Soils of the Waimea Plains: Redwood Valley-Appleby area

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Introduction

The Waimea Plains, situated at the head of Tasman Bay and north of the confluence of the Wai-iti and the Wairoa Rivers, is an important part of the arable land resource of the Nelson Province. It covers approximately 7,000 ha and comprises around one third of the land that makes up the regions extremely small and most productive soil resource base.

Information about the soils of the Waimea Plains is derived mainly from a soil survey report published in 1966 (Chittenden, Hodgson and Dodson 1966; Soils and Agriculture of Waimea County *New Zealand Soil Bureau Bulletin 30*). The soil map published with this report is at a scale of 1:126,720 (two miles to the inch) and along with the soil descriptions in the report, provides a generalised picture of the soils and their properties. The Waimea County soil report report, however, was based on extensive fieldwork, with unpublished maps drawn at a scale of 1:15,800 and showing considerable detail. The information depicted in those maps related largely to soil textural differences; other information including soil drainage characteristics, depth to gravel, rooting depth, permeability and soil horizon development was absent. A less detailed outline of the soils of the Waimea Plains was provided in the General Survey of the Soils of South Island (scale 1:250 000 Soil Bureau Staff 1968) with the same soils identified in this survey as in the Waimea County survey.

The present survey covers approximately 900 ha of the plains area and includes land lying between the Moutere Highway and the Waimea Inlet on the west side of the Waimea River.

Survey Methods

Soil examinations and field mapping were carried out over 45 days between May and November 2011. Black and white aerial stereo-photographs, taken in January 1938 were used to assist with the identification of the landform units, drainage and vegetation patterns and with positioning of soil observation transect lines. Observation transects tended to be short and disjointed owing to the fragmented pattern of land holdings and the preponderance of horticultural row crops such as apples and grapes, which restrict free movement in the field. Soil observations along the transects were made by examining the soil from auger borings up to 1 metre depth, where possible, as well as from excavated soil pits and from occasional exposures in cuttings. The auger observations provided information on the soil horizon thicknesses, colours and textures, drainage characteristics and depth to underlying gravels while the pits allowed a more

detailed assessment of the above soil properties as well as soil structural characteristics, soil strength, plant root distribution and the nature of underlying materials. A total of 747 auger observations were made with additional detailed observations from 30 pits. Inspections were also made following several storm events to observe the effects of heavy rainfall on surface drainage.

The soil description criteria used are those described in the Soil Description Handbook (Milne et al. 1995), which gives the official description standards for description of New Zealand soils. Field soil data were electronically recorded and included a digital image for the soil at each observation site. Each observation site was located and recorded using GPS and marked on 1:4500 colour photo field sheets onto which soil boundaries were plotted. The field sheets had contours at half-meter intervals and these were extremely useful in assisting with the plotting of the soil boundaries. The soil boundaries were later transferred by TDC staff onto a photogrammetric base for final map compilation. The field data for each soil that was recognised were analysed in respect of the variation in properties for each of the recognized soil types (horizon sequences and thicknesses, colour, texture, drainage, soil depth etc) and the information was used in determining the properties for each soil as well as the variability within the map units. The soil land use ratings are derived from assessments of a range of soil and land attributes as used by Agriculture New Zealand in the 1994 Classification System for Productive Land in the Tasman District (Table 2).

The Soil Landscape Environment

The Waimea Plains is a small delta-like geomorphic feature situated in a depression between the Moutere Hills in the west and the Bryant Ranges to the east. It has a low-angle surface that at its northern end adjacent to the Waimea Inlet rises from 2 metres above sea level to 9.5m over a distance of 3.5km to the south at Redwood Road. The sediments on the lower-most plain surface have been mapped as Appleby Gravel Formation (Johnston 1982) of Late Holocene age (Aranuian Stage) dating from around 4000 years. At the northern end, the surface sediments are variable and range from silts, sands to gravels and this along with shallow surface channelling that occurs here suggests this part of the plain may have been modified during a period of slightly higher Late Holocene sea level. Early 1938 aerial photographs show that this lower part of the Waimea Plain surface, prior to the construction of a marine edge stopbank, was partly estuarine.

Further south as the land gradually rises, the ground surface is predominantly flattish and undissected, apart from occasional overflow channels about 1 m deep. The soil material is relatively uniform, consisting of clay loam to silt loam alluvium, commonly passing into sandy loam at depth and this suggests that the sediments were deposited in a low energy fluvial environment. Towards the southern part of the survey area, the ground surface is in places slightly undulating with irregular shallow channels and shallower and commonly stony soils. This zone appears to mark the path of a more recent overflow of the Waimea River, towards Redwood Valley and continuing on down O'Connor Creek.

Geomorphically, terrace surfaces in the lower Waimea Plain are poorly expressed and indistinct. In the vicinity of River Road and the Moutere Highway, there is a somewhat indistinct surface, (7.5 to 8.5m asl) which forms the present floodplain of the Waimea River and which lies about 1m below the main Waimea Plain surface (8.5 to 9.5m asl)

at this locality. There is little evidence of recent river overflows on the main Waimea Plain surface. Further west from the junction of Redwood Road and Moutere Highway, deposits of reworked Moutere sediments (mapped by Johnston 1982 as Harakeke Formation) form a surface that in-fills Redwood Valley and associated gully floors and might best be described as a low angle fan rather than a terrace. Near the junction of Redwood Road with Golden Hills Road this surface rises from about 8.5m to 22m over 1.6km to the west as it grades into the surrounding Moutere Hills. Johnstone (1982) considered the Harakeke Formation to be Waimaungan (third last glaciation) in age but it is unlikely that the surface sediments are this old and it is more probable that the deposition of the surface materials date from the Last Glacial Stage onset (Alloway et al. 2007) around 28 000 yrs.

Eves Valley Stream and Redwood Valley Stream are minor channels that drain adjacent areas of the Moutere Hills. These streams are incised between 1-2m into the Harakeke Formation and Appleby Gravel and have a weakly developed terrace surface along their channels with predominantly sandy textured alluvium that is derived from recent flood deposits originating from the Moutere Hills.

Soils

The existing soil map (Chittenden et al. 1966) shows only two soil types in the area of the Waimea Plains covered by the present survey; Waimea soils (gravelly loam to clay loam from mixed alluvium including greywacke, argillite, sandstone, limestone and ultrabasic rocks) and Dovedale soils (gravelly soils on Moutere Hills valley floors) formed from resorted Moutere Gravel alluvium. Also separated were soils identified as Maori soils, which were principally Waimea soils that had been modified by the additions of sandy gravel in the surface horizon. In the present survey, ten soils are identified, these reflecting differing attributes of the alluvial deposition as well as soil drainage differences. The soils identified in the present survey are listed in Table 1 below.

Table 1

Soils of the Redwood Valley-Appleby area

Estuarine sediments on low coastal land		
Imperfectly/poorly drained soils	Motukarara soils	(Mo)
Recent river floodplain		
Well drained soils	Wai-iti soils	(Wa)
Imperfectly drained	Appleby soils	(Ap)
Older river overflow/low terrace surfaces	Redwood soils	(Rd)
Old floodplain/low terrace alluvium		
Well drained	Waimea soils	(Wm)
Moderately well/imperfectly drained	Cotterell soils	(Ct)
Recent stream alluvium from reworked Moutere Gravel		
Well drained	Eves soils	(Ev)
Imperfectly/poorly drained	Mahana soils	(Mh)
Older terrace alluvium from reworked Moutere Gravel		
Well/moderately well drained	Dovedale soils	(Dv)
Imperfectly drained	Braeburn soils	(Bn)
Undifferentiated soils in wet drainage channels		(U)

Soil name and map symbol: Motukarara soils (Mo)

Concept and overview

Motukarara soils occupy 100 ha and occur on the northern most and lowest lying part of the plains surface adjacent to the Waimea inlet. They are imperfectly to poorly drained soils formed from alluvial sediments that have been modified by fluvial action in an estuarine environment. Their imperfect to poor drainage is due to high groundwater conditions consequent upon their proximity to the Waimea Estuary.

Relationship to previously named soils

Motukarara soils were mapped by Chittenden et al. (1966) to the north of Nelson at Wakapuaka but were not separated around the margin of the Waimea estuary. These imperfectly to poorly drained estuary margin soils were included within Waimea soils. Motukarara soils have been mapped elsewhere in the South Island (Soil Bureau Staff 1968, Ward et al. 1964, Kear et al. 1967) as the soils on low lying land around the margins of estuaries, typically with slight to moderate salt concentrations due to their proximity to saline water. Tamutu soils (Gibbs et al. 1953 and Ward et al.1964) were mapped in close proximity to Motukarara soils but on slightly higher ground that was better drained.

Landform origin and history

The alluvial materials on the low-lying land adjacent to the Waimea estuary were probably deposited as part of the Holocene construction of the Waimea Plain. Subsequent to the deposition of the sediments, a small Late Holocene sea level rise (Woodroffe and Horton 2005) may have reworked the sediments adjacent to the coast, removing much of the clay loam material that characterises the Waimea soils and leaving a patchy distribution of predominantly shallow to moderately deep sand to silt textured alluvium with gravelly patches. The ground surface is bisected with shallow channels, formerly estuarine leads, but now remaining as low lying poorly drained areas since stopbanking removed direct sea access. 1938 aerial photos, taken before stopbanks were in place, show that some of this area was estuarine in character. No evidence was observed of the effects of salinity and it is probable that since the coastal stopbanks were emplaced, any salts, had they been present, would have been leached from the soil.

Key features and physical properties

Motukarara soils are shallow and imperfectly drained soils with weakly developed horizons and gravelly subsoils. The topsoil averages 15cm in thickness, is brown to dark brown coloured and has dominantly silt loam texture. The depth of fine material over gravel averaged 38cm. The subsoils are predominantly olive to greyish coloured with mottle colours that range from yellowish red to greenish grey. A watertable, commonly present at around 50cm, rises near the surface in the wetter months with areas of surface wetness.

Soil Variability

Topsoils vary in thickness (4-22cm) and there is a wide range of variation in soil colours and mottle patterns depending on the degree of wetness. The depth to gravel ranges from 10-95cm with 35% of profiles moderately deep (45-90cm) and 5% deep (>90cm). The soil drainage varies from well drained or moderately well drained on patches of slightly higher ground to imperfectly drained and

poorly drained on the lowest lying surfaces. In a few places, soil textures are sandy.

Associated and similar soils

Motukarara soils have similarities with Appleby soils (imperfectly drained soils from recent river alluvial deposits) and also with Cotterell soils (imperfectly drained soils from deeper clay loam alluvium) with which they grade into. Where the soils are formed on patches of well drained or moderately well drained sand or gravelly sand, they resemble Taumutu soils, which have been mapped in the Canterbury district (Ward et al. 1964, Kear et al. 1967) in association with Motukarara soils.

Versatility and land use rating

Motukarara soils have a low versatility (average 3.3 Table 2) with significant limitations to intensive use. These include imperfect drainage with significant seasonal wetness, shallow soils with low available water capacity, shallow rooting depth, summer moisture deficiency, weakly developed soil structure and susceptibility to flooding. They are included in class F of the Tasman District Council classification system for land management.

Horizon	Depth cm	Description
A	0-6cm	brown to dark brown (10YR 4/3) silt loam; weakly developed fine polyhedral structure; very weak soil strength; many fine roots
BC(g)	6-20cm	light olive brown (2.5Y 5/4) silt loam; 10% light brownish grey (2.5Y 6/4) and 5% reddish brown (5YR 3/4) mottles; weakly developed medium blocky structure; slightly firm soil strength, few fine roots
C(g)	20-40cm	olive brown (2.5Y 4/4) clay loam; 30% greyish brown (2.5Y 3/2) and 10% dark greyish brown (10YR 4/4) medium mottles; weakly developed medium blocky structure; slightly firm soil strength, few fine roots
Cg	40-55cm	light greyish brown (23.5Y 6/2) clay loam; 30% brown to dark brown (7.5YR 4/4) fine distinct mottles; apedal
Cr	55-74cm+	greenish grey (5GY 5/1) silty to sandy gravel; 40% medium and fine stones; apedal; disordered

Soil name and map symbol: **Wai-iti soils (Wa)**

Concept and overview

Wai-iti soils cover 73 ha and occur in patches in close proximity to the Waimea River. They are recent soils that formed from post-European flood deposits of the Waimea River and are presently largely free from flooding owing to the erection of the river stopbank system. Because of their youthful age, they have weakly developed profiles. Buried A horizons are commonly present and are indicative of the flooding history.

Relationship to previously named soils

Wai-iti soils were not separated in the previous soil survey of Waimea County (Chittenden et al. 1966) and were included within the Waimea soil type and may in part be represented by what was identified as Waimea sandy loam. There are no close correlatives to Wai-iti soils in this region. Geomorphically, they are similar to Takaka soils in the Golden Bay region in terms of their distribution in the landscape.

Landform origin and history

Wai-iti soils have formed on the floodplain zone of the Waimea River where there have been repeated river overflows during former flood events. The soil material is varied with gravel bars and deeper fine sediments deposited as a result of the varied fluvial conditions that existed.

Key features and physical properties

Wai-iti soils are mainly shallow soils that have weakly developed horizons with predominantly silt loam texture passing to sandy at greater depth. Buried A horizons, indicative of the past flooding history are commonly present. The soils are well drained.

Identified variants

The main variation in Wai-iti soils is in respect of their stoniness with gravel sometimes occurring at the surface and with an average depth to gravel of 30cm in 60% of the observations. Deep and moderately deep soils were found in 40% of the observations. In some lower lying areas, the soils are moderately well drained with subsoil mottles as they grade into the imperfectly drained Appleby soils.

Associated and similar soils

Wai-iti soils are associated with Appleby soils, which are also formed from recent flood alluvium but which occur in lower lying situations where the soil drainage is imperfect. Wai-iti soils also have similarities to Eves soils, which are formed from stream alluvium derived from erosion of Moutere Gravel.

Versatility and land use rating

Wai-iti soils have a high to moderate versatility soils (average 1.9 Table 2) with slight to moderate limitations for intensive use. These include weak soil structure, medium to low available water capacity due to the proximity of gravel to the soil surface and shallow to moderately deep rooting depth. Despite the presence of stopbanks, flooding remains a possibility in extreme events. These soils are included within class 2 of the Tasman District Council classification system for land management.

Horizon	Depth	Description
A	0-10cm	dark yellowish brown (10YR 4/3) silt loam; weakly developed fine polyhedral structure; weak soil strength; very friable; many fine roots
C	10-48cm	dark yellowish brown (10YR 4/4) clay loam; apedal; very weak soil strength; earthy; many fine roots
b A	48-65cm	dark brown (10YR 3./3) fine sandy loam; weakly developed fine polyhedral structure; very weak soil strength; very friable; few fine roots
b BC	65-75cm+	olive brown (2.5Y 4/4) loamy sand; apedal; loose; 5% fine stones; very few fine roots

Soil name and map symbol: **Appleby soils (Ap)**

Concept and overview

Appleby soils cover 9 ha and occur in association with Wai-iti on recent deposits of flood alluvium originating from the Waimea River and occur in lower lying poorly drained areas. Like Wai-iti soils, they are now essentially protected from river overflows during flood events but owing to there low lying position, the soils are imperfectly to poorly drained and during heavy rainfall events, water may lie on the surface for several days .

Relationship to previously named soils

Appleby soils were not identified or separated in the previous soil surveys. In the present survey, soils with similar drainage and flooding history attributes are Mahana soils formed from sediment from reworked Moutere Gravel along small stream channels and Cotterell soils on older alluvium and associated overflow channels where soil drainage is restricted.

Landform origin and history

Like Wai-iti soils, Appleby soils have formed on sediments from recent overflows of the Waimea River but they are formed in the lower lying areas that were part of previous overflow channels. Because of their low lying position 2-3m above sea level, they are susceptible to watertable fluctuations and are commonly inundated during wet periods.

Key features and physical properties

Appleby soils have brown to dark brown topsoils of variable thickness (6-20cm) with texture ranging from clay loam to sandy loam. Subsoils are predominantly greyish coloured with mottles that range from light grey or bluish grey and reddish brown, again with variable textures. Subsoil horizons are weakly structured and with differentiation that mainly reflects drainage differences in the soils. The soils are moderately deep (45-90cm to underlying gravel) and soil drainage is predominantly imperfect. A watertable is commonly present and fluctuates according to seasonal conditions.

Identified variants

The main variants of Appleby soils are the poorly drained soils that occur in the lowest lying areas and some patches of shallow soils where gravels are at or near the surface.

Associated and similar soils

Richmond soils were mapped by Chittenden et al. (1966) on low lying land to the east of the present survey area and are imperfectly drained and at times peaty. They have formed on somewhat older alluvium rather than recent flood alluvium as have Appleby soils. Harihari soils in the Golden Bay district are similar in character to Appleby soils.

Soil versatility and landuse

Appleby soils have a moderate to low versatility (average 2.8 Table 1), the principal limitations being their imperfect drainage, restricted trafficability, workability and rooting depth caused by soil wetness and periodic surface flooding at times of significant rainfall events. These soils are included in class F of the Tasman District Council classification system for land management.

Horizon Depth Description

A	0-12cm	brown to dark brown (10YR 3/4) silt loam; weakly developed fine polyhedral structure; weak soil strength; friable; few coarse and many fine roots
b A	12-24cm	dark yellowish brown (10YR 4/4) silt loam; 3% light brownish grey (10YR 6/2) and 5% reddish brown (5YR 5/6) fine distinct mottles; weakly developed fine polyhedral structure; weak soil strength; friable; few fine and few medium roots
C(g1)	24-34cm	light olive brown (2.5Y 5/4) clay loam; 20% olive (5Y5/3) and 20% strong brown 7.5YR 5/6) fine distinct mottles; weakly developed medium blocky structure; weak soil strength; semi-deformable; few fine roots
C(g2)	34-66cm	olive (5Y 5/3) clay loam; 40% reddish brown (5YR 5/6) fine diffuse mottles; weakly developed medium blocky structure; slightly firm; semi-deformable; very few fine roots
Cg	66-90cm	light olive grey (5Y 5/2) clay loam; 40% reddish brown (5YR 5/6) diffuse mottles; apedal; slightly firm soil strength; semi-deformable

Soil name and map symbol — Redwood soils (Rd)

Concept and overview

Redwood soils cover 180 ha on surfaces that lie a little above the floodplain of the Waimea River. They have a slightly undulating, in places distinctly channelled, ground surface that formed as a result of former overflows of the

Waimea River. The soils are weakly developed , are predominantly shallow to moderately deep and often stony at the ground surface.

Relationship to previously named soils

Redwood soils were not separated in the earlier soil survey of Waimea County (Chittenden et al. 1966) and were mapped as part of the Waimea soil type, probably Waimea sandy loam, occurring closer to the river and in strips along old river channels.

Landform origin and history

Redwood soils occur on a slightly undulating land surface, which in part comprises shallow, irregular, overflow channels that formed as a result of former flooding and overflows of the Waimea River. Redwood soils are a little younger than Waimea soils and this indicates that the flooding took place after the deposition of the Waimea soil materials. Judged by the degree of soil development, Redwood soils are probably of Late Holocene age.

Key features and physical properties

Redwood soils are weakly developed and have a dark brown sandy loam or silt loam A horizon (average depth 19 cm) overlying a weakly developed dark yellowish brown sandy loam or silt loam colour B or BC horizon (average depth 20cm). This passes into a C horizon that is olive brown predominantly gravely sandy loam. Redwood soils are commonly shallow (50% of observations <45cm to gravel) with stones often present to the soil surface, while moderately deep soils (45-90 cm to gravel) comprised 25% of the observations. Redwood soils are well drained.

Identified Variants

The main variation within Redwood soils is in respect of topsoil depth (range from 5-30cm), texture of the surface horizons (silt loam 35% sandy loam 52%) and the depth to gravel (shallow soils 86% and moderately deep 30%). In the shallow soils, stones are often present to the soil surface and in places are bouldery.

Associated and similar soils

Redwood soils were not previously identified in this district and in this survey are mapped in some areas that were previously shown as Dovedale soils. They are distinguished from Waimea soils in having shallower gravelly profiles with loamy textures rather than the deeper clay loam textured profiles of the Waimea soils.

Soil versatility and land use

Redwood soils have a moderate to high versatility (average 1.9 Table 1) and are used extensively for a range of horticultural and market garden crops. Their principal limitations are shallow weathering profiles and proximity of underlying gravels, often gravelly at the surface and low to medium available water capacity, although this can be overcome with irrigation. Redwood soils are included in class B of the Tasman District Council Classification system for productive land.

Horizon	Depth	Description
A	0-16cm	dark yellowish brown (10YR 4/3) silt loam; moderately developed fine polyhedral structure; 15% fine to coarse stones; slightly firm soil strength; friable; common fine roots
AB	16-30cm	dark yellowish brown (10YR 4/3 and 10YR 4/4) fine sandy loam; weakly developed fine polyhedral structure; 10% fine to coarse stones; slightly firm soil strength; friable; few fine roots
(B)	30-40cm	dark yellowish brown (10YR 4/4) sandy loam; weakly developed fine polyhedral structure; 2% fine to coarse stones; slightly firm soil strength; brittle; few fine and few medium roots
BC	40-50cm	light olive brown (2.5Y 5/6) sand; apedal; 5% fine to very coarse stones; earthy; slightly firm soil strength; few fine and few medium roots
C	50-70cm+	olive brown (2.5Y 4/4) coarse sand; apedal; 35% medium to very coarse stones; loose; few medium roots

Soil name and map symbol — Waimea soils (Wm)

Concept and overview

Waimea soils cover 286 ha and occur on the uppermost surface that forms the northern part of the Waimea Plain. Previously shown as covering nearly all of the lower fluvial surfaces of the Wairoa-Waimea River north of Brightwater

(Chittenden et al. 1966), in the present survey they are restricted to soils on broad level surfaces on slightly higher ground and above contemporary flood level. Waimea soils are characterised by deep profiles that are well drained and with clay loam to silt loam textures.

Relationship to previously named soils

Waimea soils of the present survey are similar to soils mapped by Chittenden et al. (1966) as Waimea clay loam although in that survey, Waimea clay loam was not mapped on the west side of the Waimea River. Soils mapped by Chittenden et al. (1966) as Waimea silt loam and sandy loam are not included with Waimea soils in the present survey and are separated as Wai-iti and Redwood soils on younger alluvial deposits.

Landform origin and history

The materials from which Waimea soils are formed are relatively uniform and comprise fine textured alluvium often passing into sandy textured alluvium and sometimes gravel at depths of between 60-100cm. More or less uniform deposition of the sediments over a broad even surface with a gentle gradient (6m rise over 3km) suggests a low energy fluvial environment, perhaps in deltaic-like conditions. Waimea soils do not have well developed morphological features suggestive of significant age, but at the same time lack features associated with recent soils and they may date in age from the Mid to Late Holocene in age.

Key features and physical properties

Waimea soils have a brown to dark brown moderately deep clay loam topsoil (average 22.5cm thick) with a dark yellowish brown B horizon (average thickness 28.5cm) with moderately developed structure. This passes into a dark yellowish brown weakly structured BC horizon then into a C horizon of olive to light olive brown sandy loam or clay loam with gravel sometimes present. Waimea soils are well drained but in about 10% of the observations some mottles are present below 50cm and the soils are moderately well drained.

Fine and medium gravel was observed in the A horizons in about 20% of the observations, occasionally with some charcoal. Sandy gravel was added to these soils in pre-European times of Maori cultivation.

Identified variants

The main variation encountered with Waimea soils is in respect of soil drainage, the soils being moderately well drained in places where they pass into Cotterell soils. Waimea soils are moderately deep in a few places where subsurface gravels are between 45-90cm of the surface. The anthropic addition of gravelly material to the surface is generally less than about 20% coarse fragments.

Associated and similar soils

Moderately well drained to imperfectly drained Cotterell soils are associated with Waimea soils and occur in some swales and slightly lower lying areas with restricted drainage. Redwood soils also occur in association with Waimea soils at sites of former river overflows.

Soil versatility and landuse

Waimea soils have a moderate to high versatility (average 1.8 Table 1) and are used mainly for orcharding and to a lesser extent vineyard and other tree crops. The chief limitations are their somewhat slow permeability which, along with seasonally restricted workability and trafficability resulting from the clay loam texture and associated slightly firm consistence restricts their use for market garden crops. Waimea soils are included in class B of the Tasman District Council Classification system for productive land.

Horizon	Depth	Description
A	0-26cm	dark yellowish brown to dark brown (10YR 3/4-3/3) clay loam; moderately developed fine polyhedral structure; 2% fine to medium stones; slightly firm strength; friable; many fine roots
AB	26-38cm	dark brown and dark yellowish brown (10YR 3/3 + 10YR 4/4) clay loam; moderately developed fine polyhedral and medium blocky structure; slightly firm soil strength; friable; many fine roots
Bw	38-60cm	dark yellowish brown (10YR 4/4) clay loam; moderately developed medium blocky structure; slightly firm soil strength; brittle; few fine roots
BC	60-85cm	dark yellowish brown to olive brown (10YR 4/4-2.5Y 5/6) silt loam; weakly developed blocky structure; weak soil strength; friable; few fine roots
C	85-100cm	dark yellowish brown to olive (10YR 4/4-2.5Y 4/4) loamy sand; apedal; loose; very few fine roots

Soil name and map symbol **Cotterell soils**

Concept and overview

Cotterell soils are mapped over 70 ha and occur on the upper surface of the Waimea plain in areas from Redwood Road to near the coast. They are formed from similar alluvial materials as Waimea soils but occur in slightly lower lying areas as well as in some lower lying natural drainage overflow channels where soil drainage is impeded. They are characterised by distinctive subsoil mottling that extends through the B and C horizons.

Relationship to previously named soils

Cotterell soils were not mapped in the previous soil survey of Waimea County (Chittenden 1966) and within the Waimea Plains area, no soils with impeded drainage were identified on the younger alluvial deposits of the Waimea River.

Landform origin and history

The alluvium from which Cotterell soils are formed is similar to that for Waimea soils with predominantly clay loam texture and is mainly deep, but sometimes passes into sandy loam or gravel at depth. For the most part, the topography has a broad near level surface but to the north, Cotterell soils are formed in narrow shallow channels, less than 1m deep and which may have formed part of the drainage system associated with deltaic conditions at the time of the sediment deposition.

Key features and physical properties

Cotterell soils have moderately deep (average 23cm) dark brown to brown topsoils, predominantly with clay loam texture and an upper B horizon of about 20cm that is variable in colour but commonly brown to olive coloured with mainly clay loam texture and with grey and reddish brown mottles. Below is a BCg horizon, commonly dominated by light grey or light brown colours along with distinct reddish brown mottles. Underlying C horizons are again dominated by grey colours but with fewer reddish brown mottles. Subsoil structure is blocky or prismatic and the soil strength is firm. Drainage in Cotterell soils ranges from moderately to imperfectly drained and a watertable is sometimes present.

Identified variants

The main variations in Cotterell soils are in respect of their drainage with moderately well drained soils occurring in transition areas with Waimea soils while shallow or moderately deep soils are present in some of the drainage channels.

Associated and similar soils

Cotterell soils are associated with Waimea soils, the two merging as drainage changes from imperfectly drained to well drained. Braeburn soils also have drainage impediments but they are characterised by clayey textures and strong subsoil mottling as well as being formed from different materials.

Soil versatility and landuse

Cotterell soils have moderate limitations and a moderate to low versatility for intensive use (average 2.4 Table 1), the chief limitations being a drainage impediment, slow permeability, restricted trafficability and workability and periodic waterlogging. They are used for orcharding and dairying and their

clayey texture and associated firm subsoil strength and blocky to prismatic structure generally restrict their use for intensive horticultural crop use. They are included in class C of the Tasman District Council Classification system for productive land.

Horizon	Depth	Description
A	0-16cm	brown to dark brown (10YR 4/3) clay loam; weakly developed fine polyhedral structure; slightly firm soil strength; friable many fine and few coarse roots
B(g)1	16-30cm	light olive brown (2.5Y 5/4) silt loam; weakly developed medium blocky structure; 5% light brownish grey (2.5Y 6/2 and 25% strong brown brown (7.5YR 5/6) fine distinct mottles; slightly firm soil strength; brittle; few fine roots
B(g)2	30-45cm	light brownish grey (2.5Y 6/2) fine sandy loam; weakly developed medium blocky structure; 15% dark yellowish brown (10YR 4/6) and 15% strong brown (7.5YR 5/6) fine and medium distinct mottles; slightly firm soil strength; brittle; few roots
Cg	45-70cm+	light brownish grey (2.5Y 6/2) sandy gravel; apedal; loose

Soil name and map symbol **Eves (Ev)**

Concept and overview

Eves soils cover 47 ha and are formed from the alluvium from secondary

streams that drain the adjacent Moutere Hills. The catchments of the Redwood Valley and Eves Valley streams are formed in the Moutere Gravel Formation and the sediment comprising Eves soils consists of materials derived from the erosion of Mapua and Rosedale soils and the underlying weathered Moutere Gravel. Eves soils are weakly developed commonly with buried A horizons as a consequence of repeated flooding.

Relationship to previously named soils

Eves soils were not separated in the previous soil survey of Waimea County (Chittenden et al.1966) and were included within the soils mapped as Waimea. In that survey, the soils on the valley floors that were derived from eroded Moutere Gravel materials were broadly grouped into two series, Braeburn and Dovedale soils with no distinctions made on the basis of variation in morphological properties.

Landform origin and history

The stream channels of Redwood and Eves streams are narrow and as they are incised between 1-2m below the plain surface formed by the Appleby Gravel and Harakeke Formations, they are relatively recent geomorphic features. Below the junction of the two streams (O'Connor Creek) the channel widens and has weakly developed terraces. Post European forest clearance in the adjacent Moutere Hills has probably resulted in accelerated rainfall run-off consequently flooding occurs along these stream channels during significant rainfall events.

Key features and physical properties

Eves soils are predominantly deep with dark yellowish brown to brown shallow, weakly structured topsoils (average 14cm) and sandy loam texture. The subsoils are varied with buried A and B horizons common reflecting the history of past flooding. Subsoil textures range from sandy loam to clay loam and colours are highly variable. Eves soils are well drained but some are moderately well drained.

Identified variants

Shallow soils (<45cm to gravel) were found in 25% of the observations and moderately deep soils in 10% of the observations. Some of the shallow soils comprised only a thin cover of recent alluvium overlying older soil materials (Braeburn). Moderately well drained soils were found in 30% of the observations.

Associated and similar soils

Eves soils are associated with Mahana soils (mapped in this survey), with Mahana soils being formed in the same topographic situation an the same materials but in low-lying areas where drainage is imperfect to poor. Eves soils are similar to Wai-iti soils in being formed from recent flood deposits but are formed from different materials.

Soil versatility and landuse

Eves soils have a moderate to low versatility for intensive use, (averagev2.4 Table 1) the chief limitations being topography (narrow stream channels that make intensive use impractical in most places), and periodic flooding. They are

used mainly for pastoral grazing but also for orchard and vineyard use in some places where easier topography allows adjacent use to be extended onto Eves soils. For the most part, they are included in class D of the Tasman District Council Classification system for productive land.

Horizon	Depth	Dsecription
A	0-15cm	dark yellowish brown (10YR 4/4) sandy loam; weakly developed fine polyhedral structure; very weak soil strength; very friable; many fine roots
AC	15-25cm	dark yellowish brown and yellowish brown (10YR 4/6 and 10YR 5/6) sandy loam; weakly developed fine polyhedral structure; very weak soil strength; common fine roots
b A	25-30cm	dark yellowish brown (10YR 4/4) sandy loam; apedal; 10% strong brown (7.5YR 5/6) and 10% light yellowish brown (2.5Y 6/4) fine distinct mottles; loose; few fine roots
b C	30-50cm	yellowish brown (10YR 5/6) sand; apedal; loose; few fine roots
2b A	50-56cm	dark yellowish brown (10YR 4/4) sand; apedal; loose; few fine roots
2b C	56-80+cm	brownish yellow (10YR 6/6) sand; apedal; loose very few fine roots

Soil name and map symbol **Mahana (Mh)**

Concept and overview

Mahana soils occupy a small area (6 ha) and are formed in low-lying areas on alluvium from the secondary streams that drain the adjacent Moutere Hills. The catchments of Redwood Stream and Eves Valley Stream provide the alluvial sediment that was derived from the weathered soils on the Moutere Gravel formation from and which Mahana soils are formed. Because of their low-lying situation, Mahana soils are poorly drained.

Relationship to previously named soils

Mahana soils were not separated in the previous soil survey of Waimea County (Chittenden et al.1966) and were included within the soils mapped as Waimea. Dovedale and Braeburn soils were identified as alluvial soils from reworked Moutere Gravel materials in the valleys of the Moutere Hills, but there were no detailed soil morphological separations made on the basis of age or drainage differences in these materials.

Landform origin and history

Mahana soils are formed in low-lying areas of the stream channels cut into the Appleby Gravel and Harakeke Formations by Eves and Redwood streams and O'Connor Creek. Although these channels may have been in part formed from earlier overflows of the Waimea River,
stream-flows and sediments are derived from the adjacent Moutere Hills. Along these stream channels, the topography varies from incised narrow channels to broader channelled surfaces with a weak terrace and flood plain formation. Mahana soils are found in a few small areas on low-lying surfaces that are frequently flooded.

Key features and physical properties

Mahana soils are characterised by their poor drainage with strongly mottled subsoil that are dominated by grey colours. The subsoils are layered due to repeated sediment deposition during flooding and buried A horizons are commonly . Topsoils are thin and soil structure is weakly developed.

Identified variants

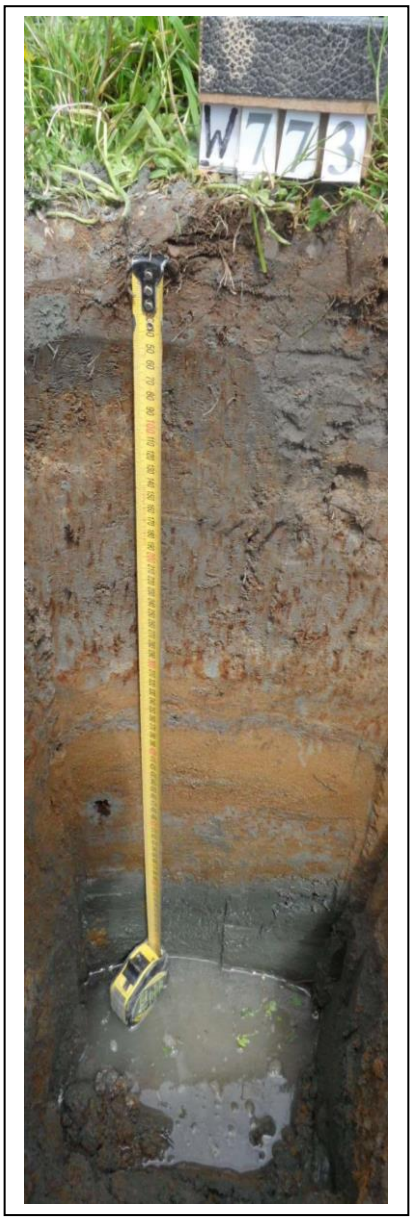
The main variations are in respect of textural differences with occasional gravelly patches being present. In the lowest lying areas, water is commonly at the surface and the surface horizon is slightly peaty.

Associated and similar soils

Mahana soils are associated with Eves soils which occur on surfaces above those on which Mahana soils occur and which are better drained. Mahana soils have similarities to Appleby soils which are formed in lower lying occasionally flooded areas associated with the Waimea River.

Soil versatility and land use

Mahana soils have a low versatility with significant limitations for land use (average 3.5 Table 1) the main limitations being low lying topography, restricted trafficability and workability due to high a high watertable and frequent flooding. They are included in Class F of the Tasman District Council Classification system for productive land but may be better included with Class H and retained for conservation and recreational use.



Horizon	Depth	Description
A	0-8cm	dark yellowish brown (10YR 4/4) silt loam; weakly developed fine polyhedral structure; very weak soil strength; very friable; common fine roots
b Ag	8-17cm	olive grey (5Y 4/2) sand; apedal; 25% yellowish red (5Y 5/8) fine distinct mottles; weak soil strength; very friable; few fine roots
b Cg	17-30cm	greyish brown (2.5Y 5/2) silt loam; apedal; 20% dark reddish brown (5YR 3/3) and yellowish red (5YR 5/6) fine distinct mottles; slightly firm soil strength; semi-deformable; very few fine roots
b C	30-50cm	yellowish brown (10YR 5/8) sand; apedal; loose
Cr1	50-70cm	olive grey (5Y 4/2) sandy loam; apedal; 5% yellowish red (5YR 4/6) fine distinct mottles very weak soil strength
Cr2	70-90cm	dark greenish grey (5GY 4/1) sand

Soil name and map symbol **Dovedale (Dv)**

Concept and overview

Dovedale soils cover 89 ha and occur in the Redwood Valley area. They are predominantly well drained or moderately well drained, sandy to silty textured shallow or gravelly soils that have formed from alluvial deposits derived from reworked Moutere Gravel materials in the coastal valleys.

Relationship to previously named soils

Dovedale soils were previously mapped by Chittenden et al. (1966) in the Soil Survey of Waimea County as the soils on valley floors of the lower rainfall, coastal valleys within the Moutere Hills. They were described as gravelly loams, formed from resorted alluvium derived from Moutere Gravels.

Landform origin and history

In the present survey, Dovedale soils occur only in the Redwood Valley area on a land surface that forms an indistinct terrace, which at its eastern margin, lies about 2 metres above the principal alluvial surface of the Waimea River. This surface rises from about 7 metres at its eastern edge to 22 metres at the south-western margin of the survey area and forms a broad gently sloping fan which occupies Redwood Valley. The alluvial sediments that underlie this surface have been mapped as Harakeke Formation (Waimean or second last glaciation age, Johnstone 1982) but the surface sediments may be younger and represent the sediments that accumulated during erosion within the Moutere Hills in the late Last Glacial period. The gravelly Dovedale soils represent the sedimentation that occurred during periods of more active fluvial conditions.

Key features and physical properties

Dovedale soils have moderately deep (average 19cm) brown to dark brown weakly structured topsoils with predominantly sandy loam texture and with stones commonly present (60% of the observations). The B horizons are predominantly yellowish brown and gravelly with sandy loam texture passing into brownish yellow gravelly sandy loam. Dovedale soils are mainly well drained, but moderately well drained soils are often present with distinct reddish or strong brown and light grey or pale yellow mottles, sometimes accompanied by dark reddish brown concretions.

Identified variants

In a few places, stones are absent and the soils are deep or moderately deep with yellowish brown sandy textured subsoils. Imperfectly drained soils with grey colours throughout the subsoil are sometimes present.

Associated and similar soils

Dovedale soils are associated with Braeburn soils which occur within the same landform unit but which are formed from deeper and finer textured alluvium and which have clayey texture and imperfect to poor drainage. Dovedale soils are have similarities with the shallow and stony members of Tapawera and Motupiko soils which occur further inland where rainfall is somewhat higher.

Soil versatility and land use

Dovedale soils have moderate to low versatility (average 2.3 Table 1) the chief limitation being their gravelly profiles which in turn influences the suitability for irrigation, available water capacity, permeability and effective rooting depth. With

irrigation, they are used predominantly for orchard and vineyard crops but rarely for more intensive horticultural use. These soils are included in Class D of the Tasman District Council Classification system for productive land.

Horizon	Depth	Description
A	0-22cm	brown to dark brown (10YR 4/3) silt loam; weakly developed fine polyhedral structure; 1% fine and medium stones; weak soil strength; friable; common fine roots
AB	22-30cm	brown to dark brown and yellowish brown (10YR 4/3 + 10YR 5/8) silt loam; moderately developed fine polyhedral structure; 1% fine and medium stones; slightly firm soil strength; friable; few fine roots
Bw	30-60cm	yellowish brown (10YR 5/8) sandy silt loam; weakly developed fine blocky structure; 20% fine and medium stones; slightly firm soil strength; brittle; few fine roots
BC	60-75cm+	brownish yellow (10YR 6/8) sandy silt loam; apedal; 60% fine to coarse stones; earthy; dense

Soil name and map symbol Braeburn (Bn)

Concept and overview

Braeburn soils occupy 60 ha and in the present survey occur within the Redwood Valley area. They are the soils that have formed from fine textured alluvium that has been derived from erosion of the Moutere Gravel sediments and soils of the adjacent Moutere Hills. They are for the most part imperfectly drained and are characterised by clayey textures and strongly mottled subsoils with distinctive reddish and whitish colours. In smaller gullies, they are sometimes poorly drained and as the slope increases, they merge into the adjacent Mapua soils formed on Moutere Gravel.

Relationship to previously named soils

Braeburn soils were previously mapped by Chittenden et al. (1966) in the Soil Survey of Waimea County as heavy textured mottled soils on valley floors, within the lower rainfall Moutere Hills area and which were formed from finer textured sediments derived from the nearby Moutere Gravel Formation.

Landform origin and history

Braeburn soils, like Dovedale soils, occur only within the Redwood Valley area in the present survey. At the eastern margin, the altitude is approximately 7 metres but the land surface gradually rises southwards into Redwood Valley and also in the smaller gullies that are dissected into the Moutere Hills. Rather than forming a distinct terrace, the gently rising surfaces into the valley and gully system indicates that there has been progressive aggradation and infilling in the valley and gully floors through erosion of Moutere Gravel materials in the adjacent hills. The clayey texture and essentially stone free nature of the Braeburn soils are indicative of gradual accumulation under weak fluvial conditions.

Key features and physical properties

Braeburn soils have moderately deep (average 24cm) clay loam textured weakly structured topsoils, overlying clay textured subsoils which at first are predominantly light yellowish but which with increasing depth become intensively mottled with a mixture of light grey, reddish, strong brown and sometimes whitish colours. The subsoil is commonly dense with prismatic or blocky structure. Braeburn soils are for the most part imperfectly drained and stone free and concretions are often present sometimes forming an indistinct iron pan.

Identified variants

Poorly drained soils are present near the heads of some minor gullies where there is excessive runoff from adjacent hilly land. Moderately deep soils with weathered stones were noted in 20% of the observations.

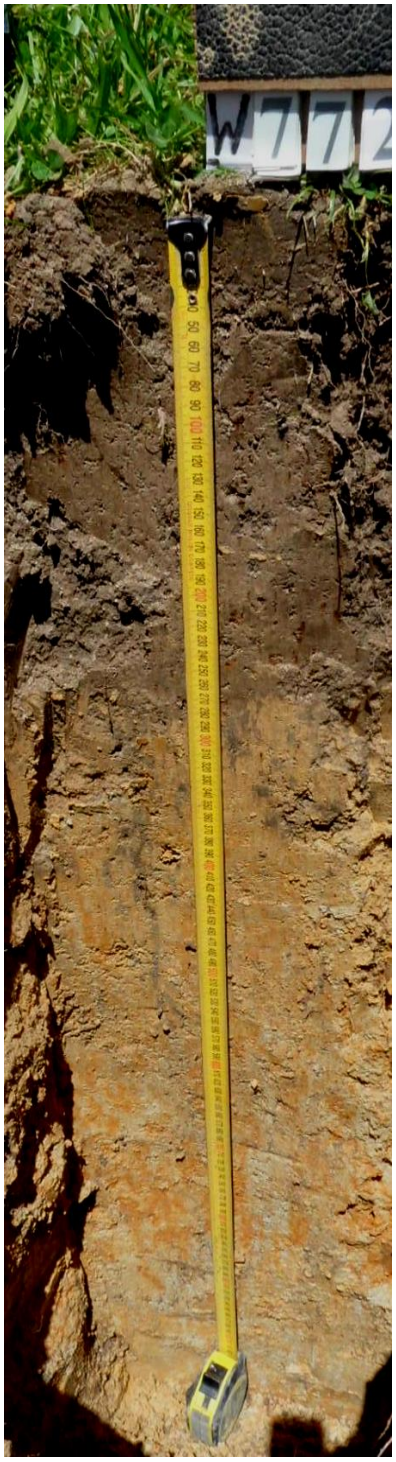
Associated and similar soils

Braeburn soils are associated with Dovedale soils which occur on the same geomorphic surface but where more active fluvial action has resulted in the deposition of gravels. In many respects, Braeburn soils resemble Mapua soils, both having similar clayey textures and intensively mottled subsoils but Mapua soils have strongly weathered Moutere Gravel clasts which increase in abundance with increasing depth.

Soil versatility and land use

Braeburn soils have moderate to low versatility (average 2.8 Table 1) with the main limitations being their clay subsoil texture and dense subsoil which in turn restricts drainage, permeability, workability and rooting depth. For the most part, they are

unused for horticultural crops. Braeburn soils are included in Class D of the Tasman District Council Classification system for productive land.



Horizon	Depth	Description
A	0-27cm	brown to dark brown (10YR 4/3) heavy silt loam; weakly developed fine polyhedral structure; 3% dark reddish brown (5YR 3/3) fine distinct soft concretions; slightly firm soil strength; friable; common fine roots
AB	27-32cm	brown to dark brown and olive yellow (10YR 4/3+ 2.5Y 6/6) heavy silt loam; weakly developed fine polyhedral and blocky structure; 2% fine distinct dark reddish brown (5YR 3/3) mottles; slightly firm soil strength; friable; few fine roots
Bw1	32-40cm	light yellowish brown (2.5Y 6/4) clay loam; weakly developed coarse blocky and weak prismatic structure; firm soil strength; dense; semi-deformable; very few fine roots
Bw2	40-56cm	light yellowish brown (2.5Y 6/4) clay loam; moderately developed coarse blocky structure; 35% strong brown (7.5YR 5/8) distinct fine and medium mottles; firm soil strength; dense; semi-deformable; very few fine roots
B(g)1	56-80cm	pale olive (5Y 6/3) sandy clay loam; moderately developed coarse blocky and medium prismatic structure; 45% strong brown (7.5YR 5/8) prominent medium mottles; firm to very firm soil strength; dense; semi-deformable
B(g)2	80-110cm	light brownish grey (2.5Y 6/2) sandy clay loam; moderately developed coarse blocky and prismatic structure; 25% strong brown (7.5YR 5/8) fine diffuse mottles; very firm soil strength; dense; semi deformable

Soil name and map symbol Unnamed soils (U)

The unnamed soils cover 12ha in the northern part of the survey area and occupy low-lying channels that form semi-permanent waterways. They are essentially unsuited for agricultural use and may be best retained for conservation purposes.

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Table 2

Soil Versatility Ratings

Soil Name	Motukarara	Wai-iti	Appleby	Redwood	Waimea	Cottrell	Eves	Mahana	Dovedale	Braeburn
Topography	1	1	2	1	1	2	4	3	1	1
Irrigability	4	2	4	2	2	2	3	4	3	3
Drainage	3	1	3	1	1	3	1	4	2	4
AWC	4	2	2	3	1	2	2	2	3	2
Stoniness	3	2	2	3	1	1	1	1	3	4
Permeability	3	2	3	3	3	3	2	3	3	4
Nutrients	3	2	2	2	3	3	3	3	4	4
Trafficability	4	2	4	2	3	3	2	5	2	4
Workability	3	2	3	2	3	3	3	5	2	4
Rooting Depth	4	3	3	2	1	2	3	3	3	3
Erosion/flooding	4	3	4	1	1	1	4	5	1	1
Waterlogging	3	1	3	1	2	3	1	4	1	3
Average	3.3	1.9	2.8	1.9	1.8	2.4	2.3	3.5	2.3	2.8

Key:		
0-1	Highly Versatile	Few limitations
1-2	Moderate to high versatility	Slight limitations
2-3	Moderate to low versatility	Moderate limitations
3-4	Low versatility	Significant limitations
4-5	Non versatile	Severe limitations