Soils of the Kotinga District

Dr Iain Campbell
Land & Soil Consultancy Services
23 View Mount, Nelson
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Introduction

As part of the updating of the basic soil and land resource data for the Golden Bay region, a survey of the soils of the Kotinga district was undertaken between October 2008 and April 2009. The area mapped was approximately 2400 ha covering lower elevation lands on the west and northern reaches of the Takaka River and extending from the west side of the Waingaro River to the Waikoropupu River at the northern edge of the survey area. The area comprises predominantly floodplain and low terrace lands but includes older elevated and dissected terraces that border the hilly and steep lands to the south and west.

Survey Methods

Forty-six days were spent on field examinations during which 881 observations were recorded. This included 803 observations from auger holes and 78 observations from excavated pits and some cutting sections, giving an observation frequency of 1 per 2.7 ha. Examinations were made primarily from cross-terrain traverses over the landform units. Landform identification was assisted by the use of 1943 and 1984 aerial photographs as well as 1:4,000 modern satellite images. Where possible, soil boundaries were drawn in the field from the auger observations aided by field observations of soil-landform changes. Soil from the auger borings was described in terms of the soil horizon sequences, the soil colours, textures and mottle patterns, as well as the stoniness and depth to gravel. Soil pits were excavated to confirm soil properties, particularly when the presence of subsurface gravel at shallow depths restricted observations of horizon sequences by augering. The observations from the soil pits allowed a more detailed assessment of the soil properties including soil structure, consistence, strength and drainage assessment as well as plant root distribution characteristics.

The locations of all observations were recorded by GPS and plotted on the 1:4,000 field sheets. A digital photo record was also made of the soil material examined at each of the observation sites. The soil data were later assessed to provide details relating to the properties of each soil unit and to the variability encountered within the mapping units. Criteria used for description of the soils are those given in the Soil Description Handbook (Milne 1995), which is the accepted standard for New Zealand soils. The soil boundaries plotted on the field sheets were transferred by TDC Staff into a digital image for reproduction of the soil map.

Previous soil surveys of the Kotinga area.

The earliest known soil survey of the Kotinga district is an unpublished and undated Soil Reconnaissance Map of Takaka County at a scale of one mile to one inch (1:63,360). This map on a cadastral base was probably compiled by Chittenden of the Cawthron Institute in the 1950's and had five soil types identified within the present survey area. In the 1:250,000 General Survey of the Soils of South Island (Soil Survey Staff 1968), only three soils were separated;

Karamea soils on all of the floodplain and lower terrace areas, Onahau soils on high and intermediate terraces and Kotinga soils on upper terrace land to the west side of the Waingaro River. The later Land Use Capability Survey provided a more detailed subdivision of the landscape at 1:63,360 scale but a soil survey was not undertaken. A brief review of the soils of Lower Takaka Valley was done by O'Byrne (1983) but did not include any new soils information.

Reliability of the information

Soils are intrinsically related to the landforms on which they occur so that within the soil map units, soil variation will be encountered in relationship to differences in the parent materials or drainage characteristics etc. across the landscape. The soil types depicted by the map units can be expected to have a range of properties in response to differences in features such as minor terracing, land undulations, surface drainage etc. Not withstanding the intensive observation frequency, separation of the soils into mapping units depicting depth, texture or drainage classes was seldom possible due to the variation encountered in these properties over short distances. This is largely because the river systems are predominantly high energy in character giving rise to much variability in sedimentation over short distances. An additional factor is the variability in sedimentation and flood patterns that results from the interaction of three river systems, the Takaka, Waingaro and Anatoki Rivers that join together within a space of 3 km.

The assessment of the differing textural types, depth classes and drainage classes etc that are given in the following soil descriptions are derived as percentages of the total observations that were made for each individual soil type. These are intended as a guide and should not be regarded as accurate. The auger observations were sometimes biased towards moderately deep or deep soils so that overall profile morphology and horizon sequences could be adequately assessed, which is not possible when augering in shallow stony soils. Where a particular soil is dominantly shallow or stony, quantitative assessment of subsurface morphological attributes is limited by a restricted ability for detailed auger observations to be made.

Soil-landscape setting in the Kotinga area

The Kotinga district differs from other parts of the Takaka region examined in the recent soil surveys in that this area encompasses terraces and floodplains immediately adjacent to mountain and hilly land from which several significant rivers discharge and in which glaciers were present in the catchments in the Last Glaciation. The proximity to this steep land is reflected in the coarse gravelly quartzitic sediments that form the terrace lands. The predominantly quartzitic sediments that occur here contrast markedly with those on similar aged terraces on the eastern side of Takaka Valley where basic rocks, (diorite), marble and limestone make up a significant component of the terrace gravels. In places, the coarse bouldery quartzitic sediments of the Kotinga area are reminiscent of outwash and may have been derived from cycles of glacial activity in adjacent hills. Down cutting in the terrace gravels increases noticeably upstream with the terrace scarps progressively increasing in elevation above river levels. Down stream, some terrace surfaces disappear and are buried by younger alluvium. The older and higher level terraces probably represent the outwash from earlier glacial periods and have cohesive or cemented gravel and in places, strongly weathered

subsurface materials. There is evidence that the older terrace surfaces may have a thin cover of loess in some places.

Secondary streams also show evidence of widespread fluvial action with the presence of coarse bouldery gravel indicating previous extensive water flows. In Go Ahead Creek catchment for example, coarse bouldery sediments are common in the upper reaches and the finer sediments are predominantly olive grey coloured, possibly due to limestone in the catchment head. In the lower reaches, they merge with or overlie sediments of the main river systems.

The Kotinga area has an appreciably greater rainfall than the areas east of Waingaro River and in the northern part of Takaka Valley and this is reflected in the soils by the development of podzlic soils, which are characterised by the presence of greyish subsoil layers and the presence of an iron pan. To the south of the survey area, the landscape is dotted with numerous sinkholes, many of which are occupied by a small lake or pond. These sinkholes are indicative of the presence of underlying limestone or marble rocks.

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Soils of Kotinga District: Legend

Soils of the river floodplain and low surfaces		Use Rating
Well drained		
Takaka soils	Tk, Tksh, Tkr	B + F+H
Imperfectly drained		
Harihari soils	Hh	F
Soils of the low river terraces		
Well drained		
Karamea soils	Km, Kmsh	A
Imperfectly drained		
Waingaro soils	Wa	C
Soils of secondary stream surfaces		
Well drained soils, floodplain and low surfaces		
Bencarri soils	Bc	D
Well drained to moderately well drained soils, low terraces		
Anatoki soils	An	A
Soils of the intermediate river and stream terraces		
Well drained		
Ikamatua soils	Ik, Ikb	A + B+F
Uruwhenua soils	Ur, Ursh	A+C
Moderately well drained		
Tukurua soils	Tu	B
Imperfectly drained		
Paton soils	Pt	D
Poorly drained		
Dogan soils	Dg	F
Soils of fan surfaces		
Moderately to imperfectly drained soils		
Pohara soils	Po	D
Soils of the higher terraces and outwash surfaces		
Well drained shallow soils		
Hamama soils	Ha	A
Well drained deeper soils		
Puramahoi soils	Pm, Pmsh	A
Imperfectly drained stony soils		
Kotinga soils	Kt, Ktbd	F
Poorly drained soils		
Waitui soils	Wt	E
Onahau soils	On, OnR, OnH	E + F
Kongahu soils	Kg	E
Poorly drained organic soils		
Kini soils	Ki	F (H)

Soils of the dissected terrace land and scarps		
Milnthorp hill soils	MnH, MnS	F, H
Moderately well drained to poorly drained with iron pans		
Pupu complex	PuH	H
Soils disturbed by extensive mechanical activity		
Anthropic soils	At	F,H

Soil name and map symbol Takaka (Tk, Tksh, Tkb, Tkr)

Concept and overview

Takaka soils cover 385 ha and occur on the low-lying land adjacent to the Waikoropupu, Anatoki, Waingaro and Takaka Rivers. They are the soils that have formed on the floodplain surfaces that are susceptible to inundation and sedimentation during high river flows. Flood frequency is greatest adjacent to rivers and where the floodplain surface has not been protected by stopbanks and becomes progressively less with increasing distance from the rivers. Takaka soils occur in broad areas in the lower reaches where the river systems merge, but further upstream, they occur in strips on the lower terrace surfaces where river downcutting is more pronounced.

Relationship to previously named soils

Takaka soils were mapped in the initial unpublished survey of Takaka County on the floodplains along with other soils of the low terrace lands that were separated as Takaka loams, sands and undifferentiated sands and gravely loams. In the 1:250,000 survey of the soils of South Island (Soil Bureau Staff 1968) they were included with Karamea set (99c). Takaka soils were mapped in the 2005-08 surveys of Lower Takaka Valley, Puramahoi district and East Takaka district (Campbell unpublished).

Landform origin and history

The lower lying surfaces of the Anatoki, Waingaro and Takaka have in the past been subject to repeated flooding with extensive floods occurring within 20-50 year time scales. Comparisons between 1943 and modern aerial photographs show that river channels have changed appreciably in a number of places although they appear to have been stable in recent times, probably as a result of river protection works. Gravels, which are often coarse and bouldery, underlie most of the floodplain area but gravels are present at the surface in many places where finer sediments are absent. Buried soils and layered sediments are commonly found and are indicative of the periodic flooding.

Key soil features

Takaka soils are predominantly moderately deep (45-90 cm over gravel) sandy loams and silt loams with a thin A horizon and little differentiation or structural development in the subsoil. A buried A horizon, which may contain some charcoal, is often present. They are well drained but commonly have some anaerobic mottling within the upper 10 cm. Depth to gravel varies greatly over short distances as a result of overland flood characteristics.

Identified variants

Included with Takaka soils (Tk) are Takaka bouldery soils (Tkb) where the surface cover is predominantly bouldery, Takaka shallow soils (Tksh) (approximately 30%) where stones or boulders are common within 45 cm of the surface, Takaka moderately deep soils (approximately 30%) where the depth to gravel is between 45-90 cm and Takaka deep soils (30%) where the depth to gravel is 90 cm or greater. Takaka raw soils (Tkr) are separated on river berms

where there is very frequent flooding and negligible soil development in the sandy alluvium.

Associated and similar soils

Takaka soils occur together with Karamea soils which are found on slightly higher parts of the floodplain and low terrace surfaces and which are less frequently flooded. They are distinguished from Takaka soils in having deeper A horizons (greater than 12 cm) a weakly developed B horizon with some colour differentiation from the underlying sediment and an absence of recent flood layering. Takaka soils are similar to Bencarri soils in that they both show little development of weathering features with variable (sandy to bouldery) profiles but Bencarri soils dominantly have olive grey subsoil colours. Harihari soils occur with Takaka soils on lower lying overflow channels that have poor drainage.

Key physical properties

Topsoils are dominantly sandy to sandy loam (60%) and silt loam (40%) and average 8 cm in thickness and are brown to dark brown. Subsoils are mainly sandy textured with olive brown colours and negligible soil structural development. Fine greyish and reddish fine mottles are often present in the A horizon and these may be due to anaerobic conditions from winter stock trampling in these poorly structured soils.

Soil versatility and land use rating

The moderately deep and deep soils are moderately versatile and if protected from frequent flooding would be included in class B of the Tasman District Council land classification scheme (Agriculture New Zealand 1994). The main limitations are droughtiness, flood frequency. Takaka bouldery and raw soils are included in class F and H

Horizon	Depth	Description
A	0-9 cm	Brown to dark brown (10YR 4/3-5/3) silt loam; weakly developed fine and medium polyhedral structure; weak soil strength; friable; indistinct boundary; many fine roots,
BC	9-40 cm	olive brown to yellowish brown (2.5Y 4/4-10YR 5/4) silt loam; very weakly developed fine blocky structure; brittle; few fine roots,
b BC	40-55 cm	light olive brown (2.5Y 5/6) silt loam; weakly developed fine blocky structure; brittle; few fine roots;
C	55-90 cm	light yellowish brown (2.5Y 6/4) medium sand; single grain structure; loose; very few fine roots

Soil name and map symbol: (Harihari soils, Hh)

Concept and overview

Harihari soils cover approximately 12 ha and occur in lower lying areas of the river floodplains, mainly in narrow strips which mark the position of overflow channels during flood events. Commonly, they lie alongside the scarp of a low terrace, which acted as a border for overflow waters, and against which flood flows are concentrated. In some places, overflow channels are marked by willows and swamp vegetation with water lying either temporally or permanently in the floor of the channel.

Relationship to previously named soils

Harihari soils were not separated in the Takaka district in the early unpublished soil survey of Golden Bay County and the later 1:250,000 of the district. In the General Survey of the Soils of South Island (Soil Bureau Staff 1968), they were mapped elsewhere as alluvial soils from schist alluvium supporting swamp forest (set 91) and were later described by Mew (1980) as imperfectly drained soils from recent alluvium. Small areas were mapped in the 2005-08 surveys of Lower Takaka Valley, Puramahoi district and East Takaka district (Campbell unpublished).

Landform origin and history

During severe flooding, overland flows on the floodplain become channelised and the associated scouring leaves low lying sinuous strips in which Harihari soils are found. These channels are often reoccupied by overland flows in subsequent floods. Drainage varies according to proximity to the watertable.

Key soil features

Harihari soils are imperfectly to poorly drained. Soil development is weak due to their youthful age and the subsoil colours are mainly grey with reddish mottles, the abundance of which is dependent on the oxidation and reducing conditions that prevail. Texture, drainage and depth to gravel vary greatly.

Associated and similar soils

Takaka soils occur on the same low floodplain surfaces as Harihari soils but on slightly higher ground, which is well drained. Karangarua soils are similar soils found in permanently wet areas and are peaty but have not been mapped in the present survey. Waingaro soils also occur in old stream channels but are on elevated surfaces associated with Karamea soils.

Identified variants

Harihari soils include a range of depth classes from stony, shallow (<45 cm to gravel) moderately deep (45-90 cm to gravel) and deep. Textures vary from silt loams to sand and drainage from imperfectly drained to poorly drained.

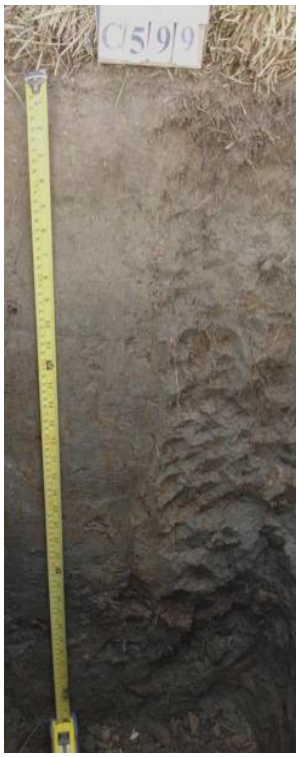
Key physical properties

Harihari soils have a thin or negligible topsoil (average 8 cm) with mottles sometimes present and typically overlie unweathered grey sandy or gravelly

alluvium that may have reddish or brownish mottles. A watertable may be present especially during the wet season.

Soil versatility and land use rating

Harihari soils have low versatility They have severe topographic, drainage, permeability, trafficability, workability and erosion potential limitations as well as susceptibility to flooding and ponding. They are included in class F of the Tasman District Council land classification scheme.



Horizon	Depth	Description
A	0-6 cm	Brown to dark brown (10YR 4/3) silt loam; weakly developed fine polyhedral structure; weak soil strength; friable; indistinct boundary; many fine and few medium roots,
Cg	6-70cm	olive grey (5Y 5/2) silt loam; 15% fine distinct reddish brown (5YR 4/3) mottles; weak soil strength; weakly developed medium blocky structure; brittle; few fine and few medium roots,
Cr	70-90+	dark grey (5Y 4/1) silt loam; massive; firm soil strength; 10% fine distinct yellowish red mottles; very few roots

Soil name and map symbol: Karamea (Km, Kmsh)

Concept and overview

Karamea soils (249 ha) are mapped on the low terraces of the floodplain surfaces and occur most extensively on the broader portion of the Takaka Valley floor where the Anatoki, Waingaro and Takaka Rivers join. These soils are on surfaces that lie just above the main floodplain surface and are essentially flood free except in rare and extreme flood events. The presence of a more distinct and deeper topsoil and a weakly developed B horizon is indicative of an absence of recent flood and sedimentation history.

Relationship to previously named soils

Karamea soils were not delineated in the unpublished soil survey of Takaka County but were instead mapped principally as Takaka sands. In the 1:250,000 General Survey of the soils of South Island (Soil Bureau Staff 1968), they were included with all of the soils on the lower terraces as Karamea set (99c). Karamea soils have been mapped in the recent Lower Takaka, Puramahoi and East Takaka surveys.

Landform origin and history

The low terraces of the Anatoki, Waingaro and Takaka Rivers are composite surfaces with terracetts that mark minor stages of river adjustments to base level changes. Soil profile development increases with height above river level but the overall degree of soil development, which is predominantly weak indicates that the low terrace surfaces are of a very recent age. Where the rivers are incised, Karamea soils are on small terrace remnants away from the river but in the lower reaches, recent flood overflows have resulted in a patchwork of Takaka soils in overflow zones and Karamea soils in slightly more elevated areas.

Key soil features

Karamea soils are predominantly moderately deep (46% 45-90 cm over gravel) with around 25% shallow (< 45 over gravel) or stony with gravel at the surface. The topsoil is brown to dark brown or brown silt loam and averages around 20 cm in thickness The B horizon is weakly developed, about 18 cm thick and is varied in colour but is mainly olive brown to light olive brown silt loam. Colour differences are largely attributable to differing sediments in the differing river systems. C horizons are mainly sandy to loamy textured.

Identified variants

Karamea deep soils (40%) occur along with Karamea moderately deep soils and Karamea shallow soils (Kmsh), which are shown separately in several places. Moderately well drained soils with some reddish brown, brownish yellow and occasionally grey mottles are sometimes found in sites where surface drainage is restricted.

Associated and similar soils

Karamea soils are associated with Takaka soils on some of the lower surfaces where flood overflows are complicated by the merging of three river systems over a short distance. Waingaro soils occur on the same land surface in sites that have poor surface drainage. Anatoki soils are somewhat similar to Karamea soils and

are confined to the Go Ahead Creek catchment but are characterised by a dominance of olive colours in the subsoil.

Key physical properties

Karamea soils are moderately deep and well drained with silt loam texture passing into sandy loam then gravel in the lower horizons. They have moderately deep rooting depth but weak soil subsoil strength and weakly developed subsoil structures.

Soil versatility and land use rating

Karamea soils have easy slopes with slight surface undulations and are relatively stone free. Trafficability is unlikely to be restricted for significant periods as waterlogging over winter months is not prolonged. A summer soil moisture deficit is relatively short and can be corrected by irrigation while flood risk where present, can be overcome by flood control measures. Karamea soils are included in class A of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-14 cm	Brown (10YR 5/3) silt loam; moderately developed medium polyhedral structure; weak soil strength; friable; many fine and few coarse roots; indistinct boundary,
B	14-30 cm	dark yellowish brown (10YR 4/4) silt loam; weakly developed coarse polyhedral and fine blocky structure; weak soil strength; friable; many fine roots; indistinct boundary,
C1	30-60 cm	olive brown to dark yellowish brown (2.5Y 4/4-10YR 4/4) silt loam; weakly developed fine polyhedral and medium blocky structure; weak soil strength; friable; few fine roots; distinct boundary,
C2	60-70 cm+	olive (5Y 4/3) sandy gravel; structure less; loose; 60% fine to coarse stones

Soil name and map symbol Waingaro (Wa)

Concept and overview

Waingaro soils occupy approximately 25 ha and are found in small areas on the low terraces of the Anatoki, Waingaro and Takaka Rivers. They occur in low lying areas of former drainage channels and in back swamp situations where runoff from adjacent higher ground is concentrated. The soils are poorly to imperfectly drained with rushes often marking their presence.

Relationship to previously named soils

Waingaro soils were not separated in the unpublished survey of the soils of Takaka County or in the 1:250,000 Survey of the Soils of South Island (Soil Bureau Staff 1968) but were included as part of Takaka and Karamea soils. Small areas were mapped in the recent soil surveys of the Lower Takaka, Puramahoi and East Takaka districts.

Landform origin and history

The low terrace surfaces of the Anatoki, Waingaro and Takaka Rivers have formed from extensive flooding in the recent past and scour channels with Waingaro soils remain as low lying features. Elsewhere, Waingaro soils occur on broader back sloping parts of the terrace surfaces where drainage is restricted and where sites are influenced by runoff from adjacent higher ground.

Key soil features

Waingaro soils are deep and imperfectly drained. Topsoils are very dark greyish brown, average 15 cm in thickness and have silt loam texture. Reddish mottles are sometimes present in the topsoil where drainage is poor. The upper subsoil commonly has low chroma greyish brown colours with a few reddish mottles. The deeper subsoil has sandy or loamy textures and has predominantly olive grey or light brownish grey colours with yellowish brown mottles. A watertable is occasionally present.

Identified variants

Waingaro shallow soils (< 45 cm to gravel) and moderately deep soils (45-90 cm to gravel) occur as well as poorly drained soils.

Associated and similar soils

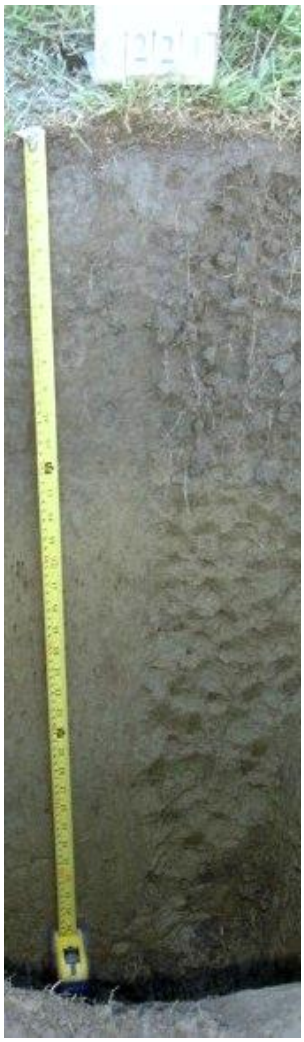
Waingaro soils (imperfectly drained) are associated with Karamea soils (well drained) and in places there is a transition or merging between the two. Kotinga soils, with their predominantly olive coloured and at times mottled subsoils, may in places resemble Waingaro soils but they are principally well drained to moderately well drained and are confined to the Go Ahead Creek catchment. Harihari soils also occur on low lying poorly drained alluvial surfaces but they are less well developed and are prone to frequent flooding.

Key physical properties

Waingaro soils are imperfectly drained due to slow permeability and the proximity of the watertable. The rooting depth is restricted where a watertable or where heavier textured subsoil layers are present. Structures are weakly developed and may be massive in lower horizons. There is occasional flooding.

Soil versatility and land use rating

Waingaro soils have a moderate suitability for intensive use where drainage improvements have been made. Irrigability, trafficability, workability and drainage may be limiting to some uses. They are included in class C of the Tasman District Council land classification scheme.



Horizon	Depth	Description
A	0-22 cm	Dark brown (10YR 3/3) silt loam; moderately developed medium polyhedral structure; weak soil strength; friable; many fine and few medium roots; indistinct boundary,
AB	22-32 cm	dark brown (10YR 3/3) and olive brown to light olive brown (2.5Y 4/4-5/4) silt loam; weakly developed medium polyhedral structure; weak soil strength friable; many fine roots,
B	32-44 cm	olive brown to light olive brown (2.5Y 4/4-5/4) silt loam; weakly developed fine blocky structure; brittle; very few fine roots,
BCg	44-65 cm	light yellowish brown to light brownish grey (2.5Y 6/4-6/2) silt loam; 20% fine distinct brown to dark brown (10YR 4/3) mottles; weakly developed medium blocky structure; brittle; very few fine roots,
C(g)	65-95 cm	olive (5Y 5/4) silt loam; 40% dark yellowish brown fine distinct mottles; massive

Soil name and map symbol Bencarri (Bc)

Concept and overview

Bencarri soils occupy 82 ha and are mapped on the low stream terraces and the floodplain surfaces adjacent to Go Ahead Creek. They are recent, mainly well drained soils formed from alluvium, that ranges in texture from bouldery sands to silts. The rocks at the head of the catchment and from which the sediments have been derived are quartzitic argillite and sandstone of the Wangapeka Formation and crystalline limestone of the Arthur Marble Formation.

Relationship to previously named soils

Bencarri soils were not previously defined in the unpublished soil survey of the soils of Takaka County but were included with soils that were mapped as Pakahi soils in that survey. In the 1:250,000 General Survey of the soils of South Island (Soil Bureau Staff 1968) they were included with Kotinga set (59a).

Landform origin and history

In the Kotinga district, glacial activity in the Anatoki, Douglas and other Ranges to the west of Takaka Valley resulted in the formation of extensive aggradational terraces from glacial outwash. Terraces from three periods of glaciation are recognised, Waimaungan, Waimean and Otirian (the last) by Grindley (1971). In the Go Ahead Creek area, Bainham Formation (Otirian aged gravels) form a prominent terrace while remnants of the older Kaituna Formation, (Waimean aged deposits) are also present. Dissection of these deposits has left a shallow but distinct valley in which Go Ahead Creek flows and is incised in the lower reaches. Bencarri soils occur principally in small semi-continuous pockets and meander channels alongside Go Ahead Creek. This implies substantial amounts of water have been available to form the landscape features.

Key soil features

Bencarri soils are well drained commonly shallow to moderately deep (<45cm to <90 cm) with sandy textures and showing weak profile development, often without a B horizon. Buried A horizons are sometimes found and indicate recent flooding and sedimentation activity. The subsoils are dominantly olive coloured.

Identified variants

On lower surfaces adjacent to the stream, Bencarri soils are commonly shallow, stony or bouldery. On levees adjacent to the stream, soil texture is generally sandy. Some mottles may be present in the subsoil where alluvium is deep.

Associated and similar soils

Bencarri soils are associated with Anatoki soils, which occur on higher parts of the fluvial surface associated with Go Ahead Creek. Anatoki soils, however have deeper and better developed profiles, often with some reddish mottles in the subsoil. Takaka soils, also from recent alluvium, have similar features but have olive brown rather than olive grey subsoil colours.

Key physical properties

Bencarri soils are well drained and dominantly sandy textured. Their topsoils are shallow (<12 cm). The potential rooting depth is shallow to moderate and available water capacity low to moderate. They are susceptible to flooding in places.

Soil versatility and land use rating

Topography, stoniness, erosion and flooding susceptibility are significant limitations for intensive use of Bencarri soils. A patchy distribution makes them unsuited to intensive use if considered as a single entity, but when managed in association with Anatoki soils productive use is possible. They are included in class D of the Tasman District Council land rating scheme.

Horizon	Depth	Description
A	0-14 cm	Brown to dark brown (10YR 4/3) loamy sand; weakly developed fine polyhedral structure; very friable; weak soil strength; 4% medium and coarse stones; abundant fine roots; indistinct boundary,
b A	14-30 cm	dark greyish brown (2.5Y 4/2) sandy loam; weakly developed fine polyhedral structure; weak soil strength; friable; many fine roots; indistinct boundary,
BC	30-50 cm	olive (5Y 4/3) silt loam; very weakly developed medium blocky structure; very weak soil strength; brittle; many fine roots;
C1	50-85 cm	olive (5Y 4/3) fine sand; single grain; loose; few fine roots; sharp boundary,
C2	85-90 cm+	olive (5Y 4/3) sandy gravel

Soil name and map symbol Anatoki (An)

Concept and overview

Anatoki soils cover 121 ha and occur on level to slightly undulating and at times slightly terraced surfaces on the floor of the shallow valley associated with Go Ahead Creek. They are for the most part well drained but some moderately well drained and imperfectly drained soils are included. Anatoki soils are mostly deep but some are moderately deep and a few are shallow. Like Bencarri soils, they are formed from sediments derived from the quartzitic argillites and sandstones of the Wangapeka Formation and crystalline limestone rocks of the Arthur Marble Formation that occur in the adjacent mountain land catchment area.

Relationship to previously named soils

Anatoki soils were not previously defined in the early soil survey of the soils of Takaka County but were included with soils that were mapped as Pakahi soils in that unpublished survey. In the 1:250,000 General Survey of the soils of South Island (Soil Bureau Staff 1968), they were included with Kotinga set (59a).

Landform origin and history

In the Kotinga district, glacial activity in the Anatoki, Douglas and other Ranges to the west of Takaka Valley resulted in the formation of extensive aggradational terraces from glacial outwash. Terraces from three periods of glaciation are recognised, Waimaungan, Waimean and Otirian (the last) by Grindley (1971). In the Go Ahead Creek area, Bainham Formation (Otirian aged gravels) form a prominent terrace while remnants of the older Kaituna Formation, (Waimean aged deposits) are also present. Shallow dissection of these deposits has left a distinct valley in which Go Ahead Creek flows. Some small terrace remnants at a slightly higher level than that on which Anatoki soils are found indicate water flows have been of sufficient magnitude to excavate the valley now occupied by Go Ahead Creek. The finer sediments from which Anatoki soils are formed have spread onto the terrace land in the lower reaches of the Anatoki and Takaka Rivers and in places overlies older (Ikamatua) soils.

Key soil features

Anatoki soils are predominantly deep (>90 cm) and well drained. Topsoils are dominantly dark brown, average 18 cm thick and have silt loam texture. Subsoils are generally weakly structured and olive coloured with silt loam textures often passing into sand or loamy sand. Reddish mottles are frequently found in the lower subsoil.

Identified variants

Anatoki moderately well drained soils occur in patches, mostly lower lying areas, while some patches of poorly drained soils are also present. Shallow and stony soils occur over <15% of the area and moderately deep soils over around 25% of the area.

Associated and similar soils

Bencarri soils are associated with Anatoki soils, being found on younger stream terraces alongside Go Ahead Creek.

Key physical properties

Anatoki soils have level to slightly undulating surfaces, are deep and moderately well drained with a moderate to high available water capacity, have a negligible stone content, a moderately deep to deep rooting depth and moderate permeability. Subsoil mottles indicate that water movement may at times be restricted.

Soil versatility and land use rating

Anatoki soils have a moderate to high versatility. Trafficability and workability restrictions are likely for some time during the wetter months because of the higher rainfalls experienced in the Kotinga area but periods of waterlogging are likely to be short, except under prolonged longer periods of heavy rains. Flood risk is negligible. These soils are included in class B of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-19 cm	Very dark greyish brown (10YR 3/2) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; abundant fine roots indistinct boundary,
AB	19-26 cm	very dark greyish brown (10YR 3/2) and olive grey (5Y 4/3) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; many fine roots,
Bw	26-40 cm	olive grey (5Y 4/3) silt loam; weakly developed medium blocky structure; 10% fine distinct light olive brown (2.5Y 5/4) fine distinct mottles; brittle; few fine roots,
BC	40-62 cm	olive grey to olive (5Y 4/2-4/3) silt loam; weakly developed medium blocky structure; 25% dark yellowish brown (10YR 4/4) distinct coarse mottles; brittle; very few fine roots’
C	62-100 cm	dark grey (5Y 4/1) fine sandy loam; massive; 2% dark yellowish brown (10YR 4/4) coarse distinct mottles

Soil name and map symbol Ikamatua (Ik, Ikb)

Concept and overview

Ikamatua soils (146 ha) are mapped mainly on terraces of the Anatoki River but also in some smaller areas near the Waingaro River and Waikoropupu Rivers. They are the soils formed on the distinct terrace surface that lies several metres above the valley floor flood plain system. They are well drained soils, commonly shallow or bouldery and sometimes moderately deep overlying gravel, with a weathering profiles <60 cm deep. These soils have formed on degradational terraces, formed by river downcutting, following the extensive aggradation of gravels that took place in the last glacial period.

Relationship to previously named soils

Ikamatua soils were not mapped in the early unpublished survey of the soils of Takaka County although the most extensive area on the south side of Anatoki River was separated but included with other low terrace stony soils. In the General Survey of the soils of South Island (Soil Bureau Staff 1968) Ikamatua soils were included with Karamea set (99c). Ikamatua soils were mapped in a few small areas in the Soil Survey of the Puramahoi district (Campbell 2007 unpublished).

Landform origin and history

Glacial activity in the ranges to the southwest of the Waikoropupu, Anatoki and Waingaro Rivers during the last glacial period resulted in extensive outpourings of gravely sediments that gave rise to the formation of prominent terrace deposits (Bainham Formation, Grindley 1971) in the river valleys. As glaciation receded and the supply of gravels diminished, rivers, which probably still had extensive flows, began to cut down into the terrace gravel sediments. This downcutting phase is especially marked along the Anatoki River where the terrace surface consists of numerous small steps, often with strongly channelised and bouldery surfaces and is indicative of high energy river flows. This sequence of climatically controlled aggradation followed by downcutting provides a strong landscape forming signature, which does however vary according to local conditions.

Key soil features

Ikamatua soils are mainly shallow (45% <45cm to gravel) and moderately deep (40% <45-90 cm to gravel). The A horizon is dark yellowish brown dominantly silt loam and averages 18 cm in thickness. The B horizon is yellowish brown predominantly silt loam around 20 cm thick and passes through a transitional olive brown loamy BC horizon (average 22 cm thick) then into unweathered gravel at around 60 cm.

Identified variants

Ikamatua bouldery soils (Ikb) are mapped in places where there are appreciable concentrations of surface boulders. Bouldery patches are widespread however and are typically scattered throughout much of the area. Ikamatua deep soils occur sporadically and moderately well drained mottled soils are present in a few lower lying areas.

Associated or similar soils

Uruwhenua soils also occur on the degradational river terraces but at a slightly higher elevation. They have somewhat deeper weathering profiles with oxidation extending to around 70 cm and with sandy horizons commonly found in the lower subsoil. Kotinga soils are also shallow and stony or bouldery soils but they are somewhat more weathered and usually have a weakly developed pale coloured podzolic horizon present just below the surface.

Key physical properties

Ikamatua soils are well drained predominantly shallow soils with silt loam or sandy loam textures passing into loam or sand. They have a moderate potential rooting depth, moderately rapid permeability and moderate available water capacity.

Soil versatility and land use rating

Ikamatua soils are moderately versatile, the chief limitations being somewhat uneven topography, shallow to moderately deep profiles, and seasonal soil moisture deficiency. They have good drainage, minimal restrictions on trafficability or workability and negligible potential for flooding or waterlogging. Ikamatua moderately deep soils are included in class A of the Tasman District Council land classification scheme, moderately deep soils in class B and the bouldery soils where cultivation is impractical, in class F.

Horizon	Depth	Description
A	0-17 cm	Dark yellowish brown (10YR3/4) sandy loam; strongly developed fine polyhedral structure; weak soil strength; friable; many fine and few medium roots,
AB	17-26 cm	yellowish brown and dark yellowish brown (10YR 5/6 + 3/4) sandy loam; moderately developed fine polyhedral structure; weak soil strength; very friable; many fine roots,
Bw	26-48 cm	yellowish brown to light olive brown (10YR 5/6-2.5Y 5/6) silt loam to sandy loam; 12% medium to very coarse stones; weakly developed medium blocky structure; weak soil strength; brittle; few fine roots,
BC	48-70 cm	light olive brown (2.5Y 5/6-5/4) sandy loam; 16% coarse to very coarse stones; weakly developed medium blocky structure; very weak soil strength; brittle; few fine roots,
C	70-75 cm	light olive brown to olive brown (2.5Y5/6-4/4) coarse sand; 35% fine to very coarse stones; loose; few fine roots

Soil name and map symbol Uruwhenua (Ur, Ursh, Urst)

Concept and overview

Uruwhenua soils (Ur, Ursh, Urst) cover 117 ha and are mapped on a surface terrace that lies just below the prominent aggradational terrace in Takaka Valley. In the present survey, they occur mainly on a level terrace surface on the northwest side of One Spec Creek and also in several patches on the terraces of the Anatoki and Waingaro Rivers. They are well drained soils with weathering profiles that are moderately deep to deep and of a greater weathering depth than is found in Ikamatua soils.

Relationship to previously named soils

Uruwhenua soils were not separated in the early unpublished survey of the soils of Takaka County but an area on the north side of One Spec Creek was mapped as Takaka gravel and stony loams (Hamama soils). Uruwhenua soils were included with Karamea soils (99c) in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). They were first separated in the Survey of the Soils of the East Takaka District (Campbell 2008 unpublished).

Landform origin and history

Uruwhenua soils occur just below the main Takaka Valley aggradational terrace surface, which was formed as a result of outpourings of gravels from late Last Glaciation activity in the mountains at the head of the contributory rivers. The early stage of river entrenchment which the soils on this terrace surface represent, appear to mark a somewhat different sedimentation phase to that which formed the main aggradational terrace (Hamama soils) and the subsequent pronounced degradational surfaces on which Ikamatua soils are formed as extensive patches of stony soils are less common.

Key soil features

Uruwhenua soils are mainly moderately deep and deep (53%) with 47% shallow and stony. The A horizon is dark yellowish brown silt loam and has an average thickness of 19 cm and overlies a yellowish brown silt loam B horizon with an average thickness of 45 cm. The B horizon passes into a transitional BC horizon of approximately 15 cm, which is yellowish brown to light olive brown with predominantly loamy texture. This in turn overlies little weathered olive to olive brown sand or sandy gravel.

Identified variants

The main variations found are related to the depth to gravel with both Uruwhenua shallow soils (Ursh) and Uruwhenua stony soils (Urst) being separated.

Associated and similar soils

Hamama soils are somewhat similar to Uruwhenua soils but are predominantly shallow and commonly have a stony surface. Where deeper patches of Hamama soils occur, they resemble Uruwhenua soils but the weathering depth is greater in Hamama soils.

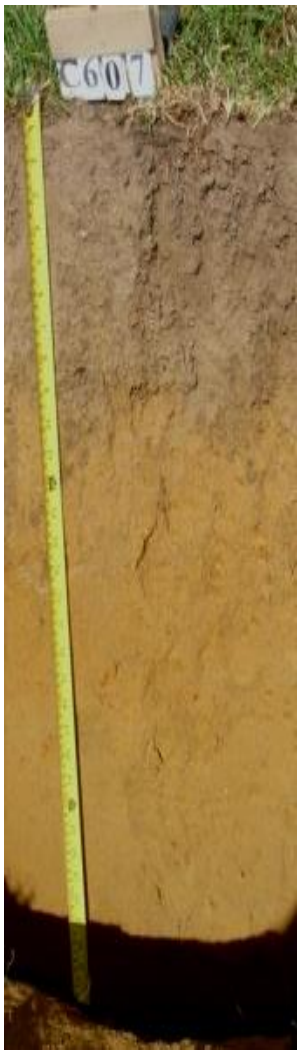
Motupipi soils (not mapped in this area) from fan outwash deposits also resemble Uruwhenua soils but they have browner profiles and are mineralogically different.

Key physical properties

Uruwhenua soils are well drained, occur on level surfaces, have a high available water capacity, have a moderately deep to deep rooting depth and in the deeper soils are stone free. They are likely to have moderate permeability and seasonal trafficability and workability restrictions are relatively slight.

Soil versatility and land use rating

Deep and moderately deep Uruwhenua soils have few physical limitations for intensive use apart from a period of summer moisture deficiency, which could be corrected with irrigation. They are included in class A of the Tasman District Council land classification scheme. The stony Uruwhenua soils have a greater summer soil moisture deficiency and the stoniness would in places restrict cultivation. They are included in class C of the Tasman District Council.



Horizon	Depth	Description
A	0-18 cm	Brown to dark brown (10YR 3/3-4/3) silt loam; strongly developed fine polyhedral structure; weak soil strength; very friable; many fine roots,
AB	18-28 cm	yellowish brown and brown to dark brown (10YR 5/6 + 10YR 3/3) silt loam; moderately developed fine polyhedral and blocky structure; slightly firm soil strength; friable; many fine roots,
Bw1	28-56 cm	yellowish brown (10YR 5/6) silt loam; weakly developed medium blocky structure; slightly firm soil strength; friable; few fine roots,
BC	56-80 cm	yellowish brown to light olive brown (10YR 5/6-2.5Y 5/6) fine sandy loam; weakly developed medium blocky structure; weak soil strength; very friable; very few fine roots,
C	80-100 cm	light olive brown (2.5Y 5/6) medium sand; weakly cohesive; very few fine roots

Soil name and map symbol Tukurua (Tu)

Concept and overview

Tukurua soils are mapped only in a small area (19 ha) on the floor of Waikoropupu Valley. They are formed on alluvium, which comprises silty material overlying gravel. They occur on a backslope surface, which lies away from the Waikoropupu River and against hilly and terrace land to the south. They are the moderately well drained to imperfectly drained soil equivalent of Puramahoi soils with which they merge closer to the river.

Relationship to previously named soils

Tukurua soils were not identified in the earlier unpublished soil survey of Takaka County or the 1:250,000 survey of the Soils of South Island their being included in Takaka sands and Puramahoi and Karamea sets (43b & 99c). They were separated in the unpublished survey of the soils of the Puramahoi district by (Campbell 2007) to distinguish them from Puramahoi soils, which are better drained and formed on the same land surface.

Landform origin and history

The Waikoropupu Valley is a small valley and remnants of older terraces with deposits that extend back several glaciations, indicate that down cutting has been continuous. The valley floor has deposits of Bainham Formation (Grindley 1971) that are outwash sediments from the Last Glacial period. The Waikoropupu River is in part incised and adjacent to its somewhat narrow channel well drained Puramahoi occur. Further from the river, soil drainage is impeded, in part from runoff from adjacent hill and terrace lands and Tukurua soils occur in these locations.

Key soil features

Tukurua soils are moderately deep to deep soils (45 cm to >90 cm over gravel) with a brown to dark brown silt loam textured A horizon, 20 cm thick, overlying a B horizon of about 25 cm thickness of light olive brown silt loam or clay loam, commonly with strong brown mottles. This passes into olive or olive brown silt mottled silt loam to clay loam then into gravel in which a water table may be present.

Identified variants

The main variation is in respect to the depth to gravel with shallow (<45 cm to gravel) moderately deep (45-90 cm to gravel and deep (> 90 cm to gravel) being encountered. Drainage also varies with imperfectly drained soils present in some places.

Associated and similar soils

Tukurua soils are associated with Puramahoi soils, which occur on better drained sites. Paton soils have similarities with Tukurua soils but have grey subsoil colours and are imperfectly to poorly drained.

Key physical properties

Tukurua soils have level slopes, are moderately well drained and have a medium to high available water capacity. They are mostly stone free, except in the lower subsoil and they have a moderately deep to deep rooting depth. Trafficability and workability restrictions are probable over wetter months and some waterlogging in the subsoil may occur.

Soil versatility and land use rating

Soil versatility is restricted in Tukurua soils by the soil drainage impediment but this can probably be overcome with soil drainage, which is likely to improve trafficability and workability. With improved drainage, Tukurua soils are included in class B of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-20 cm	Dark brown to dark greyish brown (10YR 3/3-10YR 4/2) silt loam; moderately developed fine polyhedral structure; weak soil strength; very friable; many fine roots,
AB	20-27 cm	dark greyish brown and olive brown (10YR 4/2+ 2.5Y 4/4) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; many fine roots,
Bw	27-60 cm	olive brown to greyish brown (2.5Y 4/4- 5Y 4/2) sandy silt loam; weakly developed fine polyhedral structure; weak soil strength; 20% light olive brown (2.5Y 5/6 fine distinct mottles; friable; few fine roots,
BC	60-75 cm	olive brown to dark brown (2.5Y 4/4-10YR 4/6) sandy loam; apedal; loose; 5% strong brown (7.5YR 5/6) fine distinct mottles; saturated; 20% coarse stones; very few fine roots

Soil name and map symbol Paton (Pt)

Concept and overview

Paton soils occur in few places and cover 13 ha. They are formed in lower lying areas where natural drainage is impeded and are also found on the floor of some gullies that receive drainage runoff. They are formed from alluvium from stream flows and in some places from locally derived gully-filling sediments. Paton soils are characterised pale coloured and strongly mottled subsoils indicative of imperfect drainage and slow permeability.

Relationship to previously named soils

Imperfectly to poorly drained alluvial soils are not widespread in the Takaka district and were not separately mapped in either the early unpublished survey of the soils of Takaka County or the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). Paton soils were mapped in the survey of the soils of the Puramahoi district (Campbell unpublished 2007) when they were separated as part of a sequence of soils where drainage impediment became increasingly greater (Puramahoi soils-well drained, Tukurua soils moderately well drained, Paton soils imperfectly drained). Clifton soils, mapped in the survey of the soils of Lower Takaka Valley (Campbell unpublished 2006) occur in similar topographic situations but they are formed from materials of mixed lithology rather than from quartzitic alluvium.

Landform origin and history

In the Waikoropupu Valley, the valley floor sediments are deposits of the Bainham Formation (Grindley 1971) of Late Last Glaciation age. These were extensive outflows as large boulders are present in the underlying gravels. The finer sediments overlying the gravels may in part have been derived from runoff from adjacent hilly and terrace land.

Key soil features

Paton soils are deep to moderately deep with very dark greyish brown silt loam topsoils that average 19 cm thick. B horizons have clay loam to silt loam textures and are predominantly olive grey to light brownish grey with mottles. A watertable is sometimes present.

Identified variants

Paton soils are moderately deep (45-90 cm over gravel) but deep soils (>90 cm over gravel) were found in 45% of the observations.

Associated and similar soils

Paton soils are associated with Tukurua soils, which have somewhat better drainage. Dogan soils also have similarities with Paton soils but they are poorly drained with accumulations of organic materials resulting from swampy conditions. Parapara soils, mapped in the Puramahoi district are also imperfectly drained but are formed from granite alluvium.

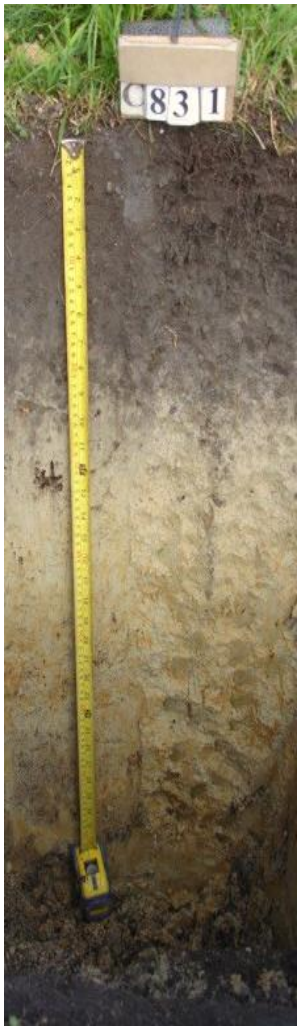
Key physical properties

Paton soils occur on level to easy sloping ground, they are imperfectly drained and remain wet for considerable periods and are relatively stone free.

Permeability is likely to be slow with some waterlogging and there are likely to be significant trafficability and workability restrictions.

Soil limitations and land use rating

Intensive use of Paton soils is restricted by imperfect drainage and heavy subsoil texture which are likely to restrict downward root growth. They are included in class D of the Tasman District Council land classification scheme.



Horizon	Depth	Description
A	0-19 cm	Very dark greyish brown (10YR 3/2) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; 1% medium stones; many fine roots,
AB	19-29 cm	very dark greyish brown and pale olive (10YR 3/2 + 5Y 6/3) heavy silt loam; weakly developed fine polyhedral and blocky structure; slightly firm soil strength; brittle; 1% medium stones; many fine roots,
B(g)	29- 43 cm	pale olive to light yellowish brown (5Y 6/3-2.5Y 6/4) sandy clay loam; 10% yellowish brown (10YR 6/8) fine distinct mottles; moderately developed coarse blocky structure; slightly firm; brittle; few fine roots,
Bw(g)1	43-70 cm	yellowish brown (10YR 6/8 60%) and light grey 5Y 7/2 40%) sandy clay loam; mottles medium distinct; moderately developed blocky and prismatic structure; firm soil strength; brittle; very few roots,
Bw(g)2	70-90 cm	brownish yellow (10YR 6/8 70%) and light grey (5Y 7/2 30%) sandy clay loam; moderately developed coarse blocky and prismatic structure; firm soil strength; semi-deformable

Soil name and map symbol Dogan (Dg)

Concept and overview

Dogan soils (10 ha) occur in a few small areas, mainly in the Waikoropupu Valley where there are patches of low-lying land. They are poorly drained soils occurring in sites that prior to the construction of drains, was formerly swamp land. Although the removal of water from these sites has improved surface drainage, the impact of former wet conditions remains through the presence of organic or peaty layers in the soils, which remain as poorly drained soils.

Relationship to previously named soils

Poorly drained soils are not widespread in the Takaka district and were not separated in either the early unpublished survey of the soils of Takaka County or the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). Dogan soils were first separated in the survey of the soils of Puramahoi district (Campbell unpublished 2007) where poorly drained soils on low lying swampy ground were recognised.

Landform origin and history

The poorly drained areas are in low lying places, chiefly back swamp situations where drainage has been cut off by accumulations of alluvium alongside stream channels. Low-lying swampy deposits have been mapped by Grindley (1971) as Post Glacial or Aranuian Stage swamp deposits. Subsequent land drainage has in most places resulted in the swamp vegetation being replaced by introduced grasses for stock grazing.

Key soil features

Dogan soils are poorly drained with the depth of fine materials extending to greater than 1 metre. A mineral topsoil that overlies an organic accumulation represents an influx of sediment possibly derived in part from farming activity. Lower horizons are dominated by olive grey colours and sometimes with humic staining. Decomposing wood from former wetland forest vegetation may be present at some depth. A watertable is usually present.

Identified variants

These soils vary considerably in respect of the amount and form of the organic matter that is present, the colours of subsurface mineral soil material and the position of a watertable.

Associated and similar soils

Dogan soils may be found in a few pockets where they merge into Paton soils where there is better surface drainage. Karangarua soils, mapped in the Lower Takaka Valley and Puramahoi district are also peaty soils but occur on very low lying wet land areas at the edge of estuaries.

Key physical properties

Dogan soils occur on level ground, they are poorly drained and have a negligible stone content. The rooting depth is restricted by the watertable which may rise to near the surface in wetter months. Waterlogging is likely for some months and restrictions on workability and trafficability are likely for significant periods.

Soil versatility and land use rating

Dogan soils have a low versatility due to their poor drainage with wetness limiting cultivation and the use of machinery. Drainage improvements have allowed these soils to be used for grazing. They are included in class F of the Tasman District Council land classification scheme. However, wetland soils such as these, are sites of past carbon accumulation, and the drainage improvements have effectively destroyed the capacity for these sites to act as carbon sinks, while decomposition of the organic deposits has contributed to greenhouse gas release. Enhancing these areas as sites for carbon accumulation should be considered.

Horizon	Depth	Description
A	0-15 cm	Black (10YR 2/1) silt loam; weakly developed fine polyhedral structure; slightly firm soil strength; friable; abundant fine roots,
Oh	15-36 cm	very dark brown (10YR 2/2) peat; strongly decomposed; apedal; very weak soil strength; very friable; many fine and few medium roots,
Br	36-47 cm	dark olive grey (5Y 3/2) silt loam; weakly developed medium blocky structure; slightly sticky; 5% reddish brown (5YR 3/4) organic stains on ped faces; few fine roots,
Cr	47-95 cm	olive (5Y 4/3) silt loam; apedal; massive; slightly sticky; very few fine roots,
on		partly decomposed wood

Soil name and map symbol Pohara soils (Po)

Concept and overview

Pohara soils are mapped in two locations and cover 10 ha. They are soils formed on gently sloping land, which comprises the accumulated fan or foot slope deposits derived from adjacent hilly land. The deposits vary in age according to the erosion history of the adjacent land but are primarily Late Last Glaciation to Post Glacial in age. Drainage conditions vary according to position on the fans and Pohara soils range from moderately well drained to imperfectly drained.

Relationship to previously named soils

Poraha soils were mapped as alluvial soils from Miocene Takaka Limestone in the early unpublished survey of the soils of Takaka County and were included with Puramahoi soils in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). In the survey of the soils of lower Takaka Valley (Campbell, unpublished) moderately to imperfectly drained Pohara soils on lower fan surfaces were mapped along with Motupipi soils on well drained surfaces and imperfectly to poorly drained Clifton soils in the lower surfaces of gullies. The soils mapped as Pohara in the present survey are derived predominantly from quartzitic rocks rather than rocks of mixed lithology as in the lower Takaka Valley district.

Landform origin and history

The deposits on sloping land at the foot of adjacent hilly land have accumulated as fans from erosion on the nearby steeper slopes. This is commonly periodic, as influenced by regular climate change events (glacial to post-glacial changes). Intermittent accumulation generally results in coarse sediments or gravels being deposited on the upper surfaces and fine sediments on the lower surfaces. Drainage and textures vary greatly over short distances.

Key soil features

Pohara soils are moderately deep (45-90 cm over gravel) with a dark brown to very dark greyish brown 20 cm thick topsoil and overlie a silt loam to clayey subsoil that is at first light yellowish brown to olive brown but which may have greyer colours with increasing depth. Where subsoil colours are dominantly greyish, the soils are imperfectly drained.

Identified variants.

Soil depth varies from shallow (<45 cm over gravel) to deep (>90 cm over gravel).

Key physical properties

Pohara soils are on sloping land, usually <5° and are moderately to imperfectly drained, in part due to heavy subsoil texture. They have medium to high available water capacity, moderately slow permeability and are slightly stony. The rooting depth is moderate and partly restricted by heavier subsoil texture. There are likely to be significant trafficability and workability restrictions with occasional waterlogging in periods of prolonged rainfall. There would be some erosion risk under intensive cultivation.

Soil limitations and land use rating

Soil drainage impediments, heavy subsoil texture which restricts rooting depth and erosion risk under a high rainfall climate are significant limitations for intensive use of Pohara soils. They are included in class D of the Tasman District Council land management classification scheme.

Horizon	Depth	Description
A	0-18 cm	Dark brown (10YR 3/3) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; many fine roots,
AB	18-24cm	olive yellow and dark brown (2.5Y 6/6+10YR 3/3) silt loam; weakly developed fine polyhedral and medium blocky structure; slightly firm soil strength; friable; few fine roots,
Bw	24-46 cm	light yellowish brown (2.5Y 6/4) heavy silt loam; weakly developed medium blocky structure; slightly firm soil strength; 10% strong brown (7.5YR 5/6) medium distinct mottles; few fine roots,
BCg	46-80 cm	pale olive (5Y 6/3) silt loam; weakly developed medium blocky and prismatic structure; 20% yellowish brown (10YR 5/6) fine distinct mottles; 2% medium stones; very few fine roots
on		firm gravel

Soil name and map symbol Hamama soils (Ha)

Concept and overview

Hamama soils are mapped over 45 ha and occur on the upper river terrace level near the lower reaches of the Waingaro River and also on a small terrace remnant of the Anatoki River near McCallums Road. They are typically shallow soils that have formed on the main aggradational terrace surface of the Takaka Valley. Hamama soils are well drained. The thickness of fine material over gravel varies and although the soils are predominantly shallow with stones to the ground surface, the weathering depth is moderate and extends to around 1 metre.

Relationship to previously named soils

Hamama soils were identified in the early, unpublished soil survey of the soils of Takaka County where they were mapped as Takaka gravel and stony loams mainly in the Hamama and East Takaka districts. A small area was also mapped north of Kotinga. In the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968), Takaka gravel and stony loams were mapped as Hamama soils (set 43a). Hamama moderately deep and Hamama shallow soils were mapped in the unpublished Lower Takaka Valley and East Takaka soil surveys (Campbell unpublished).

Landform origin and history

Hamama soils occur on the prominent upper river terrace surface in Takaka Valley that was formed by the aggradation of gravels associated with the Last Glacial period. This surface probably extended over most of the Takaka Valley but as the supply of detritus diminished, river downcutting proceeded to form the terrace surfaces that lie below the upper level of the Bainham Formation (Grindley 1971). The virtual absence of this terrace surface with Hamama soils in the Anatoki Valley suggests that the degradation regime here may have been more intense than elsewhere.

Key soil features

Hamama soils are well drained, have a dark yellowish brown topsoil averaging 18 cm thick, usually with stones, overlying yellowish brown stony silt loam to sandy loam textured B horizons that extend to about 80 cm in depth. This then passes into unweathered sandy gravel at about 90 cm. Reddish mottles may be present in the subsoil in lower lying locations.

Identified variants

Hamama soils in the present survey area are dominantly shallow (<45 cm over gravel and often stony with gravels at the surface. About 25% were moderately deep (45-90 cm over gravel). A one locality, an area was noted where there were prominent red mottles in the subsoil. This site was an area where there had been a former drainage impediment that had subsequently been removed by surface drainage work.

Associated and similar soils

Ikamatua shallow and bouldery soils resemble Hamama soils but have an appreciably shallower weathering depth. Uruwhenua soils are also brown soils often with sandy subsoils and the weathering depth is less than for Hamama soils.

Puramahoi shallow and moderately deep soils also resemble Hamama soils but generally have heavy silt loam or clay loam subsoil textures.

Key physical properties

Hamama soils occur on level surfaces, they are well drained with a moderate available water capacity and are moderately stony to stony. Permeability is moderately rapid. They have as moderately deep to deep rooting depth and trafficability and workability restrictions would be slight.

Versatility and land use rating

Hamama soils have a moderately high versatility, their chief limitations being stoniness and a soil moisture deficiency for a period during summer months, although this can be overcome with irrigation. In places, surface stoniness may restrict the range of crops that might be grown although this does not appear to restrict cultivation. In the Kotinga district, these soils support kiwifruit orchards. Hamama soils are included in class A of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-15 cm	Dark yellowish brown (10YR 3/4) silt loam; weakly developed fine polyhedral structure; weak soil strength; very friable; 15% fine to coarse stones; profuse fine roots,
AB	15-24 cm	dark yellowish brown (10YR 3/4+4/6) sandy loam; weakly developed fine polyhedral structure; weak soil strength; very friable; 20% coarse to very coarse stones; profuse fine roots,
Bw1	24-48 cm	yellowish brown to dark yellowish brown (10YR 5/6 - 10YR 4/6) sandy loam; weakly developed fine polyhedral structure; very friable; 40% coarse stones and boulders; many fine roots,
Bw2	48-78 cm	yellowish brown (10YR 5/6) loamy sand; weakly developed fine polyhedral structure; very friable; 40% coarse stones and boulders; many fine roots,
BC	78-100 cm	light olive brown (2.5Y 5/6) sand; single grain structure; loose; 55% coarse stones and boulders; few fine roots

Soil name and map symbol Puramahoi soils

Concept and overview

Puramahoi soils (Pm, Pmsh) occupy 65 ha in the Waikoropupu Valley and also occur in several patches at the margins of the upper river terrace of the Waingaro River. In Waikoropupu Valley, they are formed from locally derived alluvium of late Last Glaciation age (Bainham Formation, Grindley 1971). They are predominantly moderately deep and deep, well drained to moderately well drained soils. On the upper terrace adjacent to the Waingaro River, the distribution pattern suggests that Puramahoi soils there may have been partly derived from local wind-blown loess.

Relationship to previously named soils

Puramahoi soils (Puramahoi fine sandy loams) were mapped extensively on the alluvial plain of the Puramahoi district in the early unpublished survey of the soils of Takaka district. They were likewise separated in that area in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968) and also shown as occurring in the vicinity of Pohara. In the recent soil surveys of Lower Takaka Valley and the Puramahoi district, the soils at Pohara, previously mapped as Puramahoi were separated as Motupipi soils.

Landform origin and history

The Waikoropupu Valley is a smaller valley and has a smaller catchment than those of the Anatoki and Waingaro Rivers but never the less exhibits the same general geomorphic features. Remnants of older terraces from former periods of glacial aggradation are present on the valley sides while the valley floor has sediments from the last period of glacial induced aggradation. The Waikoropupu River is incised in the valley floor and has only developed minor postglacial terracing. Puramahoi soils here occur on the well drained parts of the valley floor.
Adjacent to the Waingaro River, the terrace surface where Puramahoi soils occur is broad and gently undulating. The distribution pattern, with Puramahoi soils occurring at the terrace margins, strongly suggests an aeolian origin for the parent material.

Key soil features

Puramahoi soils are well drained soils, predominantly moderately deep but ranging from shallow to deep. Topsoils are dark yellowish brown silt loam with an average depth of 20 cm while the B horizon is yellowish brown silt loam to heavy silt loam or clay loam, sometimes with stones, to 65 cm depth. This passes into a yellowish brown to light olive brown coloured BC horizon with variable texture. Reddish mottles may be present in the B and BC horizons. Stones or gravels are usually present in the lower horizons are commonly partly weathered.

Identified variants

Puramahoi deep soils (>90 cm to gravel) were found in 30% of the observations, with Puramahoi shallow soils (<45 cm over gravel) in 30% of the observations and Puramahoi moderately deep soils (45-90 cm over gravel) in 40% of the observations. In a few places, they are moderately well drained.

Associated and similar soils

In Waikoropupu Valley, Puramahoi soils merge into Tukurua soils in back slope situations where drainage is impeded. Puramahoi soils resemble Uruwhenua soils in their upper horizons but the weathering depth is greater in Puramahoi soils. Puramahoi soils also resemble Motupipi soils but they have darker brown colours and are mineralogically different, being formed in part from basic rocks.

Key physical properties

Puramahoi soils are formed on flat to gentle slopes, they are predominantly well drained, have a high available water capacity and minimal stone content except where shallow patches occur. The rooting depth is deep and trafficability and workability restrictions are likely only for short periods. The reddish subsoil mottles suggest that subsoil transmission of water may at times be somewhat restricted.

Soil versatility and land use rating

Puramahoi soils are versatile soils with few limitations to intensive use. Because of high rainfall, workability may be restricted at times while there may be a small soil moisture deficit in the drier months of the year. Puramahoi soils are included in class A of the Tasman District Council land management scheme.

Horizon	Depth	Description
A	0-22 cm	Dark brown (10YR 3/3) silt loam; strongly developed fine polyhedral structure; weak soil strength; very friable; abundant fine roots,
AB	22-32 cm	dark brown and yellowish brown (10YR 3/3 + 10YR 5/8) silt loam; moderately developed fine polyhedral structure; weak soil strength; friable; 2% medium to coarse stones; many fine roots,
Bw1	32-46 cm	yellowish brown (10YR 5/6) heavy silt loam; moderately developed fine blocky structure; weak soil strength; brittle; 5% medium to coarse stones; many fine roots,
Bw2	46-70 cm	yellowish brown (10YR 5/8) heavy silt loam; moderately developed medium blocky structure; weak soil strength; brittle; 10% medium to coarse stones; few fine roots,
Bw3	70-85 cm+	yellowish brown (10YR 5/6) heavy silt loam; weakly developed fine blocky structure; weak soil strength; brittle; 20% medium to boulder sized stones; very few roots

Soil name and map symbol Kotinga (Kt, Ktb)

Concept and overview

Kotinga soils occur over 183 ha in the southwest part of the survey area and are formed on gently sloping land forming part of an outwash surface that was deposited from streams flowing from the eastern end of the Anatoki Range. They are predominantly shallow to moderately deep, frequently gravelly or bouldery at the surface, with weakly developed podzolic features usually present, including an E or AE horizon and an incipient iron pan (Bfm horizon). The subsoils are commonly mottled.

Relationship to previously named soils

In the unpublished survey of the soils of Takaka County, the soils here mapped as Kotinga were shown mostly as Pakahi fine sandy loams and peaty loams. The name Kotinga (59a) was used first in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968) for soils in the Kotinga district and elsewhere that were formed from quartzose greywacke alluvium and with brownish mottled subsoils. In the present survey, the name Kotinga is retained but the soils are mapped over a smaller area than previously.

Landform origin and history

The catchment area to the south-west at the eastern end of the Anatoki Range comprises mainly quartzose sandstone and marble of the Wangapeka and Arthur Marble Formations. The topography rises to almost 1300 m, is steeply sloping and has three drainage outlets, Go Ahead Creek, Limestone Gully and The Slaty. The sediments that form the fan deposits originating from these streams are dominantly weakly sorted, coarse textured and often have large boulders. They are mapped by Grindley (1971) as intermediate terrace deposits of the Bainham Formation (Otirian or Last Glaciation) sediments. Given the coarse nature of the gravels and their distribution, it is possible that they represent outwash derived from periglacial or glacial activity in the adjoining mountain land during the last glacial period.

Key soil features

Kotinga soils are weakly podsolised and have very dark greyish brown thin topsoils (average 12 cm) with silt loam to sandy loam texture that overlies an AE horizon with dark grey to greyish brown colour and silt loam to sandy loam texture. Horizons beneath are more variable and may include a thin light grey or grey E or EG horizon (20% of observations) a weakly cemented or discontinuous iron pan (Bfm) horizon (15% of observations) and Bw, Bg and BC and horizons. The observation of horizon sequences was greatly restricted by the shallow stony nature of the soils which averaged 29 cm to gravels. Yellowish brown or reddish mottles are common in the subsoils, in many cases associated with oxidising rock fragments that may represent incipient formation of an iron pan. Drainage is moderate to imperfect.

Identified variants

The main variants recognised and separated are bouldery soils (Ktb) where there are high concentrations of boulders at or near the soil surface as well as shallow stony soils (<45 cm over gravel) that occur over about 50% of the area. Where a

distinct iron pan is present, the soil below is commonly yellowish brown and stony. Moderately deep soils were found over approximately 30% of the area.

Associated and similar soils

Kotinga soils are associated with Onahau soils which occur on a landscape that is older and undulating and which have more distinctively developed podzolic features. On recent stream surfaces that are topographically related to Kotinga soils, Bencarri and Anatoki soils are found. Waitui soils on aggradational terrace surfaces occur in proximity to Kotinga soils and also have podzolic properties and may have formed from loess. There are numerous sinkholes in the landscape associated with Kotinga soils and in some of these, peaty soils (Kini soils) occur.

Key physical properties

Kotinga soils occur on gently sloping ground and their drainage varies from moderately well drained to imperfectly drained, They are moderately stony to stony, at times bouldery with a medium to low available water capacity and a shallow to moderately deep rooting depth. There are few limitations for trafficability but workability is restricted by stoniness.

Versatility and land use rating

Kotinga soils have a limited capacity for intensive use and are included in class F of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-10 cm	Dark grey (10YR 4/1) sandy silt loam; weakly developed fine polyhedral and blocky structure; weak soil strength; friable; 5% medium stones; many fine roots,
AE	10-18 cm	grey (10YR 5/1) silt loam; weakly developed medium blocky structure; 20% light olive brown (2.5Y 5/4) and 2 % strong brown (7.5YR 5/8) fine distinct mottles; firm soil strength; brittle; 7% medium stones some oxidised; few fine roots,
Bw	18-30 cm	light olive brown (2.5Y 5/4) heavy silt loam; weakly developed medium blocky structure; firm soil strength; brittle; 3% medium stones; few fine roots,
BC1	30-65 cm	olive brown (2.5Y 4/4) sandy loam; weakly developed blocky and polyhedral structure; 15% medium and coarse stones; very few roots,
BC2	65-75 cm+	olive brown (2.5Y 4/4) sand; loose; 40% medium and coarse stones

Soil name and map symbol Waitui (Wt)

Concept and overview

Waitui soils cover 135 ha and are mapped on the southern portion of the uppermost distinct terrace surface of the Waingaro River. They are formed from fine textured silty deposits that overlie gravels up to 70 cm in depth. Waitui soils are imperfectly to poorly drained mainly silt loam textured soils with well developed podzolic features including a distinct Bh horizon and sometimes an iron pan and mottled horizons in the lower subsoil.

Relationship to previously named soils

In the unpublished survey of the soils of Takaka County, these soils were mapped as part of undifferentiated Pakahi fine sandy loam, peaty loam, sands and gravels. In the 1:250,000 General Survey of the soils of South Island (Soil Bureau Staff 1968), they were mapped as Kotinga soils. Waitui soils are separated in the present survey as they have different characteristics from the stony Kotinga soils and Onahau soils which have somewhat differing podzolic features.

Landform origin and history

The uppermost surface of the Bainham Formation (In1) is the oldest of the Otirian aged outwash terraces that were mapped by Grindley (1971). It forms a broad gently undulating largely undissected surface and it lies above the terrace surface (In2) which is thought to represent deposits of Late Last Glaciation aggradation gravels, 12,000+ years ago, and on which Hamama soils have formed. The silt loam textured material on the In1 terrace is possibly loess, derived from this younger aggradational, cold climate related surface. This possibility is reinforced by a suggestion that ventifacts, or wind facetted rocks may lie on the gravelly surface.

Key soil features

Waitui soils have a silt loam to fine sandy loam textured very dark grey or very dark greyish brown A horizon, around 12 cm thick, but an organic rich AH horizon, common in other podzolic soils is only occasionally found. An AE horizon, average 14 cm thick is dark grey to dark greyish brown silt loam with abundant white or light grey flecks and overlies an E or EH horizon with a mixture of light grey and brown colours. Below, a very firm silt loam textured brown or brown to light brown Bh horizon is present in most places and may overlie a thin reddish coloured weakly cemented iron pan (Bfm) or underlying mottled B horizons. Gravel is usually present at variable depths.

Identified variants

In places, the silty cover is absent and the soils are gravely to the surface and the soils are shallow.

Associated and similar soils

Kini soils from accumulations of organic and woody material, up to 1 m thick, are found on some lower lying parts of the landscape. Onahau soils are somewhat similar to Waitui soils but have different podzolic features.

Key physical properties

Waitui soils have broad near level surfaces and are imperfectly to poorly drained. They have a medium available water capacity while the rooting depth is shallow and restricted by the dense subsoil. Waitui soils are relatively free from stones except in patches and the permeability is expected to be moderately slow, Trafficability and workability are likely to be considerably restricted in wetter periods when some waterlogging occurs.

Versatility and land use rating

The versatility of Waitui soils is restricted by their imperfect to poor drainage, firm to very firm subsoils and moderately shallow rooting depth. Some cultivation for fodder crops is undertaken however. They are included in class E of the Tasman District Council land classification scheme.

Horizon	Depth	Description
A	0-9 cm	Very dark greyish brown (10YR 3/2) fine sandy loam; weakly developed fine polyhedral structure; weak soil strength; friable; abundant fine roots,
AE	9-19 cm	dark grey and light grey (10YR 4/2 + 7/2 (10%) fine sandy loam; weakly developed fine polyhedral to blocky structure; slightly firm; brittle; many fine roots,
Eh	19-29 cm	light grey and brown (10YR 7/2 + 10YR 5/2, 20%) fine sandy loam; massive breaking to weakly developed blocky structure; slightly firm; brittle; few fine roots,
Bh	29-35 cm	brown (10YR 4/3) sandy silt loam; massive breaking to weakly developed blocky structure; slightly firm; brittle; few fine roots,
Bfm	35-36 cm	yellowish red (5YR 5/8) discontinuous iron pan; apedal; and weakly cemented,
BC	36-55 cm	light yellowish brown (2.5Y 6/4) sandy loam; weakly developed medium prismatic structure; very firm; brittle; 2% coarse stones; few dark brown (7.5YR 3/2) staining along cracks,
	on	consolidated gravel

Soil name and map symbol Onahau (On, OnR, OnH)

Concept and overview

Onahau soils occupy 273 ha and are mapped on elevated terraces and associated undulating and hilly land (OnR, OnH) formed from extensive gravel deposits that accumulated in the earlier stages of the Last Glaciation. They are soils that are commonly known as "Pakahi" because restricted soil drainage due to the presence of an iron pan encourages the development of wetland vegetation. A characteristic feature of the soils is the presence of a pale grey or whitish layer or E horizon, formed by the removal and downward movement of iron and silicate clay.

Relationship to previously named soils

Onahau soils were identified in the early unpublished survey of the soils of Takaka County where they were mapped as Pakahi soils between Takaka Valley and Puramahoi. Onahau soils (59) were first named in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968) and again were mapped on the high terrace surfaces. In the survey of the soils of the Puramahoi district (Campbell unpublished) Onahau soils were mapped on all of the high terrace surfaces.

Landform origin and history

Throughout the Golden Bay region, the higher terrace surfaces and their gravelly deposits record a history of repeated glaciations in the western mountains, extending back to the Early Quaternary period. Land uplift and subsequent erosion have left only remnants of the earlier terraces but the later terraces are more distinct and less strongly dissected. Although Waikoropupu River is much smaller than either the Anatoki or Waingaro Rivers, a similar terrace sequence still exists. In the southwest of the survey area towards the head of Long Plain Road, the land surface is undulating and without a distinctive terrace appearance and is dotted with a number of large sinkholes. Surface features and the presence of large boulders suggest that the materials here may possibly be of glacial origin.

Key soil features

Onahau soils have a slightly peaty silt loam AH surface horizon that averages 11 cm in thickness and is very dark brown to very dark greyish brown. It overlies a silty or fine sandy loam textured 10 cm thick AH horizon that is dark grey or dark greyish brown and white or light grey. This overlies an E horizon (30%) which is light grey with pale brown staining, or a silty textured EH horizon (52%) which is light brown or brown and light grey to white. A brown coloured Bh horizon is sometimes present while an iron pan was found in over 50% of the observations. In 76% of the observations, Onahau soils were shallow with about half of these being stony. The average depth to gravel or an iron pan is 34 cm.

Identified variants

The main variations in Onahau soils relate to the depth at which stony gravel is found which ranges from very shallow soils with stones at the surface to moderately deep with gravel at < 90 cm. Soils with a distinct yellowish brown B horizon also occur. Where land slopes are between 8-15° the soils are separated as Onahau rolling (OnR) and Onahau hill (OnH) on 16-24° slopes.

Associated and similar soils

Waitui soils are similar to Onahau soils but lack an AH horizon and are silt loam textured while an iron pan is not diagnostic. Kongahu soils, separated here for the soils on the highest terrace surfaces, have more consistently developed E, Eh and Bh horizons while gleyed subsurface horizons are occasionally present. Below the iron pan, the soil material may be strongly weathered. Onahau soils are associated with Milnthorp soils, which are the well drained non-podzolised soils on predominantly hilly slopes, mainly terrace scarp lands.

Key physical properties

Onahau soils occur mostly on flat to gently sloping land and also hilly land and are poorly drained, but surface drainage is better on the rolling and hilly lands. Available water capacity is low due to the presence of an iron pan at relatively shallow depths and firm massive soil horizons above. They are moderately stony to stony soils with a shallow rooting depth. Permeability is slow and trafficability and workability are severely restricted in wetter months when water frequently lies at the soil surface.

Soil versatility and land use rating

There are severe limitations for intensive use of Onahau soils. Slope precludes intensive use on the rolling and hilly Onahau soils where erosion risk is severe. Drainage improvements that assist the removal of surface water can help to soil alleviate damage from stock treading but shallow rooting depth, firm subsoils, poor soil drainage and stoniness are difficult limitations to overcome. Onahau soils are grouped in Class E of the Tasman District Council land classification scheme and Onahau Hill soils in Class F.

Horizon	Depth	Description
AH	0-9 cm	Very dark grey (10YR 2/1) peaty silt loam; weakly developed fine polyhedral structure; very weak soil strength; very friable; abundant fine roots,
AE	9-18 cm	very dark grey and light brownish grey (10YR 3/1+ 10YR 6/1) silt loam; weakly developed fine polyhedral structure; slightly firm soil strength; brittle; few fine roots,
Eh	18-28 cm	light grey and greyish brown (10YR 7/2 + 5/2) silt to silt loam; very weakly developed coarse blocky structure; firm soil strength; brittle; very few fine roots,
Eg	28-52 cm	light brownish grey (10YR 6/2) silt; 15% strong brown medium distinct mottles; weakly developed coarse prismatic structure; firm soil strength; brittle; very few fine roots,
Bh	52-63 cm	dark brown (7.5YR 3/2) sandy gravel; single grain structure; loose; water table at 54 cm

Soil name and map symbol Kongahu (Kg)

Concept and overview

Kongahu soils are mapped over 232 ha on the highest terrace surfaces found within the survey area. The terraces occur as remnants in Waikoropupu Valley and the upper reaches of Go Ahead Creek and as extensive high level surfaces between Waikoropupu Valley and the Anatoki River. Kongahu soils are poorly drained podzols and have a sequence of horizons that is similar to those of Onahau soils from which they are here separated, but they are somewhat deeper with a more consistently developed iron pan that is strongly cemented. Underlying gravely sediments are often strongly weathered.

Relationship to previously named soils

Kongahu soils were not recognised in the early unpublished survey of the soils of Takaka County where they were included with the soils mapped as Pakahi soils. Kongahu soils were also not mapped in the Golden Bay region in the 1:250,000 Survey of the Soils of South Island (Soil Bureau Staff 1968) but were mapped elsewhere in the vicinity of Karamea as soils from mixed alluvium with a red cemented iron pan. In the soil survey of the Puramahoi district, Kongahu soils are probably present but were not separated from Onahau soils owing to insufficient information.

Landform origin and history

The higher terrace surfaces in the southwest of the region belong to the Waimean, Waimaungan and Porikan glacial stages of the Kaituna, Collingwood and Rockville Formations, extending back to the Early Quaternary period Grindley 1971). Uplift and subsequent erosion have left only remnants of the earlier terraces but the later terraces are more distinct and less strongly dissected. The terrace surfaces are best developed between the Waikoropupu and the Anatoki Valley where they form broad evenly sloping surfaces that are dissected by gullies that become shallow towards the south and merge with the terrace surface. Along the valley sides of the Waikoropupu and Anatoki Rivers, dissection has given rise to numerous step like surfaces that are separated by indistinct scarps comprising hilly or rolling land.

Key soil features

Kongahu soils are poorly drained and average 45 cm to either an iron pan or to gravel. They have a 10 cm very dark brown to black loamy peat AH horizon overlying an AE horizon , average 11 cm thick, that is black and light grey to grey with silt to sandy loam texture. An underlying Eh or E horizon has predominantly brownish and minor white to light grey colours and is typically firm to very firm, passing into reddish brown to brown sandy loam. The underlying iron pan, found in 60% of the observations, is yellowish red or reddish brown and cemented. An underlying B horizon was sometimes observed and was yellowish brown with sandy gravel texture.

Identified variants

Depth to gravel varies and in a number of places where the terraces comprise small remnants, the soils are bouldery to the surface. Subsurface horizons vary greatly in their colour and thickness.

Associated and similar soils

Kongahu soils are associated with Onahau soils which occur on lower elevation surfaces. Waitui soils, with their podzolic features, also resemble Kongahu soils.

Key physical features

Kongahu soils have predominantly gentle slopes, they are poorly drained and they have a low available water capacity and shallow rooting depth that is restricted by firm to very firm subsoil horizons and an iron pan. Mostly they are only slightly stony above the iron pan but in places are bouldery. Permeability is slow and with waterlogging occurring in wetter months, trafficability and workability are severely restricted.

Soil versatility and land use rating

Kongahu soils have severe limitations for intensive use. They are included in class E of the Tasman District Council land classification scheme.

Horizon	Depth	Description
AH	0-6 cm	Very dark greyish brown (10YR 3/2) peaty silt loam; very weakly developed fine polyhedral structure; very weak soil strength; friable; profuse fine roots,
AE	6-13 cm	dark grey and light grey (10YR 4/1+7/1) sandy loam; weakly developed fine blocky structure; weak soil strength; friable; profuse fine roots,
E	13-22 cm	light grey and white (10YR 7/3+7/1) fine sandy loam; apedal; massive; firm, few fine roots,
Eh	22-37 cm	brown and white (10YR 5/3 + 8/2) silt loam; apedal; massive; firm; very few fine roots,
Bh	37-40cm	brown to dark brown (10YR 4/3) silt to silt loam; apedal; slightly firm,
Bfm	40-41 cm	red (2.5YR 4/8) iron pan; very firmly cemented,
BC	41-65 cm	brownish yellow (10YR 6/8) sandy loam; apedal; 2% medium stones; massive; extremely firm; multiple discontinuous layers of Fe accumulations,
	on	pale olive sandy loam

Soil name and map symbol Kini (Ki)

General concept and overview

Kini soils are mapped over 14 ha on the older terrace surface to the west of the survey area. They are peat soils formed from organic deposits mostly woody forest or scrub materials that have occupied areas of low lying poorly drained land on the terrace surface. The organic material is moderately to strongly decomposed and forms fibrous peat mixed with partly decomposed woody material. Silty or gravely sediments generally underlie the peat deposits.

Relationship to previously named soils

Kini soils were not separated in the unpublished survey of the soils of Takaka County but were included with Pakahi soils as peaty loams. They were not mapped in the Takaka region in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968) but were mapped elsewhere, mainly on the West Coast where they were defined as organic soils, mainly from rushes and sedges with swamp forest and scrub. Kini soils were also mapped by Mew (1980a, b) in the Greymouth, Hokitika and Grey Valley regions where the soils comprised about 80 cm of peat over silty sediments.

Landform origin and history

The land surface on which Kini soils are mapped is the upper terrace surface of the Bainham Formation, Otirian Glaciation aggradation deposits which forms a broad even surface southwest of Kotinga. Fine textured material, possibly loess lies on the terrace surface and impedes drainage and the peat has accumulated in areas that are slightly lower lying and along some drainage ways. The landscape in this locality has numerous sinkholes, some of which have permanent or semi-permanent ponds at the floor of the depression. Small areas of peaty Kini soils occur around the margins or on the floor of some of these sinkholes.

Key soil features

Kini soils have an average thickness of around 75cm of organic material overlying a silty substrate. The topsoil, 15cm thick, (AH) is partly decomposed peat with modern organic material, overlying an organic (O) horizon, average 18 cm thick and very dark brown coloured, comprising partly decomposed organic material. This in turn overlies about 45 cm of dark reddish brown strongly decomposed and humified organic material (peat), with wood remains. This in turn passes into a Bh horizon of reddish brown silt loam. At undrained sites, the watertable is at or near the surface. Where there is an appreciable mineral component in the peat (30-50 % loamy peat) the upper peat layers are weakly podsolised and have greyish colours.

Identified variants

The main variation encountered was in respect of the depth of organic accumulation which may be less than 30 cm over underlying sediments. Where the land has been drained, the water table is at a lower depth.

Associated and similar soils

Kini soils occur on the same land surface as Waitui soils and are also associated with Anatoki and Onahau soils where there are sinkholes. Karangarua soils, mapped in the low swampy areas adjacent to estuaries in Lower Takaka Valley

and Puramahoi soils surveys are similar to Kini soils but the peat accumulations are shallower and organic accumulations are absent in lower mineral horizons.

Key physical properties

Kini soils occur on level surfaces and the floors of sink holes, they are poorly to very poorly drained and have a high available water capacity. They are free of stones and have a rapid permeability. Where they are undrained, the rooting depth is very shallow and trafficability and workability are precluded by the high watertable but these properties are improved when drainage occurs.

Soil versatility and land use rating

With improved drainage, Kini soils are included in Class F of the Tasman District Council land classification scheme but without drainage they are included in class H. However, these soils might be better considered for conservation use, particularly as carbon sinks as drainage improvements and agricultural utilisation are likely to contribute to greenhouse gas emissions through peat decomposition.

Horizon	Depth	Description
AH	0-14 cm	Black (10YR 2/1) peat; weakly developed fine polyhedral structure; very weak soil strength; very friable; few fine and medium roots,
AE	14-23 cm	black and dark grey (10YR 2/1 + 10YR 4/1) loamy peat; weakly developed fine blocky structure; very weak soil strength; very friable; few fine and medium roots,
Oh	23-52 cm	dark reddish brown and dark brown (5YR 3/2 7.5YR 4/4) peat; strongly decomposed; very weakly developed medium polyhedral and blocky structure; very weak soil strength; very friable; few medium and coarse old roots,
Bh	52-69 cm	dark reddish brown and yellowish brown (5YR 3/2 + 10YR 5/4) heavy silt loam; weakly developed medium prismatic structure; firm; brittle,
BC	69-75 cm+	light yellowish brown to pale olive (2.5Y 6/4-5Y 6/3) silt to silt loam;10% medium and coarse stones; apedal; massive; very firm to hard soil strength

Soil name and map symbol Milnthorp soils (MnH, MnS)

Concept and overview

Milnthorp soils are distributed over149 ha. They are the soils that are formed on strongly sloping mostly hilly (MnH) and some steep land (MnS) that forms the scarps of terraces, and the hilly land that is associated with gullies dissected into the higher terrace surfaces. They are formed from the terrace gravel materials that have been mixed with weathered earthy material by down-slope erosion processes. They are well-drained brown soils, generally stony with a deep weathering profile overlying bouldery gravel.

Relationship to previously named soils

Milnthorp soils were not recognised or separated in the unpublished survey of the soils of Takaka County or in the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). They were first mapped in the survey of the soils of the Puramahoi district (Campbell 2007 unpublished) to separate the soils from gully side terrace gravel materials from adjacent terrace surface soils. In the Puramahoi district, the terrace deposits were underlain by Tertiary siltstone or sandstone and Milnthorp soils there often included additions of these materials.

Landform origin and history

The elevated terraces of the region that were formed in earlier glacial periods have been progressively dissected with erosion resulting in the formation of scarps of varied length and slope, partly dependent on the age of the surface. Erosion on these surfaces is probably accelerated during colder climatic periods but the weathering mantle appears to be relatively uniform in depth suggesting that overall, the age of the surfaces is comparatively recent.

Key soil features

Milnthorp soils are moderately deep to deep (45->90 cm over gravel) commonly with some stones through the upper horizons. Topsoils are brown to dark brown averaging 17 cm thick and with silt loam texture. This passes into a yellowish brown B horizon around 35 cm thick with textures ranging from silt loam to sandy loam, then into underlying olive sandy gravel.

Identified variants

The main variations encountered are in respect of the depth of fine material over gravel with stony gravel to the surface being found in some places and also the depth to which weathering has occurred. Where the terrace gravels are firmly consolidated, as in the older terrace deposits, the terrace scarps are steeply rather than moderately steeply sloping and Milnthorp steepland soils (MnS) are separated.

Associated and similar soils

Milnthorp soils are associated with Onahau and Kongahu soils which form on the easy slopes of the terrace surfaces. In places on the gully sides, the soils have podzolic features and resemble Onahau soils (OnH). Pupu complex, mapped on hilly valley side surfaces of Waikoropupu Valley includes some Milnthorp soils. Deadman soils are similar soils found in similar topographic situations in the West Coast region (Mew 1980a,b).

Key physical properties

Milnthorp soils occur on strongly to steeply sloping land, are well drained and have a medium available water capacity. They are moderately stony to stony with a moderately deep to deep rooting depth. Slope restricts trafficability and workability and erosion risk is moderate to high.

Soil versatility and land use rating

Potential use of Milnthorp soils is restricted by steepness of slope which is mainly within the range of 16-24° for the hill soils and >25° for the steepland soils. The hill soils are included in class F of the Tasman District Council land classification scheme and the steepland soils in class H.

Horizon	Depth	Description
A	0-23cm	Dark yellowish brown (10YR 3/4) silt loam; moderately developed medium polyhedral structure; weak soil strength; very friable; 7% coarse stones; many fine and few coarse roots,
AB	23-30 cm	yellowish brown and dark yellowish brown (10YR 5/8+3/4) silt loam; moderately developed medium polyhedral structure; weak soil strength; very friable; 10% medium and coarse stones; many fine and few coarse roots,
Bw1	30-60 cm	yellowish brown (10YR 5/8) sandy loam; moderately developed medium polyhedral structure; very friable; 15% medium and coarse stones; few fine and medium roots,
Bw2	60-94 cm	yellowish brown (10YR 5/6) loamy sand; very friable; 30% medium to very coarse stones; few fine and few medium roots,
BC	94-99 cm	light yellowish brown (2.5Y 6/4) sandy gravel; apedal; loose; 65% fine to boulder sized stones; few fine roots,
C	99-115 cm	olive (5Y 5/4) sandy gravel; loose; 70% fine to boulder sized stones

Soil name and map symbol Pupu complex (PuH)

Concept and overview

Pupu Complex covers 83ha in Waikoropupu Valley and represents the soils formed predominantly on hilly land from a mixture of materials including weathered gravels from terrace deposits and weathered and unweathered sediments from sandstone rocks of the Tarakohe Mudstone Formation. Mixing of the differing lithological components to variable degrees, combined with differing amounts of weathering has resulted in a highly varied soil mantle with an extensive range of soil textural, drainage and morphological features properties. Much of the landscape is covered with dense scrub vegetation and a systematic evaluation of the soils of these surfaces was not possible.

Relationship to previously named soils

Soils on hilly lands associated with river valleys or gully land in terraces were not separated in the unpublished survey of the soils of Takaka County or the 1:250,000 General Survey of the Soils of South Island (Soil Bureau Staff 1968). Soils in the Lower Takaka and Puramahoi districts that are formed on Motupipi Formation sandstones were however mapped as Waitapu soils (Campbell 2006 unpublished).

Key soil features

Soils of the Pupu mapping unit complex have properties that range from soils podzolic to brown earths, textures that vary from stony to sandy and drainage that ranges from poor to well drained.

Identified variants

Pupu complex includes soils ranging from soils on gravel that are poorly drained with strong podzolic features, soils on deposits of mixed lithologies with strong podzolic features, soils on mixed lithologies with deeply weathered subsoils, soils on sandstone slope deposits with moderately well drained soil and soils on gravelly deposits that are well drained. In places, the weathering mantle over sandstone bedrock is shallow.

Associated and similar soils

Where weathered sandstone materials are deep and have little addition of gravelly detritus, the soils in Pupu Complex are similar to Waitapu soils. Strongly podzolised soils resemble Onahau or Kongahu soils. Well drained gravelly soils are similar to Milnthorp soils.

Soil versatility and land use rating

The soils of Pupu Complex are on moderately steep to steep slopes, are sometimes underlain by hard sandstone, are poorly to moderately well drained, have a shallow rooting depth, have a high risk of erosion and are unsuited for cultivation or intensive use. They may be better retained in native vegetation for conservation purposes. They are included in Class H of the Tasman District Council land classification scheme.

Horizon	Depth	Description 1, podzolic soil
AE	0-23 cm	Dark grey (10YR 4/1) sandy loam; weakly developed fine polyhedral structure; slightly firm soil strength; friable; many fine and few coarse roots,
E	23-44 cm	light grey (10YR 7/3) coarse sandy loam; apedal; massive; firm soil strength; brittle; many fine and few coarse roots,
Bfm	44-48 cm	dusky red (2.5YR 3/2) cemented iron pan; massive; extremely firm; 35% fine to coarse stones,
Bs	48-60 cm	brownish yellow to strong brown (10YR 7.5YR 5/8) coarse sand; weakly develop coarse blocky structure; firm soil strength, 20% coarse stones,
B(g)	60-70 cm	strong brown (7.5YR 5/6) sand; 30% light grey (2.5Y 7/2) medium distinct mottles; weakly developed coarse blocky structure; firm soil strength; 10% coarse stones,
BC	70-100+	reddish yellow (7.5YR 6/8) sand; apedal; massive; very firm

Horizon	Depth	Description 2, brown soil
A	0-18	Greyish brown (10YR 5/2) sandy loam; weakly developed fine polyhedral structure; weak soil strength; friable; abundant fine roots,
AB	17-25 cm	greyish brown and yellow (10YR 5/2 + 2.5Y 7/6) sandy loam; weakly developed medium polyhedral structure; slightly firm soil strength; brittle; few fine and few coarse roots,
Bw(g)	25-52 cm	yellow (2.5Y 7/6) coarse sandy loam; 20% strong brown (7.5YR 5/8) and 5% light yellowish brown (2.5Y 6/4) medium distinct mottles; weakly developed medium blocky structure; slightly firm soil strength; brittle; few fine roots,
BC	52-90 cm	yellow (10YR 7/8) coarse sand; 5% reddish yellow (7.5YR 6/8) medium distinct mottles; few yellowish red (5YR 4/6) firm concretions; weakly developed medium blocky structure; slightly firm soil strength; very few fine roots,
C	90-110 cm	yellowish brown (10YR 5/6) coarse sand; 7% light grey (2.5Y 7/2) and 10% yellowish red (5YR 5/6) coarse distinct mottled banding in sandstone; apedal; very firm

Soil name and map symbol Anthropic soils (At)

Concept and overview

Anthropic soils (approximately 28 ha) are soils whose properties result from human activities, such as through truncation of natural soils by earth moving equipment, through drastic mixing of soils so that their original character has been lost, or through the deposition of thick layers of earth materials (Hewett 1998). Anthropic soils do not have any specific physical characteristics but their general characteristics usually relate to the particular activity through which they were formed. Anthropic soils are mapped in several locations; in Waikoropupu Valley where some gold mining activity occurred and also where some land had been modified to accommodate salmon farming; on some terrace land near the Takaka River where soils were overturned to improve the soil drainage, and a third small area of commercial activity alongside the Anatoki River.

Relationship to previously named soils

The soils on the low terrace land west of Takaka were probably poorly drained Onahau soils and the land in this area has had the soil material reworked and the land contoured with a ridge and swale surface to improve the soil drainage.

In Waikoropupu valley, the area disturbed was part of small-scale gold mining operations on what was probably Ikamatua or Puramahoi soils, the land being left with a low hummock and mound relief.

Key soil features

Where the soil disturbance has involved some reinstatement, the soils have weakly developed stony A horizons and mixed B horizon and subsurface gravel materials with negligible soil structural development. Where no reinstatement has taken place, the soils have AC profiles with a thin A horizon over unweathered bouldery gravel.

Soil Versatility and land use rating

Anthropic soils have a low versatility owing to the disturbance of the intrinsic physical properties and are included in classes F to H for agricultural production.