowing both banks for a period of four months, and there was an attendant danger that Tarawera River floodwaters would move along Seccombes catch-water drain into the Rangitaiki River just south of Te Teko. However, the danger was averted by the building of stopbanks on the sand hills (at the railway crossing near the NZR locomotive depot, Kawerau).

In later years, the Rangitaiki River continued to cause notable floods, particularly in 1916 (two floods), 1925, 1937, 1944 and 1964.

On the eastern part of the Plains, by 1909, the drainage system was better developed than that on the western part where land, high and dry in summer, became waterlogged in winter. However, draining of the upper lands tended to flood lands lower down on the Plains. There was also much soakage of water through the sandy alluvium, and cutoff lateral drains were eventually found necessary to the successful functioning of longitudinal drains down the Plains. As the land became dewatered, flax and raupo gave way to teatree. A common practice, then, was to till the land with a swamp plough, grow a crop of turnips and, finally, sow to pasture.

The Drainage Board had only limited borrowing powers to pursue drainage schemes. Thus the settlers petitioned Government to undertake the drainage of the whole of the Plains; this work was commenced by the Land Drainage Department in 1910. In that year a map was produced showing the proposed location of principal canals and drains, including the Te Rahu, Kopeopeo and Omeheu Canals and Murrays Drain. Most of these were dug by 1914 and widened and deepened during the years 1918–20.

A road from Whakatane to Rotorua was constructed in 1910. Most roads on the Plains, however, were built at the same time as the main drains (by 1914), and by 1923 they were all metalled. Railway surveys across the Plains began in 1909 and construction started in 1914. The line from Tauranga to Taneatua was opened for transport of livestock in 1924 and for passenger traffic in 1928. Te Teko was connected to Whakatane by telephone in 1907.

In 1914, the Rangitaiki River was diverted to its new mouth at Thornton and this mouth was prevented from migrating east towards Whakatane by a groyne built in 1962. The Tarawera River was diverted to a new mouth east of Matata in 1924. The Whakatane River flood control scheme was completed in 1973 with similar schemes completed for the Rangitaiki and Tarawera Rivers in the late 1970s and early 1980s.

Up until 1917, fat livestock were driven to Ngongotaha for railing to Westfield freezing works at Auckland. Since the animals lost condition on the long journey, a cooperative freezing works and canning factory were built at Whakatane (on the site of the present Whakatane Board Mills). However, by 1921, the meat market had collapsed and the freezing works venture went into liquidation. Fatstock farmers were then forced to turn to dairy farming, which had already been established in a small way by 1916. This industry has persisted strongly to the present day.

In 1918 the sandy flats in the Onepu and Kawerau localities were suggested as possible areas for tree plantations but, eventually, the land was subdivided for dairy farming in 1935–36.

In 1912 a cheese factory was started near Halletts farm on the Tarawera River, and later shifted to Factory Road in the Omeheu locality. By 1915, there was another cheese factory at Te Teko, butter factories at Whakatane and Matata, and a mixed butter and cheese factory at Awakeri owned by the Rangitaiki Plains Dairy Co. The latter factory was shifted to Edgecumbe in 1923 and absorbed the earlier factory at Omeheu. The Rangitaiki Plains Dairy Co. Ltd has continued to produce a range of dairy products on a large scale up to the present day.

Matata was a port until 1914 but its importance declined with the building of roads across the Plains. Thornton was also a port, from 1914 to the early 1960s. The Whakatane Harbour Board was founded in 1913 and is still in existence.

An important event in 1939 was the establishment of a paper board mill at Whakatane to utilise radiata pine from the nearby Matahina Forest in the Rangitaiki Valley. Forestry was given further impetus in the 1950s by the creation of a new town, the erection of a large paper mill at Kawerau and the laying of the Kawerau–Murupara railway. In the late 1960s, the Matahina hydro-electric station was constructed on the Rangitaiki River at Te Mahoe. All these works have brought people into the district.

Possibilities for horticultural development on the Plains were discussed by dairy farmers and advisory officers in the late 1960s but the advisory officers were not optimistic about the production of fruit for export. For purposes of horticulture, the recent and organic soils on the Rangitaiki Plains are not the same as the yellow-brown loams on the terraces at Te Puna, Tauranga, Te Puke and Opotiki. Furthermore, the pattern of suitable soils is much more intricate on the Rangitaiki Plains. Nevertheless, small areas of kiwifruit, feijoas, boysenberries and citrus have been planted with only partial commercial success, suffering sometimes from late spring frosts (e.g. October 1984). More advanced sprinkler systems, adapted to the soil and climatic conditions on the Plains, will partially overcome some problems.

SOIL-FORMING FACTORS

PHYSIOGRAPHY AND SOIL PARENT MATERIALS

The Rangitaiki Plains are part of the Whakatane graben and are bounded by prominent north–south fault scarps, one along the Whakatane valley in the east and the other along part of Braemar Road in the west. Landforms of the Plains comprise coastal and inland dunes, peat swamps, backswamp lowlands, natural levée systems of rivers and streams, and present and former flood plains of the Whakatane, Rangitaiki and Tarawera Rivers. Over the last 5000 years, the area has been showered with volcanic ash, the most important eruptions being Whakatane Ash (*c.* 5200 yr BP[1]), Taupo Pumice (*c.* 1800 yr BP), Kaharoa Ash (*c.* 900 yr BP)[2] and Tarawera Ash of AD 1886. The products of these eruptions, mainly rhyolitic pumice, are responsible for the formation of much of the Plains. Greywacke alluvium from the Whakatane River is restricted to a relatively small area on the eastern Plains margin.

The elevation of the Plains ranges from near sea level at the coast to an average of 25 and 30 m near Kawerau and the Mangaone River valley respectively.

About 7000 years ago, the shoreline probably lay along the cliffs at Whakatane West, Awakeri, Te Teko and Onepu; since that time the coast has prograded about 10 km. Progradation during the last 5000 years is estimated at about 6.5 km. Former shorelines and river courses at the time of the Taupo Pumice and Kaharoa Ash eruptions are shown in Fig. 3, p.23, and discussed in Appendix 2.

Recent alluvial infilling of the Rangitaiki Plains is outlined in Appendix 3 and surficial geological cross-sections are presented in Appendix 4.

[1]Before Present

[2]Age under investigation; it could well be younger than 900 yr BP (see NZ 4991, I.A. Nairn, pers. comm.)

CLIMATE

by R. Aldridge

The Rangitaiki Plains area is noted for its sunny climate, the sunshine duration (Table 1) being the highest in the North Island. Summers are warm (Table 2), with the January mean daily maximum temperatures at Kawerau (25.5°C) and Te Teko (25.3°C) being among the highest in the country. Growing degree-days above 10°C and 15°C, but especially above 10°C, show the area to be warmer than most of the North Island, comparing favourably with Northland (N.Z. Meteorological Service 1978b). Frost-free days (air frosts) average 328 per year, again comparing favourably with most of the North Island (N.Z. Meteorological Service 1981). Frost may be expected every year, Whakatane having had only one frost-free year in 28 years and Kawerau no frost-free years. The earliest frost-day recorded at Whakatane (1948–1975) is 5 May, the latest 10 September. At Kawerau, the earliest recorded frost-day is 1 May (1954–1975) and the latest 29 September. However, ground frosts would occur earlier and later than screen frosts. On one occasion, frosts in the Mapou locality, Rangitaiki Valley, damaged maize crops on Christmas Day.

Table 1 Sunshine normals 1941–70[1]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Whakatane	252	215	217	195	163	149	161	173	191	210	232	233	2391
Te Teko	235	204	200	182	149	139	149	159	177	202	219	214	2229

[1]From N.Z. Meteorological Service (1977)

Table 2 Temperature normals 1941–70[1]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kawerau	19.3	19.5	17.8	15.1	12.2	9.6	9.1	10.0	11.8	13.9	15.9	17.7	14.3
Te Teko	18.9	19.1	17.6	14.7	12.0	9.4	9.1	9.9	11.4	13.4	15.4	17.4	14.0
Edgecumbe	18.1	18.5	16.7	14.5	11.8	9.4	8.9	9.7	11.3	13.3	15.0	16.8	13.7
Whakatane	18.9	19.3	17.8	15.0	12.3	9.8	9.3	10.2	11.9	13.8	15.6	17.6	14.3

[1]From N.Z. Meteorological Service (1978a)

Mean annual rainfall (Table 3) ranges from 1819 mm inland at Kawerau to 1304 mm on the coast at Whakatane. The variation in number of days with ⩾ 1.0 mm rainfall (Table 4) is not great over the area, ranging from 111 to 120 days per year. May to October average about 11 days per month, and November to April about 8. Heavy rainfall may be associated with the passage of tropical cyclones from the north or north-east. Other rainfall is associated with the usual pattern of frontal passages. The two-year return rainfall of 97 mm in 24 hours at Whakatane and 125 mm at Kawerau is neither unusual nor excessive.

The pattern of soil-moisture deficit or potential deficit is illustrated by the climatic water deficit and frequency of deficit (Tables 5 and 6). The potential water deficit increases from inland areas towards the coast. Although these data take no account of soil-moisture storage, an allowance of 75 mm storage shows that, at Whakatane, all years have a deficit of > 50 mm and 46% of years have a deficit of > 200 mm. With increasing rainfall inland, the deficits are likely to decrease. In a dry summer, yellow-brown sands on coastal dunes and yellow-brown pumice soils on inland dunes may suffer from a soil-moisture deficit of > 80 mm for at least two months in about one year in four.

Table 3 Rainfall normals 1941–70[1]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kawerau	112	137	155	145	193	165	191	185	137	145	114	140	1819
Te Teko	94	114	132	124	163	142	160	155	114	122	94	119	1533
Edgecumbe	97	117	137	122	155	142	160	150	112	114	97	112	1515
Awakeri	86	104	122	114	150	130	147	142	104	112	86	109	1406
Whakatane	81	99	117	107	135	124	137	130	94	99	84	97	1304
Thornton	80	100	120	110	140	120	140	130	100	100	80	100	1320

[1]From N.Z. Meteorological Service (1973)

Table 4 Average number of days with rainfall ⩾ 1.0 mm[1]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kawerau	8	9	9	8	11	9	11	12	10	11	9	11	120
Whakatane	7	8	8	8	11	10	10	10	9	11	9	9	111

[1]From N.Z. Meteorological Service (1973)

Table 5 Climatic water deficit (mm) [monthly PE (Penman) minus monthly rainfall]

	Jan	Feb	Nov	Dec	Year
Kawerau	1	36		9	46
Te Teko	54	2	29	22	107
Edgecumbe	54	3	27	32	116
Awakeri	62	12	32	32	143
Whakatane	70	21	40	47	178
Thornton	71	20	44	14	179

Table 6 Frequency of deficits at Whakatane — % of years (July–June, 1947–1976) with deficit ⩾ selected deficits, allowing 75 mm soil moisture storage

Deficit (mm)	0.1	25	50	100	150	200	250	300
Frequency (%)	100	100	100	96	79	46	25	25

SOILS

Most of the soils on the Plains are naturally poorly drained, but with extensive artificial drainage, including groundwater pumping, the soils have become moderately well drained. However, if the drainage scheme is not maintained, the soils will revert easily to the poorly drained category.

By and large, the more silty soils occur on the eastern side of the Plains and the sandier soils on the western side. The finest-textured soils occur around Whakatane Borough, where the Whakatane River has deposited greywacke silt. During periods of drought the sandy soils tend to dry out but, paradoxically, some of them on the former Tarawera River flood plain are excessively wet in winter due to a high water table.

Quite a large part of the survey area contains subsurface peat (mineral soils on peat), which must be taken into account when intensive land use is

considered. The distribution of subsurface peat deposits is discussed in Appendix 5 and shown on Fig. 8, p.35. One soil series is formed from diatomaceous earth which is a peat-like substance, the distribution of which is outlined in Appendix 6 and shown on Fig. 9, p.37.

Thirty-four mapping units are shown on the soil map accompanying this report, within which twenty-three soil series are recognised, classed into seven soil groups comprising, in order of decreasing area, recent soils, gley soils, composite recent soils on yellow-brown pumice soils, organic soils, composite recent soils on yellow-brown sands, yellow-brown pumice soils, and composite yellow-brown pumice soils on podzolised yellow-brown sands. Table 7 lists the taxonomic units (soil series) recognised in this survey, according to this grouping. The text which follows comprises a broad discussion of each of these soil groups in the order given by Table 7. The thirty-four soil mapping units are listed in Table 8, grouped according to their physiographic position and natural drainage, while properties of the individual mapping units are summarised in Appendix 7 (Soil Mapping Unit Descriptions), pp.37–74. Diagrammatic profiles of representative soils are given in Fig. 2.

A correlation of soil names used in this survey with those of previous surveys in the area is given in Table 9.

Table 7 Soil taxonomic units arranged pedologically

YELLOW-BROWN PUMICE SOILS
- From thick to very thick rhyolitic ashes (Kaharoa Ash, Taupo Pumice, Mapara Tephra and Whakatane Ash), with very thin cover of basaltic ash (Tarawera Ash), overlying wind-blown sand
  - Te Rahu series

COMPOSITE YELLOW-BROWN PUMICE SOILS ON PODZOLISED YELLOW-BROWN SANDS
- From thin rhyolitic ashes (Kaharoa Ash, Taupo Pumice and Mapara Tephra), with very thin cover of basaltic ash (Tarawera Ash), on wind-blown sand
  - Kopeopeo series

ORGANIC SOILS
- From peat with very thin cover of basaltic ash (Tarawera Ash)
  - Awaroa series
- From peat with very thin layers of basaltic and rhyolitic ashes (Tarawera Ash, Kaharoa Ash and Taupo Pumice)
  - Pongakawa series

GLEY SOILS[1]
- From very fine pumiceous alluvium
  - Paroa series
- From thin and very thin basaltic ash (Tarawera Ash) and very thin rhyolitic ash (Kaharoa Ash) on layered pumiceous alluvium
  - Onepu series
- From thin to very thin basaltic ash (Tarawera Ash) and thin rhyolitic ash (Kaharoa Ash) on peat on coarse pumiceous alluvium
  - Awakeri series
- From fine pumiceous alluvium with thin to very thin cover of basaltic ash (Tarawera Ash)
  - Omeheu series
- From layered parent materials including diatomaceous earth, peat and pumice alluvium with very thin cover of basaltic ash (Tarawera Ash)
  - Matuku series

RECENT SOILS
- Non to weakly gleyed
  - From mixed pumiceous and greywacke alluvium
    - Rapidly accumulating
      - Rangitaiki series
    - Slowly accumulating
      - Orini series
      - Opouriao series
  - From thin basaltic ash (Tarawera Ash and Lapilli) on pumiceous alluvium
    - Non-accumulating
      - Kawerau series
  - From wind-blown sand with very thin and patchy cover of basaltic ash (Tarawera Ash)
    - Non-accumulating
      - Pikowai series
- Moderately to strongly gleyed
  - From mixed very fine greywacke and pumiceous alluvium
    - Moderately accumulating
      - Poroporo series
    - Non-accumulating
      - Matata series
  - From dominantly very fine pumiceous alluvium
    - Moderately accumulating
      - Awakaponga series
  - From moderately thick, dominantly pumiceous alluvium on deep peat
    - Slowly accumulating
      - Waioho series
- Saline
  - From mixed fine pumiceous and greywacke alluvium
    - Moderately accumulating
      - Muriwai series

COMPOSITE RECENT SOILS ON YELLOW-BROWN SANDS
- From wind-blown sand with thin cover of basaltic ash (Tarawera Ash) and rhyolitic ash (Kaharoa Ash)
  - Piripai series

COMPOSITE RECENT SOILS ON YELLOW-BROWN PUMICE SOILS
- From thin basaltic ash (Tarawera Ash) and very thin and patchy rhyolitic ash (Kaharoa Ash) on mixed pumiceous and greywacke alluvium
  - Te Teko series
- From thin and very thin basaltic ash (Tarawera Ash) on fine pumiceous alluvium
  - Awaiti series
- From thin basaltic ash (Tarawera Ash and Lapilli) on thick rhyolitic ashes (Kaharoa Ash, Taupo Ash and Whakatane Ash)
  - Matahina series

[1]These gley soils were previously classed as gleyed recent soils (Pullar *et al.* 1978)

DESCRIPTION OF SOIL GROUPS

Yellow-brown pumice soils comprise one series which is dominant in two mapping units. *Te Rahu series* occurs on older inland dunes at Matata and Awakeri. The parent material is largely air-fall volcanic ashes, collectively about one metre thick, overlying wind-blown sand. At Awakeri, the swales may have a layer of peat at the surface.

Composite yellow-brown pumice soils on podzolised yellow-brown sands comprise one series which is dominant in only one mapping unit, Kopeopeo loamy sand. *Kopeopeo series* occurs on a belt of older inland dunes, formed partly from air-fall volcanic ash about 40 cm thick and partly

Table 8 Soil mapping units arranged physiographically

SOILS OF THE DUNES	
On foredunes	
Excessively drained	
Pikowai sand	Pki
On younger coastal dunes	
Somewhat excessively drained	
Piripai loamy sand	Pil
On older inland dunes	
Somewhat excessively drained	
Kopeopeo loamy sand	Koe
Well to moderately well drained	
Te Rahu loamy sand	Tr
Te Rahu loamy sand, peaty subsoil variant	Trp
SOILS OF THE FORMER TIDAL FLATS	
Poorly drained	
Muriwai silt loam	Muw
SOILS OF THE PRESENT FLOOD PLAINS	
In meander troughs	
Excessively to well drained	
Rangitaiki soils	Ran
On levées	
Well to moderately well drained	
Opouriao fine sandy loam	Ou
Orini silt loam	Ori
SOILS OF THE FORMER FLOOD PLAINS	
Excessively to somewhat excessively drained	
Kawerau loamy coarse sand	Kr
Kawerau loamy coarse sand, undulating phase	KrU
Well to moderately well drained	
Kawerau loamy coarse sand, mottled variant	Krm
Te Teko sandy loam	Tks
Awaiti sandy loam	Ats
Imperfectly to poorly drained	
Omeheu sandy loam	Ome
Omeheu sandy loam on peat	Omp
Onepu loamy coarse sand	Onc
SOILS OF THE BACKSWAMP LOWLANDS	
Imperfectly to poorly drained	
Awakaponga silt loam	Ag
Awakaponga silt loam on peat	Agp
Poroporo silt loam	Ppo
Paroa coarse sandy loam	Prc
Paroa coarse sandy loam on peat	Prs
Paroa silt loam	Pr
Paroa silt loam on peat over gravel	Prg
Paroa silt loam on peat	Prp
Paroa peaty silt loam on peat	Pry
SOILS OF THE PEATY SWAMPS	
Imperfectly to very poorly drained	
Awakeri sandy loam on shallow peat	Awi
Awakeri loamy sand on very shallow peat	Aws
Waioho silt loam	Wai
Awaroa soils	Aro
Pongakawa peaty sand	Pop
Matuku silt loam	Mtk
SOILS OF THE FANS	
Imperfectly to poorly drained	
Matata soils	Maa
SOILS OF THE DISSECTED TERRACES	
Somewhat excessively drained	
Matahina loamy coarse sand	Mbc

from wind-blown coastal sand deposited when the dunes were near the coast about 4000 years ago. The series is somewhat excessively drained and may be droughty in summer. It differs from Piripai series in having a thicker ash mantle and a much flatter surface.

Organic soils comprise two series, each of which is dominant in one mapping unit. Both series are formed from peaty material. *Awaroa series* has a thin layer of Tarawera Ash at or near the surface and occurs mainly on the western margin of the Plains along Braemar Road. *Pongakawa series* has thin layers of air-fall Tarawera Ash, Kaharoa Ash and Taupo Pumice, intercalated with peat to a depth of about 12 cm, over laminated peat to a depth of about 3 to 5 m. These soils occur in the Whakatane West–Awakeri localities.

Gley soils comprise five series which occur in a total of twelve mapping units. *Paroa series* is widely distributed and covers the largest area of the group, occurring in six mapping units. Topsoil textures may range from coarse sandy loam to peaty silt loam but the series has a characteristic silty subsoil layer (the 'buff' layer which is Kaharoa Ash). About 50% of the area covered by this series is underlain by peat. *Onepu series* is dominant in only one mapping unit, on the southern and western margins of the Plains, and differs from Paroa series in having a layered alluvial profile, of pumiceous silt, sand and gravel, and peaty loam and diatomaceous earth. *Awakeri series* is dominant in two mapping units and has a clearly layered profile, comprising Tarawera Ash, Kaharoa Ash, peat, silt and pumice gravels, with strongly marked discontinuities. Awakeri series occurs in slightly lower-lying areas than Onepu series and has more peat in the profile. *Omeheu series* is dominant in two mapping units and comprises similar profiles to those of Paroa series except that the subsoils are more sandy, ranging from fine sand to fine sandy loam. Paroa series comprises only those profiles with a silt or silt loam subsoil layer. *Matuku series* is dominant in only one mapping unit and is formed largely from diatomaceous earth, pumice silt and peat. It occurs largely in the Awaiti locality.

Recent soils comprise 10 series which are dominant in a total of thirteen mapping units. This group has the most wide-ranging parent materials of all the soil groups, including fine greywacke and pumiceous alluvium, air-fall Tarawera Ash and coastal sands. All of these series have had accumulatory products added to their surfaces, either in present-day times or in the historical past.

Rangitaiki series occurs on the present flood plains of the Whakatane, Rangitaiki and Tarawera Rivers. No separation has been made between profiles formed from greywacke alluvium and those formed from pumiceous alluvium, mainly because the profiles found on an actively accumulating flood plain are particularly diverse. Soils on the Whakatane River flood plain are more fertile than those on the flood plains of the other two rivers. *Orini series* is dominant in one mapping unit, occurring

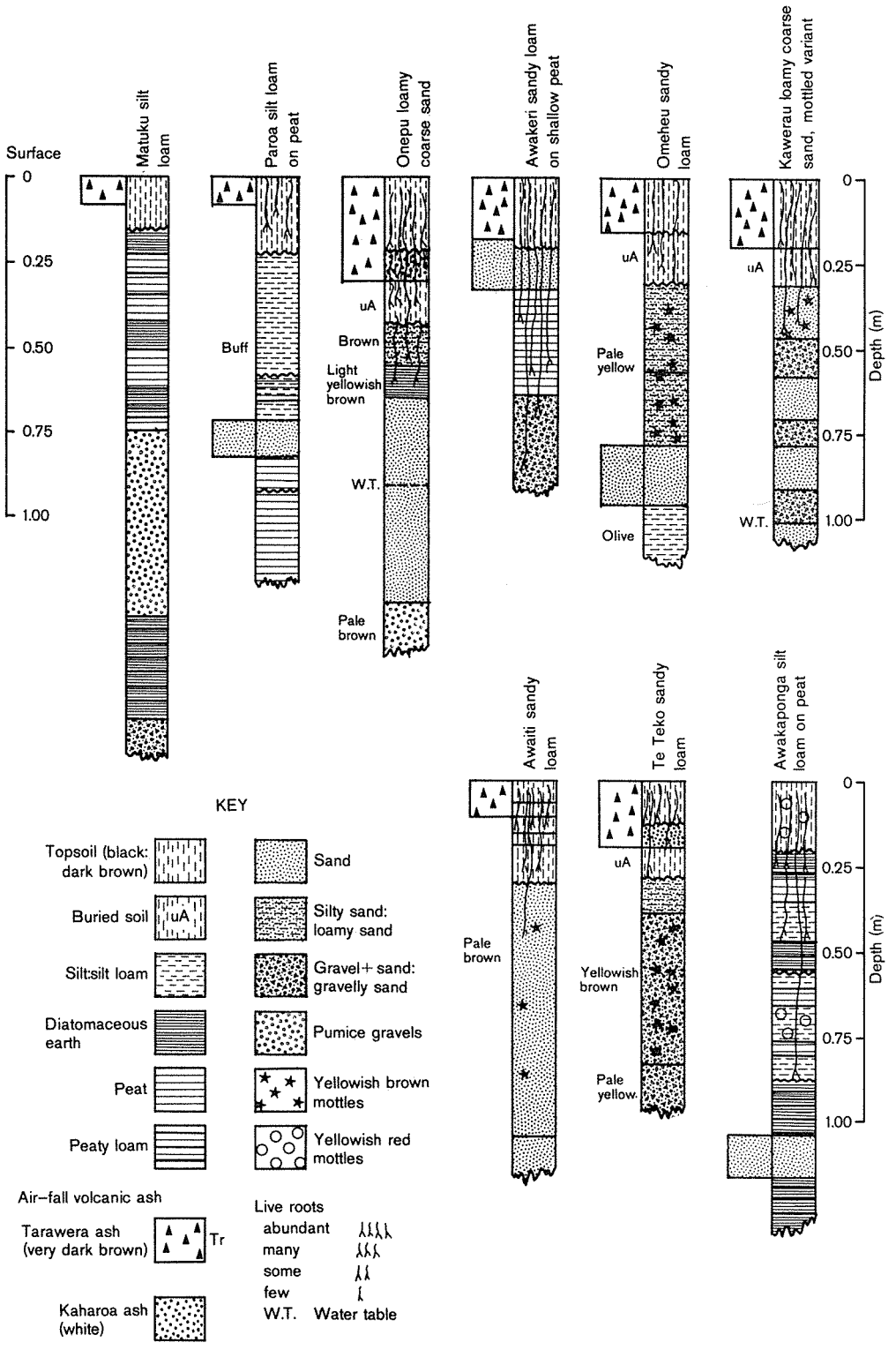

Figure 2 Diagrammatic profiles of some soils of the Rangitaiki Plains

Table 9 Correlation of soil mapping units of Rangitaiki Plains with those of other published surveys

This survey (soil types and phases)	Whakatane Borough and environs (Pullar *et al.* 1978, soil types)	Soils of North Island (N.Z. Soil Bureau 1954, soil sets)	Soils of part Whakatane County (Rijkse in prep.)
Pikowai sand (Pki)	Kopeopeo sand (7)	Patea sand (23)	Piripai soils
Piripai loamy sand (Pil)	Kopeopeo loamy sand (7a)	Patea sand (23)	Piripai soils
Kopeopeo loamy sand (Koe)	Kopeopeo loamy sand (7a)	Kopeopeo loamy sand (Koe)	Kopeopeo soils
Te Rahu loamy sand (Tr)	n.a.	Ohinepanea sand (14c)	Te Rahu soils
Te Rahu loamy sand, peaty subsoil variant (Trp)	Kopeopeo loamy sand, peaty phase (7b)	Pongakawa peaty loam (107f)	Te Rahu soils
Muriwai silt loam (Muw)	Muriwai silt loam (5)	Meeanee–Farndon complex (111)	Not mapped separately
Rangitaiki soils (Ran)	Rangitaiki soils (1)	Tukituki set (1c)	Rangitaiki soils
Opouriao fine sandy loam (Ou)	Opouriao fine sandy loam (2) and Opouriao fine sandy loam, mottled phase (2b)	Manawatu set (1)	Opouriao soils
Orini silt loam (Ori)	Opouriao silt loam (2d)	Manawatu set (1)	Opouriao soils
Kawerau loamy coarse sand (Kr)	n.a.	Tarawera gravel (5)	n.a.
Kawerau loamy coarse sand, undulating phase (KrU)	n.a.	Tarawera gravel (5)	n.a.
Kawerau loamy coarse sand, mottled variant (Krm)	n.a.	Tarawera gravel (5)	n.a.
Te Teko sandy loam (Tks)	n.a.	Tarawera gravel (5)	Te Teko soils
Awaiti sandy loam (Ats)	n.a.	Tarawera gravel (5)	Awaiti soils
Omeheu sandy loam (Ome)	n.a.	Tarawera gravel (5)	Omeheu soils
Omeheu sandy loam on peat (Omp)	n.a.	Matuku peaty gravel (107i)	Omeheu soils
Onepu loamy coarse sand (Onc)	n.a.	Not recognised, mapped as Tarawera gravel (5)	Onepu soils
Awakaponga silt loam (Ag)	n.a.	Kairanga silt loam and clay loam (2)	Awakaponga soils
Awakaponga silt loam on peat (Agp)	n.a.	Kairanga silt loam and clay loam (2)	Awakaponga soils
Poroporo silt loam (Ppo)	Paroa mottled brown silt loam (3c), Paroa silt loam on sand (3a) and Opouriao brown fine sandy loam, mottled phase (2c)	Kairanga silt loam and clay loam (2)	Paroa soils
Paroa coarse sandy loam (Prc)	n.a.	Tarawera gravel (5)	Paroa soils
Paroa coarse sandy loam on peat (Prs)	n.a.	Matuku peaty gravel (107i)	Paroa soils on peat
Paroa silt loam (Pr)	Paroa silt loam (3)	Kairanga silt loam and clay loam (2)	Paroa soils
Paroa silt loam on peat over gravel (Prg)	Paroa silt loam on peat on gravel (3c)	Kairanga silt loam and clay loam (2)	Paroa soils on peat
Paroa silt loam on peat (Prp)	Paroa silt loam on peat (3b)	Awakeri complex (15b)	Paroa soils on peat
Paroa peaty silt loam on peat (Pry)	n.a.	Pongakawa peaty loam (107f)	Paroa soils on peat
Awakeri sandy loam on shallow peat (Awi)	n.a.	Awakeri sets (15, 15a, 16b) and Otakiri sets (5a, 5b, 5c)	Awakeri soils
Awakeri loamy sand on very shallow peat (Aws)	n.a.	Awakeri sets (15, 15a, 16b) and Otakiri sets (5a, 5b, 5c)	Awakeri soils
Waioho silt loam (Wai)	Pongakawa peaty sand, loamy phase (6a) and Paroa silt loam on peat (3b)	Pongakawa peaty loam (107f)	Paroa soils on peat
Awaroa soils (Aro)	n.a.	Awaroa peaty gravel (107h)	Not recognised
Pongakawa peaty sand (Pop)	Pongakawa peaty sand (6)	Pongakawa peaty loam (107f)	Pongakawa soils
Matuku silt loam (Mtk)	n.a.	Matuku peaty gravel (107i)	Matuku soils
Matata soils (Maa)	Matata soils (4)	Kairanga silt loam and clay loam (2)	Matata soils
Matahina loamy coarse sand (Mbc)	n.a.	Manawahe gravel (14d)	Matahina soils

n.a. = not applicable

only on natural levées of the Rangitaiki River and its former distributary, the Orini Stream. This series differs from Opouriao series in that it receives some accumulation from present-day floods, is more silty in texture and has slower soil drainage. *Opouriao series* is dominant in one mapping unit and is found only on natural levées of present and former courses of the Whakatane River. It has sandy loam textures and is well drained. *Kawerau series* is dominant in three mapping units and covers the largest area of the recent soils. The topsoil of Kawerau series is formed wholly within air-fall Tarawera Ash that is $\leqslant 30$ cm thick. The series is droughty in summer, and the mottled mapping unit has a high water table in winter, due to perched groundwater seeping through the pumice alluvium. *Pikowai series* is dominant in one mapping unit and occurs on coastal dunes nearest the sea. The series is excessively drained and may be droughty in a dry summer. This coastal sand is finer than the pumiceous

sands which form the major parent materials of Kawerau, Awaiti and Omeheu series that are found on the former Tarawera River flood plain on the western side of the Plains. *Poroporo series* is dominant in one mapping unit found on the Whakatane River flood plain, mainly in the Poroporo locality, and differs from Rangitaiki series in showing a much thinner flood accumulation. Although the soils are poorly drained, they are highly fertile when used for cropping. *Matata series* is dominant in one mapping unit which covers fans where profiles are diverse and the texture ranges from sand and gravels to silt loams. Most of these fans have been inactive for some time. *Awakaponga series* is dominant in two mapping units and forms in silty pumiceous alluvium derived largely from rhyolitic pumice with minor greywacke. The series occurs near the Rangitaiki River and, in consequence, receives flood accumulations from time to time, which may be intercalated with thin beds of peat. At a depth of $\leqslant 1$ m, the mineral soils rest largely on peat. These soils are fertile when used for grassland farming, cropping, market gardening and horticulture. *Waioho series* is dominant in one mapping unit and is found mainly in the eastern and western margins of the Plains. The profile comprises a primarily mineral soil, $\leqslant 40$ cm thick, resting on deep peat. This series differs from Awaroa, Pongakawa and Matuku series, of the organic soil group, in having a discrete surface accumulation of fine alluvium.

Saline recent soils comprise one series which is dominant in one mapping unit, Muriwai silt loam. *Muriwai series* is weakly saline, occurring on former tidal flats that are now cut off from the Whakatane and Tarawera River estuaries.

The soil group comprising composite recent soils on yellow-brown sands includes only one series, which is dominant in one mapping unit, Piripai loamy sand. *Piripai series* is formed on undulating coastal dunes, from parent materials derived from layered Tarawera Ash, Kaharoa Ash and windblown coastal sand. The series is droughty in dry summer. Piripai loamy sand differs from the nearby mapping unit, Pikowai sand, in having a continuous air-fall volcanic ash mantle.

Composite recent soils on yellow-brown pumice soils comprise three series, each of which is dominant in one mapping unit. *Te Teko series* occurs in the Rangitaiki Valley north and south of Te Teko. The topsoil is formed wholly in Tarawera Ash and is characteristically underlain by a black fine sandy loam on pale yellow fine sandy loam and fine pumice gravels. Te Teko series differs from Kawerau series in having a light-coloured, yellow, fine sandy loam subsoil, and Te Teko soils have proved more productive for market gardening. *Awaiti series* has a similar profile to that of Kawerau series (a recent soil) but the Tarawera Ash forming Awaiti series is finer and the subsoil has more fine sand. Awaiti series is droughty in a dry summer, being one of the earliest soils on the Plains to dry out. *Matahina series* is dominant in one mapping unit and is found only in the Mangaone Valley in the south-west corner of the Plains. The profile is deep and sandy, composed wholly of air-fall volcanic ash associated with the Tarawera, Kaharoa, Taupo and Whakatane eruptions. A buried topsoil formed from Whakatane Ash, lying about 45 cm from the ground surface, is moisture-bearing and supplies plant nutrients, also. This buried soil is absent from Kawerau and Te Teko series and is thus the principal difference between Matahina and the other two series. All three series have similar topsoils formed from Tarawera Ash.

SOIL CHEMICAL ANALYSES

Many of the soils described in this report were sampled previously and are included with the representative set of analyses for soils of the Rangitaiki Plains published in *N.Z. Soil Bureau Bulletin 38 (Pullar et al.* 1978). However, many of the soil names given in Table 6 of this bulletin have since been changed (Table 10). Chemical analyses of a few selected soil profiles obtained for the present survey are given in Table 10, with ratings used by N.Z. Soil Bureau given in Table 11. The analyses given in this report were carried out according to the methods of Metson (1956), except that the phosphate retention values were measured according to Blakemore *et al.* (1981).

Table 10 Changes of name for soils described and analysed for *N.Z. Soil Bureau Bulletin 38*

Lab. no.	This report	*N.Z. Soil Bulletin 38*
7740	Orini silt loam	Opouriao silt loam
8014	Poroporo silt loam	Paroa brown mottled silt loam
8407	Pikowai sand	Kopeopeo sand
8164	Piripai loamy sand	Kopeopeo sand
8409	Te Rahu loamy sand, peaty subsoil variant	Kopeopeo loamy sand, peaty phase

Table 11 Chemical analyses[1]

SB lab. no.	Depth (cm)	Horizon	pH (H_2O)	Phosphorus Truog	Phosphorus 0.5 M H_2SO_4 (mg%)	Organic matter C (%)	Organic matter N (%)	Organic matter C/N	Cation exchange capacity CEC (me.%)	CEC TEB (me.%)	CEC BS (%)	Ca (me.%)	Mg (me.%)	K (me.%)	Na (me.%)	Vegetation; location; approximate mean annual rainfall; approximate elevation (all sites flat);
Awakeri sandy loam on shallow peat																
8117A	0–8	A_{11}	5.6	4	49	9.2	0.69	13	31.8	19.0	59	14.1	3.0	1.24	0.3	Paspalum pasture; J.I. Donald's farm,
B	15–20	A_{12}	5.9		16	6.4	0.48	13	22.0	8.8	39	6.8	1.1	0.20	0.4	Western Drain Road, Putiki;
C	28–36	II(B)	5.6		15	0.4	0.03	13	2.3	0.4	39	0.6	0.1	0.02	0.2	1400 mm; 6 m
D	40–48	IIIC	5.0		12	21.0	1.24	17	75.0	22.5	32	21.8	1.5	0.12	0.7	
E	53–58	uA	5.4		12	6.7	0.31	22	23.4	9.5	40	7.8	0.6	0.05	0.8	
Omeheu sandy loam																
8115A	0–8	A_{11}	5.0	17	140	6.2	0.56	11	22.1	11.0	51	6.6	2.4	2.25	0.1	Paspalum pasture; Rangitaiki Plains
B	13–20	A_{12}	5.4		54	2.5	0.20	13	11.5	3.9	35	1.9	0.9	1.13	0.1	Dairy Co. demonstration farm,
C	25–33	$(B)_g$	5.5		15	0.6	0.06	10	3.5	1.4	42	0.7	0.1	0.61	0.1	Omeheu;
D	65–72	C	6.2		6	0.2	0.02	9	1.7	0.9	51	0.1	0.3	0.47	0.1	1500 mm; 4.8 m
Rangitaiki sand																
8113A	0–8	A_1	4.7	1.4	9	2.1	0.19	11	8.4	1.4	18	0.8	0.3	0.24	0.2	Bare (1962 flood); Sutherland's Road,
B	20–25	C	5.0		7	1.0	0.08	12	5.0	0.5	12	0.2	0.2	0.04	0.1	Awaiti; 1350 mm; 2 m
Awakaponga silt loam on peat																
8116A	0–8	A_1	5.3	3	53	6.4	0.50	13	28.3	14.4	51	11.1	2.3	0.70	0.4	Paspalum pasture; Ceres Land Co.,
B	30–38	B	4.7		23	8.2	0.65	13	40.4	66.7	18	5.6	0.8	0.45	0.3	West Bank Road, Edgecumbe;
C	53–60	$u(B)_g$	5.0		19	3.9	0.37	11	26.2	5.2	21	4.1	0.6	0.24	0.5	1500 mm; 3 m
Te Teko sandy loam																
8118A	0–8	A_{11}	5.8	2	15	4.9	0.43	11	15.5	12.3	80	7.8	2.9	1.41	0.3	Paspalum, prairie grass, plantains;
B	20–28	A_{12}	6.0		5	2.1	0.15	14	9.4	3.4	35	2.4	0.4	0.37	0.1	old tobacco kiln site, W.D. & H.O.
C	40–48	(B)	5.9		8	0.4	0.03	13	2.4	0.5	29	0.4	0.1	0.12	0.1	Wills, Te Teko; 1530 mm; 12 m

[1]For precise location of sampling sites, see soil map. Samples are collected from the soil horizons seen in pits that are dug on unfarmed land, in order to examine chemical properties that have not been modified by farming practices.

Analyses by L.C. Blakemore, B.K. Daly, P.L. Searle, J. Bell, P.J. Brown, B.M. Gyllenberg, R.L. Haig, C.J. Pedersen, D.M. Small

Table 12 Ratings for chemical properties

Rating	Organic matter Organic C (%)	Organic matter Total N (%)	Organic matter C/N	Phosphorus Truog (mg %)	Phosphorus 0.5 M H_2SO_4 (mg %)	Phosphorus P retention (%)
Very high	> 20	> 1.0	> 24	> 5	> 40	90–100
High	10–20	0.6–1.0	16–24	3–5	20–40	60–90
Medium	4–10	0.3–0.6	12–16	2–3	10–20	30–60
Low	2–4	0.1–0.3	10–12	1–2	5–10	10–30
Very low	< 2	< 0.1	< 10	< 1	< 5	0–10

Rating	pH (1:2.5 soil:water)		Cation-exchange properties CEC (me.%)	TEB (me.%)	BS (%)	Exchangeable Ca (me.%)	Exchangeable Mg (me.%)	Exchangeable K (me.%)	Exchangeable Na (me.%)
Very high	> 9.0	(extremely alkaline)	> 40	> 25	80–100	> 20	> 7	> 1.2	> 2
	8.4–9.0	(strongly alkaline)							
	7.6–8.3	(moderately alkaline)							
High	7.1–7.5	(slightly alkaline)	25–40	15–25	60–80	10–20	3–7	0.8–1.2	0.7–2.0
	6.6–7.0	(near neutral)							
Medium	6.0–6.5	(slightly acid)	12–25	7–15	40–60	5–10	1–3	0.5–0.8	0.3–0.7
	5.3–5.9	(moderately acid)							
Low	4.5–5.2	(strongly acid)	6–12	3–7	20–40	2–5	0.5–1.0	0.3–0.5	0.1–0.3
Very low	< 4.5	(extremely acid)	< 6	< 3	< 20	< 2	< 0.5	< 0.3	< 0.1

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR LAND USE

by W.C. Rijkse

The following ratings are intended to aid further development of agriculture on the Rangitaiki Plains. The soils are classified according to their limitations for pastoral, cropping, horticultural, forestry and urban uses, and also according to their value for food production in terms of the Town and Country Planning Act, 1977. These ratings provide basic data to help land planners decide which soils are suitable for more intensive development and what improvements may be necessary; agriculturalists, foresters and economists can then decide whether development of a particular area is desirable, by comparing the economics of various land uses.

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR PASTORAL USE

This classification follows Gibbs (1968). It shows that while the Rangitaiki Plains are well suited to pastoral uses, the main limitations are poor to imperfect natural drainage. Some soils are rated as having insufficient moisture.

CLASS 1 Soils of flat and rolling land with minimal to slight limitations for pastoral use

1A Limitations of nutrients
- Rangitaiki soils (where protected from flooding)
- Opouriao fine sandy loam
- Orini silt loam
- Awaiti sandy loam

1B Limitations of drainage and nutrients
- Omeheu sandy loam
- Omeheu sandy loam on peat
- Onepu loamy coarse sand
- Awakaponga silt loam
- Awakaponga silt loam on peat
- Poroporo silt loam
- Paroa coarse sandy loam
- Paroa coarse sandy loam on peat
- Paroa silt loam
- Paroa silt loam on peat over gravel
- Paroa silt loam on peat
- Paroa peaty silt loam on peat
- Awakeri sandy loam on shallow peat
- Waioho silt loam
- Pongakawa peaty sand
- Matuku silt loam
- Matata soils

CLASS 2 Soils of flat and rolling land with moderate soil limitations for pastoral use

2A Limitations of insufficient moisture and, to a lesser extent, nutrients
- Piripai loamy sand
- Kopeopeo loamy sand
- Te Rahu loamy sand
- Te Rahu loamy sand, peaty subsoil variant
- Rangitaiki soils (where not protected from flooding)
- Kawerau loamy coarse sand
- Kawerau loamy coarse sand, undulating phase
- Kawerau loamy coarse sand, mottled variant
- Te Teko sandy loam
- Awakeri loamy sand on very shallow peat
- Matahina loamy coarse sand

CLASS 3 Soils of flat and rolling land with severe soil limitations for pastoral use

3A Limitations of nutrients through high fixation or salinity
- Muriwai silt loam

3B Not present in this survey

3C Limitations of excessive moisture, shrinkage
- Awaroa soils

3D Not present in this survey

3E Limitations of frequent dryness
- Pikowai sand

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR CROPPING USE

The cropping use classification follows Cutler (1968) and applies to cash cropping. The main limitations are imperfect to poor natural drainage. With artificial drainage, these soils can become moderately well drained and maize and potatoes can then be grown successfully.

CLASS 1 Soils of flat and easy rolling land with minimal to slight soil limitations for crop production

1A Soils most suitable for cropping—limitations are minimal and easily overcome
- Rangitaiki soils (where protected from flooding)
- Opouriao fine sandy loam
- Orini silt loam

1B Limitations of medium to high nutrient requirements
- Te Teko sandy loam

1C Soils which require drainage before they can be successfully cropped
- Omeheu sandy loam
- Omeheu sandy loam on peat
- Awakaponga silt loam
- Awakaponga silt loam on peat
- Poroporo silt loam
- Paroa coarse sandy loam
- Paroa coarse sandy loam on peat
- Paroa silt loam
- Paroa silt loam on peat over gravel
- Paroa silt loam on peat
- Paroa peaty silt loam on peat
- Awakeri sandy loam on shallow peat
- Waioho silt loam
- Matata soils

CLASS 2 Soils of flat to rolling land with moderate soil limitations for crop production

2A Limitations of insufficient moisture
- Te Rahu loamy sand
- Te Rahu loamy sand, peaty subsoil variant
- Awaiti sandy loam
- Awakeri loamy sand on very shallow peat

2B Limitations of subsoil pans and drainage impediments
- Onepu loamy coarse sand
- Pongakawa peaty sand
- Matuku silt loam

CLASS 3 Soils of flat and rolling land with severe soil limitations for crop production

3A Limitations of shallow and stony profiles, or coarse texture with serious moisture deficiency
- Pikowai sand
- Piripai loamy sand
- Kopeopeo loamy sand
- Rangitaiki soils (where not protected from flooding)
- Kawerau loamy coarse sand
- Kawerau loamy coarse sand, undulating phase
- Kawerau loamy coarse sand, mottled variant
- Matahina loamy coarse sand

3B Limitations of wet low-lying land that is not easily drained
- Muriwai silt loam
- Awaroa soils

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR HORTICULTURAL USE

This classification is a generalised scheme only, as the suitability of different soils will vary according to the kind of horticultural crop grown. The classification follows Cowie (1974). Most soils on the Rangitaiki Plains have only slight limitations for horticultural use. As with cropping use, the major limiting factor is imperfect or poor drainage.

CLASS 1 Soils of flat land with minimal to slight limitations for horticultural use

1A Limitations are minimal
- Te Rahu loamy sand
- Rangitaiki soils (where protected from flooding)
- Opouriao fine sandy loam
- Orini silt loam
- Te Teko sandy loam

1B Limitations are slight, e.g. imperfect drainage, but could affect the range of crops grown. Some crops could be adversely affected in wet years and the period during which the soil can be cultivated may be reduced.
- Te Rahu loamy sand, peaty subsoil variant
- Omeheu sandy loam
- Omeheu sandy loam on peat
- Onepu loamy coarse sand
- Awakaponga silt loam
- Awakaponga silt loam on peat
- Paroa coarse sandy loam
- Paroa silt loam
- Paroa silt loam on peat over gravel
- Awakeri sandy loam on shallow peat
- Awakeri loamy sand on very shallow peat

CLASS 2 Soils of flat land with moderate limitations of poor drainage for horticultural use. The choice of horticultural crops is limited and the period during which the soils can be cultivated is restricted even after artificial drainage has been carried out.
- Kawerau loamy coarse sand, mottled variant
- Poroporo silt loam
- Paroa silt loam on peat
- Paroa coarse sandy loam on peat
- Waioho silt loam
- Pongakawa peaty sand
- Matuku silt loam
- Matata soils

CLASS 3 Soils of flat and rolling land with severe limitations for horticultural use

3A Limitations of poor drainage and poor physical structure
- Awaroa soils
- Paroa peaty silt loam on peat

3B Limitations of excessive drainage
- Pikowai sand
- Piripai loamy sand
- Kopeopeo loamy sand
- Kawerau loamy coarse sand
- Kawerau loamy coarse sand, undulating phase
- Awaiti sandy loam
- Matahina loamy coarse sand

3C Limitations of liability to frequent flooding
- Muriwai silt loam
- Rangitaiki soils (where not protected from flooding)

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR FOREST GROWTH

The classification for forest growth is for commercial exotic forestry and is after Cutler (1968). It seems unlikely that the Rangitaiki Plains will ever be used for commercial forestry. Nevertheless, the following classification may be useful in the establishment of shelter belts and small wood lots, the latter especially on the soils of the dunes. On the Plains generally, apart from the soils on dunes, the main soil limitation for forest growth is poor to imperfect drainage.

CLASS 1 Soils of flat and rolling land with minimal to slight limitations for forest growth

1A No significant limitations for forest growth
- Te Rahu loamy sand
- Opouriao fine sandy loam
- Orini silt loam
- Te Teko sandy loam
- Matahina loamy coarse sand

1B Slight limitations of soil drainage which may limit the establishment of some species
- Te Rahu loamy sand, peaty subsoil variant

CLASS 2 Soils of flat and rolling land with moderate limitations for forest growth

2A Limitations of insufficient moisture; some soils also have perched water tables in wet seasons
- Kawerau loamy coarse sand, mottled variant
- Awaiti sandy loam

2B Limitations of coarse sandy textures and insufficient moisture
- Piripai loamy sand
- Kopeopeo loamy sand
- Kawerau loamy coarse sand
- Kawerau loamy coarse sand, undulating phase

CLASS 3 Soils of flat and rolling land with severe limitations for forest growth

3A Limitations of soluble salts
- Muriwai silt loam

3B Limitations of shallow and stony or sandy profiles and insufficient moisture
- Pikowai sand
- Rangitaiki soils

3C Limitations of poor drainage, and in places, frequent flooding
- Omeheu sandy loam
- Omeheu sandy loam on peat
- Onepu loamy coarse sand
- Awakaponga silt loam
- Awakaponga silt loam on peat
- Poroporo silt loam
- Paroa coarse sandy loam
- Paroa coarse sandy loam on peat
- Paroa silt loam
- Paroa silt loam on peat over gravel

Paroa silt loam on peat
Paroa peaty silt loam on peat
Awakeri sandy loam on shallow peat
Awakeri loamy sand on very shallow peat
Waioho silt loam
Awaroa soils
Pongakawa peaty sand
Matuku silt loam
Matata soils

CLASSIFICATION OF SOILS ACCORDING TO THEIR ACTUAL OR POTENTIAL VALUE FOR FOOD PRODUCTION

The classification for food production follows Cowie (1974) and is made in terms of the Town and Country Planning Act, 1977.

Soils of Class 1A are friable, generally well drained soils, with adequate levels of most nutrients. They are versatile soils which can be cultivated at most times of the year and can be used for a wide range of horticultural crops including orchards. They are also suitable for field crops and intensive dairying.

Soils of Class 1B have limitations of imperfect to poor natural drainage or of coarse textures. This limits the choice of crops which can be grown, affects yields in a wet year and limits the periods during which the soil can be cultivated. The drainage limitation can be overcome by artificial drainage, although these soils will still be less versatile than those of Class 1A.

Soils of Class 2 have limitations of poor natural drainage and poor physical properties (coarse soil textures, weakly developed structure). Poor drainage or droughtiness can be corrected with artificial drainage or irrigation, respectively, but overall these soils are not as versatile as those of Class 1 and are not suitable for such a wide range of crops.

Soils of Class 3 have limitations of very coarse textures, salinity or frequent flooding. These limitations are difficult to correct and the soils are generally unsuitable for intensive agricultural or horticultural use.

CLASS 1 Soils of high actual or potential value for food production

1A Soils of high actual value for food production
Rangitaiki soils (where protected from flooding)
Opouriao fine sandy loam
Orini silt loam

1B Soils of high potential value for food production
Te Rahu loamy sand
Te Rahu loamy sand, peaty subsoil variant
Te Teko sandy loam
Omeheu sandy loam
Awakaponga silt loam
Awakaponga silt loam on peat
Poroporo silt loam
Paroa coarse sandy loam
Paroa coarse sandy loam on peat
Paroa silt loam
Paroa silt loam on peat over gravel
Paroa silt loam on peat
Awakeri sandy loam on shallow peat
Waioho silt loam
Matata soils

CLASS 2 Soils of moderate actual or potential value for food production
Kopeopeo loamy sand
Kawerau loamy coarse sand
Kawerau loamy coarse sand, undulating phase
Kawerau loamy coarse sand, mottled variant
Awaiti sandy loam
Omeheu sandy loam on peat
Onepu loamy coarse sand
Paroa peaty silt loam on peat
Awakeri loamy sand on very shallow peat
Awaroa soils
Pongakawa peaty sand
Matuku silt loam
Matahina loamy coarse sand

CLASS 3 Soils of low actual or potential value for food production
Pikowai sand
Piripai loamy sand
Muriwai silt loam
Rangitaiki soils (where not protected from flooding)

CLASSIFICATION OF SOILS ACCORDING TO THEIR LIMITATIONS FOR URBAN USE

The classification for urban use follows Cowie (1974). Limitations are those of subsoils unsuitable for heavy foundations or of poor drainage or high groundwater tables that affect the use of septic tanks or may allow pollution problems associated with the use of septic tanks. Finally, soils that flood frequently in their natural state are given a low rating for urban use even if stopbank protection is established.

CLASS 1 Soils of flat and rolling land with minimal to slight limitations for urban use. Slight limitations are wind erosion and imperfect drainage.
Kopeopeo loamy sand
Te Rahu loamy sand
Te Rahu loamy sand, peaty subsoil variant
Opouriao fine sandy loam
Orini silt loam
Kawerau loamy coarse sand
Kawerau loamy coarse sand, undulating phase
Kawerau loamy coarse sand, mottled variant
Te Teko sandy loam
Awaiti sandy loam
Awakaponga silt loam
Awakeri loamy sand on very shallow peat
Matahina loamy coarse sand

CLASS 2 Soils of flat and rolling land with moderate limitations for urban use. Limitations are frequent flooding (ceased since stopbank building), poor to imperfect natural drainage and partly peaty subsoils.
Piripai loamy sand
Rangitaiki soils (where protected from flooding)
Omeheu sandy loam
Omeheu sandy loam on peat
Onepu loamy coarse sand
Awakaponga silt loam on peat
Poroporo silt loam
Paroa coarse sandy loam
Paroa coarse sandy loam on peat
Paroa silt loam
Paroa silt loam on peat over gravel
Paroa silt loam on peat
Awakeri sandy loam on shallow peat
Matuku silt loam
Matata soils (inactive parts of fans)

CLASS 3 Soils of flat and rolling land with severe limitations for urban use. Limitations are frequent flooding, soft peaty subsoils unsuitable for support of foundations for buildings, and very variable, possibly unstable, soils

Pikowai sand
Muriwai silt loam
Rangitaiki soils (where not protected from flooding)
Paroa peaty silt loam on peat
Waioho silt loam
Awaroa soils
Pongakawa peaty sand
Matata soils (active parts of fans)

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APPENDIX 1

GLOSSARY OF PLANT NAMES

asparagus	*Asparagus officinalis*
barley	*Hordeum vulgare*
bean, runner	*Phaesolus vulgaris*
boysenberry	*Rubus ursinus*
bracken fern	*Pteridium esculentum*
buck's-horn plantain	*Plantago coronopus*
cabbage tree	*Cordyline australis*
carrot	*Daucus carota*
cotula	*Cotula* spp.
feijoa	*Feijoa sellowiana*
flax	*Phormium tenax*
kahikatea	*Dacrycarpus dacrydiodes*
kiwifruit	*Actinidia chinensis*
kumara	*Ipomea batatas*
lettuce	*Latuca sativa*
lucerne	*Medicago sativa*
maize	*Zea mays*
manuka	*Leptospermum scoparium*
melon	*Cucumis melo*
water melon	*Citrullus* spp.
Mercer grass	*Paspalum distichum*
mingimingi	*Leucopogon fasciculatus*
onion	*Allium cepa*
parsnip	*Peucedanum sativum*
paspalum	*Paspalum dilatatum*
potato	*Solanum tuberosum*
radiata pine	*Pinus radiata*
raupo	*Typha orientalis*
rush	*Juncus* spp.
sedge	*Baumea* spp.
selliera	*Selliera radicans*
spinifex	*Spinifex hirsutus*
tall fescue	*Festuca arundinacea*
teatree	*Leptospermum scoparium* and/or *L. ericoides*
titoki	*Alectryon excelsum*
toetoe	*Cortaderia* spp.
totara	*Podocarpus totara*
turnip	*Brassica rapa*
umbrella fern	*Gleichenia* spp.
willow	*Salix* spp.

APPENDIX 2

HISTORICAL AND MODERN RIVER COURSES AND SHORELINES ON THE RANGITAIKI PLAINS

Only one tephra marker was available for tracing historical river courses, Kaharoa Ash (*c.* 900 yr BP). River courses, as known, for three historical periods are listed below (Fig. 3).

Immediate post-Taupo pumice eruptions (post *c.* 1800 yr BP)

Rangitaiki River flood plain on the eastern side of the plains with estuary at Whakatane

Whakatane River insufficient information to plot a course

Tarawera River no information

At time of Kaharoa eruption (*c.* 900 yr BP)

Rangitaiki River bifurcation at Te Teko with one course, possibly a distributary, following the now-abandoned Omeheu Stream and the other along the present course. Further bifurcation took place with early courses of the Awaiti and Orini Streams, flowing to the west and east respectively.

Whakatane River well-marked abandoned channel in the Parora locality. The deep meanders show that it was occupied for even longer than the channel marked 1867 which replaced it.

Tarawera River westerly course near Matata but no information in the south towards Kawerau

These courses are indicated by the presence of Kaharoa Ash close to the present ground surface on natural levées (within 1 m). The presence of this Ash in peat close to the present course of the Rangitaiki River, from Te Teko to Thornton, suggests that this course has been in place for a long time. Furthermore, the presence of greywacke gravels in the Awaiti locality, west of the present course of Rangitaiki River, confirms the former Omeheu Stream as a distributary of the Rangitaiki River. Only the Rangitaiki River catchment is a source for greywacke; none occurs *in situ* in the Tarawera River catchment.

Post-Kaharoa Ash eruption

Rangitaiki River further courses cut by the Awaiti and Orini Streams and main course to Matata until 1886.

Whakatane River no information except for a course dated 1867. This course may have been occupied by the Whakatane River for a long time, possibly from the time of the Kaharoa Ash eruption.

Tarawera River braided channels occurred on the flood plain near Matata and a meander trough was cut in the south towards Kawerau. A distributary, the Awaiti-Paku Stream, was active in the braided channel system near Matata until 1886 (Map 9, Bay of Plenty Catchment Commission 1970).

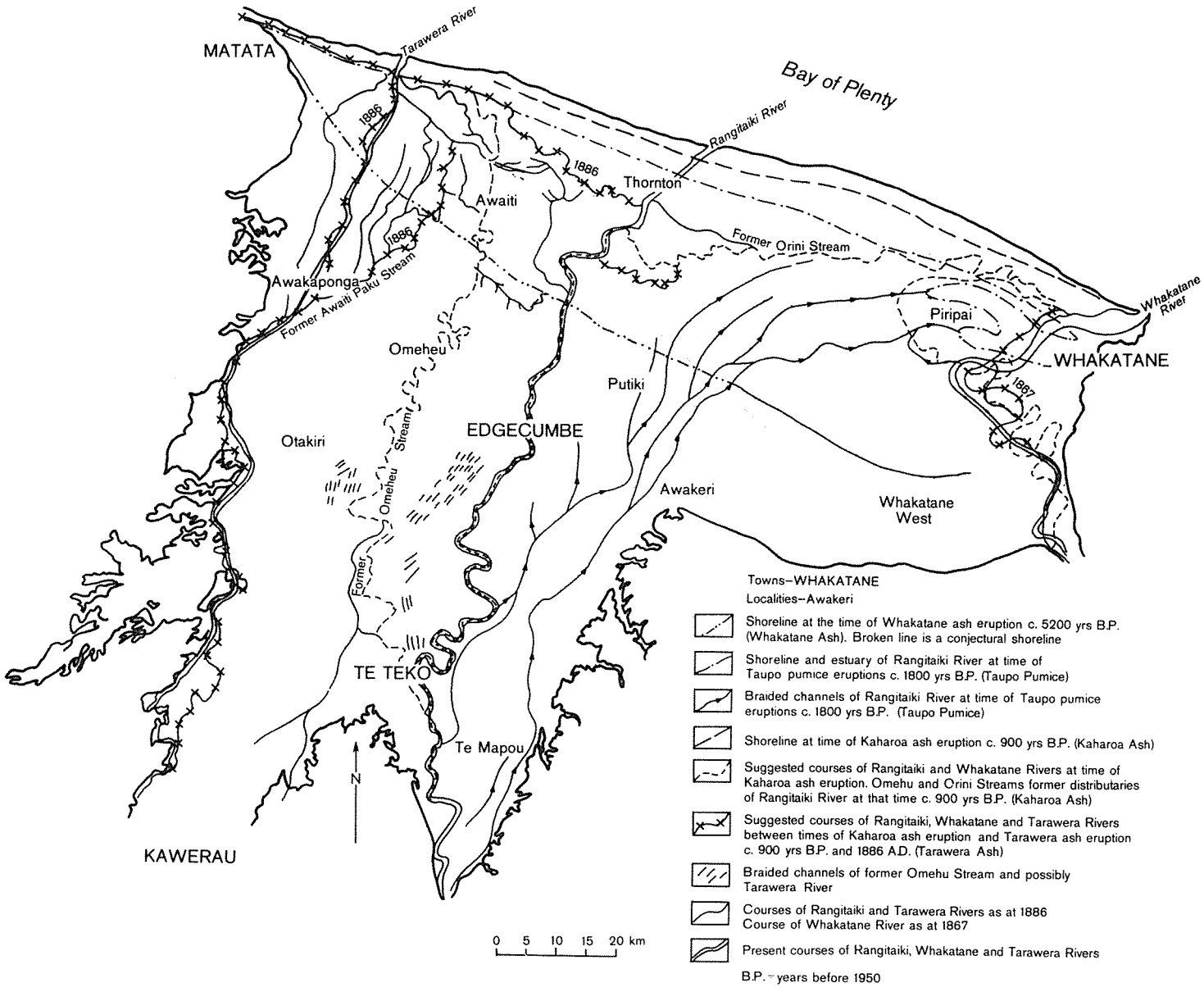

Figure 3 Historical and modern river courses and shorelines on the Rangitaiki Plains

APPENDIX 3

RECENT ALLUVIAL INFILLING OF THE RANGITAIKI PLAINS BASIN AS INDICATED BY THE TEPHRA MARKERS, KAHAROA ASH AND TARAWERA ASH

For infilling studies, only two tephra markers were available, Kaharoa Ash (*c.* 900 yr BP) and Tarawera Ash (AD 1886). Taupo Pumice (*c.* 1800 yr BP) was buried too deeply for near-surface observations to be made with the spade and auger. Furthermore, the thickness of the infilling was measured only in the alluvium, not in the peats and the dune sands. The peat deposits represent the best record for tephra markers and include the oldest tephra on the Plains, Whakatane Ash (*c.* 5200 yr BP). Unfortunately, however, the peat deposits cannot be documented for the infilling rate because artificial drainage has caused shrinkage. For example, at Whakatane West the land sank 1.5 m between 1928 and 1944, and a further 1.0 m between 1944 and 1958. Foredunes are known to have been altered by the wind; since the 1886 Tarawera Ash eruption, the air-fall ash has been buried at one place to a depth of about 7 m.

Fig. 4 shows the degree of infilling since the Kaharoa Ash eruption of *c.* 900 yr BP in broad steps, so that the general trend can be seen. The infilling areas were plotted with the aid of the soil mapping units and depth measurements. The greatest thicknesses occur on the Tarawera River flood plain, on the former flood plain of the Omeheu Stream and, also, about the lower course of the Rangitaiki River at Thornton, showing the importance of the alluvium derived from the Kaharoa Ash ejecta. Similar thicknesses on the Whakatane River flood plain occur in a much smaller area.

Infilling since the Tarawera Ash eruption (Fig. 5) is confined to small flood plains associated with the three rivers, all of which have meander troughs and levée systems, the most pronounced being those on the Rangitaiki River. The Tarawera River meander trough was filled in after the Lake Tarawera outlet burst in 1904.

Soil profiles show that infilling on the Rangitaiki Plains spans three distinct intervals (Fig. 6): (1) catastrophic infilling immediately following the Kaharoa Ash eruption, (2) intermittent infilling from the Kaharoa Ash eruption until about 400 years ago (B.G. McFadgen, pers. comm.) and (3) intermittent infilling from the Kaharoa Ash eruption to the present day. Under (1), the soil profile is non-layered and has no buried paleosols; in (2), the profile is layered and has a black A_1 horizon, indicating cessation of accumulation for a period; under (3), the profile is layered with buried paleosols. An exercise in soil classification reached the same conclusion, independently, by allotting gley soils to category (1) and recent soils to categories (2) and (3). The products of the Kaharoa Ash eruption have contributed in no small measure to the parent materials of soils on the Rangitaiki Plains.

The distribution of category (3), intermittent but continuous infilling since the Kaharoa Ash eruption, roughly follows that of the post-Tarawera deposits (Fig. 5). The most common thicknesses are 50–100 cm and 100–150 cm, giving a rate of 0.5–1.6 mm yr^{-1} for both ranges. However, since the Tarawera Ash eruption, infilling has occurred most commonly at thicknesses of 10–20 mm and 20–30 mm, giving a rate of 1.0–3.7 mm yr^{-1}. The increased rate over the last 100 years may be due to accelerated erosion in the Ikawhenua Range bordering the Galatea basin. Pain and Pullar (1968) say the post-Tarawera surface can be found on the flood plains of the Horomanga and the Whirinaki Streams and also on the fan of the Mangamate Stream.

While there are no comparable tephra markers in the Tolaga Bay Flats basin on the east coast of the North Island, the rate of infilling in that basin, since the Taupo Pumice eruptions, is clearly much less than the rate in the Rangitaiki Plains basin (Pullar and Rijkse 1977).

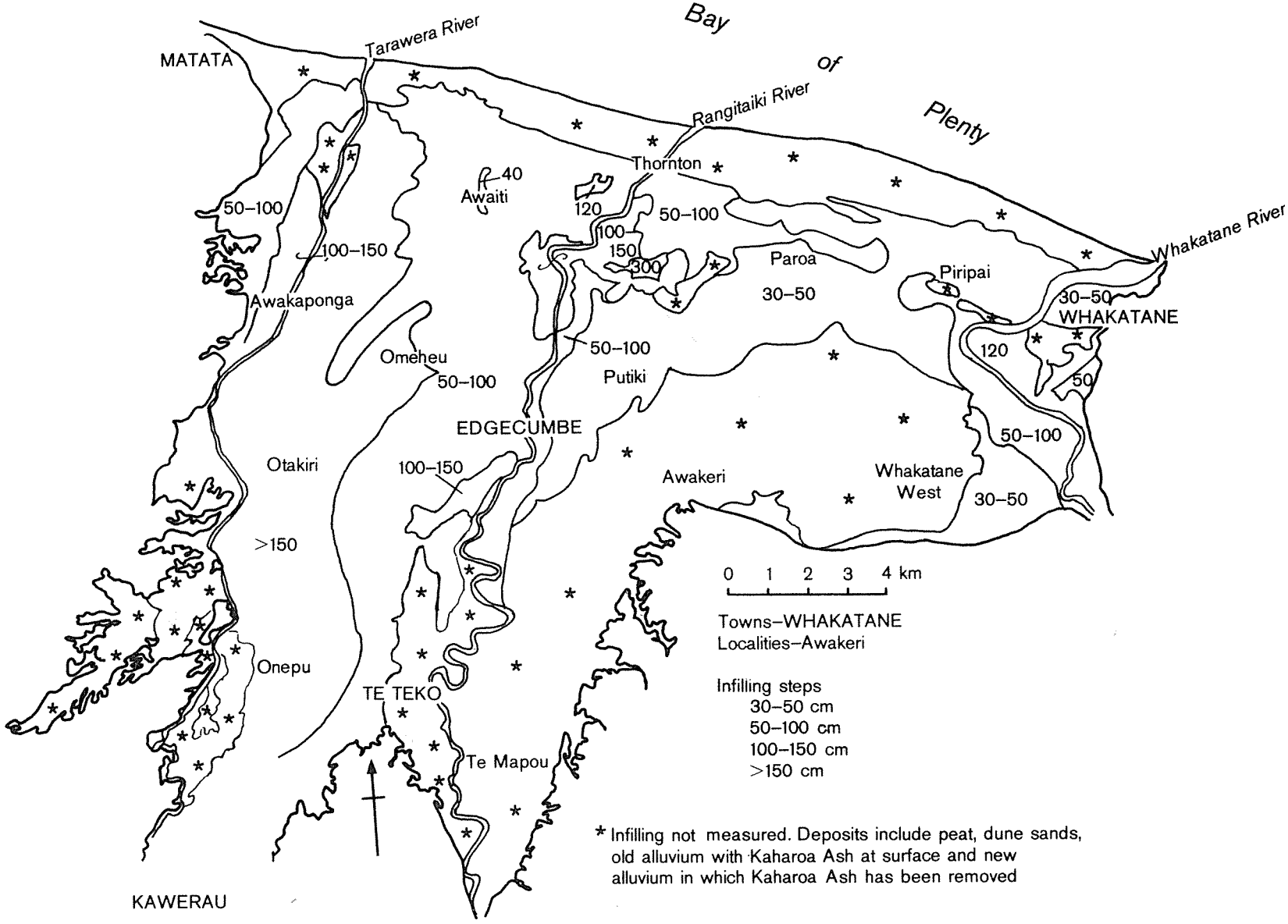

Figure 4 Infilling of the Rangitaiki Plains basin since the Kaharoa Ash eruption of *c.* 900 yr BP

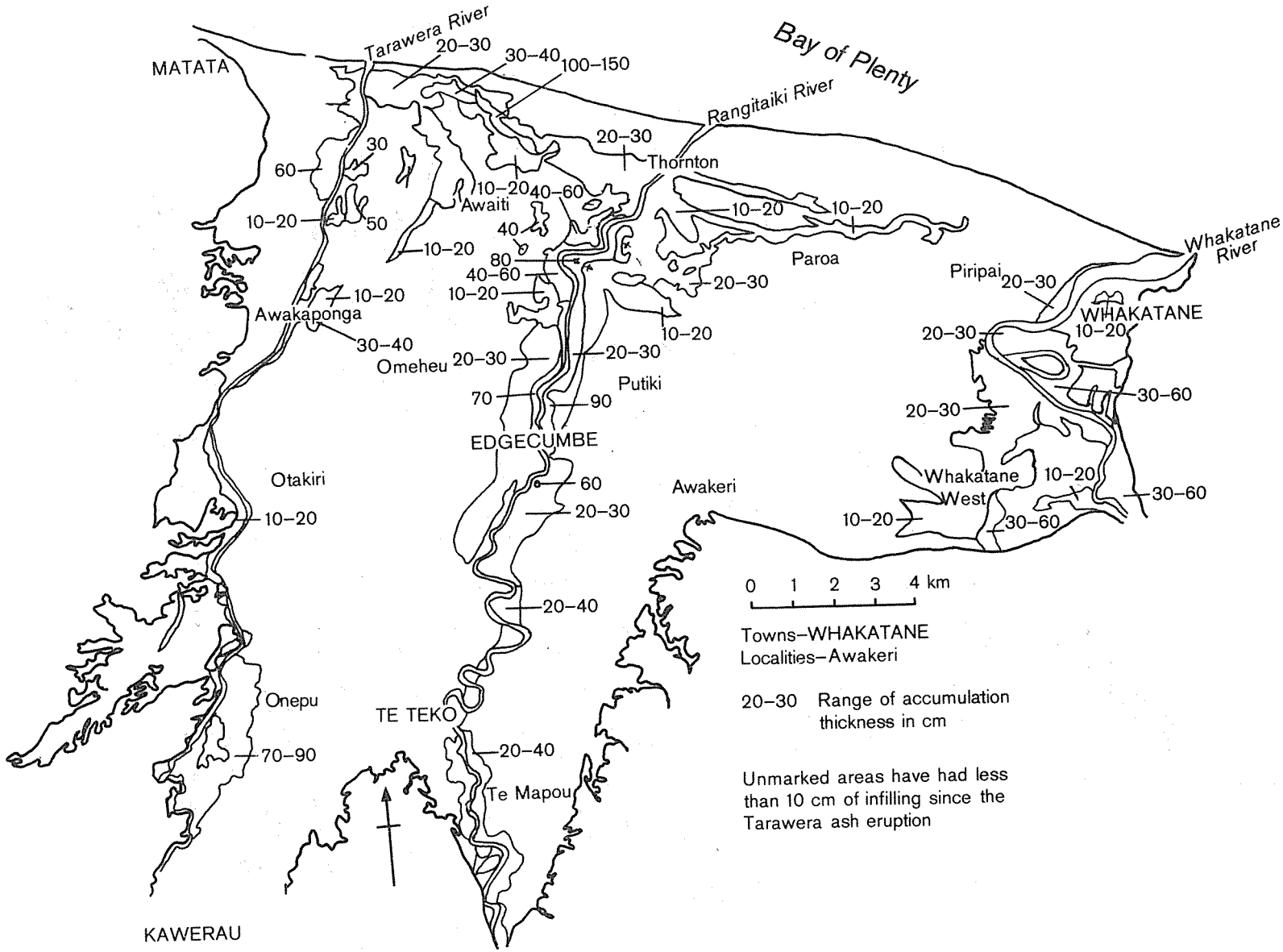

Figure 5 Infilling of the Rangitaiki Plains basin since the Tarawera Ash eruption of A.D. 1886

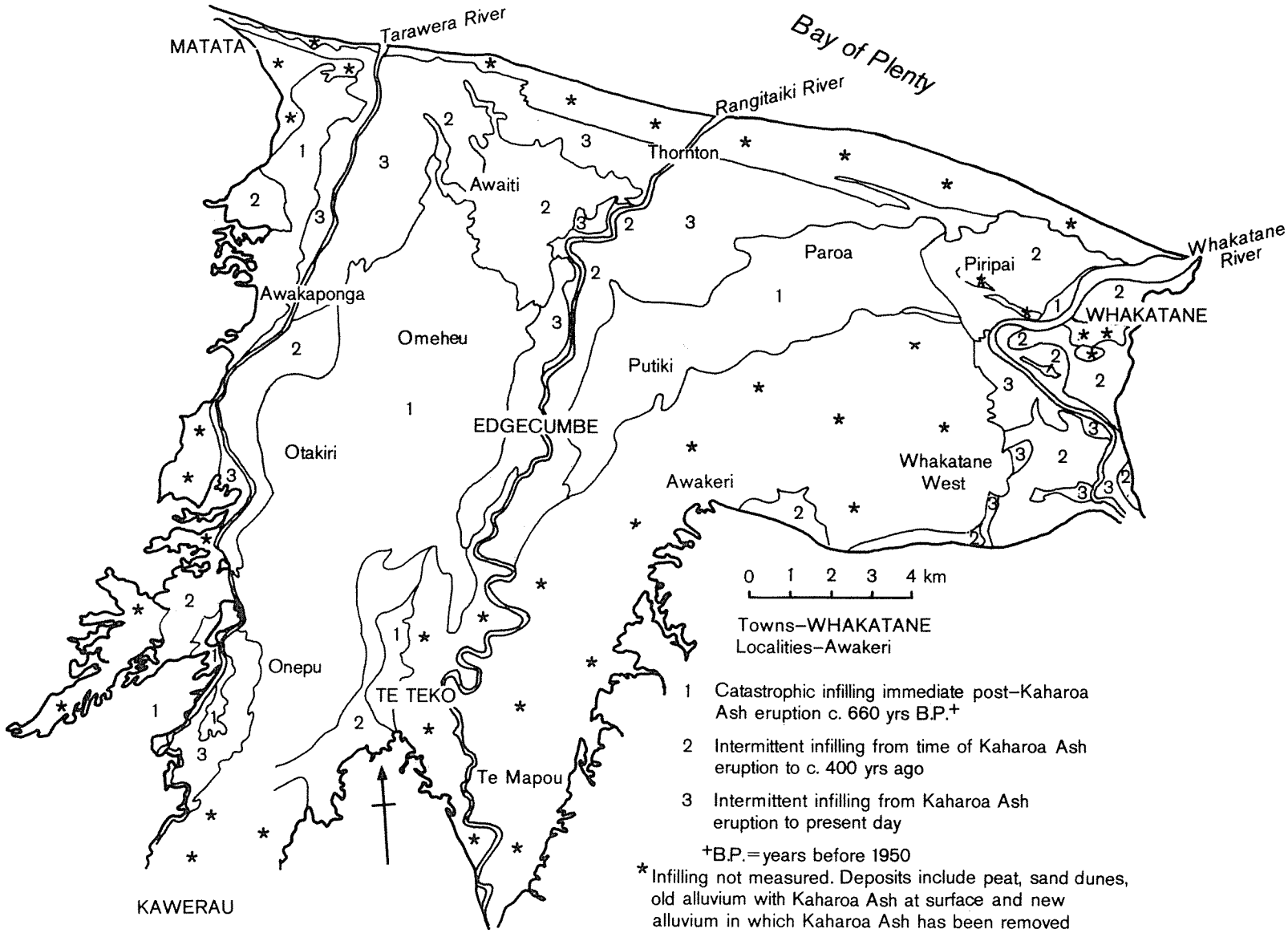

Figure 6 Periods of infilling of the Rangitaiki Plains basin since the Kaharoa Ash eruption of *c.* 900 yr BP

APPENDIX 4

SURFICIAL GEOLOGICAL CROSS-SECTIONS ON THE RANGITAIKI PLAINS

Surficial geological cross-sections were drawn across the Plains, ten at right angles to the coast (lines AA'–JJ'), and one parallel to the coast (line KK'), primarily for the purpose of plotting sea level movements over the past 6000 years or so. The exercise was abandoned after learning that earth movements would have to be measured before the validity of sea level movements could be established; recent deformation is hard to prove on the Rangitaiki Plains. Thus, the sections are not as complete lithologically as those given in *N.Z. Soil Bureau Bulletin 38* (Figs. 6a, 6b, 6c, Pullar *et al.* 1978). The section plan is given in Fig. 7a and the individual sections in Figs 7b–f.

Information was obtained mainly from borehole records kept by the Rangitaiki Plains Drainage Board and the Bay of Plenty Catchment Commission.

The cross-sections show that the Plains can be divided into two parts, (1) the eastern part from section FF' to JJ' and (2) the western part from section FF' to AA' (Fig. 7a). The break between these two parts may be an extension of a concealed fault lying along the eastern side of the Rangitaiki Valley (Fig. 7a), and it coincides with the abrupt termination of the oldest inland dunes which is clearly shown on the soil map and on line KK' in Fig. 7a.

Dune sands are the base for the eastern part of the Plains, lying at depths of about 3 m and, occasionally, 7 m. Peat valleys between the old inland dune systems are a feature on this part of the Plains. On the western part, the dune sand lies at a greater depth, 5–15 m, and becomes progressively deeper towards the south, reaching a depth of 33 m at the Whakatane–Rotorua highway near the Kawerau turn-off (not shown on section DD'). In the sections EE', DD', CC', BB', *in-situ* stumps are shown at different elevations, as are sea-shells which, however, have a more narrow depth range of 9–12 m below sea level.

The greater depth of dune sand in the western part of the Plains suggests the land has sunk with respect to the sea, and the *in-situ* stumps indicate different stages in the sinking, when the trees were at the surface for a time. Three to four stages are indicated by the cross-sections. The presence of shells indicates brief incursions of the sea that occurred a long time ago.

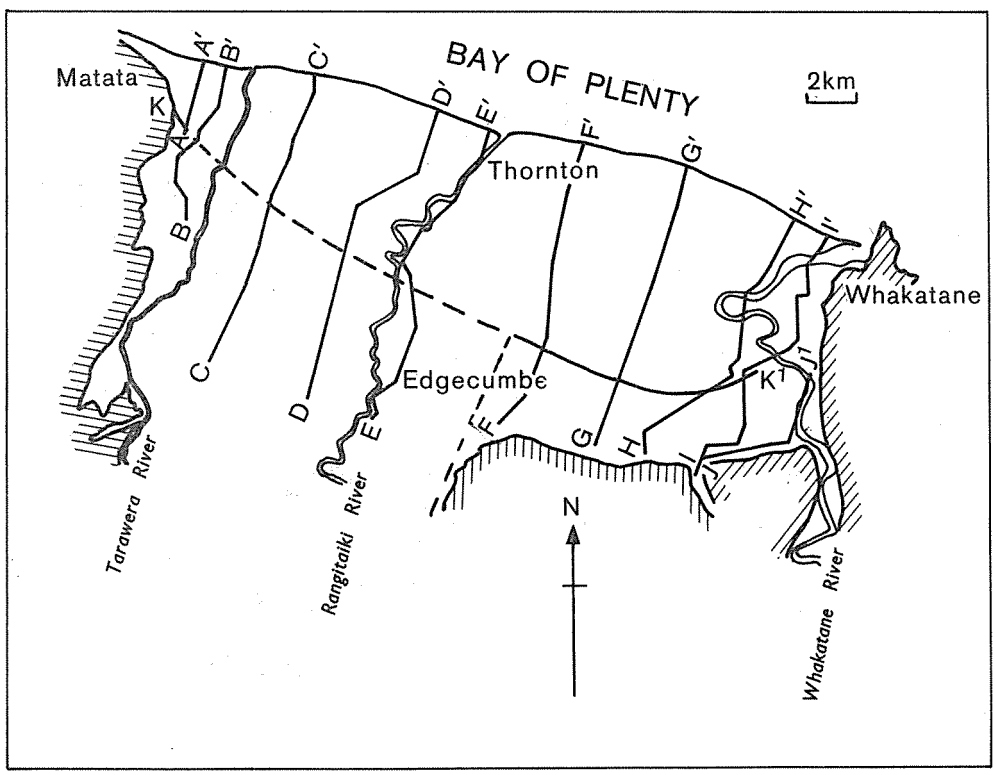

Figure 7a Plan of surficial geological cross-sections on the Rangitaiki Plain. Sections AA' to JJ' are at right angles to the coast and KK' is parallel to the coast. A broken line near the inland end of line FF' represents the extension of a concealed fault.

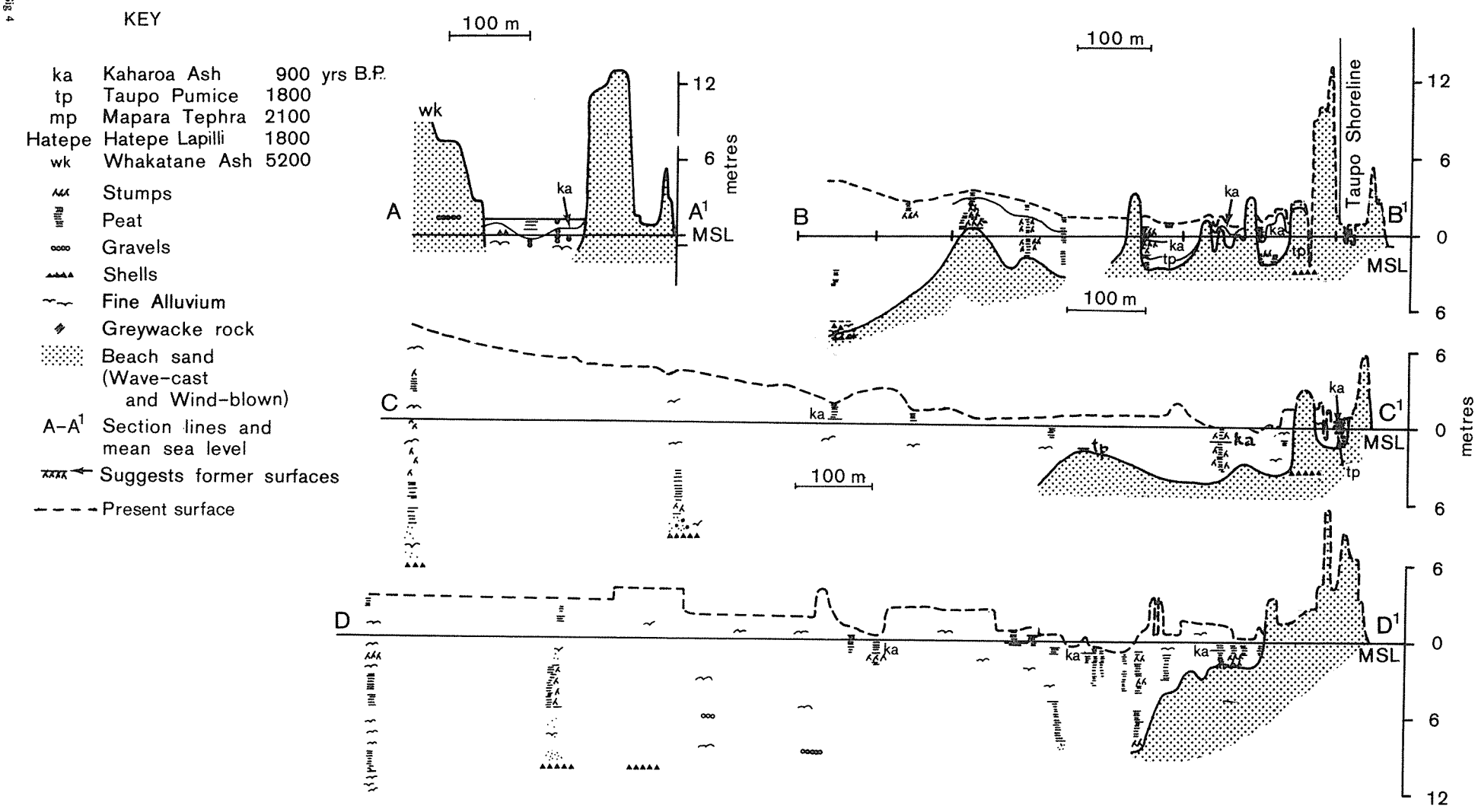

Figure 7(b) Sections AA' to DD'

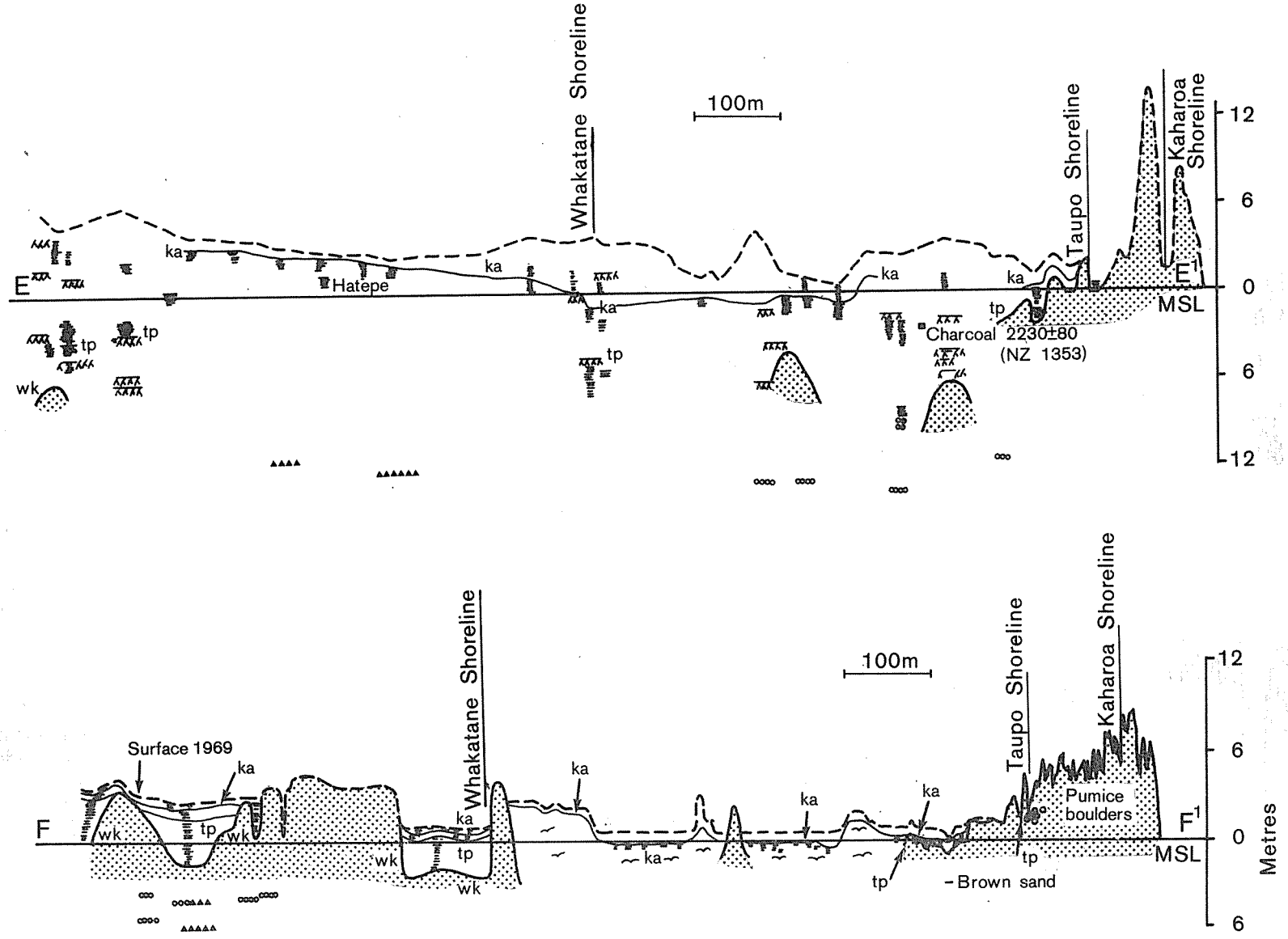

Figure 7(c) Sections EE′ to FF′

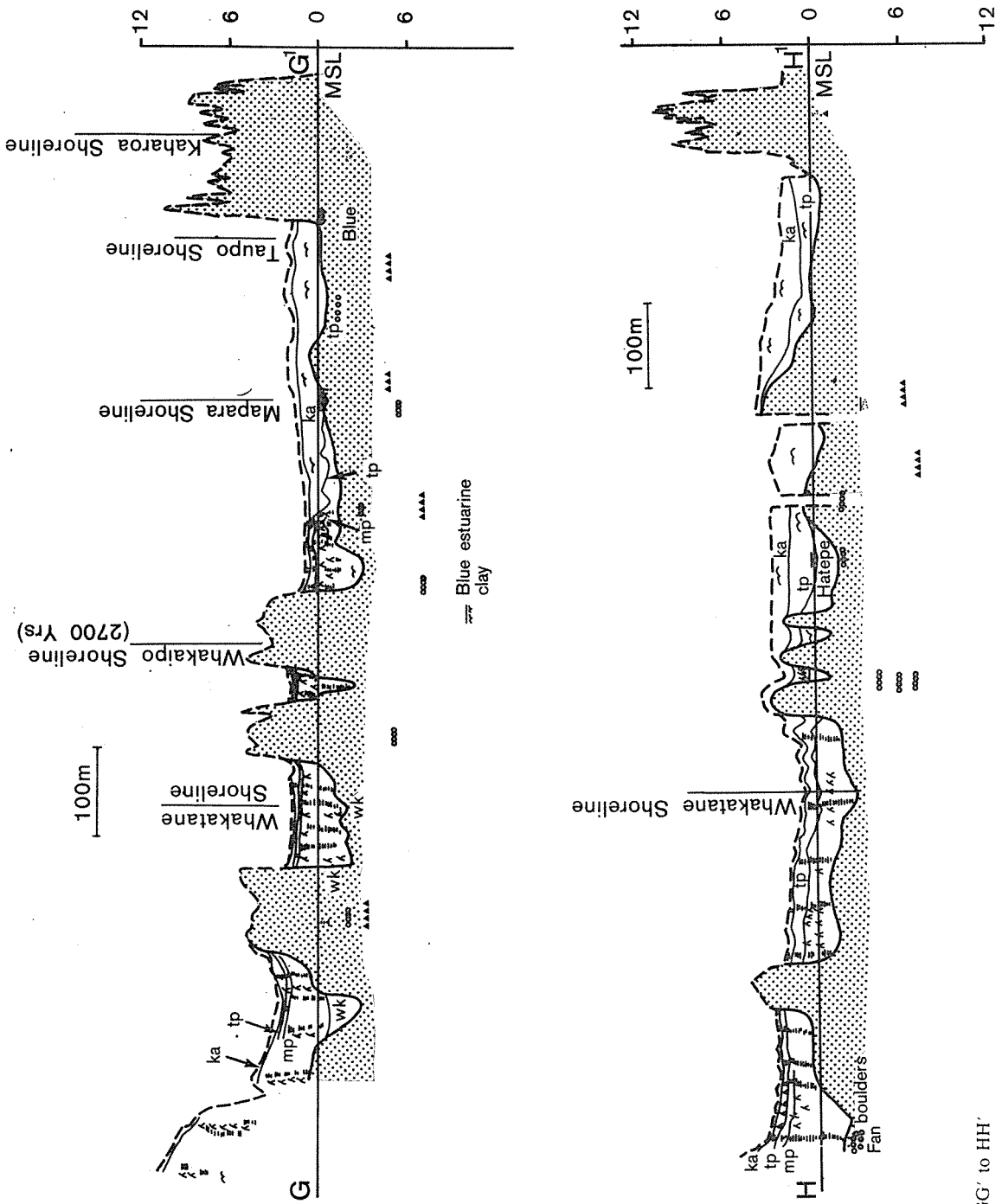

Figure 7(d) Sections GG' to HH'

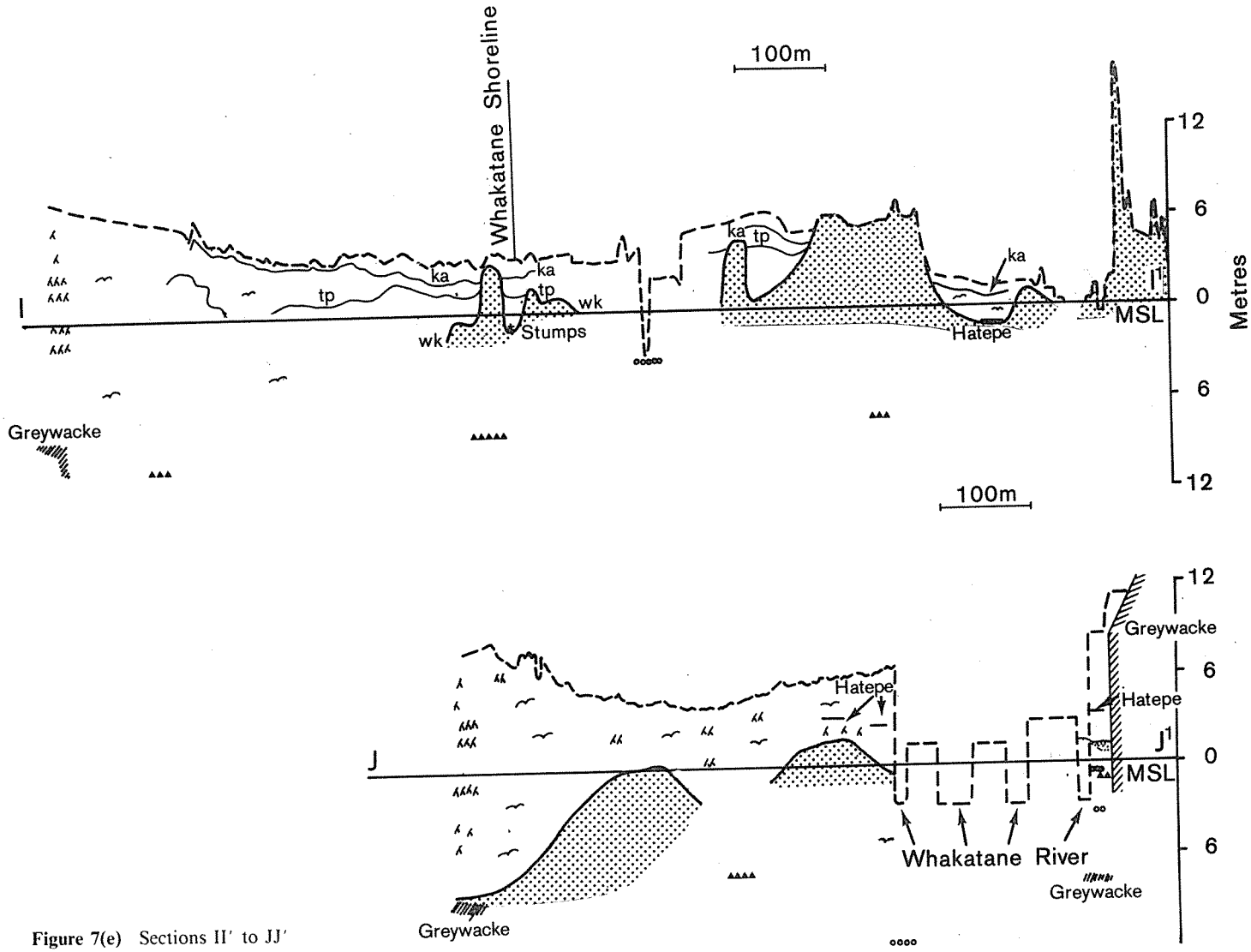

Figure 7(e) Sections II' to JJ'

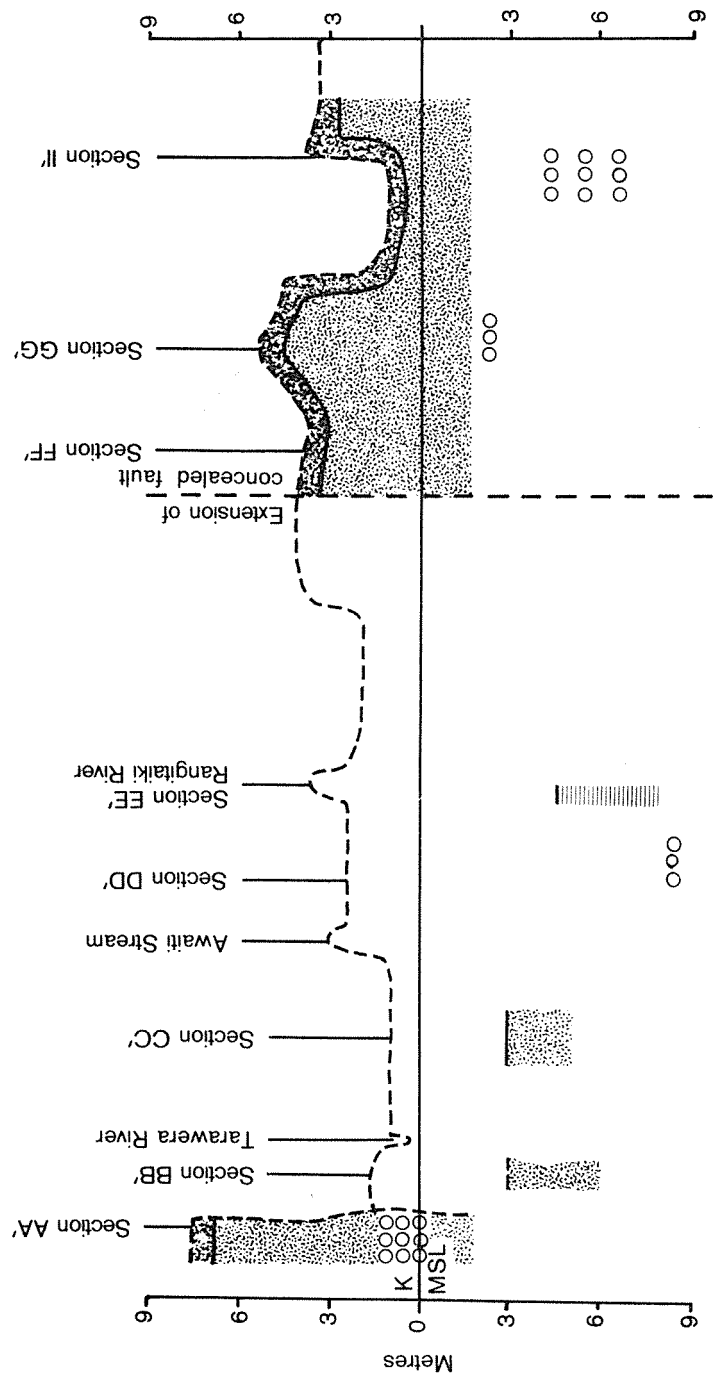

Figure 7(f) Section KK'

APPENDIX 5

DISTRIBUTION AND DEPTH OF PEAT AND PEATY DEPOSITS ON THE RANGITAIKI PLAINS

A large-scale soil map does not permit a generalised view of the distribution of peat and of peaty deposits. Fig. 8 shows the distribution and depth of these deposits according to the following categories.

1. Volcanic ash (< 40 cm) on very shallow peat (< 40 cm thick)

This peat was formed by shallow bodies of water on the former flood plain of the Rangitaiki River, between the time of the Taupo Pumice eruptions (*c.* 1800 yr BP) and that of Kaharoa Ash (*c.* 900 yr BP). At the time of peat formation, the Rangitaiki valley was a lake. The deposits are parent material for Awakeri series and when the soil is artificially drained, the thin to very thin layer of peat, which lies within 40 cm of the soil surface, dries out irreversibly. It then acts, at least partially, as a root barrier, particularly for deep rooting plants such as kiwifruit and some grass species.

2. Alluvium (< 1 m) on shallow to moderately deep peat (< 1 m thick)

This deposit is important to land planning decisions because the peat layer, although < 1 m in thickness, is hidden or masked by mineral soils, including Paroa and Awakaponga series. It particularly affects building foundations. This combination of deposits occurs near the Rangitaiki and Tarawera Rivers but was not noted on the Whakatane River flood plain.

3. Volcanic ash (< 40 cm) on deep peat (< 3 m thick)

This combination produces very peaty soils which can be used only with caution. The deposits occur mainly on the margins of the Plains: at Awakeri and Te Mapou where peat has accumulated in a depression between hills and the alluvium of the former Rangitaiki River flood plain, and on the western side of the Plains along Braemar Road between the hills and the alluvium of the Tarawera River. The deposits also occur at Thornton, in a depression between the alluvium of the former Rangitaiki River flood plain and alluvium from its former distributary, the Orini Stream. Deep peat has further been noted between old inland dune systems east of Awakeri and at Whakatane West.

The peat and peaty deposits at Te Mapou, Awakeri and Thornton were formed after the Taupo Pumice eruptions (*c.* 1800 yr BP) but before the Kaharoa Ash eruptions (*c.* 900 yr BP), while the deposits at Whakatane West were formed after the Whakatane Ash eruption (*c.* 5200 yr BP) but before the Whakaipo Tephra eruption (*c.* 2700 yr BP). No age-span can be allotted to the deposits on the western side of the Plains.

The peat is mainly low-moor sedge peat formed from *Baumea* spp. (Campbell *et al.* 1973). In wetter periods Restionaceae were established and in drier periods *Gleichenia* spp. flourished. Below a depth of about 1 m, the peat is markedly laminated and thus not easy to drain. Both Awaroa and Pongakawa soil series are formed on deep peat while Waioho series includes deep peat as subsurface material.

4. Alluvium (1–3 m, occasionally up to 7 m thick) on subsurface peat (2–4 m thick)

The presence of peat at this depth was established by shallow boreholes and the information is included to show that deep beds of peat are not confined to near-surface deposits as in categories 2 and 3 above. The base of the subsurface peat is 4–9 m below mean sea level.

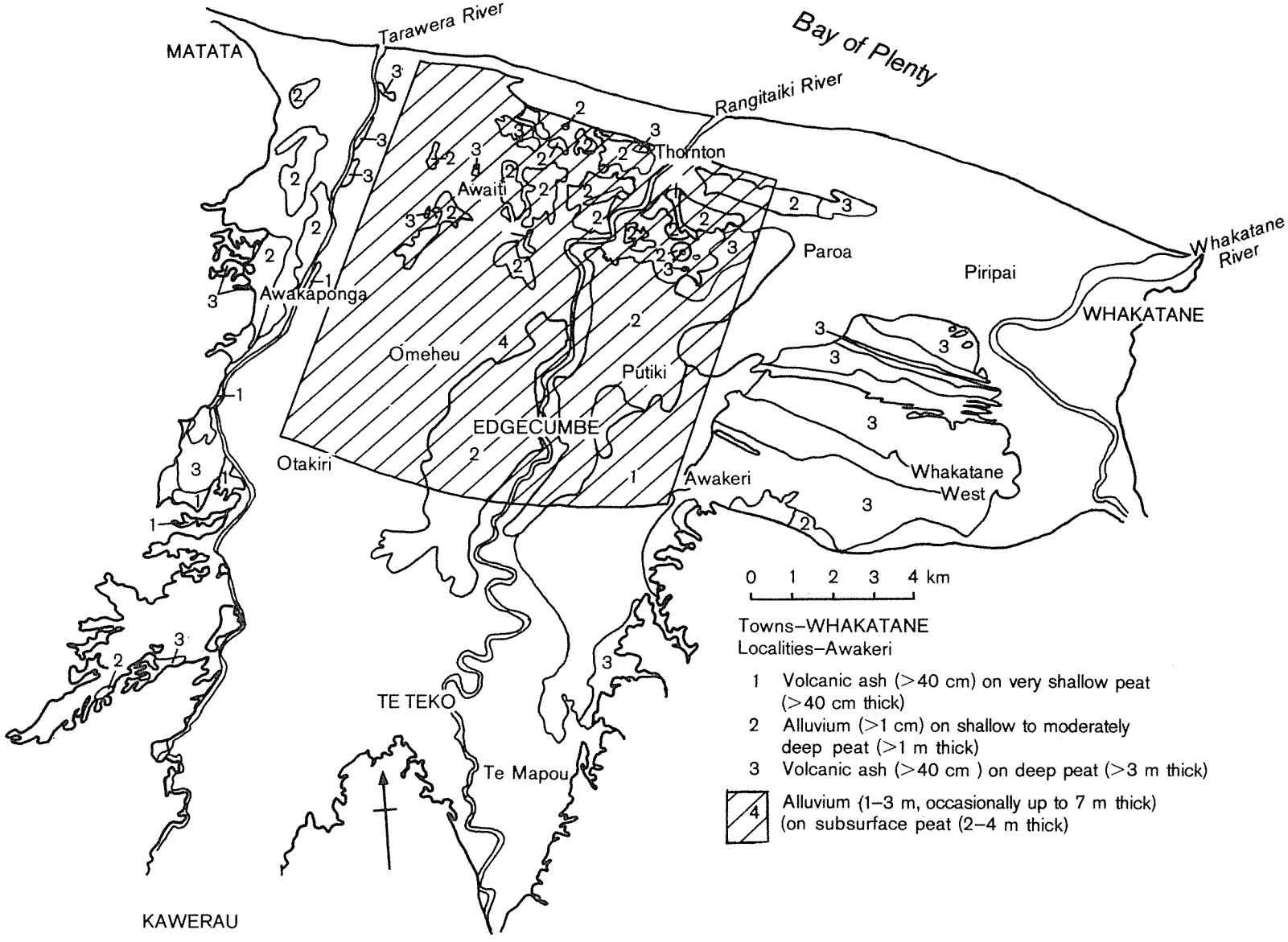

Figure 8 Distribution and depth of peat and peaty deposits in the Rangitaiki Plains basin

APPENDIX 6

DISTRIBUTION OF DIATOMACEOUS EARTH ON THE RANGITAIKI PLAINS

Although diatomaceous earth is classified as an organic material it is more nearly mineral than organic in composition. It is a limnic deposit formed from microscopic single-celled plants that secrete siliceous frustules in a great variety of forms. They accumulate in enormous numbers in the lower part of an organic soil during the open-water stage of bog development. The population of diatoms increases markedly or even explosively after a rhyolitic volcanic eruption. Thus diatomaceous earth is highly siliceous.

The distribution of diatomaceous earth is restricted to former flood plains of both the Tarawera and the Rangitaiki Rivers, particularly towards the coast from Thornton to Matata (Fig. 9). Shallow lakes of clear, fresh water were most likely a feature of these flood plains, particularly after the rhyolitic Kaharoa Ash eruption of *c.* 900 yr BP. No diatomaceous deposits have been found on the Whakatane River flood plain. In a few places, diatomaceous deposits have been found under the Kaharoa Ash layer. Thus the source of silica for the bodies of diatoms is related to the highly siliceous air-fall Kaharoa Ash and the alluvium derived from its ejecta. Taupo Pumice alluvium from the Omeheu Stream may also have been a source of silica.

When wet, diatomaceous earth looks like peat, but the colour is more olive brown than dark brown and the consistence more slippery. When dry, it is much less dense than peat, yielding a dry bulk density of about 0.7. Further, the material has a low bearing-strength when wet and is thus unsuitable for foundations. When dry, however, it seems to regain strength on compaction. Nevertheless, it is prudent to consider a concrete raft type of foundation for all buildings on this material.

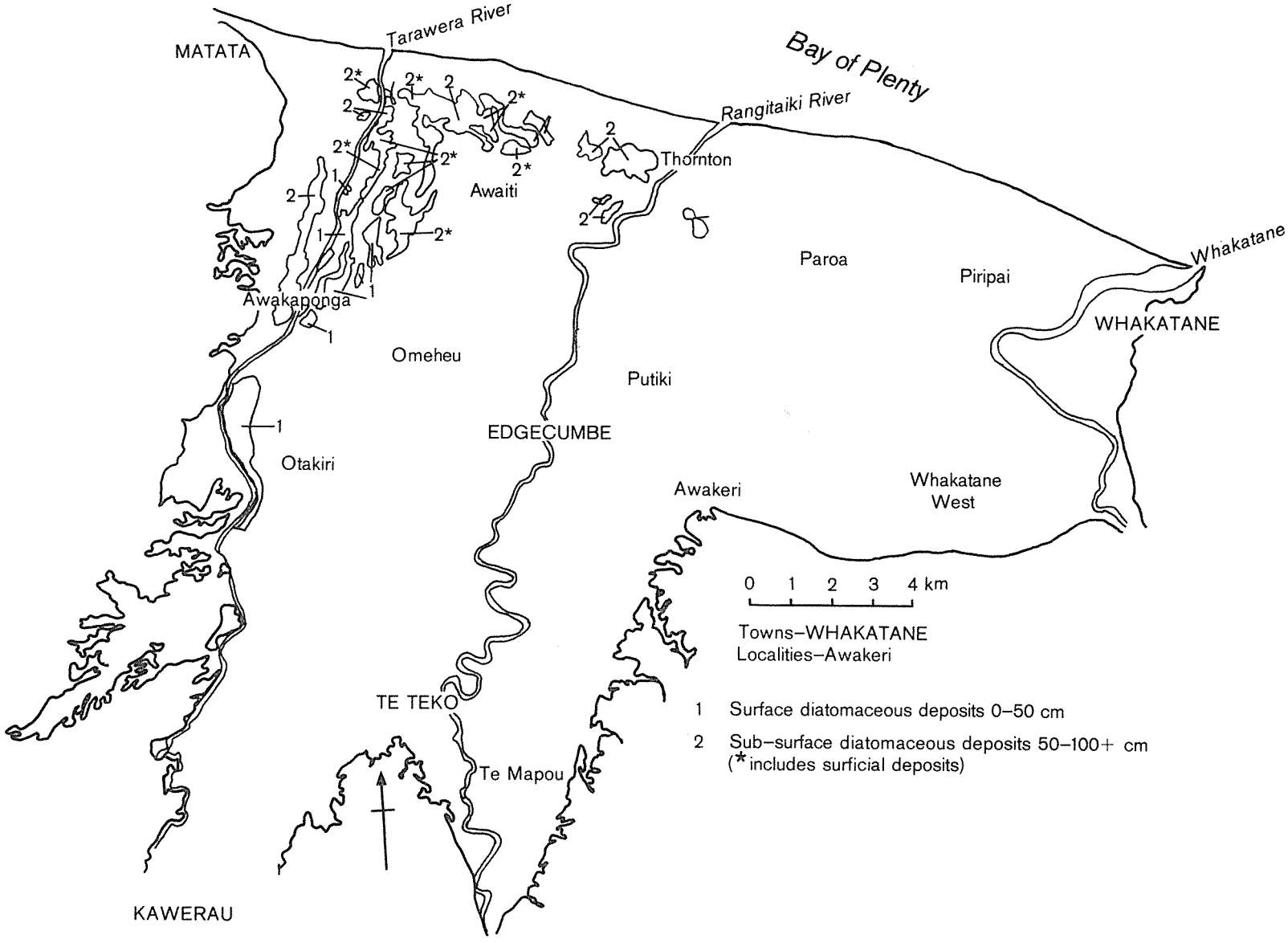

Figure 9 Distribution of diatomaceous earth on the Rangitaiki Plains

APPENDIX 7

SOIL MAPPING UNIT DESCRIPTIONS

by W.A. Pullar and W.C. Rijkse

EXPLANATORY NOTES

1 SOIL MAPPING UNIT NAME

When soils are mapped, an attempt is made to subdivide the survey area into a number of homogeneous or near-homogeneous segments, so that each segment may be classified and predictions made about the behaviour, under various conditions, of the soils found within the segment. Each of these segments is a mapping unit. In this survey, each mapping unit contains a mainly-homogeneous soil type or soil phase (Taylor and Pohlen 1979) and is, therefore, named after the relevant type or phase.

Soil types are indicated by a geographic name coupled with the textural class of the topsoil, e.g. Opouriao fine sandy loam. Sometimes the textural class of a subsoil layer is added, in order to show differences between soils which have the same topsoil layers, e.g. Paroa coarse sandy loam on peat is distinguished from Paroa coarse sandy loam by a peaty subsoil.

Soil phases are subdivisions of the type, based on differences, such as slope, which are important to land use, e.g. Kawerau loamy coarse sand, undulating phase.

A compound mapping unit, indicated by the word 'soils' after the geographic name, has been employed in this survey for soils having a wide range of profile textures, caused by fequent flooding and sedimentation, which cannot be separated at the scale of the map, e.g. Rangitaiki soils, Matata soils.

In a few areas, although the soil profiles differed sufficiently to justify creating a new series name, the total area of the proposed new series was not large enough to warrant it. These profiles have been called variants, e.g. Te Rahu loamy sand, peaty subsoil variant.

Soil types with similar site and profile features are grouped into soil series and given the same geographic name. They are regarded as the basic taxonomic units of the survey and are listed and classified in the pedological legend (Table 7, p.11). Some geographic names have been specially chosen so that the name alone indicates the nature of the soil, for instance, Kopeopeo is a locality known for its sandy soils; Paroa is named for its poorly drained soils. Other names have been taken from the soil set names in 'General Survey of the Soils of North Island, New Zealand' (N.Z. Soil Bureau 1954). These names refer to soils occurring elsewhere in the Bay of Plenty and other districts but, where possible, the original concept of the soil set has been retained. However, since many of these soil sets contain a wide range of soils, most of them have been subdivided into several different soil series in this survey. Correlation of these new soil series with the original sets is given in Table 9, p.14.

2 MAP SYMBOL

This symbol designates the soil mapping unit on the soil map.

3 AREA (ha)

The area given is the total area covered by the mapping unit, and was estimated by planimeter. Figures were rounded to the nearest 10 hectares.

4 SOIL CLASSIFICATION

Classification of the dominant soil type in the mapping unit is given in the common terms of the N.Z. genetic soil classification (Taylor and Pohlen 1979).

5 SOIL CORRELATION

Correlations are given with the North Island soil sets (N.Z. Soil Bureau 1954) and with soil types and phases of the Whakatane borough and environs survey (Pullar *et al.* 1978).

6 PARENT MATERIAL AND SUBSURFACE MATERIAL

Parent material is the weathered unconsolidated material from which the soil has been formed and, for purposes of agriculture, is not examined very much below 1 m from the surface.

On the Plains, generally unconsolidated subsurface material extends to a depth of about 5 m. A knowledge of the material at this depth is necessary for the design of foundations for buildings and roads, and is useful, also, in understanding groundwater relationships for horticulture. Surficial sections across the plains are given in Fig. 7 and discussed in Appendix 4, p.28.

7 PHYSIOGRAPHIC POSITION AND SLOPE

Physiographic position gives the position of the soil in the landscape. Slopes are classified according to Taylor and Pohlen (1979) and are as follows:

Flat and flat to gently undulating
Easy rolling (most slopes under 5°)
Rolling (most slopes under 12°)

8 GEOGRAPHIC DISTRIBUTION

Distribution gives the geographic occurrence of the soil. Each mapping unit is associated with a particular physiographic position, e.g. Opouriao soil types occur on river levées, Paroa soil types in backswamp lowlands and Kopeopeo soil types on ridges and swales of dunes.

9 VEGETATION AND LAND USE

Vegetation refers to the general trends of plant associations recorded for the soil mapping units. Land use is that recorded in the field at the time the soil profiles were being described.

10 ELEVATION RANGE (m)

This is the altitudinal range in metres above mean sea level over which the soil mapping unit occurs.

11 MEAN ANNUAL RAINFALL RANGE (mm)

The approximate range of mean annual rainfall under which the soils occur is estimated from N.Z. Meteorological Service (1973). Figures are given to the nearest 50 mm.

12 BRIEF SOIL PROFILE DESCRIPTION

This section gives a brief profile description of the dominant soil type within the mapping unit. Some variation of this representative profile can be expected and the more important are given under 'Inclusions and variants within the mapping unit'. Descriptive terminology follows Taylor and Pohlen (1979).

13 CHARACTERISTIC SOIL AND SITE FEATURES

The features given are those soil morphological and environmental features which are characteristic of the dominant soil type within the mapping unit and which distinguish it from similar soil types.

Soil thickness

The range of thickness of soil horizons and layers is given as follows:

Very thin	0–15 cm
Thin	15–45 cm
Moderately thick	45–90 cm
Thick	90–120 cm
Very thick	120+ cm

14 INCLUSIONS AND VARIANTS WITHIN THE MAPPING UNIT

Most of the individual soil mapping units contain inclusions of other, named, soils which are too small to be shown at the scale of mapping used. Variants comprise unnamed soils which differ in some major morphological features from the defined range of the soil type.

15 OVERALL SOIL DRAINAGE (class)

Overall drainage of the dominant soil type within the mapping unit, under prevailing conditions of the site, is indicated by soil drainage classes. These classes are estimated on the rate at which water is removed from the soil and the time during which the soil is above field cpacity, and are defined fully in Taylor and Pohlen (1979). The classes are: very poorly drained; poorly drained; imperfectly (or somewhat poorly) drained; moderately well drained; well drained; somewhat excessively drained. If soil drainage is given as, e.g. 'well drained to moderately well drained', the overall drainage is gradational between these two classes.

'Natural drainage' refers to drainage of the soil type under primitive conditions. This is included to indicate the class of overall drainage to which the soil type will return if artificial drainage is not maintained.

'After drainage' refers to the overall drainage class of the soil under artificial drainage, including gravity drains and groundwater pumps. Thus, naturally poorly drained soil types such as Paroa silt loam have been upgraded to moderately well drained soils. Artificial drainage is extensive on the Rangitaiki Plains.

16 SOIL EROSION AND FLOODING

The severity and type of soil erosion most commonly prevailing under current (and potential) land use is given. Flooding is given in terms of frequency and the length of time that floodwaters are likely to remain on the land. Frequent flooding in the survey area is now prevented by stopbanking on all three major rivers.

17 GENERAL CHEMICAL FEATURES

Ratings for the more important chemical measurements are given as a basis for assessment of the soil nutrient status. Chemical analyses for a few representative soil samples are given in Table 11 (p.16) with N.Z. Soil Bureau ratings given in Table 12. The analyses given in Table 10 complement those already published in *N.Z. Soil Bureau Bulletin 38* (Pullar *et al.* 1978).

18 YIELDS

Present and potential carrying capacity/dry matter production, where known, are given. Potential yields represent the highest yields known to have been obtained and do not necessarily represent the ultimate potential. Carrying capacity is expressed in stock units (ewe equivalents) per hectare. Dry matter production (DM kg per ha per yr) was obtained on three soil types from ryegrass variety trials and from mowing trials designed to evaluate the role of phosphate and sulphur topdressing. Dry matter production for the remaining soil types was assessed by MAF Farm Advisory Officers, Whakatane.

19 PASTURE RESPONSES TO TOPDRESSING

On the Plains, the rate of topdressing is assumed to be approximately 200 kg of 30% potassic superphosphateper year. Responses have been noted from pasture observational trials and from mowing trials. For the observational trials, responses are given as nil, fleeting, slight, fair, good, very good or excellent. Not all soils have been assessed for pasture responses and interpolation was carried out for some soil units. Elements required for plant growth include phosphorus (P), potassium (K), sulphur (S) and lime (L). Cobalt (Co), selenium (Se) and Copper (Cu) are occasionally used for maintenance of stock health.

20 SOIL LIMITATION CLASSES

The dominant soil type within the mapping unit is rated according to the type and degree of soil limitations for various kinds of land use, including pastoral farming, cropping, horticulture, exotic forestry and urban uses. Different ratings may apply to areas of any other soil types occurring within the mapping unit. The limitations refer to soil properties that cannot easily be changed by land users, including soil texture, liability to erosion and slope. Nutrients are not a true limitation for potential use as deficiencies may readily be corrected by topdressing.

Complete classifications, listing the soil limitations for each class together with brief explanations, are given on pp.17–19.

21 VALUE FOR FOOD PRODUCTION (class)

The dominant soil type within each mapping unit is classified according to the soil's value for food production in terms of Section 3d (also 3e and f) of the Town and Country Planning Act 1977. The full classification given on pp.19–20 includes the names of the soil types in each class. Class 1 is subdivided into subclass 1A for soils of high actual value for food production and subclass 1B for soils of high potential value (e.g. for soils with slight but easily remedied drainage problems).

22 GENERAL SOIL LIMITATIONS AND POTENTIAL

A very general indication is given of the main limitations for use of the dominant soil type found within the mapping unit.

Soil mapping unit name[1]: PIKOWAI SAND

Map symbol[2]: Pki **Area** 461 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Patea sand (23) (N.Z. Soil Bureau 1954); Kopeopeo sand (7) (Pullar *et al.* 1978).

Parent material[6]: Wind-blown coastal pumiceous sand, mantled with a thin cover of Tarawera Ash except where eroded from foredunes. Subsurface material is partly wind-blown sand and partly wave-cast sand.

Physiographic position and slope[7]: Dune system with ridges and swales parallel to and bordering the coast, also partly irregular, curvilinear blow-out dunes near Whakatane. The dune system was formed partly after 1886 and partly before. Undulating to easy rolling slopes.

Geographic distribution[8]: Occurs as a single continuous belt immediately behind the Bay of Plenty shoreline, from Matata to Whakatane. This belt is 22 km long and 100 m wide at Matata and 800 m wide near Whakatane.

Vegetation and land use[9]: Herbs, exotic pasture grasses and bracken fern. Wintering land for dairy farming; residential in the Piripai locality.

Elevation range (m)[10]: 6–14 mainly, occasionally as low as 1.5

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

RIDGE

Horizon	*Depth (cm)*	*Description*
O	0–2	grass and fern litter; continuous cover,
A_1	2–6	very dark brown humic sand; many live and dead roots; sharp smooth boundary,
C	6–7	grey sand; few live roots; sharp smooth boundary,
IIC	7–13	dark greyish brown sand; sharp smooth boundary (Tarawera Ash),
IIIuA	13–16	dark brown sand; few live and dead roots; sharp smooth boundary,
	on	greyish brown sand; decayed sheaths of bracken fern rhizomes; few live roots (wind-blown sand).

SWALE

O_1	0–1	discontinuous litter,
A_1	1–6	very dark brown fine sandy loam; very friable; cast granular structure; many live roots; sharp wavy boundary (Rotomahana Mud),
C_1	6–9	dark olive grey fine sandy loam; firm; few live roots; sharp wavy boundary (Rotomahana Mud),
IIC_1	9–13	very dark greyish brown sand and coarse sand; few live roots; sharp smooth boundary (Tarawera Ash),
	on	very dark grey humic sand; occasional live roots; sharp smooth boundary (coastal wind-blown sand).

Characteristic soil and site features[13]: Rudimentary surface profiles on ridges, but up to five thin, buried soils occur to a depth of nearly a metre for profiles in the swales. On the dunes nearest the sea, the topsoil is a very shallow (4 cm) grey sand underlain by loose olive sand, but spinifex roots persist beyond a depth of 80 cm. On ridges further inland, the effective topsoil (14 cm) is dark brown and includes layers of raw sand and Tarawera Ash. Profiles in swales are too variable for general description.

Inclusions and variants within the mapping unit[14]: Piripai loamy sand (the Kaharoa Ash boundary does not strictly follow the mapped topographic boundary between Pikowai sand and Piripai loamy sand)

Overall soil drainage (class)[15]: Excessively drained; water table low. Permeability is slow in the subsurface sand, evidenced by slow drainage of stormwater in soak holes.

Soil erosion and flooding[16]: Wind erosion

General chemical features[17]: Plant nutrients are associated with the humus fraction of the upper 0–8 cm of the topsoil. This horizon is moderately acid and is medium in exchangeable calcium, low in potassium and low to medium in plant-available phosphorus. Nutrient levels fall off sharply below a depth of 8 cm in the raw dune sand.

Yields[18]: Present levels of 7 su per ha and 5500 kg per ha per yr may be raised with difficulty to 10 su per ha and 6500 kg per ha per yr

Pasture responses to topdressing[19]: P fair, P+K good, K good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
3E	3A	3B	3B	3

Value for food production (class)[21]: 3

General soil limitations and potential[22]: Sandy soil having a low moisture-holding capacity. Soil must be covered with vegetation in order to prevent wind erosion. Droughty in a dry summer. Suitable for pastoral farming and exotic forestry. Severe limitations of wind erosion for urban use; houses should be built no further seaward than the second ridge from the shoreline (about 100 m). At this distance, Tarawera Ash is found in the topsoil of stable dunes.

Soil mapping unit name[1]: **PIRIPAI LOAMY SAND**

Map symbol[2]: Pil **Area** 305 ha

Soil classification[4]: Composite recent soil on yellow-brown sands

Soil correlation[5]: Patea sand (23) (N.Z. Soil Bureau 1954); Kopeopeo loamy sand (7a) (Pullar *et al.* 1978).

Parent material[6]: Wind-blown coastal sand from rhyolitic pumice alluvium, capped with a thin cover (< 30 cm) of basaltic Tarawera Ash and rhyolitic Kaharoa Ash.

Physiographic position and slope[7]: Dune system with ridges and swales parallel to the coast, formed between 1800 and 900 years ago. Easy rolling slopes; hummocky.

Geographic distribution[8]: Occurs as a single continuous belt of young coastal dunes (excluding foredunes).

Vegetation and land use[9]: Herbs and exotic pasture grasses. Wintering land for dairy farming; recreational, residential and idle land.

Elevation range (m)[10]: 3–6 mainly, occasionally as high as 9

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–4	black loamy sand; very friable; cast granular structure; abundant live and dead grass roots; sharp smooth boundary (Tarawera Ash),
C	4–9	very dark grey sand and coarse sand; loose; some live roots; sharp smooth boundary (Tarawera Ash),
IIuA	9–12	black loamy sand; very friable; moderately developed medium and fine granular structure; some live roots; sharp irregular boundary (Kaharoa Ash),
IIu(B)	12–20	dark brown sand and coarse sand; loose; slippery; sharp smooth boundary (Kaharoa Ash),
IIIuC	*on*	yellowish brown sand; loose (coastal wind-blown sand).

Characteristic soil and site features[13]: On dune ridges, the topsoil is a shallow (< 17 cm) black to very dark brown loamy sand derived from Tarawera Ash and Kaharoa Ash and the subsoil is a shallow (< 10 cm) dark brown to yellowish brown, slippery sand derived from Kaharoa Ash. This rests on yellowish brown to olive brown, loose, wind-blown sand. In swales the effective topsoil is much deeper (up to 30 cm); the subsoil from Kaharoa Ash is thicker (up to about 15 cm) and more greasy and slippery.

Inclusions and variants within the mapping unit[14]: Pikowai sand on ridges eroded of Kaharoa Ash, with Tarawera Ash resting on dune sands. Wind-blown sand mixed with Tarawera Ash. Unnamed swale variant in lowest part of swale where topsoil may be as thick as 70 cm.

Overall soil drainage (class)[15]: Somewhat excessively drained; The subsurface sand at Piripai is now found to be slowly permeable for stormwater discharge.

Soil erosion and flooding[16]: Negligible wind erosion has occurred since the Tarawera eruption. No flooding.

General chemical features[17]: Plant nutrients are associated mainly with the humus fraction of the upper 8 cm of the topsoil. This horizon is moderately acid and is high in exchangeable calcium and magnesium, medium in potassium and low to medium in plant-available phosphorus. Nutrient levels fall off sharply below a depth of 8 cm.

Yields[18]: Present levels of 7 su per ha and 5500 kg per ha per yr may be raised with difficulty to 10 su per ha and 6500 kg per ha per yr

Pasture responses to topdressing[19]: P fair, P+K good, K good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	3B	2B	2

Value for food production (class)[21]: 3

General soil limitations and potential[22]: Sandy soil having a low moisture-holding capacity and rapid permeability. Soil must be covered with vegetation in order to prevent wind erosion. Droughty in a dry summer. Ideal wintering land for pastoral farming. Suitable for exotic production forestry. Suitable for urban, residential and recreation uses, provided measures are taken to minimise wind erosion.

Soil mapping unit name[1]: **KOPEOPEO LOAMY SAND**

Map symbol[2]: Koe **Area** 253 ha

Soil classification[4]: Composite yellow-brown pumice soil on podzolised yellow-brown sands

Soil correlation[5]: Patea sand (23) (N.Z. Soil Bureau 1954); Kopeopeo loamy sand (7a) (Pullar *et al.* 1978).

Parent material[6]: Fine air-fall tephra, including thin layers of Tarawera Ash, Kaharoa Ash, Taupo Pumice, Mapara Tephra and Whakaipo Tephra, overlying dune sand at 40–60 cm depth. The dune sand is 9–15 m thick, resting on mud and pumice gravels, respectively at about 10 and 13 m below mean sea level.

Physiographic position and slope[7]: Inland dune system formed between 5000 and 1800 years ago. Mainly undulating with minor easy rolling slopes.

Geographic distribution[8]: Occurs as a mainly continuous belt inland from coastal dunes, from Matata to Whakatane, and discontinuous areas in the Whakatane West locality

Vegetation and land use[9]: Mainly improved pasture. Dairy farming; residential in Whakatane borough.

Elevation range (m)[10]: 16 at Matata, falling to 5 at Awakeri and 6 at Whakatane

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–10	black loamy sand; very friable; weakly developed fine crumb structure; abundant live roots; sharp smooth boundary (Tarawera Ash),
IIA_{12}	10–20	dark brown sand; loose; many live roots; sharp smooth boundary (Kaharoa Ash),
$(III)A_{13}$	20–30	very dark brown loamy sand and coarse sand; very friable; weakly developed medium crumb structure; some live roots; sharp smooth boundary (Taupo Pumice),
$(III)B_{2feh}$	30–36	dark reddish brown fine gravel (iron-oxide coated); loose; some live roots; sharp irregular boundary (Taupo Pumice),
(IV)C	36–51	light brownish grey fine sand and loamy sand; loose; few live roots; sharp wavy boundary (dune sand),
$(V)uB_{2h}$	51–80	dark reddish brown sand coated with humus; very firm; massive; sharp wavy boundary (dune sand) (pan),
	on	light olive brown sand; loose; some mottles with strong brown centres (dune sand).

Characteristic soil and site features[13]: Topsoils are deeper than most other soils in this survey, ranging from 30 to 50 cm. Subsoils are dark reddish brown from the iron-oxide coated Taupo Pumice gravels. On the oldest inland dunes, the subsoil grades into a pan of humus-iron-oxide coated dune sand, 30 to 50 cm thick. On occasions, egg-cup podzols have been noted, suggesting that the soil formed under podocarp trees not now seen. The iron-oxide pan is an obsolete feature in present-day soils.

Inclusions and variants within the mapping unit[14]: In Whakatane borough, soils have been disturbed during Polynesian occupation and the volcanic ash layering has been destroyed; the topsoil contains burnt stones, shells and charcoal.

Overall soil drainage (class)[15]: Moderately well to somewhat excessively drained

Soil erosion and flooding[16]: Nil

General chemical features[17]: The upper topsoil is moderately acid with medium levels of exchangeable calcium, magnesium and potassium, and low to medium plant-available phosphorus. Underlying horizons are slightly acid and the nutrient levels fall, sharply at first, then a steady decline. The upper topsoil is medium in organic carbon and the nutrient values are probably related to the organic matter from present-day vegetation.

Yields[18]: Present levels of 12 su per ha and 7500 kg per ha per yr can be raised to 17 su per ha and 10 000 kg per ha per yr

Pasture responses to topdressing[19]: P fair, P+K good, K very good, Mo nil, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	3B	2B	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Iron-oxide–humus pan would restrict root penetration for deeper-rooting plants such as fruit trees but the pan is brittle and easily broken up with a ripper. Less than adequate moisture is available in summer for high production from pasture. Some of the younger dunes towards the coast may need drainage. Suitable for wintering land for dairying if farmed with Paroa and Pongakawa soil types. Market gardening and horticulture may be satisfactory if irrigation water available. Asparagus has proved successful near the coast at Thornton.

Soil mapping unit name[1]: **TE RAHU LOAMY SAND**

Map symbol[2]: Tr **Area** 58 ha

Soil classification[4]: Strongly leached yellow-brown pumice soil

Soil correlation[5]: Ohinepanea sand (14c) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin layer of Tarawera Ash, over thin layers of Kaharoa Ash, Taupo Pumice, Mapara Tephra and a thick layer of Whakatane Ash. On dune sand.

Physiographic position and slope[7]: Inland dunes. Undulating.

Geographic distribution[8]: Small belt of inland dunes at Matata

Vegetation and land use[9]: Improved pasture. Dairy farming, horticulture.

Elevation range (m)[10]: 3–7

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–8	black loamy sand; very friable; cast granular and crumb structure; live roots abundant in upper 5 cm; sharp smooth boundary (Tarawera Ash),
IIA_{12}	8–18	black loamy sand; very friable; cast granular and crumb structure; some live roots; distinct wavy boundary (Kaharoa Ash),
$(III)A_{13}$	18–26	very dark brown fine sandy loam; very friable; moderately developed medium granular and cast granular structure; some live roots; distinct wavy boundary (Taupo Pumice),
$(III)A_{14}$	26–33	brown coarse sand and fine gravel; loose; a few live roots; sharp but irregular boundary (Taupo Pumice),
IVB_{11}	33–58	reddish brown loamy sand; brittle; some live roots; distinct wavy boundary (Whakatane Ash),
IVB_{12}	58–88	reddish brown coarse sand and occasional fine gravel; loose; some live roots; sharp smooth boundary (Whakatane Ash),
	on	light grey sand; loose (dune sand).

Characteristic soil and site features[13]: Soils and buried soils formed from layered air-fall volcanic ash on the oldest inland dunes. Deeper than usual topsoil of 33 cm.

Inclusions and variants within the mapping unit[14]: Paroa silt loam on peat at boundary with Te Rahu loamy sand.

Overall soil drainage (class)[15]: Well drained; water table low.

Soil erosion and flooding[16]: Not applicable; no erosion and surface water from neighbouring hills runs off quickly.

General chemical features[17]: The upper part of the topsoil is moderately acid (pH 5.5) and is medium in plant-available phosphorus, nitrogen, and exchangeable calcium and magnesium, but low in exchangeable potassium.

Yields[18]: Present levels of 12 su per ha and 7500 kg per ha per yr can be raised to 17 su per ha and 10 000 kg per ha per yr

Pasture responses to topdressing[19]: P fair, P+K good, K very good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	2A	1A	1A	1

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Upper part of topsoil may tend to dry out in a dry summer. Suitable for intensive pastoral farming when associated with Paroa silt loam on peat. Suitable for exotic production forestry and highly suitable for urban residential use.

Soil mapping unit name[1]: **TE RAHU LOAMY SAND, PEATY SUBSOIL VARIANT**

Map symbol[2]: Trp **Area** 256 ha

Soil classification[4]: Strongly leached yellow-brown pumice soil

Soil correlation[5]: Pongakawa peaty loam (107f) (N.Z. Bureau 1954); Kopeopeo loamy sand, peaty phase (7b) (Pullar *et al.* 1978).

Parent material[6]: Thin layer of Tarawera Ash, over thin layers of Kaharoa Ash, Taupo Pumice, Mapara Tephra and a thick layer of Whakatane Ash, on dune sand. Thin layers of peat and peaty loam occur in the upper 50 cm. Rotomahana Mud may occur, also, with Tarawera Ash.

Physiographic position and slope[7]: Oldest inland dunes. Undulating.

Geographic distribution[8]: Single belt of inland dunes in the Awakeri–Whakatane West locality

Vegetation and land use[9]: Improved pasture. Intensive dairy farming; small area of kiwifruit.

Elevation range (m)[10]: 4.5–5

Mean annual rainfall (mm)[11]: 1350–1450

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–10	black sandy loam; friable; cast granular structure; live roots abundant in upper 5 cm; many dead roots; sharp smooth boundary (Tarawera Ash and Rotomahana Mud),
IIA_{12}	10–20	black loamy sand; very friable; fragments and grains; some live roots; distinct wavy boundary (Kaharoa Ash),
IIC	20–25	dark greyish brown sand; some live roots; sharp smooth boundary (Kaharoa Ash),
(III)uA	25–33	very dark brown fine sandy loam; friable; moderately developed medium granular and cast granular structure; some live roots; distinct wavy boundary (Taupo Pumice),
IV2uA	33–45	dark reddish brown sandy peaty loam; sharp smooth boundary,
V3uA	45–70	reddish brown loamy sand; brittle; some live roots; distinct wavy boundary (Whakatane Ash),
$V3uB_{2fe}$	70–100	reddish brown coarse sand and occasional fine gravel; loose; some live roots; sharp smooth boundary (Whakatane Ash),
VI4uA	100–115	pale brown sand and fine sand; loose.

Characteristic soil and site features[13]: The profile is not a typical yellow-brown pumice soil. Thin accumulations of volcanic ash (and peat) seem to have encouraged the formation either of thicker than usual topsoils or of darkened horizons (up to 50 cm); this feature can also be seen in Te Rahu loamy sand and Kopeopeo loamy sand, and in Whakatane loamy sand on rolling land near Whakatane. The dunes are so much subdued, topographically, that they are scarcely recognisable.

Inclusions and variants within the mapping unit[14]: Pongakawa peaty sand in the Whakatane West locality. Only the swale portion of the dune system has peaty layers but they are too small in area to be separated individually.

Overall soil drainage (class)[15]: Well to moderately well drained. The area covered by the dunes was swampy at the time of European settlement. The water table now lies at about 3 to 6 m depth.

Soil erosion and flooding[16]: Nil

General chemical features[17]: The upper part of the topsoil is moderately acid (pH 5.5) and is medium in plant-available phosphorus, organic carbon, nitrogen, and exchangeable calcium and magnesium, but low in exchangeable potassium.

Yields[18]: Present levels of 15 su per ha and 10 000 kg per ha per yr can be raised to 20 su per ha and 12 000 kg per ha per yr

Pasture responses to topdressing[19]: P fair, P+K good, K good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	2A	1B[1]	1B	1

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Surface may tend to puddle in a wet winter and the upper topsoil (0–20 cm) may dry out in a dry summer. The topsoil of the Te Rahu peaty variant may be more moisture-retentive than Te Rahu loamy sand but would not offer as firm a surface in winter. Suitable for pastoral farming when associated with neighbouring Pongakawa peaty sand. Root crops such as carrots, parsnips, lettuces, runner beans and melons are likely to be suitable, provided irrigation water is available. Suitable for exotic production forestry and highly suitable for urban residential use.

[1]shallow peat in places

Soil mapping unit name[1]: **MURIWAI SILT LOAM**

Map symbol[2]: Muw **Area** 105 ha

Soil classification[4]: Saline gleyed recent soil

Soil correlation[5]: Meeanee–Farndon complex (111) (N.Z. Soil Bureau 1954); Muriwai silt loam (5) (Pullar *et al.* 1978).

Parent material[6]: Fine alluvium from rhyolitic ash. May also include fine greywacke alluvium in Whakatane estuary and organic matter in former estuary of Rangitaiki River near Thornton.

Physiographic position and slope[7]: Former tidal flats of Rangitaiki and Whakatane Rivers now protected from flooding. Flat.

Geographic distribution[8]: Areas near the coast east of the Tarawera River mouth

Vegetation and land use[9]: Largely poor pasture with some improved paspalum/white clover pasture; salt-tolerant plants such as selliera and cotula near Matata and buck's-horn near Whakatane. Mainly unused land.

Elevation range (m)[10]: < 1

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{1g}	0–15	very dark grey and dark greenish grey silt loam; massive; many live, some dead roots; sharp smooth boundary,
G	15–23	greyish brown and greenish grey sandy loam; massive; many dead roots; distinct smooth boundary,
CG_{11}	23–31	greenish brown coarse sand; a few live roots; sharp smooth boundary,
CG_{12}	31–39	olive grey sand with much dark brown organic staining; smooth sharp boundary,
CG_{13}	39–57	grey silt loam; massive; many dead roots; distinct smooth boundary,
CG_{14}	57–75	dark greenish grey sandy loam; massive; many dead roots; distinct smooth boundary,
	on	dark greenish grey sand; some dead roots; brackish.

Characteristic soil and site features[13]: The kind of soil is indicated by the salt-tolerant plants growing in it. A wet soil with high water table for most of the year. Colours of the topsoil indicate slow drainage. The level of soluble salts is fairly high in places. Sometimes there are peaty layers which become malodorous when brought to the surface. Greenish grey estuarine sands at a depth of < 1 m.

Inclusions and variants within the mapping unit[14]: Awakaponga soil types in the Thornton and Matata localities. Unnamed peaty variants.

Overall soil drainage (class)[15]: Poorly to very poorly drained

Soil erosion and flooding[16]: Soil erosion nil. Tidal flats near Whakatane flooded by Whakatane River until 1972. Sea-water flooding by earthquake-generated tidal waves in 1960 and a storm in 1968.

General chemical features[17]: No samples collected for analysis. After the 1968 inundation, soluble salts in the 0–5 cm layer ranged from 0.99% to 1.68% and in the 2–10 cm layer from 0.39% to 1.67%. These levels are far too high for pasture plants to survive. An optimum level is < 0.1% total soluble salts.

Yields[18]: Potential is 15 su per ha and 11 000 kg per ha per yr but these levels may be difficult to sustain because the land is near sea level and swards tend to revert easily to tall fescue, Mercer grass, selliera and buck's-horn plantain.

Pasture responses to topdressing[19]: P fair, K nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
3A	3B	3C	3A	3

Value for food production (class)[21]: 3

General soil limitations and potential[22]: High level of soluble salts in some places is a limitation. Pastoral farming may be carried out if Muriwai silt loam is farmed in conjunction with Pikowai sand on neighbouring coastal dunes. Suitable for foundations in alluvium at Piripai and in both peat and alluvium at Matata for residential zones. Muriwai silt loam on estuarine sand at 1.0 m to 1.5 m depth is suitable for commercial and industrial zoning.

Soil mapping unit name[1]: **RANGITAIKI SOILS**

Map symbol[2]: Ran **Area** 1160 ha

Soil classification[4]: Recent soils

Soil correlation[5]: Tukituki set (1c) (N.Z. Soil Bureau 1954); Rangitaiki soils (1) (Pullar *et al.* 1978).

Parent material[6]: Alluvium deposited on flood plains since the Tarawera eruption of 1886. On the Rangitaiki River flood plain, fine pumiceous alluvium and minor greywacke; on the Tarawera flood plain, fine and coarse pumiceous alluvium. Pumiceous silt, sand and gravels occur to a depth of > 3 m.

Physiographic position and slope[7]: Meander troughs and narrow strips bordering rivers. Flat.

Geographic distribution[8]: Narrow strips bordering both Rangitaiki and Tarawera Rivers

Vegetation and land use[9]: Poor or improved pasture. Largely dairying, with small area of market gardening at Te Teko.

Elevation range (m)[10]: 10 at Te Teko and 6 at Edgecumbe; up to 15 at Onepu and 1.5 at Matata.

Mean annual rainfall (mm)[11]: 1300–1800

Brief soil profile description[12]:

RANGITAIKI RIVER FLOOD PLAIN

Horizon	*Depth (cm)*	*Description*
A_{11}	0–5	light olive brown silt loam; friable; moderately developed granular structure (1964 flood),
A_{12}	5–23	brown sandy loam; friable; weakly developed fine granular structure,
IIC	23–33	very dark brown coarse sand; loose; few live roots; sharp smooth boundary (Tarawera Ash),
uA	33–51	dark yellowish brown fine sandy loam; friable; moderately developed fine granular structure; few live roots; sharp smooth boundary,
2uA	51–74	black silt loam; friable; slippery; moderately to strongly developed fine nut structure; few live roots; sharp smooth boundary,
IIIuC	*on*	light grey sand and fine gravels (pumice).

TARAWERA RIVER FLOOD PLAIN

A_1	0–25	brown silt loam; weakly developed medium granular structure; some live roots,
C	*on*	light grey fine gravels and coarse sand (pumice).

Characteristic soil and site features[13]: On the Rangitaiki River flood plain, individual flood layers are not commonly discrete but are joined to give a fairly well-humified yellowish brown accumulation about 20 cm thick.

On the Tarawera flood plain, the profile comprises thin buried topsoils distributed in strips where the Tarawera River has broken through its stopbanks.

Inclusions and variants within the mapping unit[14]: Poroporo silt loam near Onepu. Textural variants, including a silt loam variant, occur on both flood plains: a fine sandy loam variant occurs near Edgecumbe, a coarse sand variant at Onepu and a pumice-gravel variant in the Awakaponga and Awaiti localities where deposits range from 45 to 150 cm thick, overlying layers of diatomaceous material, silt, sand and pumice gravels.

Overall soil drainage (class)[15]: Largely well drained. Small areas near Onepu are imperfectly drained.

Soil erosion and flooding[16]: Erosion confined to bank corrosion. Frequent flooding now confined to floodways of main rivers with flood control schemes.

General chemical features[17]: A sample taken from a Rangitaiki soil on the Tarawera flood plain was strongly acid (pH 4.7 and 5.0), low in organic matter, low in phosphorus, and very low in exchangeable bases, with low cation exchange capacity. Furthermore, exchangeable magnesium and potassium are very close to deficiency levels; reserves of these elements are low, also. Thus the soil at this site appears to be the most strongly leached soil on the Plains. However, flood sediment on the Whakatane River flood plain, which may include some greywacke parent material, appears to be of high nutrient status.

Yields[18]: On the Whakatane flood plain protected by stopbanks, 20 su per ha can be carried and yields of 16 000 kg per ha per yr can be obtained.

Pasture responses to topdressing[19]: P fair, K slight

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1A[1]	1A[1]	1A[1]	3B	2[1]
2A	3A	3C		3

Value for food production (class)[21]: 1A[1] or 3

General soil limitations and potential[22]: No limitations on silty soils but sandy soils may become droughty in a dry summer. Where protected from flooding, land is suitable for pastoral farming, cropping, market gardening, horticulture and urban use. Unprotected land is best suited to dairy farming and beef production. Each flood plain must be examined on its own merits.

[1]where protected from flooding

Soil mapping unit name[1]: **OPOURIAO FINE SANDY LOAM**

Map symbol[2]: Ou **Area** 533 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Manawatu set (1) (N.Z. Soil Bureau 1954); Opouriao fine sandy loam (2) and Opouriao fine sandy loam, mottled phase (2b) (Pullar *et al.* 1978).

Parent material[6]: Fine alluvium from greywacke and weathered volcanic ash (minor). Thin layer of Tarawera Ash and Rotomahana Mud at surface (< 10 cm).

Physiographic position and slope[7]: Natural levées of present and former courses of Whakatane River and of present course of Rangitaiki River from Edgecumbe to Thornton. Flat.

Geographic distribution[8]: Narrow sinuous strips in the Thornton–Awaiti locality, at Matata and on the Rangitaiki River levée from Edgecumbe to Thornton.

Vegetation and land use[9]: Largely improved pasture. Mainly dairy and beef cattle grazing; minor maize growing and market gardening.

Elevation range (m)[10]: 3–6

Mean annual rainfall (mm)[11]: 1300–1550

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–13	very dark greyish brown fine sandy loam; very friable; weakly developed fine crumb structure and few cast granules; many live roots; distinct wavy boundary,
A_{12}	13–23	very dark greyish brown fine sandy loam; friable; moderately developed medium and fine granular structure; many cast granules; many live roots; distinct wavy boundary,
A_3	23–32	greyish brown and pale brown sandy loam; friable; moderately developed medium nut structure and numerous cast granules; many live grass roots; distinct smooth boundary,
(B)	32–47	light brownish grey fine sandy loam; firm; tends to fissure with ped faces slickensided; crushes under pressure to clods and many fine and medium cast granules; many live roots; indistinct wavy boundary,
	on	pale brown fine sandy loam; weakly developed fine prismatic structure crushing to firm clods; many major, live roots but few laterals that penetrate clods.

Characteristic soil and site features[13]: The Opouriao soil profile is one of the few unlayered profiles on the Plains, with a deep, dark coloured, friable topsoil over a pale brown subsoil that becomes more massive with depth. Kaharoa Ash may be found within 1 m of the ground surface; below the ash layer, yellowish brown mottling may be seen, indicating a fluctuating water table.

Inclusions and variants within the mapping unit[14]: None recognised

Overall soil drainage (class)[15]: Mainly well drained. Water table may lie within 1 m of the surface in a wet winter.

Soil erosion and flooding[16]: Nil. Seldom flooded naturally.

General chemical features[17]: To a depth of 8 cm, topsoil is moderately acid (pH 5.5) and is high in exchangeable calcium, magnesium and potassium. At 8–36 cm depth, the exchangeable magnesium is medium but potassium remains high. The cation exchange capacity of the topsoil drops sharply below 8 cm, indicating that organic matter plays an important part in the nutrient status of this soil.

Yields[18]: Present levels of 20 su per ha and 16 000 kg per ha per yr can be raised to 25 su per ha and 17 000 kg per ha per yr provided pasture is improved and its growth stimulated with nitrogenous fertilisers.

Pasture responses to topdressing[19]: P slight, K slight, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1A	1A	1A	1A	1

Value for food production (class)[21]: 1A

General soil limitations and potential[22]: Topsoil may dry out in a dry summer. Cool winds down the river valleys may adversely affect the microclimate at ground level and so retard plant growth. Opouriao soil types are limited in area and their distribution in small and narrow sinuous strips discourages their use on a field scale for cropping and horticulture. The land is suitable for market gardening but is too valuable for pastoral farming. Highly suitable for urban use.

Soil mapping unit name[1]: **ORINI SILT LOAM**

Map symbol[2]: Ori **Area** 933 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Manawatu set (1) (N.Z. Soil Bureau 1954); Opouriao silt loam (2d) (Pullar *et al.* 1978).

Parent material[6]: Fine pumiceous alluvium and minor greywacke alluvium deposited by the Rangitaiki River. Subsurface alluvium 3 to 5 m thick.

Physiographic position and slope[7]: Natural levées of the Orini Stream and the Rangitaiki River. Flat.

Geographic distribution[8]: Narrow continuous strips on levées of the Orini Stream and the Rangitaiki River in the Paroa and Thornton localities and from Edgecumbe to Thornton

Vegetation and land use[9]: Improved pasture. Dairy farming.

Elevation range (m)[10]: 2–4 at Paroa and Thornton, 6 at Edgecumbe

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–10	dark brown silt loam; friable; moderately developed fine granular structure; abundant live roots; sharp smooth boundary (flood accumulation),
A_{12}	10–20	very dark greyish brown and dark grey silt loam; massive; crushes to large clods and cast granules; many live roots; organic staining on faces of clods and granules; sharp smooth boundary (accumulation),
IIC	20–22	very dark greyish brown sand; sharp smooth boundary (Tarawera Ash and Lapilli),
uA_1	22–30	very dark greyish brown and pale brown silt loam; massive; a few live roots; organic staining around old root channels; distinct smooth boundary,
u(B)	30–60	light olive grey fine sandy loam; common medium strong brown mottles; massive; crushes easily to small and medium clods; few live roots; old root channels lined with organic matter; indistinct wavy boundary,
uC	*on*	pale olive sandy loam; few strong brown mottles; massive; crushes easily to large and small clods and crumbs.

Characteristic soil and site features[13]: Deeper than usual topsoil of pale olive to dark greyish brown silt loam up to 45 cm thick. Both topsoil and subsoil have a high incidence of yellowish-red organic staining on aggregate faces and around old root channels, suggesting slow drainage. This soil is firmer and the structure less well developed than the topsoil of Opouriao fine sandy loam. Flood accumulation has occurred since the Tarawera eruption. Opouriao soil types have no such accumulation.

Inclusions and variants within the mapping unit[14]: Rangitaiki soil types occur on the banks of Rangitaiki River at Thornton. Variants occur with colours, consistence and structural properties in between those of Rangitaiki and Orini series.

Overall soil drainage (class)[15]: Well to moderately well drained

Soil erosion and flooding[16]: Possible bank erosion of the Rangitaiki River channel. Flooding now prevented by stopbanking.

General chemical features[17]: Where this soil is formed on the natural levées of the Orini Stream, its fertility lies largely in the topsoil which is very high in plant-available phosphorus and medium in organic matter and nitrogen. Exchangeable potassium is very high, and calcium and magnesium are high.

Yields[18]: Present levels of 20 su per ha and 16 000 kg per ha per yr can be raised to 30 su per ha and 18 500 kg per ha per yr

Pasture responses to topdressing[19]: P slight, K slight, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1A	1A	1A	1A	1

Value for food production (class)[21]: 1A

General soil limitations and potential[22]: Moderately slow permeability. Highly suitable for market gardening and suitable for horticulture. Suitable for dairy farming when farmed in association with lower-lying soils. Suitable for urban use, as at Edgecumbe.

Soil mapping unit name[1]: KAWERAU LOAMY COARSE SAND

Map symbol[2]: Kr **Area** 675 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Tarawera Ash and Lapilli > 20 cm thick on coarse pumiceous alluvium of > 3 m derived from Kaharoa Ash

Physiographic position and slope[7]: Former flood plain of Tarawera River. Flat.

Geographic distribution[8]: Large areas in Kawerau, Onepu and Otakiri localities

Vegetation and land use[9]: Poor and improved pasture. Dairy farming, egg production, horticulture including pip and stone fruits, kiwifruit and feijoas.

Elevation range (m)[10]: 10–30

Mean annual rainfall (mm)[11]: 1500–1800

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–9	very dark brown loamy coarse sand; very friable; moderately developed fine and medium granular structure; abundant live roots; sharp smooth boundary (Tarawera Ash),
A_{12}	9–18	very dark greyish brown loamy sand and coarse sand; very friable; weakly developed fine nut and granular structure; few live grass and fern roots; sharp smooth boundary (Tarawera Ash),
C_1	18–33	black fine gravels; loose; few live grass roots; sharp smooth boundary (Tarawera Ash),
IIuA	33–61	dark greyish brown sand; loose; few live grass roots; sharp smooth boundary (pumiceous alluvium),
III2uA	61–70	black sand; slippery; loose; few live grass roots; sharp smooth boundary (pumiceous alluvium),
	on	olive yellow sand; slippery; loose; occasional live grass roots (pumiceous alluvium).

Characteristic soil and site features[13]: Discrete surface layer of Tarawera Ash (20–30 cm) on coarse pumiceous sandy alluvium. The topsoil is formed wholly within Tarawera Ash but the subsoil is partly Tarawera Ash and partly pumiceous alluvium. The topsoil is characteristically a very dark brown while the raw alluvium is olive yellow.

Inclusions and variants within the mapping unit[14]: Awaiti sandy loam in northern areas and Kawerau loamy coarse sand, mottled variant, in western and southern areas. Mapping unit boundaries are more of a zone than a line.

Overall soil drainage (class)[15]: Excessively to somewhat excessively drained but infiltration is slow. Water table within 1 m of surface in a wet winter and has fluctuated between 45–100 cm.

Soil erosion and flooding[16]: Erosion nil. No flooding at present.

General chemical features[17]: No analysis undertaken but properties expected to be similar to those of Te Teko sandy loam.

Yields[18]: Present 12–14 su per ha. No information for dry matter production.

Pasture responses to topdressing[19]: No information from trials. Application of P, S, K and N recommended by MAF Advisory Officers.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	3B	2B	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Droughty in summer giving rise to low milk production. Slow infiltration of water and slow permeability through the topsoil possibly due to interlocking of grains of Tarawera Ash with sharp faces. Suitable for pastoral farming using lucerne to tap moisture at depth. Tyne harrows needed to break up incipient iron-oxide pan in the topsoil. With frequent tilling, Tarawera Ash grains tend to comminute to finer particles. Suitable for foundations for residential, commercial and industrial zones. A measure of care may have to be exercised for industrial land use because of a layer of peat, lying at a depth of 3–4 m at the intersection of Lambert Road and the Murupara–Kawerau railway. The distribution of this peat layer is unknown.

Soil mapping unit name[1]: **KAWERAU LOAMY COARSE SAND, UNDULATING PHASE**

Map symbol[2]: KrU **Area** 90 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Tarawera Ash and Lapilli > 20 cm thick on wind-blown sand up to 3 m thick derived from alluvium

Physiographic position and slope[7]: Inland sand dunes. Undulating and hummocky.

Geographic distribution[8]: Narrow strip near Te Teko

Vegetation and land use[9]: Poor pasture. Dairy farming associated with farming on Kawerau loamy coarse sand.

Elevation range (m)[10]: 15–25

Mean annual rainfall (mm)[11]: 1500–1800

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–5	very dark brown loamy coarse sand; very friable; weakly developed medium crumb structure; abundant live roots; sharp smooth boundary (Tarawera Ash),
C	5–18	very dark greyish brown coarse sand and fine gravels; loose; abundant live roots; sharp smooth boundary (Tarawera Ash),
IIuA	18–23	dark grey sand; loose; sharp smooth boundary (wind-blown sand),
IIu(B)	23–39	yellowish brown sand; loose; moist; many live roots; (wind-blown sand),
IIuC	*on*	light brownish grey sand; loose; moist; some live roots, a few persisting to 100 cm.

Characteristic soil and site features[13]: Topsoil formed wholly within the Tarawera Ash. Bracken fern and paspalum roots persist to more than 100 cm in search of moisture in the wind-blown sand. Soil structure not well developed; loose sand.

Inclusions and variants within the mapping unit[14]: Kawerau loamy coarse sand at boundary zones

Overall soil drainage (class)[15]: Somewhat excessively drained

Soil erosion and flooding[16]: Nil

General chemical features[17]: Similar to Kawerau loamy coarse sand

Yields[18]: Carrying capacity would be less than that given for Kawerau loamy coarse sand. No information for dry matter production.

Pasture responses to topdressing[19]: Similar to Kawerau loamy coarse sand

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	3B	2B	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: More droughty in summer than Kawerau loamy coarse sand. Water table at 3.6 m on a layer of peat at Murupara–Kawerau railway on Lambert Road. Iron-oxide pan reported at a depth of 1.2 m in places close to the boundary with Kawerau loamy coarse sand. Suitable for pastoral farming using lucerne to tap moisture at depth. Highly suitable for over-wintering of live stock. Highly suitable for foundations for residential and commercial zones. A measure of care is required with industrial zoning because peat may lie at a depth of nearly 4 m.

Soil mapping unit name[1]: **KAWERAU LOAMY COARSE SAND, MOTTLED VARIANT**

Map symbol[2]: Krm **Area** 1008 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Tarawera Ash and Lapilli > 20 cm thick on coarse pumiceous alluvium of > 3 m derived from Kaharoa Ash

Physiographic position and slope[7]: Former flood plain of Tarawera River. Flat to slightly undulating.

Geographic distribution[8]: Large areas in Kawerau, Onepu and Otakiri localities

Vegetation and land use[9]: Poor and improved pasture. Horticulture including citrus, pip and stone fruits, kiwifruit and feijoas.

Elevation range (m)[10]: 8–25

Mean annual rainfall (mm)[11]: 1500–1800

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–6	very dark brown loamy coarse sand; very friable; grains held together in granules by abundant grass roots (turf-bound); moderately developed fine granular structure; sharp smooth boundary (Tarawera Ash),
A_{12}	6–16	very dark brown loamy coarse sand; very friable; weakly developed fine granular structure; many grass roots; sharp smooth boundary (Tarawera Ash),
IIuA	16–27	black fine sandy loam; friable; moderately to strongly developed medium and fine granular structure; some grass roots; sharp smooth boundary (pumice alluvium),
IIu(B)	27–47	pale yellow sand; loose; many distinct yellowish brown mottles; few live grass roots; horizon moist; distinct smooth boundary (pumice alluvium),
	on	light grey coarse sand and fine gravel; loose; no live roots; horizon moist and becoming wet at depth of 80 cm; water table at 100 cm from ground surface.

Characteristic soil and site features[13]: Very dark brown topsoil formed wholly within Tarawera Ash. Yellowish brown mottles between 27–47 cm indicate a fluctuating water table but no mottles seen below this depth. The latter observation suggests that below 47 cm the soil is always moist.

Inclusions and variants within the mapping unit[14]: Kawerau loamy coarse sand, Awaiti sandy loam and Onepu loamy coarse sand, especially near soil boundaries.

Overall soil drainage (class)[15]: Moderately well drained. High water table in winter, low in summer to below 1 m.

Soil erosion and flooding[16]: Nil

General chemical features[17]: No analysis undertaken but properties of topsoil expected to be similar to those for Te Teko sandy loam.

Yields[18]: No information but carrying capacity similar to that of Kawerau loamy coarse sand

Pasture responses to topdressing[19]: No information from trials. Recommendations as for Kawerau loamy coarse sand.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	2	2A	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Water table high in winter and low in summer—a too wet and too dry soil. Drainage difficult to manage. Plastic drainpipes laid at about 1 m depth promise controlled drainage throughout the year. Unlined drains gradually deepen themselves by scouring the loose sandy alluvium. Infiltration and permeability may be slow through the topsoil (Tarawera Ash) and periodic passes with the tyne harrows are useful to break up the incipient iron-oxide pan in the topsoil. Horticulture is being expanded on this soil. Irrigation is required. The subsurface material is suitable for foundations for residential, commercial and industrial zones but the water table must be controlled.

Soil mapping unit name[1]: **TE TEKO SANDY LOAM**

Map symbol[2]: Tks **Area** 1586 ha

Soil classification[4]: Composite recent soil on yellow-brown pumice soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin to very thin air-fall Tarawera Ash on mixed fine and coarse pumice and very fine greywacke alluvium deposited by Rangitaiki River. Very thin air-fall Kaharoa Ash may occur below the Tarawera Ash layer.

Physiographic position and slope[7]: Former flood plain of the Rangitaiki River at the time of the Taupo Pumice eruption about 1800 years ago. Flat with small shallow depressions in places.

Geographic distribution[8]: Large areas in the Te Mapou–Te Teko locality

Vegetation and land use[9]: Improved pasture. Mainly used for dairy farming. Horticulture includes pip and citrus fruit and kiwifruit growing in the Te Teko locality and asparagus in the Te Mapou locality. Other crops are kumaras, maize, barley, carrots, onions and water melons. Land was used for vegetable gardens (carrots) during World War II for supplying armed services.

Elevation range (m)[10]: 8–20

Mean annual rainfall (mm)[11]: 1400–1550

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–12	very dark greyish brown sandy loam; very friable; moderately developed fine nut and granular structure; many live roots; distinct smooth boundary (Tarawera Ash),
C	12–18	very dark greyish brown coarse sand; loose; few fine live roots; dry; sharp smooth boundary (Tarawera Ash),
IIuA	18–28	very dark grey loamy sand; very friable; weakly to moderately developed medium and fine nut and crumb structure; few fine live roots; distinct wavy boundary,
IIu(B)	28–38	yellowish brown sandy loam; friable; weakly developed medium and fine nut and crumb structure; few small rounded pumice gravels and worm casts; distinct smooth boundary (pumice alluvium),
$IIuB_{fe}$	38–83	yellowish brown pumice gravels with iron-oxide coatings which result from water-table fluctuations; moist,
	on	pale yellow pumice gravels with weak iron-oxide coating; moist.

Characteristic soil and site features[13]: A non-layered profile having a dark greyish brown topsoil wholly within Tarawera Ash, and a very dark grey buried topsoil of fine sandy loam. The subsoil is characteristically a light-coloured fine sandy loam with fine pumice gravels.

Inclusions and variants within the mapping unit[14]: None recognised, except at boundary zones with neighbouring soil types such as Onepu, Awakeri and Paroa

Overall soil drainage (class)[15]: Well to moderately well drained

Soil erosion and flooding[16]: Nil

General chemical features[17]: This soil shows the effects of organic matter build-up in the medium cation exchange capacity and the very high base saturation of the 0–8 cm layer. Exchangeable potassium is also very high. These values drop sharply in the subsoil. Plant-available phosphorus is medium in this topsoil.

Yields[18]: No trials undertaken. Potential of 16 su per ha suggested.

Pasture responses to topdressing[19]: No trials undertaken. Application of P, K and N recommended by MAF Advisory Officers.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	1B	1A	1A	1

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Mottles in the subsoil on Bright's Road and in the area north of Te Teko suggest a fluctuating water table, temporarily high in winter, but it is doubtful whether this soil requires drainage. The topsoil may be droughty in a dry summer. East of Te Teko, this soil type seems to hold moisture better than that to the west, possibly because a higher proportion of greywacke silt is present. Irrigation may be required. Potential for cash cropping, market gardening and dairy farming. Late frosts in December have been known to destroy maize crops. Suitable for foundations for residential, commercial and industrial buildings.

Soil mapping unit name[1]: **AWAITI SANDY LOAM**

Map symbol[2]: Ats **Area** 1611 ha

Soil classification[4]: Composite recent soil on yellow-brown pumice soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin and very thin Tarawera Ash on fine pumiceous alluvium derived from Kaharoa Ash

Physiographic position and slope[7]: Higher parts of former flood plain of the Tarawera River. Mainly flat, but hummocky in parts.

Geographic distribution[8]: Large and small areas in the Otakiri–Awaiti locality

Vegetation and land use[9]: Improved pasture. Dairying.

Elevation range (m)[10]: 3–10

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–5	very dark brown sandy loam; very friable; weakly developed fine and medium granular structure; abundant live grass roots; sharp smooth boundary (Tarawera Ash),
C	5–12	very dark brown fine and coarse sand; loose; some grains covered with pale olive material; sharp smooth boundary (Tarawera Ash),
IIuA	12–16	black silt loam; friable; moderately to strongly developed fine granular structure; some grass roots; indistinct smooth boundary with a few tongues from worm mixing,
$IIuC_1$	16–20	very dark grey silt loam; firm; massive; few live roots; sharp smooth boundary,
$IIuC_g$	20–120+	pale brown fine and medium sand; loose; many medium and coarse distinct yellowish brown mottles.

Characteristic soil and site features[13]: Black topsoil (with Tarawera Ash) over very dark grey silt loam with a sharp boundary to pale brown sand and fine sand. Awaiti sandy loam has more sand and less organic matter than Te Teko sandy loam. Yellowish brown mottles may occur in the subsoil.

Inclusions and variants within the mapping unit[14]: Inclusions of Kawerau loamy coarse sand, mottled variant, in western boundary areas and of Omeheu sandy loam especially in eastern boundary areas (soil boundary is more of a zone than a line). In some places a gravel layer occurs near the surface.

Overall soil drainage (class)[15]: Well to moderately well drained. Water table may fluctuate.

Soil erosion and flooding[16]: Soil erosion nil. Storm water may lie on the surface for a brief period.

General chemical features[17]: No samples taken. For approximate analysis see Omeheu sandy loam.

Yields[18]: Potential for 16–18 su per ha. No trials undertaken.

Pasture responses to topdressing[19]: No trials undertaken. Application of P, K and Mg recommended by MAF Advisory Officers.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1A	2A	3B	2A	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Topsoil dries out in a dry summer (the first soil to dry out on the Plains). Hollows in an undulating and hummocky surface may have high water tables in winter. Possible perching of groundwater. In pastoral farming, organic matter should be conserved in the topsoil. Cropping not recommended because organic matter build-up tends to be destroyed with tilling. Suitable for foundations for residential and commercial zones. No information at 3 m depth for industrial purposes but believe that material could be a silt with 1-m thick layers of peat at a depth of 7 m.

Soil mapping unit name[1]: **OMEHEU SANDY LOAM**

Map symbol[2]: Ome **Area** 1369 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Very thin Tarawera Ash on fine pumiceous sand on silt. Subsurface material comprises pumiceous alluvium including layers of sand, silt and gravels to a depth of more than 12 m. A 2-m thick layer of peat may occur at 8 m depth from the surface.

Physiographic position and slope[7]: Lower-lying parts of the former flood plain of the Tarawera River and the former Omeheu Stream. Flat and smooth; rhyolite boulders on surface at time of European settlement.

Geographic distribution[8]: Large single area in the Awaiti–Te Teko locality; small areas in the Awaiti and Awakaponga localities

Vegetation and land use[9]: Improved pasture. Dominantly dairy farming; minor horticulture including feijoa, kiwifruit and boysenberry growing.

Elevation range (m)[10]: 2–10

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–20	very dark greyish brown sandy loam; friable; weakly to moderately developed medium and fine nut structure; many fine roots; distinct smooth boundary (Tarawera Ash),
C_1	20–58	very pale brown fine sand; firm in place breaking easily to single grain; many distinct strong brown mottles; few live roots; sharp smooth boundary,
IIC	58–78	light grey coarse sand; loose; no live roots; sharp smooth boundary (Kaharoa Ash),
IIIuA	78–100	greyish brown fine sandy loam; many small distinct strong brown mottles; firm in place; weakly developed medium blocky structure; distinct smooth boundary,
	on	olive fine and medium sand and silt in thin layers; no mottles; moist.

Characteristic soil and site features[13]: Topsoil formed wholly within Tarawera Ash with sharp boundary to very pale brown fine sand noted for strong brown mottles. This soil is poorly drained and has more silt than the Awaiti, Kawerau and Te Teko soil types.

Inclusions and variants within the mapping unit[14]: Narrow strips of Awaiti sandy loam and possibly Paroa soil types in the Omeheu locality. In the Awakaponga locality, diatomaceous earth occurs at about a metre from the surface.

Overall soil drainage (class)[15]: Poorly drained. High water table in a wet winter.

Soil erosion and flooding[16]: Nil

General chemical features[17]: This soil shows the effects of an organic matter build-up which is spread over a greater depth than in Opouriao fine sandy loam, for example. Exchangeable potassium and plant-available phosphorus are high in the topsoil. Organic matter levels and cation exchange values fall sharply in the subsoil and are extremely low in the C horizon at 65 cm from the surface.

Yields[18]: Possibly, potential for 18–20 su per ha

Pasture responses to topdressing[19]: No trials undertaken. MAF Advisory Officers recommend application of Mg, N, P and S.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Topsoil tends to dry out in summer. High water table in a wet winter, due to groundwater perching on silty layers a metre below the surface. Subsoil wets quickly but also dries out quickly. Topsoil puddles during heavy rain and in winter is easily poached by cattle (cattle hooves sometimes penetrate to the subsoil). In the Awaiti locality, stumps may occur at a depth of 150 cm. Suitable for dairy farming and horticulture, but with organic matter should be conserved and no cropping should be undertaken, as for Awaiti sandy loam. Suitable for foundations for residential and commercial zones. No information at depth for industrial zoning but data obtained from a borehole, a little east of the main area mapped, suggest that silt and clay layers occur from a depth of 1 m to 6 m below the surface, followed by a layer of peat with stumps 3-m thick. Beach sand with shells occurs at a depth of 13 m.

Soil mapping unit name[1]: **OMEHEU SANDY LOAM ON PEAT**

Map symbol[2]: Omp **Area** 191 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Matuku peaty gravel (107i) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin Tarawera Ash on fine pumiceous sand on silt on peat. Subsurface material comprises pumiceous alluvium including layers of clay, sand, silt and gravels. A metre-thick layer of peat may occur at 3 m depth from the surface.

Physiographic position and slope[7]: Lower-lying parts of the former flood plain of the Tarawera River and the former Omeheu Stream. Flat.

Geographic distribution[8]: Single small area in the Otakiri–Te Teko locality

Vegetation and land use[9]: Improved pasture. Dairy farming.

Elevation range (m)[10]: 8–9.5

Mean annual rainfall (mm)[11]: 1500–1550

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–15	very dark greyish brown sandy loam; very friable; weakly developed fine nut and crumb structure; abundant live roots; sharp smooth boundary (Tarawera Ash),
IIuA	15–23	black peaty loam; massive; sharp smooth boundary,
$IIuC_1$	23–31	grey loamy sand; loose; sharp smooth boundary,
$IIuC_2$	31–66	pale brown fine sand; firm in places but crushes easily to single grains; sharp smooth boundary,
III2uA	66–86	greyish brown silt loam; few small yellowish brown mottles; firm; weakly developed medium blocky structure; sharp smooth boundary,
	86–114	black peat; laminated; massive; wet.

Characteristic soil and site features[13]: Topsoil formed wholly within Tarawera Ash. Topsoil texture approaches loamy coarse sand, because the soil occurs near the boundary of the coarse facies of Tarawera Ash. The name 'sandy loam' is used in order to avoid fragmenting the soil map into small units. The subsoil of this soil type is partly peaty. The peat base is about a metre thick.

Inclusions and variants within the mapping unit[14]: Possibly, Paroa coarse sandy loam on peat

Overall soil drainage (class)[15]: Poorly drained. High water table in a wet winter.

Soil erosion and flooding[16]: Nil

General chemical features[17]: Similar to Omeheu sandy loam

Yields[18]: Possibly, potential for 18–20 su per ha

Pasture responses to topdressing[19]: No trials undertaken. MAF Advisory Officers recommend application of Mg, N, P and S.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Agricultural potential as for Omeheu sandy loam. For urban use, expensive foundations are required for residential buildings. Subsurface material appears to be satisfactory for commercial and industrial zones, provided the layer of peat at a depth of about 3 m is considered.

Soil mapping unit name[1]: **ONEPU LOAMY COARSE SAND**

Map symbol[2]: Onc **Area** 1951 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Mapped as Tarawera gravel (5) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin Tarawera Ash (20–30 cm) on layered pumiceous silt, sand and gravels. Very thin Kaharoa Ash can be seen under the Tarawera Ash in the Te Mapou locality, Rangitaiki Valley. Occasional thin layer of diatomaceous earth. Subsurface material unknown but most likely pumiceous alluvium comprising sands and gravels.

Physiographic position and slope[7]: Present and former flood plains of the Tarawera River; part of the former flood plain of the Rangitaiki River. Flat, with some small depressions.

Geographic distribution[8]: Long continuous strip just east of Tarawera River; shorter strips in the Onepu–Te Teko locality and a single area in the Te Mapou locality in the Rangitaiki Valley.

Vegetation and land use[9]: Poor and improved pasture. Dominantly dairying; pip and stone fruit at Te Teko, kiwifruit at Otakiri; pine tree nursery; market gardening (vegetables and small fruits); some barley and maize cropping.

Elevation range (m)[10]: 1.5 nearer coast, rising to 15 in Rangitaiki Valley

Mean annual rainfall (mm)[11]: 1300–1800

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–22	very dark greyish brown loamy coarse sand; very friable to loose; weakly developed fine crumb structure; abundant live roots; distinct wavy boundary (Tarawera Ash),
C	22–30	dark greyish brown gravelly sand; loose; many live roots; sharp smooth boundary (Tarawera Ash),
IIuA	30–43	black peaty loam; friable; strongly developed medium granular and cast granular structure; many fine live roots; wet; sharp smooth boundary,
$IIIuC_1$	43–55	brown loamy coarse sand grading to fine sand at base; many distinct medium yellowish red mottles; few live roots; wet; sharp smooth boundary,
$IVuC_2$	55–65	light yellowish brown silt; massive; some live and some dead roots; wet; sharp smooth boundary (diatomaceous earth),
VuC_3	65–125	light brownish grey coarse sand; loose; weak iron-oxide staining of sand grains in top 10 cm; wet; water table at 90 cm; sharp smooth boundary,
	on	pale brown pumice gravels and rhyolite stones; loose; some gravels coated with iron-oxide.

Characteristic soil and site features[13]: Upper A/C horizons are formed wholly within Tarawera Ash. The subsoil material is layered with sands, gravels, diatomaceous earth and peaty loam. The difference between Onepu loamy coarse sand and the Kawerau and Te Teko soil types is that Onepu loamy coarse sand has a diversity of layers in the subsoil material and the presence of diatomaceous earth suggests that the soil formed partly in a lacustrine environment. The soil types of the other two series were probably formed on higher land, so that diatomaceous earth is absent.

Inclusions and variants within the mapping unit[14]: Possible inclusions of Kawerau loamy coarse sand, mottled variant, and Matuku silt loam

Overall soil drainage (class)[15]: Poorly drained; high water table in winter; artificial drainage needed.

Soil erosion and flooding[16]: Nil

General chemical features[17]: No samples collected

Yields[18]: No trials undertaken. Potential possibly 18 su per ha.

Pasture responses to topdressing[19]: No trials undertaken. MAF Advisory Officers recommend applications of P, S and K.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	2B	1B	3C	2

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Naturally poorly drained with groundwater perching on sand and silt pans in the subsoil material and with lower-lying position in the landscape. Suitable for dairying and possibly cash cropping. Suitable for foundations for residential, commercial and industrial zones.

Soil mapping unit name[1]: **AWAKAPONGA SILT LOAM**

Map symbol[2]: Ag **Area** 478 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954)

Parent material[6]: Fine alluvium derived from rhyolitic ash and minor greywacke. Subsurface material is similar to a depth of 3–4 m. The alluvium rests on dune sand.

Physiographic position and slope[7]: Back-swamp lowlands of the former courses of the Rangitaiki River and the Omeheu Stream, also along the Tarawera River. Flat.

Geographic distribution[8]: Awaiti and Awakaponga localities, also near Gow Road

Vegetation and land use[9]: Poor and improved pasture. Bird sanctuary; dairying.

Elevation range (m)[10]: 1–4

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]: Similar to that for Awakaponga silt loam on peat

Characteristic soil and site features[13]: Deep topsoil (30–40 cm) formed from thin humified flood layers, similar to those of Awakaponga silt loam on peat but with less peat. Accumulation approaches 90 cm and soil was periodically flooded until 1973.

Inclusions and variants within the mapping unit[14]: Matuku silt loam and Paroa silt loam on peat

Overall soil drainage (class)[15]: Imperfectly to poorly drained; high water table in winter

Soil erosion and flooding[16]: Erosion nil. Occasional flooding by the Tarawera River.

General chemical features[17]: Similar to those of Awakaponga silt loam on peat

Yields[18]: As for Awakaponga silt loam on peat

Pasture responses to topdressing[19]: No information available

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	1

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: As for Awakaponga silt loam on peat. The area covered by this soil type is much less than that of Awakaponga silt loam on peat.

Soil mapping unit name[1]: **AWAKAPONGA SILT LOAM ON PEAT**

Map symbol[2]: Agp/

Area 1117 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954)

Parent material[6]: Fine alluvium derived from rhyolitic ash and minor weathered greywacke. Subsurface material is fine alluvium from volcanic ash and minor greywacke, interlayered with peaty material and stumps, resting on dune sands at 4–6 m from the surface.

Physiographic position and slope[7]: Drained back-swamp lowlands associated with the Rangitaiki River and subject to periodic flooding (now prevented by stopbanks). Flat.

Geographic distribution[8]: Large areas about the Rangitaiki River in the Edgecumbe–Thornton locality and smaller areas in the Thornton–Awaiti locality

Vegetation and land use[9]: Largely improved pasture. Dairy farming; residential and commercial zoning in Edgecumbe county town.

Elevation range (m)[10]: 1.5–8.0

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–20	dark brown silt loam; friable; moderately to strongly developed medium and fine nut structure; many fine roots; distinct irregular boundary,
C	20–30	greyish brown silt loam; few distinct strong brown mottles; friable; weakly developed fine blocky structure; few fine roots; distinct wavy boundary,
uA	30–55	dark greyish brown silt loam; friable; weakly developed coarse blocky structure; few fine roots; distinct wavy boundary,
uC	55–65	light grey, with inclusions of dark greyish brown, silt; few distinct strong brown mottles; friable; weakly developed coarse blocky structure; few fine roots; indistinct wavy boundary,
2uA	65–90	dark greyish brown silt loam; few fine strong brown mottles; friable; weakly developed coarse blocky structure; some dead, few live roots; distinct wavy boundary,
2uC	90–110	pale brown fine sand; strong brown staining around old root channels; no live roots,
3uA	110–130	very dark brown peaty loam: friable; weakly developed medium blocky structure; few dead roots,
IIC	130–145	light grey pumiceous sand; loose; sharp smooth boundary (Kaharoa Ash),
	on	very dark brown peat and loamy peat.

Characteristic soil and site features[13]: A layered soil, with humified layers sometimes intercalated with peat, up to a total of 60 cm thick. Diatomaceous earth may occur at about a metre depth in the Thornton locality.

Inclusions and variants within the mapping unit[14]: Possible inclusions of Paroa soil types near soil boundaries in the Edgecumbe and Thornton localities

Overall soil drainage (class)[15]: Imperfectly to poorly drained. High water table in a wet winter.

Soil erosion and flooding[16]: Erosion nil. Periodically flooded by the Rangitaiki River until about 1973.

General chemical features[17]: The organic matter in this soil does not decrease with depth, because of the organic matter built up when now-buried flood layers were at the surface. Cation exchange capacity is high in all horizons, mainly due to the organic colloid. Plant-available phosphorus is high.

Yields[18]: Suggested potential of 22 su per ha. No information available about dry matter production.

Pasture responses to topdressing[19]: MAF Advisory Officers recommend applications of P, N and S

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained, with high water table in a wet winter in some places. Suitable for cash cropping, market gardening and dairy farming. Horticulture suggested on higher-lying parts. Suitable for foundations for residential zones but recommend wide footings. Foundations for commercial and industrial zones require removal of stumps and peat.

Soil mapping unit name[1]: **POROPORO SILT LOAM**

Map symbol[2]: Ppo **Area** 89 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954); mapped mainly as Paroa mottled brown silt loam (3e), also Paroa silt loam on sand (3a) and Opouriao brown fine sandy loam, mottled phase (2c) (Pullar *et al.* 1978).

Parent material[6]: Very fine alluvium derived from greywacke (dominant) and rhyolitic volcanic ash. Subsurface material is very fine alluvium (clays) and stumps up to 3.5 m thick on dune and estuarine sands.

Physiographic position and slope[7]: Drained back-swamp lowlands. Flat.

Geographic distribution[8]: Small and medium-sized areas on the left bank of the Rangitaiki River near Edgecumbe

Vegetation and land use[9]: Improved pasture. Predominantly dairy farming.

Elevation range (m)[10]: 2–6

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–25	dark greyish brown silt loam; friable; moderately developed fine granular and cast granular structure; many live roots to 13 cm; distinct smooth boundary,
uA_1	25–33	dark grey, dark greyish brown and pale olive silty clay loam; very friable; moderately developed granular structure with much cast granular structure; some live, few dead roots; some organic staining; sharp smooth boundary,
uAC	33–51	dark grey and pale olive silt loam; friable; moderately developed fine granular and cast granular structure; sharp smooth boundary,
uC	51–79	greyish brown and pale yellow silt loam; many fine strong brown mottles; friable; moderately developed fine granular structure; occasional live roots; sharp smooth boundary,
IIC	*on*	light grey sand; loose; water-bearing (Kaharoa Ash).

Characteristic soil and site features[13]: Thick accumulation from 1964 and 1967 floods, giving a deeper than usual topsoil (33 cm). Subsoil noted for its strong brown mottles. Layering not as distinct as in Awakaponga soil types.

Inclusions and variants within the mapping unit[14]: Possibly Paroa silt loam

Overall soil drainage (class)[15]: Imperfectly to poorly drained. Water table naturally high in winter.

Soil erosion and flooding[16]: Erosion nil. Formerly flooded periodically by the Rangitaiki River but now prevented by stopbanks.

General chemical features[17]: No samples collected during this survey. A sample of the 1964 flood deposit to a depth of 8 cm (Pullar *et al.* 1978) showed the fresh alluvium to be near neutral, with a medium supply of slightly raw organic matter and generally high levels of exchangeable cations. Plant-available phosphorus, however, is low. Soil tests by the Ministry of Agriculture and Fisheries on composite samples from 0–8 cm depth show that the soil is moderately acid and has medium levels of calcium, potassium and phosphorus.

Yields[18]: Present levels of 20 su per ha and 16 000 kg per ha per yr could be raised to 30 su per ha and 18 500 kg per ha per yr if the land is drained

Pasture responses to topdressing[19]: P good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	2	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained, with high water table in winter. Soil puddles after heavy rain. Most clayey soil on the Plains. Suitable for market gardening, cash cropping and dairy farming. Suitable for foundations for residential, commercial and industrial zones if the land is drained. For commercial and industrial zoning, secure foundations can be obtained on pumice gravels within a metre of the surface.

Soil mapping unit name[1]: **PAROA COARSE SANDY LOAM**

Map symbol[2]: Prc

Area 272 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Mapped as Tarawera gravel (5) but does not correlate well, also Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954)

Parent material[6]: Tarawera Ash (15–20 cm) on fine pumiceous alluvium derived from Kaharoa Ash and deposited by the Rangitaiki River and the former Omeheu Stream. Subsurface material comprises pumice alluvium and layers of peat to a depth of > 18 m.

Physiographic position and slope[7]: Drained back-swamp lowlands of the former Omeheu Stream and the Rangitaiki River. Flat.

Geographic distribution[8]: Medium-sized areas in the Te Teko locality, small areas south-west of Otakiri

Vegetation and land use[9]: Poor pasture. Maize cropping and dairy farming; pip and stone fruit, kiwifruit, feijoas, citrus.

Elevation range (m)[10]: 9–14

Mean annual rainfall (mm)[11]: 1400–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–15	black coarse sandy loam; very friable; much visible organic matter; abundant live paspalum roots; sharp smooth boundary (Tarawera Ash),
uA	15–25	very dark greyish brown silt loam; friable; strongly developed fine granular and cast granular structure; abundant live roots; distinct wavy boundary,
u(B)	25–48	pale yellow silt loam; firm in place but crushes easily to large and small clods; non-sticky; some dead roots; sharp wavy boundary,
$IIuC_1$	48–73	white sand; firm in place but crumbles easily to loose grains; sharp wavy boundary (Kaharoa Ash),
$IIIuC_2$	73–86	light yellowish brown silty clay loam; massive; breaks to large and small clods; some yellowish brown small and medium mottles; sharp smooth boundary,
$IIIuC_3$	86–146	dark greenish grey silty fine sand and fine pumice gravel in layers; water table at depth of 146 cm.

Characteristic soil and site features[13]: Noted for coarse Tarawera Ash, overlying black buried topsoil, over pale yellow silt loam subsoil, on white Kaharoa Ash. Profiles of Paroa soil types are recognisable by the silty 'buff' layer in the subsoil.

Inclusions and variants within the mapping unit[14]: None recognised

Overall soil drainage (class)[15]: Poorly drained. With artificial drainage the soil becomes moderately well drained. Naturally high water table in a wet winter.

Soil erosion and flooding[16]: Nil. Formerly flooded periodically, now protected by stopbanks.

General chemical features[17]: No samples collected

Yields[18]: Possible potential for 20 su per ha. No trials undertaken for dry matter production.

Pasture responses to topdressing[19]: No trials undertaken but applications of N, P and K recommended by MAF Advisory Officers

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained. Coarse texture. Suitable for cash cropping (maize), market gardening and dairy farming, also horticulture. Satisfactory for foundations for residential zones. Care may be required with commercial and industrial zoning because of occasional, 1 m thick, beds of peat, intercalated with silt and clay layers to a depth of > 18 m. First bed of peat encountered at a depth of 7 m.

Soil mapping unit name[1]: **PAROA COARSE SANDY LOAM ON PEAT**

Map symbol[2]: Prs **Area** 412 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Matuku peaty gravel (107i) (N.Z. Soil Bureau 1954)

Parent material[6]: Tarawera Ash (15–20 cm) on fine pumiceous alluvium derived from Kaharoa Ash and deposited by the Rangitaiki River and the former Omeheu Stream, overlying peat. Subsurface material comprises pumice alluvium in clay-, sand- and gravel-sized layers intercalated with beds of peat to a depth of > 18 m. Stumps may be present at about 7 m.

Physiographic position and slope[7]: Drained back-swamp lowlands of the former Omeheu Stream and the Rangitaiki River. Flat.

Geographic distribution[8]: Medium-sized areas near Edgecumbe

Vegetation and land use[9]: Improved pasture. Dairy farming; kiwifruit, citrus, feijoas, boysenberries.

Elevation range (m)[10]: 4–9

Mean annual rainfall (mm)[11]: 1400–1500

Brief soil profile description[12]: Similar to Paroa coarse sandy loam but with a peat base below the Kaharoa Ash layer

Characteristic soil and site features[13]: Similar to Paroa coarse sandy loam but with a peat base below the Kaharoa Ash layer

Inclusions and variants within the mapping unit[14]: Possible inclusions of Paroa silt loam on peat and Omeheu sandy loam on peat

Overall soil drainage (class)[15]: Poorly drained, with naturally high water table in a wet season

Soil erosion and flooding[16]: Nil. Formerly flooded periodically, now protected by stopbanks.

General chemical features[17]: No samples collected

Yields[18]: Possible potential for 20 su per ha. No trials undertaken for dry matter production.

Pasture responses to topdressing[19]: No trials undertaken but applications of N, P and K recommended by MAF Advisory Officers

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	2	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained, with peat layer near surface. Suitable for cash cropping (maize), market gardening and dairy farming. Care is required with foundation design for all urban zones. Near-surface peat is up to a metre thick. This material would have to be excavated for commercial and industrial foundations. Furthermore, two layers of peat, each about a metre thick, and close together, occur at a depth of about 6 m.

Soil mapping unit name[1]: **PAROA SILT LOAM**

Map symbol[2]: Pr

Area 623 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954); Paroa silt loam (3) (Pullar *et al.* 1978). Paroa silt loam on sand (3a) in Pullar *et al.* (1978) is merged with Paroa silt loam in this survey.

Parent material[6]: Thin Tarawera Ash on fine pumiceous alluvium (coarse silt) derived from Kaharoa Ash and deposited by the Rangitaiki River. A thin layer of Kaharoa Ash lies below the alluvium. West of the Rangitaiki River, the subsurface material comprises silt, peat and dune sand at a depth of 12 m, and near Whakatane, pumiceous silt, sands and gravels with dune sands occur < 3 m from the surface.

Physiographic position and slope[7]: Drained back-swamp lowlands of former distributaries of the Rangitaiki River, and the Awakaponga and the Awaiti Streams. Flat.

Geographic distribution[8]: Small to medium-sized areas in the Edgecumbe, Awaiti, Thornton, Paroa and Matata localities

Vegetation and land use[9]: Improved pasture. Predominantly dairy farming, minor horticulture and market gardening.

Elevation range (m)[10]: < 4

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_p	0–15	very dark greyish brown silt loam; friable; strongly developed fine granular and cast granular structure; abundant live roots; distinct wavy boundary,
(B)	15–20	pale yellow silt loam; firm in place, crushing easily to large and small clods; non-sticky; much organic staining around old root channels; some dead roots; sharp wavy boundary,
IIC	20–33	pale yellow sand; firm in place, crushing easily to loose sand; sharp wavy boundary (Kaharoa Ash),
$IIIuA_1$	33–53	pale olive (tinged green) clay loam; medium strong brown mottles which follow old root channels; crushes under pressure to large clods; non-sticky; distinct smooth boundary,
$IIIuC_1$	53–69	greyish brown silt loam; yellowish brown mottles; crushes to clods; few dead roots; many old root channels,
$IIIuC_2$	69–107	light brownish grey silty sand; massive; breaks easily to large clods; many dead roots; weak organic staining around old roots; distinct wavy boundary,
	on	light grey pumice gravel.

Characteristic soil and site features[13]: An easily recognisable soil profile comprising dark coloured topsoil over pale yellow subsoil ('buff layer') on white to pale yellow layer of Kaharoa Ash. Pumice gravel may occur just below a metre from the surface. One of the few clayey soils on the Plains.

Inclusions and variants within the mapping unit[14]: Paroa silt loam on peat; Awakaponga silt loam on peat in the Edgecumbe and Thornton localities.

Overall soil drainage (class)[15]: Poorly drained. With artificial drainage, the soil becomes moderately well drained. Naturally high water table in a wet winter.

Soil erosion and flooding[16]: Erosion nil. Previously flooded periodically but now protected by stopbanks and an overflow channel.

General chemical features[17]: No samples collected. Soil tests by the Ministry of Agriculture and Fisheries show the upper 8 cm of the topsoil to be strongly to moderately acid with medium levels of plant-available calcium, potassium and phosphorus.

Yields[18]: Present levels of 20 su per ha and 16 000 kg per ha per yr can be raised to 30 su per ha and 18 500 kg per ha per yr

Pasture responses to topdressing[19]: P good, K fair, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained. Soil drainage through the subsoil may be low if cracks and fissures not present. The subsoil dries out quickly but re-wets quickly. Seasonally high water table for short periods. Droughty in a dry summer. Suitable for cash cropping for maize, market gardening, dairy farming and horticulture. Suitable for foundations for residential, commercial and industrial zones.

Soil mapping unit name[1]: PAROA SILT LOAM ON PEAT OVER GRAVEL

Map symbol[2]: Prg **Area** 430 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954); Paroa silt loam on peat on gravel (3c) (Pullar *et al.* 1978).

Parent material[6]: Thin layer of Tarawera Ash on fine pumiceous alluvium on thin layer of Kaharoa Ash underlain by peat and pumiceous gravel. Subsurface material comprises pumiceous sand and gravel > 2 m thick.

Physiographic position and slope[7]: Former back-swamp lowlands of the Rangitaiki River. Flat.

Geographic distribution[8]: Large areas in the Putiki locality

Vegetation and land use[9]: Improved pasture. Predominantly dairy farming; minor horticulture and market gardening.

Elevation range (m)[10]: 0.5–1.5

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–5	very dark brown silt loam with coarse sand (Tarawera Ash); sharp smooth boundary,
A_{12}	5–18	very dark brown silt loam; very friable; strongly developed fine to medium granular structure; abundant live roots to 8 cm and some to 15 cm; some organic staining on aggregate faces; sharp smooth boundary but sharp and irregular where old tree-root channels penetrate 18 cm into horizon below,
$(B)_g$	18–45	pale yellow silt loam; some medium strong brown mottles; massive; crushes to large, medium and small clods; cast granules of topsoil confined to old tree-root channels; sharp irregular boundary,
uA	45–49	very dark brown silt loam; friable; strongly developed cast granular and fine granular structure; few live roots; sharp smooth boundary,
IIC	49–61	light grey sand; loose; occasional live roots; sharp wavy boundary (Kaharoa Ash),
IIIC	61–76	very dark brown loamy peat; massive; laminated in lower 8 cm; sharp smooth bondary,
IV2uA	76–91	yellowish brown silt loam; massive; breaks to large clods; abundant rush roots; sharp smooth boundary,
	on	brown and pale olive sand and coarse sand and fine to medium pumice gravels; loose; water-bearing.

Characteristic soil and site features[13]: A layered profile and the most easily recognisable on the Plains. Dark coloured topsoil on pale yellow subsoil ('buff layer') on white Kaharoa Ash followed by peat on pumice gravel.

Inclusions and variants within the mapping unit[14]: Possible inclusions of Paroa silt loam on peat and Awakeri sandy loam on shallow peat

Overall soil drainage (class)[15]: Naturally poorly drained. With artificial drainage the soil becomes moderately well drained. Naturally high water table in a wet winter.

Soil erosion and flooding[16]: Erosion nil. Formerly periodically flooded by Rangitaiki River but now controlled by stopbanking and over-flow channel.

General chemical features[17]: The upper 5 cm of the topsoil is moderately to strongly acid, with high levels of organic matter and exchangeable calcium, very high levels of magnesium and potassium but a low level of plant-available phosphorus. The lower 8 cm of the topsoil is medium in organic matter which is not as well decomposed as that in the upper 5 cm. At a depth of 20–28 cm, the subsoil is moderately acid and low in exchangeable bases.

Yields[18]: As for Paroa silt loam if the water table is controlled. Soil puddling can be a problem and concrete feeding pads may be necessary for top carrying capacity.

Pasture responses to topdressing[19]: P fair, K good, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained. Permeability slow in subsoil if cracks and fissures not present. Pumping of groundwater from the subsurface pumice gravel has been successful in making the land productive. Suitable for dairy farming and maize cropping. Suitable for foundations for residential, commercial and industrial zones if foundations are sunk into the pumice gravel below the peat layer which lies about a metre from the surface.

Soil mapping unit name[1]: **PAROA SILT LOAM ON PEAT**

Map symbol[2]: Prp **Area** 1925 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Awakeri complex (15b) (N.Z. Soil Bureau 1954); Paroa silt loam on peat (3b) (Pullar *et al.* 1978).

Parent material[6]: As for Paroa silt loam on peat over gravel, except that peat layer is thicker and gravel is not encountered within a metre of the surface. West of the Rangitaiki River in the Thornton locality, the subsurface material comprises peat and pumice alluvium to a depth of 5–6 m followed by a 3 m-thick layer of peat, on pumice alluvium, while on the eastern side, in the Putiki locality, the peat is > 1 m thick and rests on pumice sands and gravels to a depth of > 3 m.

Physiographic position and slope[7]: Former back-swamp lowlands of the Tarawera River, the Awaiti and Orini Streams and the Rangitaiki River. Flat.

Geographic distribution[8]: Scattered areas in the Matata, Awaiti, Thornton, Putiki and Awakeri localities.

Vegetation and land use[9]: Improved pasture. Dairy farming.

Elevation range (m)[10]: 1–5

Mean annual rainfall (mm)[11]: 1300–1400

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–23	very dark brown silt loam; very friable; strongly developed fine and medium granular and cast granular structure; abundant live roots to 8 cm and some to 15 cm; sharp smooth boundary,
(B)	23–58	pale yellow silt loam; massive; crushes to medium and small clods; finely fissured; old root channels filled with sand and peaty sand; sharp irregular boundary,
IIC_1	58–62	very dark brown loamy peat; massive; sharp smooth boundary,
$IIIC_2$	62–82	light grey sand; loose; sharp wavy boundary (Kaharoa Ash),
IVC_3	82–100+	dark brown peat; massive; laminated.

Characteristic soil and site features[13]: Easily recognised profile. Layered as for Paroa silt loam on peat over gravel except that the peat is more than one metre thick and gravel is not encountered.

Inclusions and variants within the mapping unit[14]: Possibly Paroa silt loam on peat over gravel; Awakaponga silt loam on peat in the Thornton–Edgecumbe locality.

Overall soil drainage (class)[15]: Naturally poorly drained to very poorly drained. High water table in winter.

Soil erosion and flooding[16]: As for Paroa silt loam on peat over gravel

General chemical features[17]: No samples collected. Soil tests by the Ministry of Agriculture and Fisheries indicate that the upper 8 cm of the topsoil is moderately acid, is medium in calcium, medium to high in potassium, and low to medium in phosphorus.

Yields[18]: As for Paroa silt loam, provided the water table is controlled, being kept high in summer and low in winter

Pasture responses to topdressing[19]: P good, K fair, L nil

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	2	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained. Infiltration tests in the subsoil show the rate to be highly variable over short distances according to the presence or absence of fine fissures from old root channels and, thus, of differential movement within the horizon. The topsoil tends to puddle after heavy rain, restricting aeration and drainage, and so less winter grazing is obtained from the land. Suitable for dairy farming, cash cropping and horticulture, in selected areas. Expensive foundations for all urban zones.

Soil mapping unit name[1]: **PAROA PEATY SILT LOAM ON PEAT**

Map symbol[2]: Pry **Area** 365 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Pongakawa peaty loam (107f) (N.Z. Soil Bureau 1954)

Parent material[6]: Peaty alluvium and fine alluvium, on peat, with logs to a depth of just over 2 m, on pumice gravel

Physiographic position and slope[7]: Back-swamp lowlands of the former Orini Stream, now channelled as a canal. Flat.

Geographic distribution[8]: Limited to the Thornton–Putiki locality

Vegetation and land use[9]: Poor and improved pasture. Dairy farming.

Elevation range (m)[10]: 1–2

Mean annual rainfall (mm)[11]: 1300–1350

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–13	very dark grey peaty silt loam; much dead organic matter, rich in roots of rush, raupo and manuka; very firm turf; distinct smooth boundary,
IIC	13–23	black peaty sand and coarse sand; numerous live roots; sharp smooth boundary (Tarawera Ash),
uA	23–41	very dark brown peat; finely laminated with alternating peat and alluvium in lower 5 cm; dry; sharp smooth boundary,
uC	41–76	black peat; much organic matter, mainly rush roots, still visible; wet; sharp smooth boundary,
IIIuC	76–114	light grey non-sticky silt ('buff layer'); many dead roots embedded in fine channels; sharp smooth boundary,
IVuC	114–119	black peat; partly decayed raupo remains; sharp smooth boundary,
VuC	119–132	light greenish grey sand; sharp smooth boundary (Kaharoa Ash),
	on	black loamy peat, with logs at 2.3 m depth; much visible organic matter little decayed.

Characteristic soil and site features[13]: A layered profile of peaty silt loam, over Tarawera Ash, over peat, over silt loam ('buff layer'), over Kaharoa Ash over peat. Could be considered a composite gley/organic soil but, most likely, the peaty material will oxidise, leaving a residue of inorganic material on peat. The type name would then change to Paroa silt loam on peat.

Inclusions and variants within the mapping unit[14]: Paroa silt loam on peat and Awaroa soils, possibly

Overall soil drainage (class)[15]: Naturally very poorly drained, with high water table near surface in winter

Soil erosion and flooding[16]: Erosion nil. Flooding confined to storm water now that the Rangitaiki River has stopbanks.

General chemical features[17]: No samples collected

Yields[18]: No information available

Pasture responses to topdressing[19]: No trials undertaken

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	3A	3C	3

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Naturally very poorly drained—the last area remaining to be fully drained on the Plains. Has a peaty topsoil which will, in the course of time, reduce in thickness as the peat oxidises. Subsurface peat and logs occur at a depth of 2 m. Suitable for dairy farming. Unsuitable for residential zoning; buildings for commercial and industrial use would require expensive foundations.

Soil mapping unit name[1]: **AWAKERI SANDY LOAM ON SHALLOW PEAT**

Map symbol[2]: Awi **Area** 751 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Awakeri sets (15, 15a, 16b) and Otakiri sets (5a, 5b and 5c) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin air-fall Tarawera Ash and Kaharoa Ash on thin layer of peat on pumice gravel and sand derived from Taupo Pumice. Subsurface material comprises pumice gravel and sand to a depth of > 3 m.

Physiographic position and slope[7]: Drained, shallow peat swamp on former flood plain of the Rangitaiki River; small areas of the present flood plain of the Tarawera River. Flat.

Geographic distribution[8]: Mainly in the Awakeri and Te Mapou localities; small areas around the Tarawera River.

Vegetation and land use[9]: Improved pasture. Dominantly dairy farming; minor horticulture.

Elevation range (m)[10]: 2–20

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–20	very dark brown sandy loam; friable; moderately developed medium and fine nut structure breaking easily to fine nut and granular structure; abundant fine roots; distinct regular boundary (discrete layer of Tarawera Ash 5 cm thick about 10 cm from surface),
IIC	20–40	pale brown medium to coarse sand; loose; few roots; distinct regular boundary (Kaharoa Ash),
IIIC	40–80	dark brown peaty loam; friable; weakly to moderately developed medium and fine nut structure; upper 17 cm is laminated and compact peat; many live roots; sharp smooth boundary,
IVC	80–120	few pumice gravels grading to light brownish grey medium sand; firm in place, crushing easily to loose grains; few roots; 2 cm-thick seam of reddish yellow pumice gravels at base; distinct smooth boundary,
	on	light brownish grey medium sand and pumice gravels; finely bedded; compact (Taupo Pumice alluvium).

Characteristic soil and site features[13]: Profile noted for marked lithological discontinuities of Tarawera Ash, Kaharoa Ash, peat and gravels; this arrangement distinguishes Awakeri soil types from others on the Plains. Soil activity is confined to the topsoil, although many live roots may be seen in the peaty layer at 40–80 cm from the surface.

Inclusions and variants within the mapping unit[14]: No Kaharoa Ash visible in the Awaiti–Braemar Road area and the Te Teko locality

Overall soil drainage (class)[15]: Very poorly drained. Perched water table in a wet winter.

Soil erosion and flooding[16]: Piping in sand lenses in Taupo Pumice alluvium, below the peat layer, occurs in the Awakeri locality. Holes left by decayed stumps provide pipeways, particularly near deep drains. No flooding; some storm-water ponding in shallow hollows.

General chemical features[17]: Two of the most notable features are the medium to high organic-matter levels and the evenness of the base saturations below the Tarawera Ash horizon, whether in sand (Kaharoa Ash) or in the peaty layer underneath. Effects of the medium organic matter content in the upper 8 cm of the topsoil include a high cation exchange capacity, a medium, approaching high, base saturation and very high exchangeable potassium. Plant-available phosphorus in the topsoil is high.

Yields[18]: No trials undertaken but levels of 18–20 su per ha and 12 000 kg per ha per yr may be possible

Pasture responses to topdressing[19]: No trials undertaken but MAF Advisory Officers suggest applications of K, P, S and N

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	1B	3C	2

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained, with high water table in winter. Land has been made productive with open drains. The upper 45 cm would tend to dry out in a dry summer but in most years the peat layer would remain moist. At the time of European settlement, peat fires were known to occur in this soil. Low ground temperatures may occur in hollows and even ground frosts may be troublesome. Suitable for dairy farming. Market gardening and horticulture may have possibilities. Suitable for foundations for residential, commercial and industrial zones, provided the foundations are sunk into the pumice gravels below the peat layer, at about a metre.

Soil mapping unit name[1]: AWAKERI LOAMY SAND ON VERY SHALLOW PEAT

Map symbol[2]: Aws **Area** 1221 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Awakeri sets (15,15a,16b) and Otakiri sets (5a, 5b and 5c) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin air-fall Tarawera Ash and Kaharoa Ash on thin layer of peat on pumice gravel and sand derived from Taupo Pumice. Subsurface material comprises pumice gravel and sand to a depth of > 3 m.

Physiographic position and slope[7]: Drained, shallow peat swamp on on former flood plain of the Rangitaiki River; occurs on a higher part than Awakeri sandy loam on shallow peat. Flat with shallow ridges and hollows in places, particularly on the crown of the former flood plain.

Geographic distribution[8]: Large areas in the Awakeri and Te Mapou localities

Vegetation and land use[9]: Improved pasture. Predominantly dairy farming with minor horticulture.

Elevation range (m)[10]: 2–20

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–25	very dark grey loamy sand; very friable; weakly developed crumb structure; sharp smooth boundary (Tarawera Ash and Kaharoa Ash),
IIuA	25–35	dark brown loamy peat; laminated; lucerne roots grow sideways along lamination planes and then downwards; dry; sharp smooth boundary,
IIIu(B)	35–45	yellow sand and fine sand; lucerne roots; dry; sharp smooth boundary,
IIIuC	45–65+	pale yellow pumice and greywacke gravels; well sorted; dry.

Characteristic soil and site features[13]: As for Awakeri sandy loam on shallow peat except that the peat layer is thinner (very shallow). Water table high in winter but in a dry summer the peat dries out to become like leather.

Inclusions and variants within the mapping unit[14]: Possible inclusions of Awakeri sandy loam on shallow peat. This mapping unit includes areas of higher ground (e.g. along Melville Road) on which the soils are better drained and less affected by a high water table.

Overall soil drainage (class)[15]: Imperfectly drained. This soil can be over-drained.

Soil erosion and flooding[16]: No piping erosion seen. Nil flooding

General chemical features[17]: As for Awakeri sandy loam on shallow peat. Topsoil fertility is very important in this shallow soil.

Yields[18]: No information available, but likely to be less than for Awakeri sandy loam on shallow peat

Pasture responses to topdressing[19]: As for Awakeri sandy loam on shallow peat

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	2A	1B	3C	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Even if the peat is kept moist, this soil does not store as much water as Awakeri sandy loam on shallow peat. It also dries out more quickly in summer; in a dry summer, the peat layer becomes so dry that it is impossible to re-wet and prevents the movement of soil water to the topsoil by capillary action. Lucerne is being grown in experiments, but stands are patchy. Lamination planes in the peat seem to restrict the vigorous growth of tap roots. This soil type is suitable for dairying only if a feed-crop like lucerne can be grown. Market gardening may have possibilities as the sandy texture makes the soil easy to work all the year round. Some horticulture is being attempted. Soil is highly suitable for foundations for residential, commercial and industrial zones. Foundations should be sunk in pumice gravel and sand.

Soil mapping unit name[1]: **WAIOHO SILT LOAM**

Map symbol[2]: Wai

Soil classification[4]: Recent soil **Area** 164 ha

Soil correlation[5]: Pongakawa peaty loam (107f) (N.Z. Soil Bureau 1954); Pongakawa peaty sand, loamy phase (6a) and Paroa silt loam on peat (3b) (Pullar *et al.* 1978).

Parent material[6]: Mixed pumiceous (dominant) and greywacke alluvium on deep peat on dune sand

Physiographic position and slope[7]: Former swamps. Flat and shallow concave surface.

Geographic distribution[8]: Small total area; small areas near the western boundary of the survey in the Awakaponga–Onepu locality and in the Awaiti locality, slightly larger areas in the Te Rahu–Whakatane West locality.

Vegetation and land use[9]: Improved pasture, especially in the Whakatane West locality. Some rush species in the western localities. Mainly dairying, with some beef production in the Whakatane West locality and minor horticulture; some idle land in the western localities.

Elevation range (m)[10]: 1–14

Mean annual rainfall (mm)[11]: 1300–1600

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–10	very dark brown silt loam; friable; moderately developed fine granular and cast granular structure; many live roots; worms; a little organic staining on aggregate faces; sharp smooth boundary (accumulation layer),
A_{12}	10–18	black silt loam with sand (Tarawera Ash); very friable; moderately to strongly developed fine granular and cast granular structure; some live roots, some dead rootlets; organic staining on aggregate faces; sharp smooth boundary,
A_{13}	18–31	black fine sandy loam; very friable; moderately developed fine granular and cast granular structure; some live roots, some dead rootlets; organic staining on aggregate faces; sharp smooth boundary,
IIC	31–43	light brownish grey sand; firm in place but breaks easily to single grains; sharp smooth boundary (Kaharoa Ash),
IIIC	*on*	very dark brown loamy peat; massive; laminated; few live roots; wet.

Characteristic soil and site features[13]: Up to 30 cm of loamy, dark coloured topsoil on deep peat. Well developed fine granular and cast granular structure.

Inclusions and variants within the mapping unit[14]: Possibly, narrow strips of Pongakawa peaty sand in the Whakatane West locality

Overall soil drainage (class)[15]: Naturally poorly drained, but with artificial drainage the soil becomes imperfectly drained. High water table in a wet winter.

Soil erosion and flooding[16]: Erosion nil. Formerly flooded periodically but finally ceased by 1973 (Whakatane River Flood Control Scheme).

General chemical features[17]: No samples collected. Soil tests by officers of the Ministry of Agriculture and Fisheries show that the 0–10 cm horizon is moderately acid, low to medium in potassium and medium tending low in plant-available phosphorus. The topsoil becomes less acid with the addition of each layer of fresh alluvium.

Yields[18]: Present levels of 12 su per ha and 10 500 kg per ha per yr could be raised to 20 su per ha and 17 500 kg per ha per yr

Pasture responses to topdressing[19]: P good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	2	3C	3

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained. Suitable for pastoral farming, cash cropping and market gardening. Severe limitations for foundations for residential, commercial and industrial zones. For residential use, concrete raft foundations are required to counteract differential shrinking in the peaty subsurface material; for commercial and industrial buildings, piles may have to be driven into the dune sand that lies at a depth of 3–5 m.

Soil mapping unit name[1]: **AWAROA SOILS**

Map symbol[2]: Aro

Area 443 ha

Soil classification[4]: Organic soil

Soil correlation[5]: Awaroa peaty gravel (107h) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin layer of Tarawera Ash at and near surface and layered low-moor sedge peat to a depth of up to 3 m. In the Thornton locality thin beds of fine pumiceous alluvium may occur below 1 m depth.

Physiographic position and slope[7]: Shallow depressions between natural levées on the Tarawera and Rangitaiki River flood plains. Flat.

Geographic distribution[8]: Small and scattered depressions bordering the Tarawera River in the Onepu and Awakaponga–Awaiti localities and at Thornton

Vegetation and land use[9]: Improved pasture on newly developed land and *Salix* spp. in undeveloped land. Dairy farming.

Elevation range (m)[10]: 5–6 in the Awakaponga locality, 13–15 at Onepu and 1–2 in the Thornton locality

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–23	black and very dark brown peaty sand; very friable; weakly developed fine crumb structure; abundant live roots; sharp smooth boundary (Tarawera Ash and peat),
uA	23–38	black peat and peaty loam; friable; moderately developed fine granular structure; some live roots; distinct smooth boundary,
	on	black and dark reddish brown layered loamy peat; firm; massive.

Characteristic soil and site features[13]: Topsoil generally of peaty sand, passing sharply to peaty material.

Inclusions and variants within the mapping unit[14]: Un-named peaty loam variant occurs in shallow swampy depressions near the Rangitaiki River in the Thornton locality, where plant remains have accumulated since the Tarawera Ash eruption (1886) and muddy flood waters have deposited fine pumiceous sediment.

Overall soil drainage (class)[15]: Naturally very poorly drained, but with artificial drainage the soil becomes imperfectly drained. Some topsoils may become moderately well drained. Naturally high water table.

Soil erosion and flooding[16]: Erosion nil. Possible storm-water flooding.

General chemical features[17]: No samples collected but analysis expected to be similar to that of Pongakawa peaty sand.

Yields[18]: Expected to be similar to those for Pongakawa peaty sand

Pasture responses to topdressing[19]: Expected to be similar to those for Pongakawa peaty sand

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
3C	3B	3A	3C	3

Value for food production (class)[21]: 2

General soil limitations and potential[22]: High water table and slow permeability. Deep peat. Suitable for pastoral farming; peaty loam variant suitable for cropping. Horticulture and forestry more difficult as land may be difficult to drain adequately.

Soil mapping unit name[1]: **PONGAKAWA PEATY SAND**

Map symbol[2]: Pop

Area 713 ha

Soil classification[4]: Organic soil

Soil correlation[5]: Pongakawa peaty loam (107f) (N.Z. Soil Bureau 1954); Pongakawa peaty sand (6) (Pullar *et al.* 1978).

Parent material[6]: Low-moor sedge peat with thin layers of Tarawera Ash and Kaharoa Ash at or near the surface. Layered peat to a depth of 3–5 m.

Physiographic position and slope[7]: Deep swales between inland dunes and shallow basins bordering eastern hills. Flat.

Geographic distribution[8]: Awakeri and Te Mapou localities

Vegetation and land use[9]: Improved pasture. Dairy farming.

Elevation range (m)[10]: 1–10

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_{11}	0–8	black peaty sand; very friable; weakly developed fine crumb structure; abundant live roots; distinct smooth boundary (Tarawera Ash),
A_{12}	8–23	black peat with dark brown fine sand; friable; moderately developed fine granular structure; abundant live roots; sharp smooth boundary (Tarawera Ash with some Kaharoa Ash),
IIC_1	23–33	pale brown sand; loose; sharp smooth boundary (Kaharoa Ash),
uA	33–61	dark reddish brown peat; firm; massive; weakly laminated; distinct smooth boundary,
	on	dark reddish brown peat with twigs of manuka; firm; massive; laminated below 100 cm.

Characteristic soil and site features[13]: A layered profile, with thin black Tarawera Ash on thin white Kararoa Ash on peat, becoming laminated and hard to drain at a depth of about one metre.

Inclusions and variants within the mapping unit[14]: Unnamed peaty loam variant where peaty material between Tarawera Ash and Kaharoa Ash ranges from 10 to 20 cm thick. Unnamed coarse sand topsoil in the Awakeri locality, where Tarawera Ash is a coarse sand about 18 cm thick; also, no peaty material is present between Tarawera Ash and Kaharoa Ash, and thus the variant is a sandy soil on peat.

Overall soil drainage (class)[15]: Naturally very poorly drained. With artificial drainage, the soil is somewhat poorly drained in winter and moderately well drained in summer. Naturally high water table.

Soil erosion and flooding[16]: Erosion nil. Flooding now prevented by stopbanking associated with the Whakatane River Flood Control Scheme (1973).

General chemical features[17]: Topsoil strongly acid (pH 4.5), very high in organic matter, high in exchangeable magnesium and very high in exchangeable potassium. Plant-available phosphorus is very low.

Yields[18]: Present levels of 15 su per ha and 9000 kg per ha per yr can be raised to 20 su per ha and 13 000 kg per ha per yr (with drainage and fertiliser)

Pasture responses to topdressing[19]: P good

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	2B	2	3C	3

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Naturally high water table in winter and peat laminations at depth make it difficult to drain the soil. A controlled water table is essential. Sandy topsoil may be droughty in dry summer. Potassium deficiency may be induced in plough layer if Kaharoa Ash is brought to the surface. Highly suitable for dairy farming and blueberries. Foundations for urban use are expensive, involving raft and piles.

Soil mapping unit name[1]: **MATUKU SILT LOAM**

Map symbol[2]: Mtk **Area** 827 ha

Soil classification[4]: Gley soil

Soil correlation[5]: Matuku peaty gravel (107i) (N.Z. Soil Bureau 1954)

Parent material[6]: Intercalated diatomaceous earth and peat, with very thin Tarawera Ash, on sand and pumice gravel below 2 m depth

Physiographic position and slope[7]: Former flood plain of the Tarawera river; The diatomaceous earth was formed in shallow lakes on the flood plains. Flat but with shallow undulations.

Geographic distribution[8]: Confined to the western margin of the Plains, in the Onepu, Hawken's Junction and Awaiti localities. In the latter locality, the total area is relatively large but occurs as small areas separated by fingers of Onepu loamy coarse sand.

Vegetation and land use[9]: Improved pasture. Dairy farming and beef production.

Elevation range (m)[10]: 1–13

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_p	0–20	very dark greyish brown fine sandy loam with coarse sand (Tarawera Ash); friable; moderately developed medium and fine nut structure; many diffuse yellowish brown mottles; few diatomaceous silt inclusions from horizon below; many fine roots; dry; sharp smooth boundary,
IIC_1	20–30	light brownish grey and brown silt; friable; weakly developed coarse blocky structure, almost massive; reddish brown staining around old root channels; few fine roots; moist; smooth distinct boundary (diatomaceous earth),
IIC_2	30–50	very dark brown peaty silt loam; friable; massive; thin layers of plant remains; inclusions of diatomaceous earth; reddish brown staining around old root channels; few fine roots; moist distinct regular boundary;
IIIuA	50–57	pale brown fine sandy loam; friable; weakly developed medium blocky structure, almost massive; many small distinct yellowish red mottles; few fine roots; plant remains visible; distinct smooth boundary,
IIIuC	57–87	pale brown medium sand; loose; very few live roots; moist; sharp smooth boundary,
IV2uA	87–97	dark brown silt with inclusions of organic matter and sand; few dead roots; wet; diffuse boundary (diatomaceous earth),
	on	light grey fine sand; wet; water table at 110 cm.

Characteristic soil and site features[13]: Layered profile of diatomaceous earth, peat and silt, may be > 1 m thick. The profile above is from the Otakiri locality where the land had not been tilled and the topsoil texture is a fine sandy loam. Further north in the Awaiti locality, the texture is closer to a silt loam. Pumice gravels occur on ridges in the Awaiti locality but peat layers are found under the gravels.

Inclusions and variants within the mapping unit[14]: Rangitaiki soils on ridges of pumice gravel; Onepu loamy coarse sand.

Overall soil drainage (class)[15]: Very poorly drained; naturally high water table in a wet winter.

Soil erosion and flooding[16]: Erosion nil. Infrequent flooding by the Tarawera River.

General chemical features[17]: No samples collected

Yields[18]: Possibly, 20 su per ha

Pasture responses to topdressing[19]: No trials undertaken

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	2B	2	3C	2

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Naturally poorly drained. Strip inclusions of Rangitaiki soils dry out in a dry summer. Suitable for dairy farming and beef production. Severe limitations for foundations for residential, commercial and industrial zones. For residential use, the land would need drainage and the diatomaceous earth would need to be compacted when dry. For commercial and industrial buildings, piles should be driven into the pumice alluvium which lies ⩾ 2 m from the surface.

Soil mapping unit name[1]: **MATATA SOILS**

Map symbol[2]: Maa

Area 331 ha

Soil classification[4]: Recent soil

Soil correlation[5]: Individual areas too small to be shown on small-scale map but would have been included in Kairanga silt loam and clay loam (2) (N.Z. Soil Bureau 1954); Matata soils (4) (Pullar *et al.* 1978).

Parent material[6]: Mainly fine, pumiceous colluvium with minor greywacke. May also include strongly weathered ash (Hamilton Ash and Pahoia Tuffs). At Matata, the subsurface material is dune sand for > 3 m and at other places, largely pumiceous colluvium of fine gravel and sand.

Physiographic position and slope[7]: Small low-angled fans. Flat to broadly convex surface. Basalt boulders on surface at Wilson's Creek, Awakaponga.

Geographic distribution[8]: Scattered areas on the margins of the Plains near Matata, Awakaponga, Te Mapou and Awakeri

Vegetation and land use[9]: Mainly poor pasture. Dairy farming; boysenberries in the eastern areas.

Elevation range (m)[10]: 10–16 at Matata; 3–30 in the Awakaponga locality; 15–30 in the Te Mapou locality; 5–30 in the Awakeri locality.

Mean annual rainfall (mm)[11]: 1300–1500

Brief soil profile description[12]:

ACTIVE FAN

Horizon	*Depth (cm)*	*Description*
C	0–3	greyish brown loamy sand with fine gravel (1970 flood),
uA_1	3–11	dark grey sandy loam with partly decayed grass leaves and living roots of tall fescue (1964 flood),
$2uA_2$	11–15	very dark greyish brown silt loam; friable; moderately developed fine granular structure; sharp smooth boundary,
$3uA_{1g}$	15–25	dark greenish grey silt loam; weakly developed fine granular structure; many dead grass roots; sharp smooth boundary,
IIC_g	25–53	pale olive brown pumice sand; firm, breaking to fragments.

INACTIVE FAN

A	0–26	very dark grey sandy loam; friable; weakly developed medium and fine nut structure,
AB	26–41	very dark grey and brown gravelly sand; very friable; weakly developed blocky structure; few medium brown mottles,
C_{g1}	41–66	grey and light yellowish brown gravelly sand; friable; weakly developed blocky structure; few distinct brown mottles.

Characteristic soil and site features[13]: Active fans have obvious signs of accumulation from flooding. Subsoils have greenish grey colours indicating a fluctuating perched water table and temporary water-logging. Inactive fans have dark grey and very dark grey topsoils. Matata soils are invariably associated with fans bordering the margin of the Plains, particularly at the mouths of gullies that contain streams. Fans thus receive large amounts of water.

Inclusions and variants within the mapping unit[14]: A variant of Opouriao fine sandy loam occurs as an inclusion near Matata; Rangitaiki soils are included in the Awakeri locality.

Overall soil drainage (class)[15]: Imperfectly to poorly drained

Soil erosion and flooding[16]: Erosion nil. Active fans are subject to periodic flooding after heavy rain.

General chemical features[17]: No samples collected for analysis. Soil tests by the Ministry of Agriculture and Fisheries (Pullar *et al.* 1978) show the upper 8 cm to be moderately to slightly acid with medium levels of calcium, low and medium levels of potassium and medium to very high levels of phosphorus.

Yields[18]: Present levels of 10 su per ha and 7500 kg per ha per yr can be raised to 12 su per ha and 10 000 kg per ha per yr where there is not too much stony colluvium and the water table is not too high.

Pasture responses to topdressing[19]: P good, K fair

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
1B	1C	2	3C	3[1]

Value for food production (class)[21]: 1B

General soil limitations and potential[22]: Naturally poorly drained, particularly towards the toes of the fans. Higher parts of the fans may be suitable for horticulture, but are probably more suitable for pastoral farming in association with adjacent soil units. Inactive parts of fans are suitable for foundations for residential and commercial zones, although a high water table would pose problems in an industrial zone. On active fans, flooding by stone- and silt-laden water is a severe limitation for use. Both active and inactive fans need drainage.

[1]Class 2 on inactive parts of fans

Soil mapping unit name[1]: **MATAHINA LOAMY COARSE SAND**

Map symbol[2]: Mbc **Area** 211 ha

Soil classification[4]: Composite recent soil on yellow-brown pumice soil

Soil correlation[5]: Manawahe gravel (14d) (N.Z. Soil Bureau 1954)

Parent material[6]: Thin air-fall basaltic Tarawera Ash and Lapilli on thin air-fall Kaharoa Ash on very thin air-fall Taupo Pumice on moderately thick Whakatane Ash. Subsurface material is pumiceous alluvium > 3 m thick.

Physiographic position and slope[7]: Former flood plains of the Mangaone, Waikamihi and other tributary streams of the Tarawera River; land not flooded for 5000 years. Flat.

Geographic distribution[8]: Small areas in the south-western part of the Plains near the Tarawera River

Vegetation and land use[9]: Improved pasture; fruit trees. Sheep and cattle farming and horticulture, including pip and stone fruit, kiwifruit and citrus growing.

Elevation range (m)[10]: 3–60

Mean annual rainfall (mm)[11]: 1300–1800

Brief soil profile description[12]:

Horizon	*Depth (cm)*	*Description*
A_1	0–23	very dark greyish brown loamy coarse sand; very friable; weakly developed medium granular structure; many live roots; sharp smooth boundary (Tarawera Ash),
IIuA	23–25	black fine sand; very friable; sharp smooth boundary (Kaharoa Ash),
IIuC	25–45	pale olive sand; loose; sharp smooth boundary (Kaharoa Ash),
(III)2uA	45–68	yellowish brown fine sandy loam; friable; few live roots; indistinct wavy boundary (Whakatane Ash),
$(III)2uB_{11}$	68–88	yellow sand and coarse sand; loose when disturbed; few live roots; indistinct wavy boundary (Whakatane Ash),
$(III)2uB_{12}$	88–113	yellow sand and coarse sand (Whakatane Ash).

Characteristic soil and site features[13]: Sandy soil comprising dark brown topsoil from Tarawera Ash and a yellowish brown buried soil from Whakatane Ash. The buried soil is a source of moisture and nutrients, and distinguishes Matahina loamy coarse sand from Kawerau, Te Teko and Onepu soil types.

Inclusions and variants within the mapping unit[14]: Awaroa soils

Overall soil drainage (class)[15]: Somewhat excessively drained

Soil erosion and flooding[16]: Nil

General chemical features[17]: No samples collected. For approximate analysis of topsoil see results for Te Teko sandy loam.

Yields[18]: No trials undertaken. A potential carrying capacity of 12–14 su per ha is suggested.

Pasture responses to topdressing[19]: No trials undertaken. MAF Advisory Officers recommend applications of P, K, S, N and Mg.

Soil limitation classes[20]:

Pastoral	*Cropping*	*Horticultural*	*Forestry*	*Urban*
2A	3A	3B	1A	1

Value for food production (class)[21]: 2

General soil limitations and potential[22]: Sandy soil unsuitable for continuous cropping. Topsoil may dry out in a dry summer. Organic matter is a source of topsoil nutrients and the buried soil formed from Whakatane Ash, at a depth of 50 cm, is a source both of nutrients and moisture. Matahina loamy coarse sand is suitable for forestry and for cattle and sheep farming; also suitable for foundations for residential, commercial and industrial zones.

INDEX TO SOILS