Soils of the Tasman District

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Introduction

The village of Tasman is located at the southern end of the Moutere Inlet and is the focus for the somewhat loosely defined *'Tasman District'* that borders the inlet coast and extends southward toward Mapua. In the early 1900's this area was recognised as being well suited for apple production because of its 'clayey soils' and high sunshine hours and larger blocks of land were subdivided and planted in pip fruits. By 1934 one million bushels of fruit were exported, largely through the port at Mapua. Apple production peaked in the 1980's but in the 1990's there was a rapid fall in grower returns due to a number of causes. The failure to adjust to different marketing conditions with the adaption of new varieties, new growing techniques, alternative crop uses or consolidation of land holdings into larger economic units led to many land owners exiting the industry and resorting to land subdivision for financial gains. While there has been some substitution of pip fruit with crops such as black currants, viticulture and olive production, the result is that a significant part of the area that was formerly under intensive horticulture has now been converted to predominantly unproductive lifestyle block utilisation. This process was aided by the rezoning of a significant part of the area as Rural 3 land.

Figure 1. Aerial photo of part of the Tasman District between Moutere Bluff and Kina, probably 1940's.

On a national basis, the total area of potentially high producing land and soils within the Tasman provincial area, (Class A land Agriculture New Zealand 1994) that is suited for intensive and sustained horticultural use is exceedingly small (approximately 250km^2 or around 2.5% of the region) and is located in the lowlands of the Golden Bay Motueka and the Waimea River valleys). A significant portion of this area has already been lost and squandered through urban development. Land classified as Class B in the Classification System for Productive Land in the Tasman District includes Mapua soils and covers a similar area to the Class A land. Although this land is more limited by intrinsic soil characteristics in respect of its use for horticultural production, it is no less valuable in terms of its economic potential and is likewise being steadily lost through unproductive 'lifestyle' and housing 'development' subdivisions.

Soil identification

Soils formed on the widespread Moutere Gravel Formation were initially called *Moutere soils*, but subsequent investigation recognised essential differences. Rosedale, Stanley, Spooner, Korere and Hope soils are formed on Moutere Gravel and progressively occur under increasingly higher rainfall regimes, cooler climate and at greater distances from the coast. Mapua soils were identified as occurring in the lower rainfall areas nearest to the coast (Rigg 1945, Fox and Chittenden 1952, Chittenden et al. 1966). The survey of the soils of Waimea County (Chittenden et al. 1966) showed Mapua soils on the undulating coastal lands (identified as Mapua sandy loam) covering approximately 6,900 ha and Mapua soils on hilly land (Mapua Hill soils) approximately 6,800 ha.

Although the Mapua soils are relatively well known because of their capacity to support pip fruit production and other horticultural crops, notwithstanding their intractable properties, surprisingly little data exits regarding their physical and chemical attributes or their landscape relationships etc. Mapua soils are however referred to in a range of studies including the relationship of the soils to various horticultural management practices (largely research related to the former Appleby Research orchard), studies related to the growth of Pinus radiata, comparisons of some chemical properties in New Zealand soils, modelling of soil hydrological properties in New Zealand soils and some contaminant studies. Soil chemical data were given for two sites in the report by Chittenden et al. 1966 (Table 4) and data from a more comprehensive set of chemical and physical analyses from a single site were included in a New Zealand Society of Soil Science field guide (Campbell and Killman 1988, Appendix 2).

Soil Investigation in the Tasman Vicinity

In 1917/18 an area covering approximately 1250ha (Figure 2) in the vicinity of Tasman was examined for the purpose of providing a better definition of the soils within this locality. The landscape has a predominantly undulating to rolling topography, with a dissection pattern comprising broad ridges and gullies with a largely north-north-east orientation. The elevation rises from sea level to about 100m in the southwest part of the area. The coastal land adjacent to Tasman Bay has steep cliffs. Gully bottoms within the undulating landscape are mostly narrow, apart from a small area following the Tasman-Mapua Highway that is wider and flat.

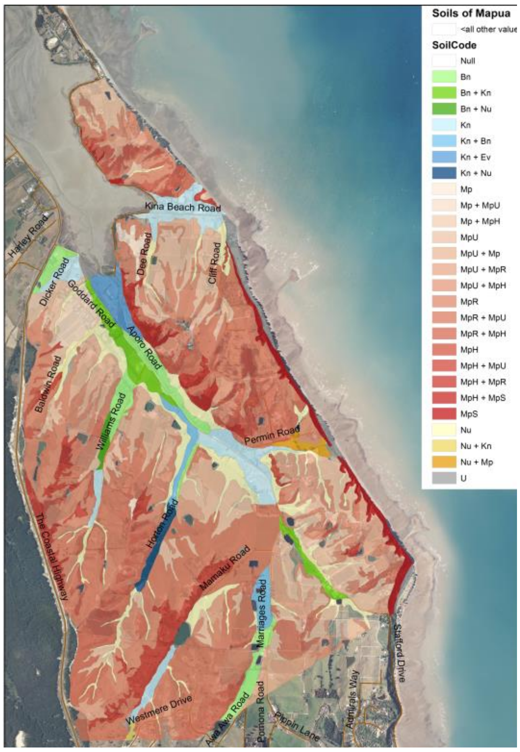

Figure 2.

Area covered in the survey of the soils of Tasman District.

Soil Survey Method

The field examinations of the soils was carried out over 40 days through May to November 2017 by making soil auger observations and some pit observations largely following traverse lines that criss-crossed the area. Additional observations were made from soil exposures in cuttings and sections. A total of 665 soil observations have been recorded for the area, including 140 recordings from two earlier examinations. Base maps provided by TDC for the survey were at a scale of approximately 1:3000. Also provided were maps showing land slope classes. In carrying out the soil survey, transects were made to intersect these identified land slope units wherever practicable. Land slope class differentiations that were made were as follows:

0-3° Flat to gently undulating
3-7° Undulating
7-15° Rolling
15-25° Strongly rolling-moderately steep (Hilly land)
>25° Steepland

These land slope classes are the nationally recognised land categories (Lynn et al. 2009) used to distinguish land with differing agronomic potential, owing to the increasing difficulties of cultivation, use of machinery, irrigation application and erosion potential with increasing slope values. While this is a convenient way of designating land for general agricultural use, it does not exclude the use of land for specific crops, as land modifications (terracing or slope smoothing), trickle irrigation or development of machinery specifically for use on steeper slopes allows productive use on land that might otherwise be thought of as unsuited for intensive use (Figure 3). The economic value of a crop is a strong driver in determining whether land of any particular slope class will be utilised for any specific crop. Conversely, economic returns should not be used as a reason for allowing land subdivision, since the intrinsic productive potential of the soil remains regardless of the economic climate. The preservation of productive potential is essential to meet the future challenges in a world in which there is a continual decline in the renewable resource base.

Figure 3. Slope need not be an impediment to intensive use as shown by this picture showing orchard use on hill slopes >16°. In some other locations, slope smoothing has been employed to even the contour for practical management.

During the survey, auger observations were made generally to a depth of 1m and the soil properties assessed were soil horizon thicknesses, soil colour patterns, soil texture, soil drainage attributes with site slope, position on the slope, aspect, and altitude being noted. Soil samples were collected at 3 sites for particle size analyses and calibration of field assessment of soil textures (Appendix 2). Detailed chemical and physical data for a Mapua soil from a site at Appleby (sampled in 1978) are included as part of the characterisation of Mapua soils.

Soil assessments were made following the National Guidelines for soil description set out by Milne et al. (1995). All data were electronically recorded for later incorporation into the National Soils Database and for assessment of variability in soil properties. At the completion of the field work, the distribution of the various classes of soils that were identified was plotted onto a base map for final drawing by TDC Staff

Background to soil formation in the Area

The coastal Tasman district is part of the extensive Moutere Gravel geological formation first described by Hector (1879). This formation occupies the Moutere Depression (Campbell & Johnston 1982; Johnston 1983), an extensive lowland area formed between the west and east Nelson Ranges. The thick deposit of gravel that

Figure 4. Weathered Moutere Gravel which forms the parent material for Mapua soils. Weathering is influenced by the composition of individual clasts. The pale clast is siltstone v and is soft, and brown coloured clasts are sandstone (greywacke). Dark red clasts have higher iron content and may become iron cemented and persist in the soil. Weathering is strongly influenced by the translocation of iron which is evident in rinds of some clasts. Quartz clasts remain largely unaltered. Within the lower part of the soil profile, weathering clasts may remain only as ghosts.

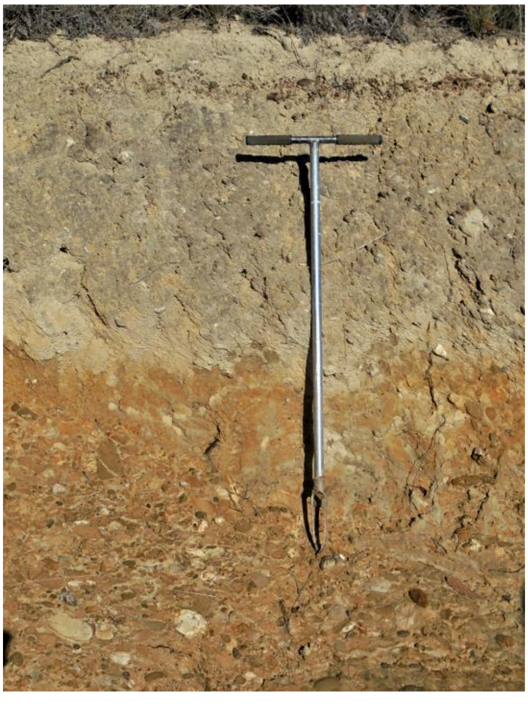

Figure 5. Profile of a Mapua soil showing the transition into underlying altered Moutere Gravel. The upper pale-coloured soil material is a surface bleaching/drying phenomena, as freshly exposed material is usually brown. The brown coloured soil between the pale material and the underlying weathered gravels is the BC transition horizon and commonly has rotted rock clasts (ghosts). The layer of brown pebbles above the auger handle are residual strongly oxidised concreted clasts, formed during soil weathering by iron enrichment and concentrated over time by slow loss of surface soil material. They occur intermittently and to a varying extent in soils through the area.

constitutes the Moutere Gravel Formation, once formed a large alluvial plain that was probably deeply weathered and has subsequently been dissected to form the present day landscape consisting of a complex pattern of ridges, valleys and gullies. In higher elevation inland areas, glacial climatic episodes through the Pleistocene period resulted in intermittent landscape rejuvenation, particularly towards the colder south where weathering within the mantle materials is less intense. In the northern coastal lands, there is little evidence for cold climate landscape rejuvenation and the surface soil mantle across the landscape is comparatively uniform and weathered to greater depth (Figure 5). Within the Moutere Gravel, thin lenses of consolidated sand are sometimes found, while the gravels vary in particle size, these differences being due to fluctuating fluvial conditions at the time of deposition of the gravels.

General landscape description

The surveyed area forms two distinct geomorphic entities, a coastal unit of about 425ha and a larger area of approximately 820ha to the south, the two being separated by a small valley that rises gently from sea level at Tasman to 40m near Moutere Bluff. The northern area is predominantly undulating to rolling land with shallow gullies that slope in a northerly direction but the southern portion that borders Aporo Road is largely rolling to moderately steep land. Along the exposed ocean coastline, slopes are very steep. The valley that follows the line of Aporo Road may once have been an extension of the Moutere Inlet at a time of former high sea levels with coastal erosion contributing to the formation of the steeper slopes along the southern margin of this area.

The larger southern portion of the surveyed area has predominantly undulating to rolling land bordering Aporo Road, the whole area being dissected by several small valleys. Towards the south, the dissection pattern is greater and there is a higher proportion of rolling to hilly land.

The valleys within this dissected landscape have bottoms that are around 100m wide in their lower reaches and become progressively narrower further up-valley where widths diminish to less than 10m. In many places, the valley and gully bottoms have poor surface drainage and a wetland vegetation is often present. The valley floors and low lying areas have accumulations of sediments, derived from erosion from adjacent hilly slopes. In most of the lower altitude parts of the valley floors, stream channel alignments have improved the overall land drainage.

Soil pattern of the area

The initial soil survey of the former Waimea County identified two soil units within the area, Mapua soils (Mapua sandy loam and Mapua Hill soils) on the Moutere Gravel materials and Braeburn soils formed from sediments from eroded Moutere Gravels on the valley floors. In the present survey, the soils that were identified are given in Table 1 below. A summary of data for the soils is given in Appendix 1.

Soil Name	Map Symbol	Soil Material	Soil Drainage	Topography
Mapua	Mp	Moutere Gravel	Moderate	Dissected land
Mapua Undulating	MpU	Moutere Gravel	Moderate	Dissected land
Mapua Rolling	MpR	Moutere Gravel	Moderate	Dissected land
Mapua Hill	MpH	Moutere Gravel	Moderate	Dissected land
Mapua Steep	MpS	Moutere Gravel	Moderate	Dissected land
Braeburn	Bn	Moutere Alluvium	Mod/imp	Valley floor
Neudorf	Nu	Colluvium/alluvium	Imp/poor	Valley/gull floor
Kina	Ki	Alluvium/colluvium	Poor	Valley floor
Eves	Ev	Moutere Alluvium	Well	Valley floor

Table 1. Soil map units in the survey of Tasman District soils and associated map symbols.

Each of the Mapua soils are characterised by weakly structured topsoil's of variable thickness and slightly sandy to silty texture. They overlie subsoils with dominantly clayey textures (silty clay to clay loam or clay), variable but often intensive brownish and greyish mottling, firm consistence and blocky/prismatic structure. This passes into an intermediate or BC horizon that is firm and compact, clayey to sandy clay textured, has blocky/prismatic structure and mottles ranging from strong brown to white (Figures 6 & 7). Weathered rock remnants (strongly altered gravel clasts or ghosts) are commonly present. The underlying weathered Moutere Gravel may lie between 70cm and 200cm of the soil surface. The Mapua soils have broadly similar features across the range of slope classes with variations in texture, structure, mottle patterns and depth largely related to specific site factors such as position on a slope, length of slope or slope shape (concave or convex). Profiles on ridge slopes were found to have an average depth to the BC horizon of 70cm, those on side slopes an average depth of 61cm to a BC horizon and those on toe-slopes 74cm to a BC horizon.

In the previous soil survey of the region, (Chittenden et al. 1966) Braeburn soils were identified as occurring on valley floor surfaces and being formed from sediments derived from erosion of weathered Moutere Gravel. In the present survey, three groupings of soils are separated that represent depositional and drainage differences within the valley floor topographic unit. Braeburn soils are moderately well drained to imperfectly drained soils on Late Pleistocene to Recent sediments deposited in a fluvial environment and are commonly underlain by Recent sand or gravel materials. Neudorf soils, formed largely on toe-slopes and gully or valley bottoms (Figures 8 & 9) are from lower slope Moutere materials, slope wash or colluvial sediments from erosion on adjacent lands. They are largely imperfectly to poorly drained, often have a veneer of younger surface sediment that overlies a buried topsoil and typically have pale coloured subsoils overlying mottled subsoil at greater depth.

Figure 6. Mapua soil profile showing blocky structured subsoil and typical bleaching of the soil surface on an exposed cutting.

Figure 7. Mapua soil profile showing strongly developed prismatic structure in the subsoil.

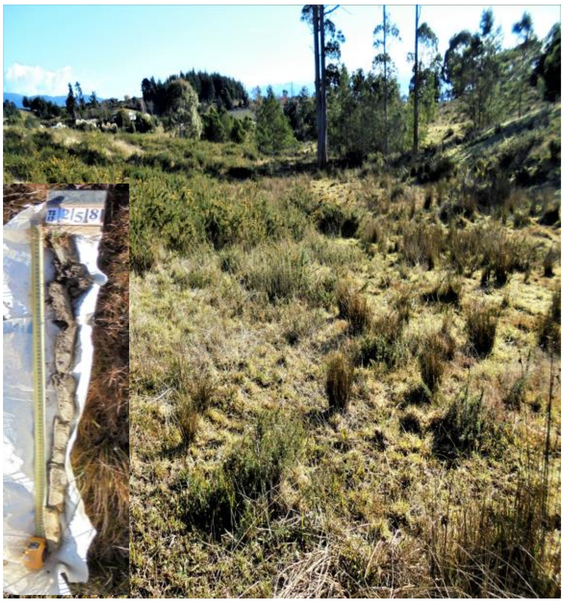

Figure 8. Gully bottoms and lower slopes (above) typically have imperfectly to poorly drained Neudorf soils. Neudorf soils (inset) have some sediment overlying the earlier topsoil and grey mottled horizons beneath.

Figure 9. Mapua soils have weakly developed topsoil structure and after cultivation, silty sediment, seen here in tracks and hollows, is lost from sloping ground and is deposited on lower slopes and valley floors.

Kina soils occur on low lying surfaces (Figure 10) and have formed under conditions where drainage was poor with a watertable close to the surface through much of the year. They are characterised by grey subsoil colours, typical of soils that exhibit strong gley conditions. Where land drainage has taken place, soil drainage has been improved and the soils have been utilised for agricultural use.

Figure 10. Within this dissected undulating Mapua soil landscape, .
Kina soils occur on the poorly drained valley floor.

Mapua (Mp)

Mapua soils (Appendix 3) cover 38ha (including some areas of MpU and MpH) and occur mainly on the lower elevation slopes of both the northern and southern blocks on land with a slope of between 0-3°. The topsoil's are brown to dark brown with thickness varying between 7 and 35cm and texture dominantly sandy clay to clay. The B horizons are variable, sometimes with few mottles in the upper part before passing into distinctly mottled clay loam to clay, overlying the more intensely mottled BC horizon at an average depth of 68cm. The depth to the BC horizon varied between 55-80cm and soft weathered stone remnants are usually present.

Mapua undulating (MpU)

This unit (Appendix 3) occurs with areas of Mp, MpR and MpH, and covers a total of 251ha. Mapua undulating soils occur at slightly higher elevations on broader surfaces and on land with slopes between 3 and 7°. The soils are fairly similar to the Mapua soils on easier slopes and have a brown to dark brown coloured topsoil averaging 21cm in thickness (with a range of between 10 and 35cm) and clay loam to sandy clay loam texture. The B horizons are brownish yellow to yellowish brown, with strong brown through to grey coloured mottles, and clayey texture, overlying a mottled BC horizon at an average depth of 69cm. The depth to the BC horizon varied from 45-90cm.

Mapua rolling (MpR)
Land mapped as Mapua rolling (Appendix 3) includes some areas of MpU and MpH and covers 515ha. Topsoil's are brown to dark brown, averaged 19cm thick and ranged between 7 and 31cm thick, while textures varied from sandy loam to clay. B horizons (brownish yellow and average 40cm thick) with nil or just a few mottles were found in 40% of the observations, a reflection of somewhat better soil drainage on rolling land. The deeper clayey textured B horizons again have distinctive strong brown mottles while the BC horizon (at an average depth of 71cm) had sandy clay to clayey texture with common strong brown, white and pale yellow mottles. The depth to the BC horizon was between 45 and 90cm from the ground surface.

Mapua hill (MpH)
Mapua hill soils (Appendix 3) are on slopes between 16° and 25° (include some MpU, MpR and MpS) and cover 127ha. The topsoil is brown to dark brown, has a thickness between 5-35cm and an average thickness of 15cm. Subsoils are again mottled to varying intensities and have clayey to sandy clay textures and the average depth to the BC horizon was 57cm and a range of between 30-90cm.

Mapua steepland soils (MpS)
Mapua steepland soils (Appendix 3) are of limited extent and cover <30ha on surfaces with slopes >25°. Excluding an area of unusable very steep land on the exposed northern coastal margin, Mapua steepland soils are restricted to small patches of over-steepened slopes in gully heads or on truncated spurs. The average depth of topsoil was found to be 15cm and depth to the BC horizon 61cm. Subsoil mottling was found to be less intensive than in the other Mapua soil units, probably reflecting a greater propensity for water run-off and shorter periods of oxidising and reducing conditions within these soils.

Braeburn soils
Braeburn soils (Appendix 3) are present on valley floors and were mapped over 58ha (including some patches of Kina and Neudorf soils with which they merge as drainage conditions change) and are formed from alluvium from eroded Moutere Gravel materials. They are imperfectly to moderately drained soils with a very dark brown to dark brown topsoil (average 21cm thick) and silt loam to clay loam texture, passing into silt loam to clay loam subsoil with strong brown and light grey or white distinct mottles. An underlying C horizon of compact sand or gravelly sand may be present at an average depth of 72cm.

Neudorf soils
Neudorf soils (Appendix 3) cover 78ha along with some small areas of Kina and Mapua soils. They have a dark brown to very dark brown topsoil (average 22cm thick)

overlying pale brown to light grey silt loam to clay loam, passing into clayey deeper subsoil with prominent strong brown mottles. In 30% of the observations, the upper30-50cm of the soil profile comprises a recent accumulation of sediment (with an A and weakly developed B horizon) overlying a buried topsoil which is indicative of soil erosion on adjacent slopes since farming began. Accumulations of Fe concretions are sometimes present in the subsoil, especially where a watertable may be present.

Kina soils
Kina soils (Appendix 3), along with some patches of Braeburn, Eaves and Neudorf soils, cover 81ha and occur on low valley floor surfaces where the original natural drainage conditions were poor. The average topsoil thickness was 21cm and dark brown to very dark brown coloured silt loam to clay loam with a buried A horizon present in 50% of the observations. Underlying subsoil horizons have predominantly white, grey or pale brown colours, commonly with strong brown oxide mottles at greater depth. Dark brown concretions sometimes present.

Eves soils
Eves soils were not mapped separately in the present survey although were identified in small areas in the floodway zones of stream channels. They were first mapped in soil surveys on the Waimea Plain where, as in the Tasman district, they are formed from recent stream sediment alluvium derived from erosion of Moutere Gravel materials. The topsoil is brown dark brown silt loam with an average thickness of 24cm, overlying a weakly developed brown to olive brown coloured B horizon passing into olive brown sand or gravel (BC or C horizon) at about 40cm.

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