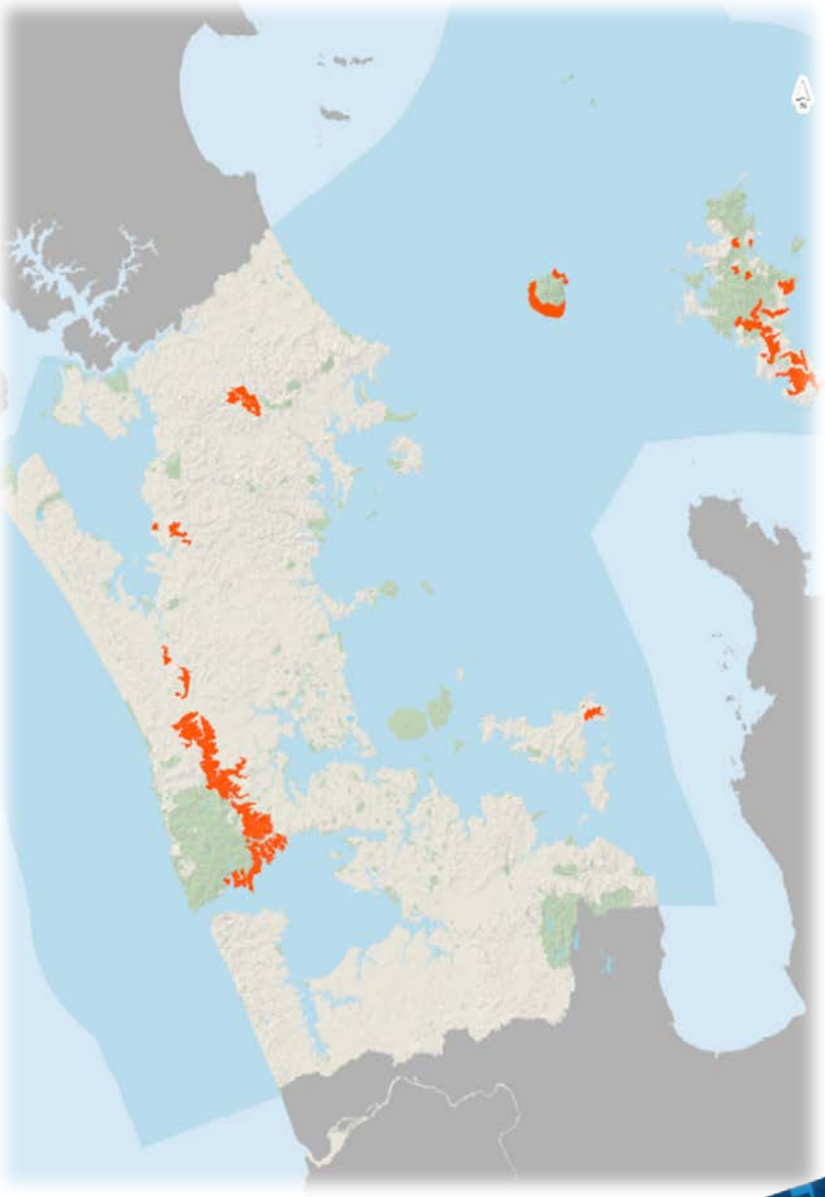
Soil Information Inventory:

Parau and related soils

October 2018 Soil Information Inventory 14



RIMU Research and Evaluation Unit

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Soil Information Inventory 14:

Parau and related soils

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Auckland Council
Soil Information Inventory, SII 14

ISBN 978-1-98-858918-3 (Print)
ISBN 978-1-98-858919-0 (PDF)

Approved for Auckland Council publication by: Name: Dr Jonathan Benge Position: Manager, Environmental Monitoring, Research and Evaluation (RIMU)
Date: 1 October 2018

Recommended citation

Martindale, M., D Hicks and P Singleton (2018). Soil information inventory: Parau and related soils. Auckland Council soil information inventory, SII 14

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1 Introduction

With Auckland's expected growth from 1.7 to 2.0 million people in the next 30 years (The Auckland Plan 2050) and a goal to double New Zealand's agricultural exports by 2025 (Ministry for Primary Industries), an understanding of Auckland's soil resources is essential for planning urban growth, and sustaining if not expanding rural production, while managing the impacts of both on our region's environment.

Existing information on Auckland's soils is difficult to assess and interpret. Electronic versions of soil maps are available on research institute websites. Some have been uploaded into Auckland Council's geographic information system (GIS, GeoMaps) for use by council staff and for public viewing. However, the GIS maps and their attached attribute lists cannot be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports. Many of these documents are now hard to find.

Auckland Council has undertaken to compile old information for the region's main soils into single documents called soil information inventories (SIIs). These may be viewed on Knowledge Auckland, www.knowledgeauckland.org.nz council's research and technical publications website, downloaded and printed. It is expected that there will be gaps in each inventory. The gaps will be filled as new information becomes available. Each inventory is a repository for information old and new and will be a "living document".

Their intent is to:

- ease access to soil information
- enable better understanding of the soils' properties
- enhance public awareness about the location of productive or problematical soils
- improve awareness of the soils' potential and limitations, amongst consultants and planners
- help council staff provide better advice, and make more informed decisions.

Our role has been document compilers, not authors. We have selected information which appears useful for landowners, farm, forest, environmental or planning consultants, and the council staff who deal with them. While we regard the selected information as reliable, responsibility for accuracy of contents rests with the organisations which originally collected and published the maps or documents which we cite. Auckland Council makes the information available on the Knowledge Auckland website with this understanding.

Acknowledgments are due principally to old soil surveyors of the DSIR's Soil Bureau, who collected most of the information reproduced here, notably Charles Sutherland, Charles Wright, Norman Taylor, Edward Cox, and Gary Orbell.

Assistance from Mandy Holt (cross-section), Tyana Rowe-Kurene, Tony Edhouse and Linda Wallis (document editing and layout), Fiona Curran-Cournane (internal publication referee) and Malcolm McLeod (external publication referee) is also acknowledged.

Michael Martindale, Douglas Hicks and Peter Singleton
June 2016, October 2018

2 Published maps

On DSIR's published soil maps of North Auckland (1:100,000), soils on old andesitic agglomerates and breccias are depicted as four series i.e. soils with distinct profiles and parent materials:

PA, PAH	Parau clay loam
BM, BMH	Bream clay loam
CW, CWH	Cornwallis clay
DV, DVH	Dome Valley clay

Related soils on old shattered dolerites, breccias and tuffs are depicted as another three series:

AW, AWH	Awapuku clay loam
MN, MNH	Mangonui clay
Ru, RuH	Rangiuru clay

DSIR's oldest maps of South Auckland (1:253,840) map just one of these series and separate an extra on small areas of old basalt:

87H	Awapuku hill soil
95cH	Bald Hill hill soil

On old volcanic rocks of Little and Great Barrier Islands the maps depict soils as four series:

87, 87H	Awapuku clay loam
88b	Parau clay loam
89, 89H	Mangonui clay
90, 90H	Rangiuru clay

More recent medium-scale maps (1:63,360, 1: 50,000) re-label the South Auckland soils as:

Ak	Awapuku clay loam
BhH	Bald Hill hill soil

and the Great Barrier soils as:

RB, RBH	Rosalie Bay clay loam
AO, AOH	Aotea clay loam or clay

FR, FRH	Fitzroy clay loam and bouldery clay loam
TY	Tryphena clay
KF	Korotiti clay

Sourced from:
Soil maps of Maungaturoto-Kaipara area; Mangawhai-Warkworth area; Helensville-Waitakere area; Whangaparaoa-Auckland area
NZ Soil Bureau maps 189, 190, 220, 221

Soil map of the North Island, sheets 2 and 3 (Auckland and Waikato)
NZ Soil Bureau maps 11/2, 11/3

Soil map of part Franklin county *NZ Soil Bureau map 149/1*
Soil map of Great Barrier Island *NZ Soil Bureau map un-numbered*

3 Online maps

Landcare Research's online soil map (S-map, 1:50,000) re-names and re-labels the soils as follows:

PA, PAH	No family name or sibling number
BM, BMH	No family name or sibling number
CW, CWH	No family name or sibling number
DV, DVH	Whangaripo family sibling 14a, Warkworth family sibling 10a
AW, AWH	No family name or sibling number
MN, MNH	No family name or sibling number
87, 87H, Ak	Awapuku family, sibling 1
88b, 89, 89H, 90, 90H	No family names or sibling numbers
95cH, BhH	Bald Hill family, sibling 1
RB, RBH, etc.	No family names or sibling numbers

Reasons for the basis of S-map can be found in the S-map database manual. The names and numbers were assigned by computer-matching local soil properties with different soils in other parts of the country.

Sourced from S-map Online – Home *http://smap.landcareresearch.co.nz/home*

4 Farm-scale maps

North of Auckland, any published map polygon labelled as PA etc. turns out to be a mosaic of Parau plus other soil types when investigated in the field by local soil mappers. Few farm-scale soil maps (1:5,000 - 1: 10,000) have been prepared yet; but when identifying or sampling the soils, they are labelled as:

Pa	Parau clay loam
Bm	Bream clay loam
Cw	Cornwallis clay
Dv	Dome Valley clay
Aw	Awapuku clay loam
Mn	Mangonui clay
Ru	Rangiuru clay
Ak	Awapuku clay loam (South Auckland)
Bh	Bald Hill clay loam (South Auckland)

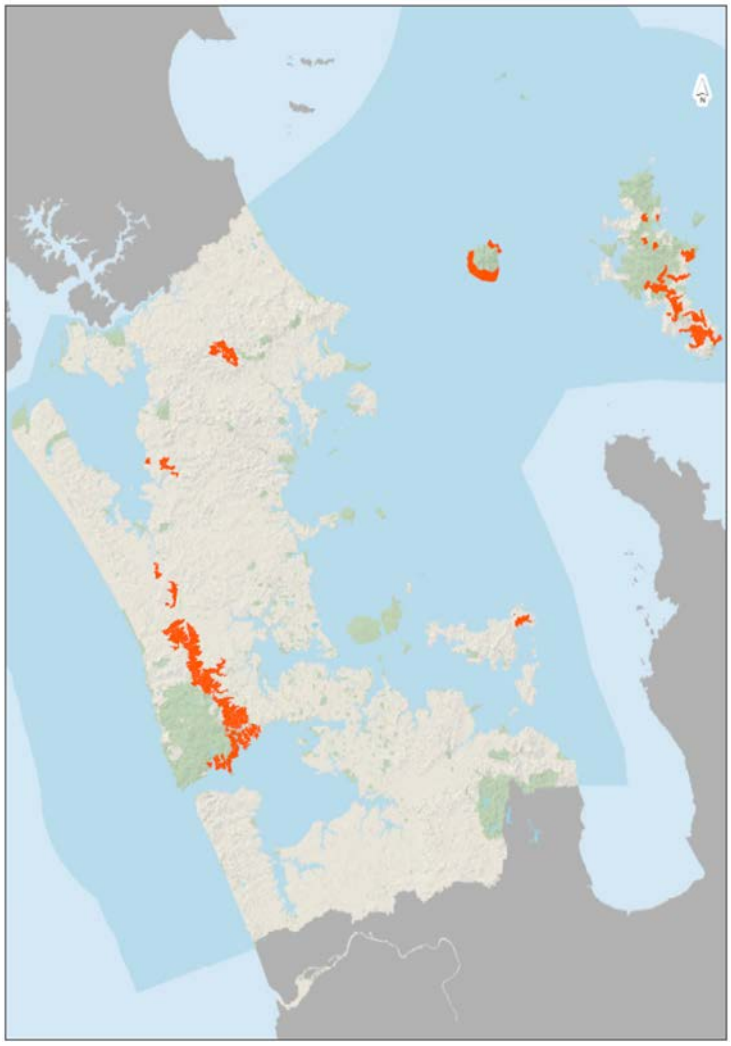
Appropriate map labels have not been determined for Great Barrier Island, where yet no farm-scale maps have been prepared. Here soil sampling has been carried out just in scrub or bush at four sites on steepland phases of the soils (see Soil Information Inventory for Huia and related soils).

Local series names for Parau and related soils have been retained on Auckland Council's farm-scale maps for continuity with published nomenclature.

Sourced from 1995-2015 farm-scale maps and soil notes prepared for private landowners, Auckland Regional Council or Auckland Council

5 Where the soils occur

Patchily through the hills east of Kaipara harbour, then extensively through foothills of the Waitakere Ranges from Waimauku to Parau. Extensively on Little and Great Barrier islands. As small patches on the region's southern boundary, from Bald Hill to Mt. William.



Location of Parau and related soils

Parau and related soils are mapped on 15,700 hectares (3% of Auckland region). About 5000 hectares (32% of the area mapped) are in productive use, mainly as drystock pasture or forest plantation (estimated from overlay of Agribase 2010 on Fundamental Soils Layer). *http://intermaps.arc.govt/AucklandCouncilViewer/*

Parau clay loam, on easy-contour footslopes of the Waitakere Range, is usually in pasture. It is interspersed by patches of Cornwallis clay which have reverted to scrub. *Photo: D Hicks*

5.1 On what landform

Parau and Cornwallis soils weather from Manukau Group andesite or andesitic breccia; sea-floor lava flows and lahars erupted during the Miocene epoch (8 to 25 million years ago). Uplifted from the sea, only the volcano's eroded eastern flank now remains as the Waitakere Ranges. Parau and Cornwallis soils also occur on moderate hillslopes to the east of Helensville and northward towards the Dome Hills, wherever old lahar deposits interfinger marine sediments of the Waitemata Group. North of the Dome Hills, similar soils are mapped as Bream and Dome Valley series.

Awapuku, Mangonui and Rangiuru soils develop on rocks that are geologically similar though much older: blocks of sea-floor basalt or andesite dating from the Cretaceous to early Tertiary periods (90 to 25 million years ago) rafted along in submarine landslides which deposited the Northland Allochthon. They are now isolated resistant outcrops, standing up above the subdued relief of surrounding crushed-rock terrain.

Out in the Hauraki Gulf, the same names were initially applied to soils on andesite from volcanoes that built islands above sea level during the Piocene epoch (eight to two million years ago). They have since been given local soil names, Rosalie clay loam etc. (perhaps un-necessarily).

Most volcanic terrain south of Auckland is young. Within the South Auckland Volcanic Field, just a few outcrops of old basalt date to the Pliocene/Pleistocene

boundary (about two million years ago). They form moderate hillslopes, weathered enough to have similar soil, mapped here as either Awapuku or Bald Hill series.

Sourced from Edbrooke, S. W., 2001, Geology of the Auckland Area, Institute of Geological and Nuclear Sciences 1: 250,000 map 3 and accompanying bulletin

5.2 How they differ from other soils

Huia and related soils have shallower profiles than the old volcanic soils on easy slopes. Weathered rock fragments are visible in subsoil, and un-weathered rock protrudes as outcrops or bluffs. Compared with steepland soils weathered from sedimentary rocks (see Soil Information Inventories for Puhoi and Te Ranga soils), Huia and related soils have brighter red-brown colour, caused by iron and magnesium oxides which weather out of dark volcanic rock fragments.

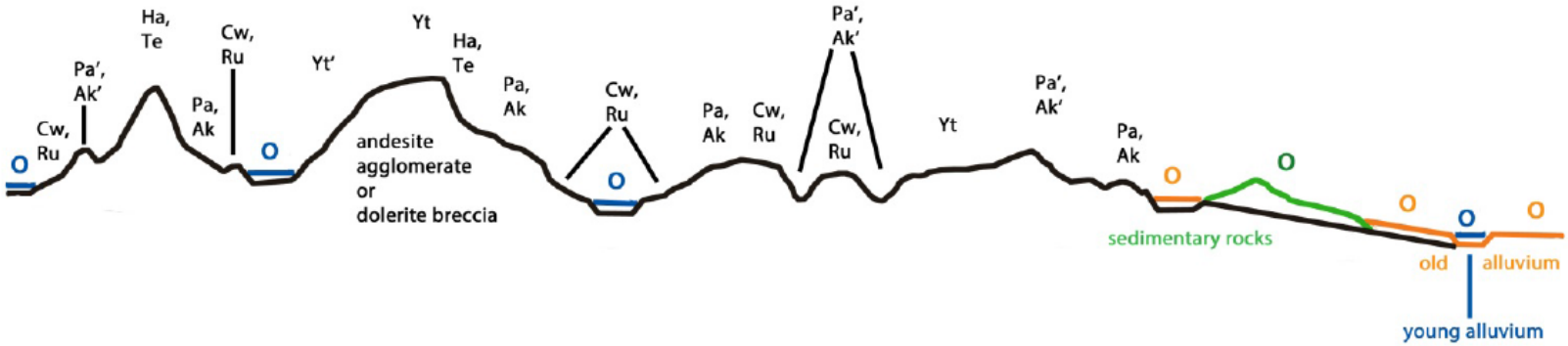
Sourced from: Wilson, A.D. and Cox, J.E., Soils of Rodney County, Unpublished report, Soil Bureau DSIR; Molloy, L., 1987, Soils in the New Zealand landscape, New Zealand Society of Soil Science

6 Classifications

NZ genetic (NZG):	brown granular clay
NZ soil (NZSC):	typic orthic granular, acid or perch-gley orthic brown, typic or raw orthic recent *http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx*
Soil Taxonomy (USDA):	udox (Waitakere etc.), udept (Huia etc.) *http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051544.pdf*
World Soils (FAO):	oxisol (Waitakere etc.), leptosol (Huia etc.) *http://www.fao.org/3/a-i3794e.pdf*

DSIR replaced the NZ genetic classification dating from 1930s with the NZ soil classification in 1990s. DSIR's soil scientists considered that Soil Taxonomy did not work well in New Zealand, nor did World Soils. Soil Taxonomy and World Soils remain internationally accepted classifications.

Cross section showing Parau and related soils' position in the landscape



On elevated plateau
Yt Waitakere clay

On steep faces (stable)
Yt' Waitakere clay (shallow)

On steep faces (unstable)
Ha, Te Huia or Te Kie stony loam

On rolling lower slopes, upper slopes & ridges
Cw, Ru Cornwallis or Rangiuru clay
Pa, Ak Parau or Awapuku clay loam

On moderate hillslopes (parts unstable)
Cw', Ru' Cornwallis or Rangiuru clay (shallow)
Pa', Ak' Parau or Awapuku clay loam (shallow)

O, O, O Other soils (refer to relevant soil information inventory

Soil type labels on the cross-section are sourced from Auckland Council's farm-scale maps

7 Soil profile descriptions

DSIR's unpublished profile descriptions contain four for Parau clay, collectively re-labelled by hand as "Parau clay loam - Warkworth clay - sandy clay loam". Parent material is described as "strongly and deeply weathered andesitic tuff and sediments dominant; some strongly weathered andesite; plus ... massive sandstones ... banded sandstones (only minor areas); these sandstones all belong to the Waitemata beds". The first profile appears to be modal (most widespread):

Parau clay loam *Photo: A Thompson*

Parau clay loam

Horizon	Depth (cm)	Description
A	0-8	Very dark greyish brown (10YR 3/2) clay; firm but friable in the hand; moderately developed medium and fine subangular polyhedral structure; contains very fine subrounded casts and abundant fern and grass roots; indistinct boundary.
Ag	8-21	Dark grey brown (10YR 4/2) clay; the faces of some of the aggregates have either a faint, strong brown coating of iron or a dark grey staining; medium packing; strongly developed, medium and some coarse subangular polyhedral; breaks down to a fine subangular polyhedral structure; contains some fine and very fine subrounded casts and numerous fern and grass roots; diffuse boundary.
Bw1	21-56	Brownish yellow (10YR 6/6) clay; few faint, yellowish red (5YR 4/8), thin coatings of iron on the faces of some of the aggregates and also a light greying; firm, high packing; moderately developed, medium and some coarse subangular polyhedral structure, breaking to fine subangular polyhedral; contains some dark grey fine casts and fewer of the finer grass roots some penetrating the aggregates; diffuse boundary.
Bw2	on	Yellow to brownish yellow (10YR 7/8-6/8) clay; friable; high packing; moderately developed medium and fine subangular polyhedral structure breaking to very fine subangular polyhedral with a tendency to blocky structure; contains about 1% of the strongly weathered tuff; few roots.

A second profile labelled “brown phase” is deeper (at about 90 cm) with a compact A/B horizon, an upper B with more iron coatings (mottles) on the faces of aggregates, and a brown lower B with poorer (blocky or prismatic) structure. It is described as “a more impermeable profile with poor pore space; very high moisture holding capacity, moister with increasing depth” i.e. despite its brown colour appears to be a phase with iron mottles on wet sites.

The third profile is labelled “dark brown phase” and described as grading to Waitakere clay. Given the DSIR mappers’ opinion that it is neither a typical Parau nor a typical Waitakere soil, their description is not reproduced here (for Waitakere clay, refer to Soil Information Inventory for Huia and related soils).

The fourth, labelled “pale brown phase” is described as grading to Warkworth clay loam. Its description resembles the brown type of Warkworth clay loam weathered from tuffaceous sandstone, now mapped as a separate series, Matakana sandy clay loam (see Soil Information Inventory for Whangaripo and related soils).

Awapuku clay loam *Photo: D Hicks*

DSIR appears not to have prepared type profiles for the related soils Bream clay loam (mapped on just small areas towards Auckland region’s northern boundary), and Awapuku clay loam. Nor are there type profiles for two more weathered soils, Dome Valley clay (mapped on hills east of the Kaipara), or Mangonui clay (mapped on parts of Great Barrier Island). Soil Bureau Bulletin 5 (General Survey of the Soils of North Island) contains the following brief descriptions:

Awapuku clay loam

Horizon	Depth (cm)	Description
A	0-15	Dark brown granular clay loam.
B	on	Light brown compact granular clay (stony in places).

NB: granular = subrounded polyhedral in modern soil description terms.

Dome Valley clay *Photo: D Hicks*

Dome Valley clay

Horizon	Depth (cm)	Description
A	0-10	Dark brown crumbly clay, or greyish brown clay.
B	on	Reddish brown compact clay, or brown flecked clay.

Mangonui clay

Horizon	Depth (cm)	Description
A	0-13	Blackish- brown granular clay loam.
B	on	Light brown and brown compact clay.

Cornwallis clay *Photo: F Curran-Cournane*

The DSIR's unpublished type profile descriptions for Cornwallis clay were originally labelled "Parau poorer clays (Pas)", and then re-labelled by hand as "Cornwallis clay - Mahurangi fine sandy loam (CW - MV)". They are described as forming on "strongly and deeply weathered andesitic tuff and massive strongly and deeply weathered sandstones of the Waitemata beds" on "low-set hills with very short moderately steep slopes; larger areas of strongly rolling slopes with rolling and easy rolling ridges and foothills". Four profiles are given, the first of which is described as modal (most widespread) on rolling slopes (8 to 20 degrees):

Cornwallis clay

Horizon	Depth (cm)	Description
Ah	0-13	Very dark grey brown (10YR 3/2) clay; moderately developed, medium to fine subangular polyhedral and fine to very fine blocky structure, friable when disturbed; firm, medium packing; abundant scrub roots; sharp boundary.
Bw1	13-23	Yellowish brown (10YR 5/8) clay; strongly developed medium and fine subangular polyhedral breaking down to a fine blocky structure; some intermingling of the upper horizon; contains some fine subrounded casts; firm, high packing; many scrub roots mainly along the faces of the aggregates; diffuse boundary.
Bw2	23-58	Yellowish brown (10YR 5/6) clay; strongly developed, medium and fine subangular polyhedral, breaking to very fine blocky structure; contains some small particles of the strongly weathered tuff; firm, high packing; many scrub roots along the faces of coarser aggregates; diffuse boundary.
Bw3	58-68	Yellow (10YR 7/6) clay; moderately developed, fine and very fine angular polyhedral breaking top very fine blocky structure; firm; medium packing; common scrub roots; diffuse boundary.
Bwv	on	Pale yellow (2.5Y 8/4) clay; firm, high packing in place, but not as hard as the upper horizons to dig; moderately developed, medium and fine angular polyhedral breaking to very fine blocky structure; contains more small particles of the strongly weathered tuff, these appear as variegated colours of white, red and reddish yellow; few fine scrub roots;

The second profile is described as modal on moderate slopes (21 to 30 degrees). It has a topsoil which breaks to subrounded polyhedral structure, a shallower A/B horizon (4 cm), a deeper upper B (45 cm), a deeper and brighter lower B (25 cm) without weathered tuff fragments. The DSIR mappers' description indicates they initially considered the subsoil as having "poor pore space, slow permeability when saturated" but revised their opinion about pore space and permeability to "very high water holding capacity".

The third profile, described as “pale brown clay on a 12-degree slope” (rolling) and “easily mistaken for the Waikare sandy clay part of the complex”, appears to be an andesitic breccia equivalent of either the mottled or the perch-gley soils that develop on tuffaceous sandstone (see Soil Information Inventories for Whangaripo and Mahurangi soils). Its description is:

Cornwallis clay (pale phase)

Horizon	Depth (cm)	Description
Ah	0-10	Dark grey (10YR 4/1) clay; very firm, tightly packed in place; moderately developed, medium subangular polyhedral breaking to fine subangular polyhedral structure; few very fine subrounded polyhedral casts; abundant scrub roots; merging boundary.
A/Bw(f)	10-20	Intermingling colours, yellow brown, dark grey brown and dark grey (10YR 5/4 - 5/2 - 4/1) clay; few distinct, fine, reddish yellow (7.5YR 6/8) mottles; extremely firm, high packing; moderately developed, medium and coarse subangular polyhedral breaking to fine subangular polyhedral structure; upper part of structure has dark grey staining on the faces; few very fine subrounded polyhedral casts and many scrub roots; diffuse boundary.
Bwv1	20-45	Brownish yellow (10YR 6/6) clay; extremely firm, high packing; moderately developed coarse subangular polyhedral structure; strong dark grey staining on the vertical ped faces; contains some particles of the weathered tuff, giving a white, reddish yellow, strong brown and red speckled effect, few and finer scrub roots; merging boundary.
Bwv2	45-80	Yellow (10YR 7/6) waxy clay; firm, high packing; moderately developed fine and very fine subangular polyhedral structure; vertical fissures with a dark grey staining on the faces; some iron accumulation in the lower part of this horizon on the faces of some of the aggregates; abundant small particles of the weathered tuff giving the same effect as described in the upper horizon, fewer and finer scrub roots.
C	on	Strongly and deeply weathered andesitic tuff.

A fourth profile labelled “reddish brown phase on a 12-degree slope”, appears from its description to be a strongly weathered phase of Cornwallis clay on dry sites, perhaps transitional to Waitakere clay on adjacent broad ridges, so its description is not included here (for Waitakere clay, see Soil Information Inventory for Huia and related soils).

There is no type profile for Rangiuru clay (a related soil to Cornwallis clay) mapped on parts of Great Barrier Island. Soil Bureau Bulletin 5 contains a brief description:

Rangiuru clay

Horizon	Depth (cm)	Description
A	0-10	Grey-brown granular clay.
B	on	Light brown strongly granular clay, or greenish sticky granular clay.

A local soil mapper (DLH) considers that in Auckland region, Parau, Bream and Awapuku clay loams are sufficiently similar to merge as a single series. Likewise Dome Valley and Mangonui clay; also, Cornwallis and Rangiuru clay could be merged as a single series.

Sourced from:
Sutherland C.F., Cox, J.E., various dates, Type profile descriptions for North Auckland Soil Survey, Unpublished documents, Soil Bureau, DSIR
Gibbs, H. (ed), 1954, General Survey of Soils of North Island, Soil Bureau Bulletin 5, DSIR

8 Properties of typical profile

Properties of typical profiles are best indicated by analysis results for the type profiles i.e. sites where Parau and Cornwallis series were defined and described. Data for other sites will vary somewhat, particularly where different types within the series are found. Properties of the related soils may differ from those reported below.

8.1 Chemical

http://soils.tfrec.wsu.edu/mg/chemical.htm

An incomplete chemical analysis for Parau clay loam appears in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 5:

Parau clay loam

Property	Topsoil	Subsoil	Units
Acidity	5.7	5.5	pH
Total carbon	6.1	-	%
Total nitrogen	0.34	-	%
Available phosphorus	0.003	0.002	mg %
P retention	-	-	%
Available sulphur	-	-	%
Cation exchange capacity	36.8	23.0	me %
Base saturation	38	48	%
Calcium	7.2	5.5	me %
Magnesium	5.2	4.9	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB0794, DSIR Soil Bureau

Cornwallis clay

No chemical analysis appears in the online version of NSD, nor has any been located in Soil Bureau Bulletin 5, or Bulletin 28. Bulletin 5 contains a chemical analysis for the related soil Rangiuru clay:

Rangiuru clay

Property	Topsoil	Subsoil	Units
Acidity	4.8	4.6	pH
Total carbon	4.8	-	%
Total nitrogen	0.24	-	%
Available phosphorus	0.001	0.001	mg %
P retention	-	-	%
Available sulphur	-	-	%
Cation exchange capacity	16.7	17.3	me %
Base saturation	11	8	%
Calcium	0.8	0.4	me %
Magnesium	1.3	0.9	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB0665, DSIR Soil Bureau

8.2 Physical

http://soils.tfrec.wsu.edu/mg/chemical.htm

No physical analysis appears in the online version of National Soils Database (NSD). The following estimates are sourced from the Fundamental Soils Layer (FSL):

Parau clay loam

Property	Topsoil	Subsoil	Units
Stones	-	0-4	%
Sand	-	-	%
Silt	-	-	%
Clay	-	-	%
Dry bulk density	-	-	g/cm³
Total porosity	-	-	%
Macroporosity	0.0-9.9	-	%

Sourced from FSL table, Landcare Research

Cornwallis clay

Property	Topsoil	Subsoil	Units
Stones	-	0-4	%
Sand	-	-	%
Silt	-	-	%
Clay	-	-	%
Dry bulk density	-	-	g/cm³
Total porosity	-	-	%
Macroporosity	0.0-9.9	-	%

Sourced from FSL table, Landcare Research

8.3 Irrigation and drainage

http://irrigationefficiency.co.nz/assets/Uploads/Farmers-Guide.pdf

No soil moisture analysis appears in the online version of National Soils Database (NSD). The following estimates are sourced from the Fundamental Soils Layer (FSL):

Parau clay loam

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	75-250		mm
Depth to slowly permeable layer	0.60-1.19		m
Perm. at slowly permeable layer	<4		mm/hr

Sourced from FSL table, Landcare Research

Cornwallis clay

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	25-99		mm
Depth to slowly permeable layer	1.20-1.49		m
Perm. at slowly permeable layer	<4		mm/hr

Sourced from FSL table, Landcare Research

8.4 Topsoil properties under different uses

Local management practices affect the properties of soil, so the history of land use needs to be considered. For many Auckland soils, an indication is provided by soil test results collected by Auckland Council from sites known to have been under the same use long-term. These sites are being re-sampled at five to ten-year intervals to detect any trends. Parau and related soils have been sampled at four sites in the Auckland region, corresponding to the main land uses which are bush, scrub, drystock farms and lifestyle blocks.

Land Use		**Natural Cover**		**Pasture**	
Type:		**Bush**	**Scrub**	**Lifestyle**	**Drystock**
Sample number-		**99/20**	**99/19**	**99/24**	**00/22**
Acidity	pH	5.4	6.5	5.5	6.5
Total carbon	%	9.3	11.7	7.4	7.7
Total nitrogen	%	0.40	0.66	0.60	0.58
Available nitrogen	µg/ cm³	91	167	171	256
Available phosphorus	µg/ cm³	1	7	9	11
Cation exchange capacity	cmol/cm³	46.3	44.4	32.1	28.6
Base saturation	%	64.0	79.2	56.7	104.3?
Calcium	cmol/ cm³	10.1	25.7	13.8	25.4
Magnesium	cmol/ cm³	16.6	7.8	3.9	2.1
Potassium	cmol/ cm³	1.6	1.3	0.4	0.5
Sodium	cmol/ cm³	1.4	0.5	0.2	0.2
Bulk density	t/ m³	0.83	0.71	1.00	0.95
Particle density	t/ m³	2.43	2.41	2.35	2.44
Aggregate stability	mm mwd	2.33	2.20	2.75	2.72
Total porosity	%	65.8	70.7	57.6	61.4
Macroporosity	%	5.1	15.2	2.9	4.6
Total available water	%	21.5	22.7	20.6	22.7
Readily available water	%	7.0	9.3	7.9	7.1

Sourced from Sparling, G. et al, various dates, 500 Soils Project, Landcare Research Reports to Auckland Council

and *Soil quality of indigenous sites in the Auckland region 2012*

9 Land use capability

Land use capability is a classification of land according to properties that determine its capacity for sustained primary production. Classes 1 to 4 are arable, classes 5 to 8 non-arable. Class 1 is versatile i.e. capable of many uses, with negligible limitations to any use. Class 8 is land with extreme limitations that preclude productive use.
http://www.landcareresearch.co.nz/publications/books/luc

Three factors - geology, soil and slope - are considered when assigning land use capability classes. Another two - erosion and vegetation - may be recorded but rarely affect the decision. On regional-scale maps, notably the 1: 50,000 New Zealand Land Resource Inventory (NZLRI), limitations to use are indicated by four subclasses, c (climate), w (wetness), s (soil) or e (erosion). Unit numbers (1, 1b etc.) are used as labels for areas of land (map polygons) with the same geology, soil and slope, which are considered to have similar productive potential and management needs. General descriptions of productive potential and management needs are attached to NZLRI unit numbers.

NZLRI sub-classes and unit numbers were used for farm-scale land use capability maps (1:5,000 - 1: 10,000) prepared by Auckland Regional Authority or Auckland Regional Council between 1979 and 2010. On farm-scale soil maps prepared for Auckland Council since 2011, the four sub-classes are now replaced by twenty specific limitations. NZLRI unit numbers and their attached general descriptions are replaced by farm-specific tables.

Landform	NZLRI	Farm	Main limitation	Sustainable uses
Colluvial footslopes	3e8	3e	Moderate risk of topsoil loss if cultivated	Orchards, vineyards, rotational grain and fodder crops, improved pasture
Regolithic footslopes	4e3	4t	Severe risk of topsoil loss if cultivated	Orchards, vineyards, occasional grain and fodder crops, improved pasture
Spurs and ridges	5s2	5s	Slope or irregular shape preclude cultivation	Orchards, vineyards, improved pasture
Undulating slopes, iron nodules in subsoil	4s3	4p+w	Imperfect drainage	Occasional fodder crops, semi-improved pasture
Rolling slopes, iron nodules in subsoil	4e3b	4p+t	Imperfect. drainage, severe. risk of topsoil loss	Occasional fodder crops, semi-improved pasture
Und. to rolling slopes, iron pan in subsoil	4s3b	5p	Impeded drainage	Semi-improved pasture, woodlots

Sourced from: Harmsworth, G.R. 1996, Land use capability classification of the Northland region, Publication 9, Landcare Research; Anonymous 1979, NZLRI Waikato region land use capability extended legend, Water and Soil Division, MWD; Jessen, M.R. 1984, Additions to NZLRI Waikato Region land use capability extended legend, Water and Soil Division, MWD; Hicks, D. and Vujcich, V. 2017, Farm-scale land use capability classification for Auckland. Auckland Council technical report TR2017/016.

9.1 Past and present land uses

There does not appear to have been any concentrated Maori settlement on Parau and related soils, which are for the most part back from shorelines, sloping and in heavy bush. Such areas certainly would have been traversed when foraging for edible plants and hunting birds. European settlement commenced in the mid-1800s close to creeks or harbour shores. Here the principal activity was timber-cutting rather than clearance for agriculture. By 1900 a pattern emerged on the Waitakere foothills - also on Great Barrier - of small farms separated by tracts of cut-over bush or regenerating scrub.

The reasons, on this easy contour and apparently farmable landscape, have a lot to do with the soils. Parau clay loam plus Awapuku clay loam are the main ones farmed. They have a bit much slope to be cultivated regularly for grain or fodder crops. Their undulating to rolling contour plus friable slow-draining soil favour fruit trees and vines. That said, tree horticulture remains small-scale, perhaps because commercial growers prefer other soils (Otao and Waitemata) with better properties on undulating terraces to the east. On hills east of the Kaipara, Dome Valley and Mangonui clays have similar properties but very little horticulture or cropping, probably because little of their terrain is rolling.

Livestock grazing has always been, and remains, the main farming activity. Close to Auckland, small dairy farms, supplying cream by launch or horse and cart, have long since disappeared. The land is now lifestyle blocks grazed by drystock (beef cattle, sheep, or more exotic beasts e.g. alpaca). Farther from Auckland, Parau and related soils in hills east of the Kaipara are part of large drystock farms. Small lifestyle blocks close to settlements, large drystock farms farther away, is also the pattern on Great Barrier Island.

Areas of Cornwallis clay around the Waitakere foothills - plus a few areas of related Rangiuru clay north of the Dome Hills or on Great Barrier Island - remain cut-over bush or (where once cleared for farming) reverted scrub, now with a mix of wildling exotic and regenerating bush trees emerging through canopy. The retreat of farms from these soils has a lot to do with two properties: iron nodules or pans (causing imperfect or impeded subsoil drainage), and high aluminium from protracted weathering of volcanic clay (in places to a level that retards plant growth).

Farm woodlots and shelterbelts are common on Parau and Awapuku soils. Here growth appears good. There are a few commercial tree plantations on Dome Valley clay, also on Mangonui clay farther north. Plantations have been attempted on Cornwallis and Rangiuru soils, but growth has been variable, even stunted at some locations, so commercial foresters now avoid them.

A surprising feature of these soils is the extent of residential development. The Waitakere foothills at Titirangi were just close enough for a suburb to develop when linked to Auckland by bus in the 1920s-1930s. Houses in the bush appealed to quite a number of people, so similar suburbs sprang up in the Glen Eden, Henderson and Swanson Valleys post-war. Farther out, people built baches at remote beaches (Parau, Huia, Karekare, Piha, Muriwai) between 1920s-1960s. By 1970s as road access improved, permanent house construction commenced. Today the beach settlements are well-populated villages. Similar developments have occurred around the principal harbours and beaches of Great Barrier at Port Fitzroy, Tryphena and Claris.

Sourced from:
Scott, D., 1979, Fire on the clay: the pakeha comes to west Auckland, Southern Cross Books.

9.2 Typical pasture and tree plantation yields

Pasture	Yield	Units
Improved pasture (dairy)	13.0	t dm/ha/yr
Improved pasture (drystock)	12.4	t dm/ha/yr
Semi-improved pasture	8.4	t dm/ha/yr
Un-improved pasture	6.2	t dm/ha/yr

Source: MAF and Dexcel trials cited in Lincoln Farm Technical Manual 2008; various papers in NZ Journal of Agricultural Research

Timber	Yield	Units
Radiata pine (clearwood regime)	?	t/ha
Radiata pine (unpruned pulpwood)	?	t/ha
Macrocarpa cypress (woodlot)	?	t/ha
Eucalypt (woodlot)	?	t/ha
Acacia (woodlot)	?	t/ha

Source: FRI trials cited on SCION website; various papers in NZ Journal of Forestry and NZ Farm Forestry

10 Information about soil management

Parau and Awapuku clay loams are not as versatile as neighbouring soils (Otao, Waitemata) weathered from airfall or waterlaid ash. Although they can support tree or vine horticulture and occasional cropping, the soils are mainly used for small-scale drystock grazing, plus small-scale timber harvest from farm woodlots and shelterbelts. Dome Valley and Mangonui clays, on hillier terrain, have a greater area under commercial tree plantation. Cornwallis and Rangiuru clays are not versatile at all. Although they have granular structure with friable consistence, poor subsoil drainage (caused by iron nodules and pans) together with soluble aluminium (in places toxic) restrict commercial use to a little drystock grazing and firewood cutting.

Key management issues that arise, are:

- High fertilisation to sustain fruit trees or vines
- Adequate fertiliser to replace uptake by grass
- Correcting alumnium toxicity where it is a problem for plant growth
- Improving subsoil drainage where iron nodules or pans are present
- Grazing control to maintain dense sward in pasture
- Temporary ground cover after felling timber trees
- Runoff control along farm or forest tracks (exposed soil is susceptible to rilling and gullying)
- Identifying stable building platforms for houses
- Safely disposing sewage and stormwater

Tips for conserving vegetation, also for controlling runoff and sediment loss along tracks or on exposed soil, are contained in:

- *Light clay soils* *Soil Information Sheet 11, Auckland Council*
- *Heavy clay soils* *Soil Information Sheet 12, Auckland Council*
- *Code of Practice for Nutrient Management* *Fertiliser Association*
  Code of Practice for Nutrient Management
- *A guide to managing farm dairy effluent (Auckland)* *Dairy NZ*
  http://www.dairynz.co.nz/media/880785/auckland_guide_to_managing_farm_dairy_effluent_pdf
- *Forest harvest guidelines* *TP223 Auckland Regional Council*
- *Streamside planting guide* *Auckland Council*
- *Native forest restoration guide* *Auckland Council*
- *Control of soil erosion in farmland* *Technical Paper 95/4, MAF Policy*
  http://maxa.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/land-management/soil-erosion.htm
- *Poplars* *Soil Conservation Leaflet, Auckland Regional Council*
- *Willows* *Soil Conservation Leaflet, Auckland Regional Council*
- *Soils on ranges* *Soil Information Sheet 15, Auckland Council*

Find out more: phone 09 301 0101, email rimu@aucklandcouncil.govt.nz or visit aucklandcouncil.govt.nz **and knowledgeauckland.org.nz**

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